Inductance loops are vehicle sensing devices that are widely-used for traffic detection. The traffic signal control (GLIDE) system in Singapore uses traffic demand information provided by inductance loops installed at the signalised junctions for signal coordination in the island-wide road network. The loop detectors are installed just before the stop-line and are laid out mostly in “double-eight” configuration along each lane. Inductance loops are reliable detectors when traffic is free-flowing and follows a well-defined wheel path such as along highway links. However, traffic movements at signalised junctions, being controlled by signal phasing, are necessarily staggered, and are slow-moving under congested conditions; furthermore, the paths of turning vehicles are more spread out across the lanes.

The performance of loop detectors was examined at the junctions. Data were collected from eight approaches at six signalised junctions; three junctions were located in the downtown CBD area and the other three in the western suburbs of Singapore. Quarter-hourly vehicle counts were obtained by two methods: non-classified GLIDE loop counts, as provided by the Land Transport Authority, and manual counting from video records. The manual counts were classified into 4 vehicle classes of car, light commercial vehicle (LCV), heavy commercial vehicle (HCV) and motorcycle (MC). Each pair of quarter-hourly counts (manual count, $V_m$, versus loop count, $V_p$) was compared. A percentage error given by $PE = 100 \left( \frac{V_m - V_p}{V_m} \right)$ was computed; a positive PE value means $V_p < V_m$ i.e. a case of under-counting by the loops. It was found that the loops tended to under-count, by about 7.5% PE on average, among the study sites. Sample values from a study site are illustrated in Figures 1 and 2. It can be observed that there were distinct differences between manual and loop counts while the PE values were rather variable.

The variability in the PE values was examined using correlation and GLM statistical analyses against five variables, namely, study site locality (CBD versus non-CBD), quantum of quarter-hourly manual counts, MC proportion, HCV proportion, and vehicle manoeuvre type (moving straight ahead, turning right, turning left, combination). The results suggest that an inductance loop detector on a lane with right-turning movements, with a higher proportion of motorcycles, or at a junction in non-CBD area, tends to be associated with a greater degree of under-counting. Altogether, close to 350 data-points were used in the analyses but the database is considered rather small. The results should therefore be treated as exploratory as more data are being collected for a larger-scale analysis.
Are Zebra Crossings Safe Enough for Pedestrians?

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Introduction

Zebra crossings such as the one used in Singapore (see Figure 1) are used as uncontrolled crosswalks on roadways with relatively low traffic flow and low speed environment. They are widely classified as “safe” locations and many jurisdictions give pedestrians the right-of-way. As pedestrian-vehicle accidents may be higher at zebra crossings than at unmarked crossings, there is a growing concern whether zebra crossings are really safe enough for usage.

Research methodology

The driver and pedestrian behavioural interaction at zebra crossings can be studied by (a) perception survey (b) field observational study and (c) combination approach of perception and field observational study. One major concern of the first method using perception survey is that the findings gathered may not truly reflect the behaviour of drivers and pedestrians as a number of research studies have revealed that what is perceived might not necessary be translated into reality, that is, the perception and actual course of action of both drivers and pedestrians can be quite different. A well-designed questionnaire coupled with a large sample size may somewhat help to alleviate this concern but may not be cost effective and efficient. On the other hand, the second method of field observational study provides an insight into users’ actual behaviour but not all scenarios can be tested as in the case of a controlled experiment. The third method, which is the most viable, supplements the perception data with field data capturing the actions of drivers and pedestrians at zebra crossing with the intended purpose of validating the perceptions, including the correctness of the survey findings. Also, one may not necessarily need to have a large perception sample size.

The combination method was adopted for this study. A perception survey addressing a variety of safety-related issues using face-to-face interview method was carried out on an almost equal number of pedestrians and drivers. The behaviour interactions of drivers and pedestrians at zebra crossing were captured using video filming. Data reduction via video playback was used to gather the speed profile of drivers and other behavioural actions such as their stopping and starting characteristics. The looking out behaviour of pedestrians and other safety-related characteristics were also captured for comparative evaluation.

Discussions of survey and field observational findings

As shown in Figure 2, almost all respondents perceived that pedestrians have the right-of-way at zebra crossings. However, having high perception of pedestrian right-of-way does not necessarily equate to high perception of safety level at zebra crossings. In fact, only slightly more than one in two perceived that zebra crossings were safe enough for crossing. It was found that both drivers and pedestrians perceived that their own “good” habits contributed to safer zebra crossing. This significant difference in perception at 95% confidence level strongly suggests that there is room for improvement if both parties can view each other’s actions congruently.

Besides, the findings on what they would do when faced with various situations at zebra crossing are highlighted as follows:

- Almost all drivers looked out for pedestrians at zebra crossings, and four in five reduced their vehicle speed irrespective of whether there were pedestrians waiting to cross at the zebra crossing or not. The perception on speed reduction appears to agree well with those results gathered from the field observational study as significant reductions in speed profile were noted when drivers approached the zebra crossing.

- Almost nine in ten drivers perceived that they “always” slow down and stop their vehicles for pedestrians to cross. This perception was, however, not shared by pedestrians as only fewer than four in ten had such a
perception. Are there any biases on the part of drivers and pedestrians in their perception? The field observational study indicates that almost 93% of drivers would slow down their vehicles. Of these, more than six in ten drivers would come to a complete stop while the remaining would crawl forward without stopping. The difference in their perceptions could simply be answered by addressing a related question “Should we consider those drivers who had crawled forward to have come to a stop?” If the answer is “Yes”, then one could conclude that there is agreement between the perception survey and the field observational results. To the drivers, he/she may have thought so, but not in the eyes of the pedestrians.

- Seven in ten drivers perceived that they “always” wait patiently for all pedestrians to clear the zebra crossing before moving their vehicles, while only one in four pedestrians perceived likewise. However, it is evident that there was not much difference in driver perception and their actual course of action as eight in ten drivers were observed to have patiently waited for all pedestrians to clear the road before driving off. Yielding on the side of cautiousness may have led to a reduced number of pedestrians to have such a perception.

- More than eight in ten pedestrians perceived that they would look out for oncoming vehicles before crossing the road, while the field observational study indicates that slightly more than six in ten pedestrians would look out while reaching the kerbside prior to crossing. One may infer that there is general agreement between the perception and observational findings as head movement rather than actual looking was measured in the field. Of course, including those pedestrians who had looked out for vehicles without turning their head will result in better agreement of the findings.

Concluding remarks

By and large, drivers and pedestrians generally exhibit good behaviour and have strong awareness of each other at a zebra crossing. Both the perception and field observational findings are generally in agreement with each other. On the whole, a safer zebra crossing requires the input of both drivers and pedestrians, that is, safety will not be compromised if drivers are giving the right-of-way and exhibiting good driving habits and similarly with pedestrians exercising due care and caution prior to using a zebra crossing.

Study of the Singapore Maritime Logistics Industry

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With its long tradition as an international maritime centre, Singapore is now aspiring to become a major logistics hub in Asia. A recently completed study of seventy companies involved in maritime logistics in Singapore has investigated how deployment of new technologies and R&D projects can facilitate the development of this industrial sector. The study aimed to identify critical issues, strengths and weaknesses, most promising technologies and potential areas for maritime logistics research.

Some 48 companies participated in the first phase of the survey which was conducted by the Maritime Research Centre of NTU. The second phase of the survey was carried out by MSc Logistics students and captured data from an additional 22 companies. The sample constitutes a good representation of the Singapore logistics industry: it covers a wide range of company sizes and includes several key players. Both local and multi-national companies are represented. About two-third of the companies in the sample engage in comprehensive logistics services, including warehousing and transport.

Figure 1 shows the distribution of importance rating of critical issues facing the Singapore logistics industry.

According to the survey respondents, the number one issue is responding to regional competition. Among the issues rated as highly important or critical by over 80% of respondents were: time reliability of deliveries, improving IT systems integration, tapping strong demand potential and developing value-added services. This reflects a clear
awareness of the regional competitors while appreciating potential business opportunities. Other highly rated issues were: optimum use of storage space and developing intermodal connections.

Survey respondents recognise that Singapore has many logistical strengths, related to a highly developed and efficient transportation system (good infrastructure, congestion-free roads, world-wide connectivity and flow-through PSA gates) as well as efficient warehouse operations. In the area of dangerous goods transport, the highly-rated strengths were: ability to deal with chemical incidents and good safety record. IT systems support was identified as an important strength under IT and e-logistics. The principal weakness of the local logistics industry identified in the survey was the high cost of operations (including high cost of labour and land, warehousing and transport cost, port charges and IT start-up cost).

A gap analysis was carried out to find the most promising technologies and solutions. Gaps were identified by comparing the usefulness rating with the current deployment status (Figure 2). Technologies and solutions which were rated as very useful but were currently not widely used were: tracking of dangerous goods movements, cargo pre-clearance, multimodal IT platform and cargo tracking. Implementation of these solutions would result in the highest utility and productivity gains. The next group were very useful technologies which some companies were using while others planned to introduce in the future. This group included: in-vehicle GPS navigation systems and vehicle tracking, real-time fleet management and drive-up warehouses.

Among the suggested R&D topics, those related to dangerous goods (DG) logistics received the highest importance ratings: development of one system for DG monitoring, crisis management system, cheap and secure technologies for DG tracking. The second most important topic was optimisation of warehouse design. Topics related to logistics IT, such as development of integrated, user-friendly transport and logistics solutions have also received high importance ratings. Topics related to transport of goods received lower ratings, with the exception of screening of containers for security reasons.

To address the main weakness of the Singapore logistics industry, which is high operating costs, solutions leading to increased productivity and efficiency should be supported. It was recommended that the agencies responsible for logistics take the lead to implement solutions which show the widest utility gap, like vehicle and cargo tracking (especially for dangerous goods).

One such pilot project is the implementation of vehicle tracking for container transport. It is sponsored by SPRING Singapore (Standards, Productivity and Innovation Board) and five local companies are participating. The Container Depot Association of Singapore will operate a central hub for processing the real time tracking information. An evaluation study for this project (currently under way) aims to measure productivity gains resulting from equipping some 220 prime movers (tractors) with GPS receivers and communication consoles.
Development of an Intelligent Transportation System Test Bed

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Intelligent Transportation Systems (ITS) represent a multi-discipline collection of technologies working together to help the road network and transit systems to become more efficient, safer and user-friendly. In Singapore, deployments of ITS can be found in systems providing real-time traffic information and incident management, information on road pricing to relieve urban congestion and controlling traffic signals to smoothen road traffic. Same as in other similar developments worldwide, the success of the systems not only relies on the system design itself but also depends upon whether users’ needs are satisfied. Due to difficulties in carrying out surveys and experiments, literature on users’ responses to ITS technologies is relatively limited. This has constrained the wider acceptance of ITS, which is not uncommon problem in many countries. As investments on each ITS project are normally substantial, it is very important to be able to implement a thorough testing phase in the development cycle of any ITS solutions to address the real and varying needs of different users. Such is the motivation for the setting up of a laboratory testing environment for ITS – an ITS Test Bed to obtain the fundamental understanding on how an ITS solution may be more successfully implemented.

At the current stage of development, the core of the ITS test bed is a driving simulation system (DSS), although the full development envisaged is a multi-modal laboratory, a travel simulation system, for testing various types of ITS technologies. The main mission of the DSS is to provide a laboratory setting for studying user responses to existing or new ITS technologies and such responses will be useful to improve the design of ITS systems so that they can better address the needs of users. Given its nature of development, the DSS can also be used to study other aspects such as new and existing road designs, driving safety, and other driver responses. Currently, Phase 1 of the planned development has been completed. In this phase, the visual scenes of driving along a stretch (about 5 km in length) of Central Tunnel Expressway (CTE) have been created. Figure 1 illustrates a typical scene captured within the tunnel section of CTE. The implementation concept is to achieve a geo-typical (with similar geographic feature) representation of details of the real site. Variable Message Signs (VMS), Electronic Road Pricing (ERP) gantries, road signs and other standard roadside furniture are captured and included in the DSS. The system is also able to generate different weather conditions (sunny, light rain and heavy rain) and lighting (daylight and night time). The ownership, i.e. the virtual vehicle to be controlled by a test subject, can be a passenger car, a luxury car, a light goods vehicle or a heavy truck, in order to evaluate any ITS and/or road designs from a comprehensive range of perspectives.

Apart from the advanced technologies and systems available with the DSS, it is also a system that are calibrated carefully by engineers and researchers who have extensive knowledge on the interaction between drivers and their environment and how they respond to various driving conditions. This is a crucial development in making the DSS a system that can be put to practical use.

The Phase 2 development of the DSS will push the technology boundary further by incorporating more advanced features to further enhance the realism of the driving experience. The system will be developed to provide a highly immersive driving environment, through facilities at the Reality Theatre at NTU, for users who are subjects of laboratory surveys. The phase 2 development will also capture the visual scenes of a longer stretch of expressway and include more ITS devices, existing or new, to facilitate studies of a wider range of the fundamental aspects of users’ responses. The results can provide important information to improve on the design of ITS and this is the main objective of developing the ITS test bed.

In conclusion, the gap of ITS technologies between the designers and the users can be filled by an ITS test bed. By immersing the potential users in a virtual environment that simulates an actual system, important information about the design and knowledge about how users would respond to the designs at various situations can be obtained. This is not easily attainable, if not impossible, through alternative means such as field surveys and conventional preference surveys. For longer term development, it is envisaged that the ITS test bed will be expanded into one that can be used to test ITS technologies for both drivers and transit users.