Utilization of In-Vehicle Technology for Managing Speed: Challenges and Progress of Intelligent Speed Adaptation (ISA) Pilot Study in Malaysia

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Abstract: A sustainable transport system needs to focus not only on reliability and efficiency, but also on the safety aspect. Speeding problem has becoming one of the major road safety focuses around the globe (Global Road Safety Partnership, 2008; OECD/ECMT Transport Research Centre, 2006). Many researchers have shown the negative effect of speeding on road safety (Nilsson, 2004; Walz et al., 1983; OECD/ECMT Transport Research Centre, 2006). One of the speed management strategies to reduce the harmful effects of speeding is by utilizing in-vehicle technology such as intelligent speed adaptation (ISA). Several previous researches have shown the effectiveness of ISA system in reducing the speeding problem (Sundberg, 2001; Lahrmann et al., 2001; Jamson et al., 2006). This concept paper discusses the settings of a pilot study in Malaysia along with its challenges as well as recent progress on adapting a commercially available handheld GPS device as working ISA system.

Key Words: speed management, intelligent speed adaptation, in-vehicle technology

1. INTRODUCTION

For sustainability, transportation system should not only focus on the reliability and efficiency, but also on the issue of safety. One of the main issues in land transport safety, especially road safety, is speed management in which it has been selected as the central focus in safe system (Global Road Safety Partnership, 2008). Defined as “an active approach that requires (or persuades) drivers to adopt speeds while offering mobility without compromising safety,” speed management aims to “limit the negative effects of excessive and inappropriate speeds in the transport system” (OECD/ECMT Transport Research Centre, 2006). It has been well established that speeding has positive correlation towards number of road crash cases.

2. EFFECTS OF SPEED

Power model illustrates that an increase of 5% in mean speed results to an increase of approximately 10%, and 20% for all injury cases and fatal cases respectively. Likewise, the reduction of 5% in mean of speed also brings down the number of cases by approximately 10% and 20% for injury cases, and fatal cases (Nilsson, 2004). Furthermore, another study demonstrates that the probability of a pedestrian being killed in a car accident has a positive relationship with the impact speed. Hitting a pedestrian at 30 km per hour results to 90% survival chance, however, the colliding with additional 20 km per hour brings down the survival chance of a pedestrian to only 20% (Walz et al., 1983). Besides these crash related evidence, French Ministry of Transport, as cited in OECD/ECMT Transport Research Centre,
(2006), has conducted a study to show that visual field of a driver is reduced when the speed increases. Driving at 40 km per hour gives the driver a field of vision covering 100°, which allows obstacles on the roadside, or other potential hazards, to be seen. However, the field of vision covers around only 30° if the speed goes up to 130 km per hour, which reduces considerably the capability of the driver to assess potential danger.

3. SPEEDING IN MALAYSIA

Defined as travelling at inappropriate speeds or exceeding specified speed limit (OECD, 2006), speeding also exist on Malaysian roads as proven by several studies. Speed survey conducted for a preliminary study to evaluate automated enforcement system at 55 sites reveals that only 24.6% of study location has 85th percentile lower than specified speed limit (Sharifah Allyana Syed Md Rahim et al., 2009). Furthermore, even during festive season – Chinese New Year 2007 – when the enforcement activity is intensified, only one location out of seven spots has a 85th percentile that is below the speed limit of 80 km per hour; while the rest of the locations have 85th percentile that ranges from 81.9 km per hour up to 100 km per hour with mean value of 87.7 km per hour (Abdul Rahmat Abdul Manap et al., 2007). This finding is also consistent for a consecutive festive season – Eidul Fitr 2007. A longitudinal spot speed survey conducted at eleven locations along non-expressway federal roads for two weeks before the festive holidays as well as two weeks during the festive holidays shows that the mean of every 85th percentile value for each week is still above the speed limit of 80 km per hour regardless of the decreasing pattern of the mean of 85th percentile speed for the whole four weeks (Mohd Fauzi Mohd Yusoff et al., 2007). Besides happening at high speed locations, speeding also a serious problem at vicinity of school area where a traffic calming study found that the average of 85th percentile speed for all the surveyed schools is surprisingly at 87 km per hour which is clearly very dangerous and violating the speed limit at the school area (Muhammad Marizwan Abdul Manan et al., 2008). However, an observation conducted using travel speed method conversely shows that the average travel speed is less than speed limit even though there are still 15% of road users travelling at that road had exceeded the speed limit (Alvin Poi et al., 2009).

Regardless of how intense the existence of speeding on Malaysian road, there is no concrete evidence from Malaysian crash database to link speeding with crash occurrence. Despite that, out-of-control crash cases that may be associated with speeding contribute to a significant chunk of road fatalities with 23.8% in 2008, making it as the highest cause of death among road users in Malaysia (PDRM, 2009). Considering the value of statistical life (VOSL), speeding alone have cost the country approximately RM 1.7 billion with VOSL of RM 1.2 million per fatality (Nor Ghani Md. Nor, et al., 2003).

4. INTERVENTION PROGRAMS

Intervention program in speed management aims to strike balance between efficiency of transport system and safety aspect. Safe system approach emphasizes on intervention programs that anticipate and allow for human error, while minimizing the risk of fatality or serious injury.

4.1 Conventional Intervention
Currently, enforcement is one of the major interventions to control speeding problem.
However, regardless of numbers of summonses issued, speeding is still a problem in Malaysia. Statistic from Malaysian Royal Police shows that on average, 38% of daily summonses issued, for January and first two weeks of February 2009, were due to speeding problem (PDRM, 2009). Regardless of the effort done by the enforcement officers, the effectiveness of the enforcement activities is still debatable. One possible reason of this problem is due to lack of “anytime, anywhere” kind of enforcement activity to monitor the traffic condition. For instance, in an unpublished local report, a survey conducted during Chinese New Year 2009 found that Malaysian drivers’ perception of being caught at expressway due to speeding shows a decreasing pattern of mean score from 5.4, during the event, to 5.1 after the event. This may be an indication that drivers perceive speeding enforcement activity to occur only at certain time and certain location.

Besides enforcement, there are also engineering measures applied to tackle speed related problems. For instance, speed humps have been proven to be able to reduce speed. Engel and Thomsen (1992) shows that for every 10 mm of height of the hump, the speed reduction gained is 1km per hour. Hence, a 10 km per hour speed reduction requires hump that heights 100 mm more. Other study found that the effect of a hump on speeding is restricted to 20 to 30 meters before and after the hump, (Pau and Angius, 2001). This shows that speed hump is effective in reducing speed, but suffers from a restricted effective coverage.

All of these intervention efforts have one common setback – that is their effect is limited to certain time and location. They may be able to reduce speed at a specific spot, but inappropriate for a larger scale implementation. In order to overcome these shortcomings, utilization of technology such as intelligent speed adaptation (ISA) is indeed another possible alternative.

4.2 Intelligent Speed Adaptation
ISA is a generic name for any system that provides support to driver on vehicle speed control. This system varies from advisory type – that produce only audio and/or visual warning to the driver – up to mandatory type, where it intervenes to the vehicle control system. The intervention may be done in numerous ways such as haptic throttle, direct brake application or engine control unit (ECU) manipulation.

Not only ISA is time and location independent, GPS oriented ISA requires no additional infrastructure to be developed along the road network. This reduces financial implications relating to the installation and maintenance that is always an issue of traditional speed control signage and measures. Unlike other engineering measures – like road humps – that affect all road users even if they are traveling at appropriate design speed, ISA intrudes only when the maximum allowable speed is reached; thus punishing only those who are non-abiding-law users (Jamson et al., 2006).

Many other countries are considering about implementing ISA by conducting studies to understand its effectiveness to solve speeding problem. As cited in Jamson et al. (2006), advisory ISA is predicted to be able to produces a 10% reduction in injury accidents and a 18% reduction in fatal accidents based on simulation a study conducted in United Kingdom.

A preliminary result for large scale study conducted at Umeå revealed that majority of participants (72%) indicated that it was easier to adhere to speed limits on 30 km/h roads with the advisory ISA system installed. In addition, 67% of the drivers claimed that they totally avoided speeding after an ISA warning was issued. However, the drivers also indicated that
they felt the pleasure of driving had decreased, and frustrated by the slower speeds and that they experienced an increase in travel times (Sundberg, 2001).

Besides Umeå, Aalborg University in Denmark has also conducted an on-road advisory ISA trial involving 24 drivers. The speed data indicated that mean speeds were lower during the test period compared to the before period. There was also a clear decline in speed violations. Even though result in Umeå shows a negative effect of ISA on drivers, this study reveals that 75% of the test drivers hold positive attitudes towards ISA as a speed-monitoring device. Many of them also reported that the lower speeds when using ISA did not lead to longer travel times (Lahrmann et al., 2001).

In short, even though ISA is capable of solving speeding problem, other side effects – psychological effect, travelling time, fuel consumption, etc – have also been detected (Comte et al., 1997; Besseling and Van Boxtel, 2001; Biding and Lind, 2002).

The objective of this paper is to highlight the concept of conducting an ISA study using a commercially available handheld GPS device. The content of the paper is divided into two chapters explaining the challenges of conducting the study, followed by the effort in overcoming the challenges as well as progress made towards the setting-up a pilot study in Malaysia. Even though the actual study has not been executed, the paper intends to highlight the possibility of using the handheld GPS device in the study of ISA system.

5. PILOT STUDY CHALLENGES

So far, there is no established nationwide effort in making ISA part of speed management strategies in Malaysia. For this study, research scope will be limited to only advisory type of ISA that produces audio and visual warning to a driver when speeding occurs. The outputs from this study may contribute to the nationwide implementation in the future.

5.1 Study Objectives

The main objective of this study is to investigate whether the non-intervening type of ISA system supports the hypothesis of significantly constraining the driver within the speed limit. The second output that may be delivered is the effect of this system on total travelling time. Even though, theoretically, obeying the ISA system means moving at slower speeds add to travelling time, the significance of this delay is yet to be determined. Since the non-intervening ISA utilizes audio and visual warning to alert the driver on speeding, the next output may be the determination of psychological influence of this warning on the driver as well as his or her acceptance of the ISA system. Besides the research content, the study serves as a platform in evaluating the simple instrument used in the study in terms of constraints and enhancement potentials.

5.2 Study Design

The design of this study is longitudinal, adopting three repeated measurement sessions. The first session is for baseline data collection. Participants will be exposed with the instrument for two weeks to ensure the data collected from them really reflects the normal driving situation by taking their average driving behavior pattern and unaffected by extraneous events such as accidents, flash floods, etc. ISA system is activated in the second session for another two weeks. This serves as a training session for the respondent to modify his or her driving behavior especially in respect of identifying the respondent’s speed over a given time frame.
(“speed profile”). Following two weeks thereafter is the third session when the ISA intervention is removed from the samples. The purpose of this session is to examine the sustainability (Halo effect) of the ISA intervention on the driving behavior. To have a complete view of the effect of ISA system on speed issues, instead of looking at only one specific speed limit area, outcomes for respective available speed limits have to be taken into account as well. The various speed limits involved in this study are 30 km per hour, 50 km per hour, 60 km per hour, 70 km per hour, 80 km per hour, 90 km per hour and 110 km per hour.

The activation of the ISA system in the second session of data collection will trigger audio warning if the participants’ travelling speeds exceed the speed limit. Thus, to gauge the warning acceptance level of the device, at the end of this data collection session, participants will be asked to give feedback on general warning acceptance level, trustworthiness of the warning, warning timing deployment and warning volume suitability. These items will be rated on a Likert scale of 1 to 7.

5.3 Study Sampling
Data will be collected at Putrajaya and Cyberjaya. These two locations are chosen due to the population its represent – mix of socioeconomic status, age, occupation, vehicle characteristic. The sample size for this study is 30 subjects that will be selected via two-stage sampling technique.

The first stage will adopt non-probabilistic snowballing that will focus on getting as many subject candidates as possible. This method is chosen for its feasibility in getting sample candidates that fulfill following criteria: driver who is living in Putrajaya/Cyberjaya and working outside those locations, or living outside and working in Putrajaya/Cyberjaya. Subject candidates are asked to submit some information pertaining to their commuting route, as well as other demographic details.

The output from the first stage will be a pool of subject candidates with various demographics. This pool will be used in the second stage sample selection where random stratification sampling is applied. Strata involved in this stage include demographics as well as commuting route. The route used by each candidate will have to cover every speed limit for at least once. Only subject candidates that fit in these requirements will be eligible as subject for the study.

5.4 Study Requirements
There are two requirements that must be fulfilled before data collection can be conducted. The obvious requirement is to identify/or develop any in-vehicle technology system that can act as ISA system.

Since there is no specific available ISA system in Malaysia, the next eligible option is to develop a custom technology for this purpose. However, a global positioning system (GPS) navigator, Garmin nüvi 205, has been selected as the ISA system as it is sufficient to provide the audio warning when the speed of the vehicle exceeds the posted speed limit. Besides, the GPS is relatively cheap compared to a custom build ISA system. Audio and visual warnings in ISA system are triggered when speed of a vehicle exceeds the reference speed limit. The reference speed limit has to be updated to cover all the commuting routes of the samples. Thus, the next requirement for this study is a complete digital speed limit database to cover every single stretch of route in Malaysia. Unfortunately, such database
is not available. Even though focusing only at Putrajaya and Cyberjaya making the development of speed limit database more manageable, it is still very time consuming to record every posted speed limit at every single route due to the enormous number of the routes in these two areas. Thus, by using the information of commuting route, common routes for most of the samples are identifiable. These common routes are then become highest priority in the development of the posted speed limit database. The development of this database is conducted by a survey team that is deployed to the site to record information on posted speed limit with its respective GPS coordinate.

5.5 Data Collection

Every subject who agrees to participate will be required to give written consent. The participant will be informed that the data from the study will remain anonymous. Thus, any attempt to tamper the data will be intolerant.

The participants will also be notified that the study is focusing on the navigation of route in daily commuting purpose. However, they also will be warned that in the case of the device making an audio warning, it is probably due to the excessive travelling speed.

Data from memory of ISA system will be collected after the completion of each session by a team. Besides this data, the team will also collect the trip logbook to begin processing the data as well as spotting any unforeseen problems in the study. Beginning of the second session, the team will activate the Garmin GPS unit to fully functioning as the advisory ISA system, including the audio and visual warnings function. After all three sessions, each sample will be required to answer a questionnaire to assess the acceptance level towards ISA as well as psychological effect on the driver.

5.6 Data Coding

Data coding stage involves six layers (refer Figure 1). Each layer represents repetitive step that has to be conducted. For each subject, data from each session will be coded separately (Layer 2). In each session, the data will then be coded according to day for fourteen days (Layer 3). Daily data will include two separate trips (Layer 4) with each trip will consist seven speed zones (Layer 5). Data for each zone will then be coded by calculating average of speed profile and travelling time profile (Layer 6).

For speed profile data, speed average for each speed limit will be calculated to indicate the speed behavior in respective speed limit for each sample. To eliminate the error of speed extraction value due to possible technical problems, a filter to wipe out sudden acceleration (or deceleration) value will be used before calculating the average for each speed limit.

5.6.1 Coding for Speed Variation

Speed variation is defined as the difference of the speed with posted speed limit for every trip.

\[ \Delta s = s - s_{lim} \]  \hspace{1cm} (1)

Where:

- \( \Delta s \) : Speed variation
- \( s \) : Speed data
- \( s_{lim} \) : Posted speed limit
Based on this definition, positive value of $\Delta s$ means that the subject will be moving at higher speed from the posted speed limit; while $\Delta s$ with negative value means otherwise. The magnitude of $\Delta s$ describes the intensity of the difference compared to the posted speed limit.

Based on the studies conducted overseas, ISA has been able to reduce the occurrence frequency of positive value of $\Delta s$ in a trip. Thus, similar result is also expected for this study. In order to ensure the reduction is solely due to ISA, a statistical analysis (analysis of variance) has to be conducted taking into account the weather and traffic condition for each trip as well.

![Figure 1 Data coding process flow](image)

Once the effectiveness of ISA is established, a correlation of this effectiveness to other variables such as demographics may be conducted to see any establishment of relationship. A
mathematical model on speed pattern may also be developed to understand the speed behavior of the subjects. If the \( \Delta s \) is significantly varies according to different speed zone, it also makes sense to have a separate model for each speed zone.

\[
\Delta s = f(\text{Demography, ISA status, Weather, Traffic volume, Trip type})
\]  

(2)

5.6.2 Coding Travelling Time Variation
Since travelling time is flexible depending on individual driving performance, there is no established standard travelling time or even any method to derive it. Thus, the travelling time variation is defined as the difference between travelling time and average travelling time for each trip.

\[
\Delta t = t - t_{avg}
\]  

(3)

Where:

- \( \Delta t \) : Travelling time variation
- \( t \) : Travelling time data
- \( t_{avg} \) : Average travelling time

Unlike speed variation, there is no consensus among previous studies on the effect of ISA towards \( \Delta t \). Regardless of this disagreement, this study expects that the ISA does carry some impact to the \( \Delta t \) especially when it involves long distance travelling. To ensure that this effect is exclusively due to ISA, statistical analysis (analysis of variance) on the data considering other possible contributing variables such as weather as well as traffic condition has to be conducted.

After the establishment of the effect of ISA on \( \Delta t \), correlation analysis may be conducted to find any significant relationship of the effect towards other independent variables such as demographic details of the subjects. By identifying these variables, a model to explain the \( \Delta t \) may be developed to further understand the effect of ISA on \( \Delta t \).

\[
\Delta t = f(\text{Demography, ISA status, Weather, Traffic volume,} \Delta s, \text{Trip type})
\]  

(4)

6. PILOT STUDY PROGRESS

6.1 Participation
Using the snowballing technique – first stage of sampling – 62 sample candidates have agreed to participate in this study. From this, 59.7% are females, with the age ranges from 20 until 55 years old. Table 1 describes distribution of age and gender

<table>
<thead>
<tr>
<th>Table 1 Distribution of age based on gender</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 &amp; below</td>
<td>15</td>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>31 - 50</td>
<td>9</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>51 &amp; above</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>37</td>
<td>62</td>
</tr>
</tbody>
</table>
Before deciding which sample candidates are eligible for second stage selection, the travelling route has to be surveyed to determine the distribution of speed limit along these routes. Based on this information the selection can then be conducted by selecting candidates who experience all speed limits into a pool of eligible subjects. In the second stage of sampling, stratified random sampling technique is used to select 30 subjects from this pool.

6.2 Speed Limit Database
The development of the speed limit database has been conducted focusing on the major roads in Putrajaya and Cyberjaya.

Based on Figure 2, it is clear that the speed limit of Putrajaya varies from 30 km per hour to 90 km per hour. The absence of 110 km per hour may be a problem to capture data with respect to this speed limit. The biggest distribution of speed limit in vicinity of Putrajaya is found to be 50 km per hour with 43.7% distribution. This is followed by 80 km per hour that covers 22.0% of surveyed roads in Putrajaya. With less than 6.7%, 40 km per hour is found to be the next Putrajaya widest speed limit area. The distributions of other surveyed speed limit in Putrajaya are 10.7%, 6.3% and 2.0% for speed limit of 60 km per hour, 70 km per hour and 30 km per hour respectively. Speed limit database for Cyberjaya is not yet been developed.

6.3 Data Coding Tool
Data coding process involves six layers of data manipulation. Referring to Figure 1, layer 1 until layer 4 is manually conducted by segregating the data into multiple spreadsheets and folders. Since the raw data provided by Garmin nüvi 205 does not come automatically with speed limit assignment, a software has been developed to handle this task more efficiently. The initial intention of the software is the assignment of speed limit to each item of the collected data. However, further development has managed to embed Layer 6 processing in the same software.
Developed using MATLAB, the data coding software consists of three segments (refer Figure 3). The first segment is on the left showing the progress of data loading into the software working memory. The above compartment of the software is where the buttons of data processing is located. Most of the software interface is consumed by the third segment. This segment plays a big role in displaying all the information as well as result after the coding process is executed. Besides the demographic information of the sample, the spider plot on the right portrays the current sample average speed according to its speed limit.

The software loads trip coordinate and speed data from GPS navigator and reference coordinate, speed limit and zone proximity data from speed limit database to execute process of Layer 5 (assignment of speed limit) and Layer 6 (average calculation of the data) before outputting coded data.

Distance of each item in the raw data from speed limit reference coordinate is computed using the trip coordinate. The raw data item is assigned to that speed limit when the computed distance is less than the speed limit zone proximity radius. To calculate the distance of two coordinates, the following Haversine formula is applied.

\[
d = R \cdot 4 \tan^{-1}\left(\frac{\sqrt{a}}{1 + \sqrt{1-a}}\right)
\]

\[
a = \sin^2\left(\frac{\text{lat}_{ref} - \text{lat}_{trip}}{2}\right) + \cos(\text{lat}_{trip}) \cdot \cos(\text{lat}_{ref}) \cdot \sin^2\left(\frac{\text{long}_{ref} - \text{long}_{trip}}{2}\right)
\]

Where:
- \(d\) : Distance of the two coordinates in kilometer
- \(R\) : Earth’s radius (mean radius = 6,371 km)
- \(\text{lat}_{ref}\) : Latitude of reference coordinate

![Figure 3 Screen snapshot of the data coding software](image)
Since the Haversine formula only works in radians, conversion formula from degree, minute, second to radian is described below.

\[
\theta = \left( \frac{d + \frac{m}{60} + \frac{s}{3600}}{180} \right) \pi
\]  

(7)

Where:
- \(\theta\) : Angle in radian
- \(d\) : Degree portion of the angle
- \(m\) : Minutes portion of the angle
- \(s\) : Seconds portion of the angle

In short, Haversine formula determines whether the trip coordinate is within the proximity area of speed zone reference coordinate by comparing the distance of these two coordinates with the reference speed proximity radius. Following example simulates detail utilization of the formula.

Sample of a trip coordinate (raw data) : 2°58.635N, 101°47.703E
Sample of a speed limit reference coordinate : 2°58.635N, 101°49.703E
Sample of a speed limit reference proximity radius : 5.2 km/h
Sample of a speed limit for the associated zone : 70 km/h

Applying Haversine formula, the distance between the trip coordinate and reference coordinate is equal to 3.701 km. Figure 4 summarizes this calculation.

Since the distance is less than the proximity radius of the reference point (5.2 km), then the trip coordinate (2°58.635N, 101°49.703E) is assigned in 70 km per hour speed limit zone data group.

The software applies the Haversine formula during its assignment of speed limit zone. If the Haversine formula produces a "yes" response, this indicates that the trip coordinates is within the proximity radius of the reference point. The next step then is to assign that data to its
associated speed zone group. However, if the Haversine results to “no” – the trip coordinate is not within the proximity radius of the reference point – then the further step is to load the next speed zone reference data point. Refer figure 5 for summary of process flow of this software utilizing Haversine formula.

![Process flow of data coding software](image)

### 6.4 GPS Device Testing
A test to measure reliability and validity has been conducted to ensure applicability of using Garmin nüvi 205 as the ISA system.

The test involved three speed limits – 50 km per hour, 70 km per hour, and 80 km per hour. For each speed limit, three sub-studies runs were conducted to investigate three parameters. While the first sub-study is to determine whether the speed calculated from device is similar enough to the speedometer of a vehicle; the second sub-study is to investigate whether the device produce warning when a vehicle is travelling above the set speed limit. The final sub-study for the testing is to check on the accuracy of warning produced with respect to the position of the vehicle. In a situation when the travelling speed is fixed above the speed limit, a warning should only be produced when a vehicle is in the declared vicinity of speed limit.

The test was conducted using a compact car, Perodua MyVi 1.3 at the vicinity of Putrajaya.
with speed limit of 80 km per hour. Two video cameras – that has been timely synchronized – was used to record the speedometer of the car as well as the data from the GPS device.

By matching the speeds recorded from both videos, the first sub-study concludes that the speed produced by the device was similar enough to the speed shown by the speedometer (refer to the red and blue lines in Figure 6). Furthermore, in Figure 6, the yellow dots which represent the production of audio warning with respect to each data point only occur above the green line that represents speed limit declared. Therefore, the second sub-study may conclude that the warning of the device was found out to be produced only if the vehicle exceeded the speed limit, thus meeting the expectation. Using the time from the video camera as the common reference, the warning produced by the GPS was matched with the declared study location when the travelling speed was fixed above speed limit. This final sub-study concludes that the device is not producing any fake warning with respect to wrong positioning data as the yellow dots in Figure 6 only occur with the same boundary of green lines, which is the declared speed limit area.

Figure 6 Result on reliability and validity testing of the device

7.0 CONCLUSION

Speed management is one of the major issues in the safety aspect of road transportation. Besides conventional intervention programs, application of technology is indeed an alternative to manage speeding problem. In context of road transport, intelligent speed adaptation has becoming more popular nowadays due to its huge potential to minimize speeding problem as well as maintaining a balance of transportation needs. Many research projects around the globe have emerged to study the effectiveness of this system in managing speed on the road.
In Malaysia, a pilot study has also been established to study the possibility of utilizing the intelligent speed adaptation in local transport context. This longitudinal study aims to measure the effectiveness of ISA system in reducing speeding problems along with its possible negative responses from the drivers. The major challenge that the team has encountered is to establish a digital speed limit database system that will be used in this study. By having a proper setting of the study, this constraint may be overcome. Furthermore, the absence of an ISA system in Malaysia has put some delay in this study. However, after some testing and verification, the researchers have found that a GPS navigator, Garmin nüvi 205, is sufficient to be used as an advisory type of ISA system. With current pace and progress, this study is hoped to be able to give some results on the effectiveness of ISA system as well as its acceptance level from the road users.

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