Developing a new index for comparing road safety maturity: Case study of the ASEAN Community

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Abstract

As part of the development of the ASEAN Regional Road Safety Strategy, a new index for measuring road safety maturity (RSM) was constructed from numerical weightings given to measurable factors presented for each of the pillars that guide national road safety plans and activities in WHO Global Road Safety Report 2013: road safety management, safer road and mobility, safer vehicles, safer road users and post-crash response. The index is based on both a content analysis approach and a binary methodology (report/no report) including measures which have been considered pertinent and not redundant. For instance, the use of random breath testing and/or police checkpoints in the national drink driving law are combined in the enforcement index. The value of the index per pillar ranges from 0 to 100%, taking into account whether there is total, partial or non-implementation of certain actions. In addition, when possible, the self-rated level of enforcement is included. The overall ratings for the 10 ASEAN countries and the scores for each of the pillars are presented in the paper. The extent to which the RSM index is a valid indicator of road safety performance is also discussed.

Introduction

Transport plays a critical social and economic role, but failures of the system can have severe consequences for quality of life, including death and severe injuries (Ra'ed & Keating, 2014; Salmon, McClure, & Stanton, 2012). The social and economic losses associated with road trauma are enormous. According to the WHO Global Road Safety Report (2013) about 1.24 million people are fatally injured each year in road traffic related incidents. In addition, between 20 and 50 million non-fatal injuries are reported every year; with many people incurring disability as a result of their injury (Al Turki, 2014). It is clear that these numbers could be significantly higher if the effect of underreporting is taken into account, particularly in low- and middle-income countries.

One of the lessons of the recent literature in road safety is that road trauma is not equally distributed worldwide, with the incidence differing according to the level of economic development of the countries (Kopits & Cropper, 2005). To illustrate, it is estimated that 91% of road fatalities occur in low-income and middle-income countries (WHO, 2013). High-income countries have reported decreasing trends in deaths on their roads when compared with the increasing fatalities in low- and middle-income countries. Developed Regions such as Europe experience approximately 10.3 deaths per 100,000 inhabitants annually, whilst Africa and Asia have higher rates of 24.1 and 18.5 respectively (WHO, 2013).

The overall road fatality rate of the countries belonging to the Association of South-East Asian Nations (ASEAN) is 18.5 per 100,000 inhabitants; however the individual rates for countries differ substantially from 5.1 in Singapore to 38.1 in Thailand (WHO, 2013) with a median of 17.5. The variability in road trauma rates reflects underlying socioeconomic differences among the countries. Table 1 shows the distribution of ASEAN countries by socioeconomic level and fatalities per 100,000 population. It is apparent from this table that

at the regional level, high income countries have lower rates of fatalities while middle and low income countries usually have higher fatality rates. This is consistent with similar studies that have found that in low income countries, the combination of poor road infrastructure, regulations, and emergency response expose drivers to more complex situations beyond their training and experience resulting in collisions while a slow emergency response potentially increases the severity of the original injury (Forjuoh, 2003; Huicho et al., 2012). It is hypothesised that economic differences among countries in the ASEAN region may lead to differences in road safety management and, therefore, in road safety outcomes.

Table 1. Socio-economic level and Fatalities per 100,000 population in the ASEAN region

Fatalities per 100,000 population	**Socioeconomic Level**			
	Low income	**Lower middle income**	**Upper middle income**	**High income**
Low (<10)		Philippines		Brunei Singapore
Medium (10-15)	Myanmar			
High (>15)	Cambodia Laos PDR	Indonesia Viet Nam	Malaysia Thailand	

*Adapted using data from the World Bank and World Health Organization

Road safety management includes the participation of governmental and organizational bodies in the provision of road safety strategies such as agreed targets and goals to be achieved, proposal of actions, regulation of vehicles safety standards, road design standards, and the organisation of a road crashes database (Bezerra, Kaiser, & Battistelle, 2015). At a regional level, evidence-based policy making requires data for monitoring the performance of the transport system segregated by country. However, qualitative and quantitative measures of the effectiveness of road safety management are difficult to integrate and the availability of these measurements varies across countries. So far, there has been little discussion about how to integrate the indicators established in five pillars outlined in the Global Plan for the Decade of Action for Road Safety 2011-2020. This integration is required to measure and compare road safety maturity and so identify opportunities for improvement.

Following the theoretical rationale of this paper, economic development is a major determinant of a region/country's maturity level and the outcomes of the road safety management systems. Worldwide the five-pillar model defined in Decade of Action for Road Safety 2011-2020 has been used as a surveillance tool for the independent outcomes but so far there is no global concept of road safety maturity. The aim of this paper is to commence the development of a new index for comparing road safety maturity integrating the five pillars model. This novel index has the potential to serve as a diagnosis tool of the road traffic system for detecting disparities and improvement opportunities. The index makes use of the WHO Global Road Safety Report (2013) as the most consistent and complete source of road safety indicators. The ASEAN region will be used as a case study in this paper due to different socio-economic and road safety patterns across its countries. This paper has been divided into four parts. The first part explains the Road Safety Maturity Index. This is followed by the case study of the ASEAN region. Finally, the discussion and conclusions of the case study and performance of the index are presented.

Road Safety Maturity Index

The Road Safety Maturity Index uses a content analysis approach and a binary methodology (report/no report) to integrate road safety outcomes. The main advantage of implementing this methodology is the flexibility for integrating qualitative and quantitative data, as is quite common in practice. This methodology has been widely used in other areas such as accounting/finance (Zorio, García-Benau, & Sierra, 2013), corporate social responsibility (Jain, Keneley, & Thomson, 2015), management (Eugene Fibuch & Arif Ahmed, 2013), among many others. It is important to note that this proposal is a preliminary test of a concept and how it is best operationalised, therefore further refinements of the model need to be explored.

The Index assigns numerical weighting to the indicators in the five pillars of the WHO Global Road Safety Report 2013 (WHO, 2013): road safety management, safer road and mobility, safer vehicles, safer road users and post-crash response. The value of the index per pillar ranges from 0 to 100%, and takes into account whether there is total, partial or non-implementation of certain actions. In addition, when possible, the rating of effectiveness of enforcement is included. Table 2 shows the final weightings and possible values for each of the indicators in the five pillars. In this preliminary version, the indicators of each pillar are equally weighted, in order to obtain a 100%, based on the total number of indicators. In the Pillar 1, for instance, each of the five indicators is assigned a 20%. Using the value criteria in Table 2, a value between 0 and 1 will be assigned based on the conditional rules developed with the binary methodology. If a country receives value 1 in each of the five indicators for Pillar 1, then these values will be multiplied by their respective weighting factor (20%), resulting in a perfect score of 100%. The possible overlap between indicators was avoided by including just a single indicator in the ranking. For instance, the uses of random breath testing and/or police checkpoints in the national drinking law were combined in the enforcement score. The overall level of maturity was obtained by averaging the score of each pillar by country. The levels of maturity by country or pillar are assigned using the scale described in the Figure 1. To the best of our knowledge, the proposed Road Safety maturity index is a novel approach to comparing commitment to improving road safety across all countries listed in the Global status report on road safety 2013.

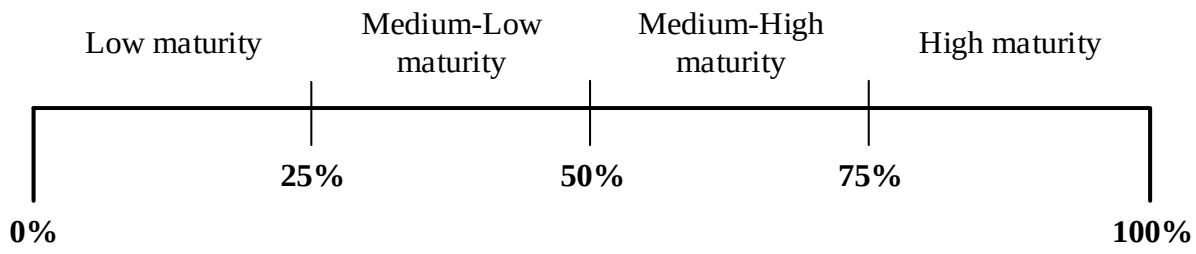


Figure 1. Scale for level of road safety maturity

Table 2. Road Safety Maturity Index indicators and weightings

Indicators	Weightings*	Value
Pillar 1. Road Safety Management	***100%***	
Lead Agency	20%	(1 if yes, 0 if no)
Funded in national Budget	20%	(1 if yes, 0 if no)
National road safety strategy	20%	(1 if yes, 0 if no)
Funding?	20%	(1 if fully 0.5 if partially, 0 if no)
Targets	20%	(1 if yes, 0 if no)
Pillar 2. Safer Road and Mobility	***100%***	
Formal audits required for new road construction	20%	(1 if yes, 0 if no)
Regular inspections of existing road infrastructure	20%	(1 if yes, 0.5 if partially, 0 if no)
Policies to promote walking or cycling	20%	(1 if yes, 0.5 if subnational, 0 if no)
Policies to encourage investment in public transport	20%	(1 if yes, 0.5 if subnational, 0 if no)
Policies to separate road users to protect VRUs	20%	(1 if yes, 0.5 if subnational, 0 if no)
Pillar 3. Safer Vehicles	***100%***	
Subscribes to UN World Forum on Harmonization of Vehicle Standards	25%	(1 if yes, 0 if no)
New car assessment programme	25%	(1 if yes, 0 if no)
Front and rear seat-belts required in all new cars	25%	(1 if yes, 0 if no)
Front and rear seat-belts required all imported cars	25%	(1 if yes, 0 if no)
Pillar 4. Safer Road Users	***100%***	
Penalty/demerit point system in place	14.3%	(1 if yes, 0 if no)
National speed limits	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
Local authorities can set lower limits	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
National drink driving–driving law	14.3%	(1 if yes, 0 if no)*(Enforcement/10)
National motorcycle helmet law	4.8%	(1 if yes, 0 if no)*(Enforcement/10)
Applies to drivers and passengers	4.8%	(1 if yes, 0 if no)*(Enforcement/10)
Helmet standard mandated	4.8%	(1 if yes, 0 if no)*(Enforcement/10)
National seat-belt law	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
Applies to front and rear seat occupants	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
National child restraint law	14.3%	(1 if yes, 0 if no)*(Enforcement/10)
National law on mobile phones while driving	-	-
Law prohibits hand-held mobile phone use	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
Law also applies to hands-free mobile phones	7.1%	(1 if yes, 0 if no)*(Enforcement/10)
Pillar 5. Post-crash Response	***100%***	
Vital registration system	16.7 %	(1 if yes, 0 if no)
Emergency Room based injury surveillance system	16.7%	(1 if yes, 0 if no)
Emergency access telephone number(s)	16.7 %	(1 if yes, 0.5 if subnational/multiple, 0 if no)
Seriously injured transported by ambulance	16.7 %	% of Seriously injured transported by ambulance
Emergency medicine training for doctors	16.7 %	(1 if yes, 0 if no)
Emergency medicine training for nurses	16.7 %	(1 if yes, 0 if no)

** Values rounded to 0.1%*

Case Study of the ASEAN countries

The ten member countries of the Association of Southeast Asian Nations (ASEAN) are: Brunei, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Viet Nam, Laos PDR, Myanmar, and Cambodia. In 2011, it was estimated that more than 75,000 people died in

road crashes in ASEAN countries and many more sustained long term injuries (Turner, McIntosh, & Ogden, 2011). Figure 2 shows the distribution of fatalities across the ASEAN countries. Given that an estimated 630 million people live in this region (Clemente, 2015), improving road safety outcomes in ASEAN is not only important for the welfare and economic benefit of the populations of these countries, but also for the attainment of global goals for improved road safety.

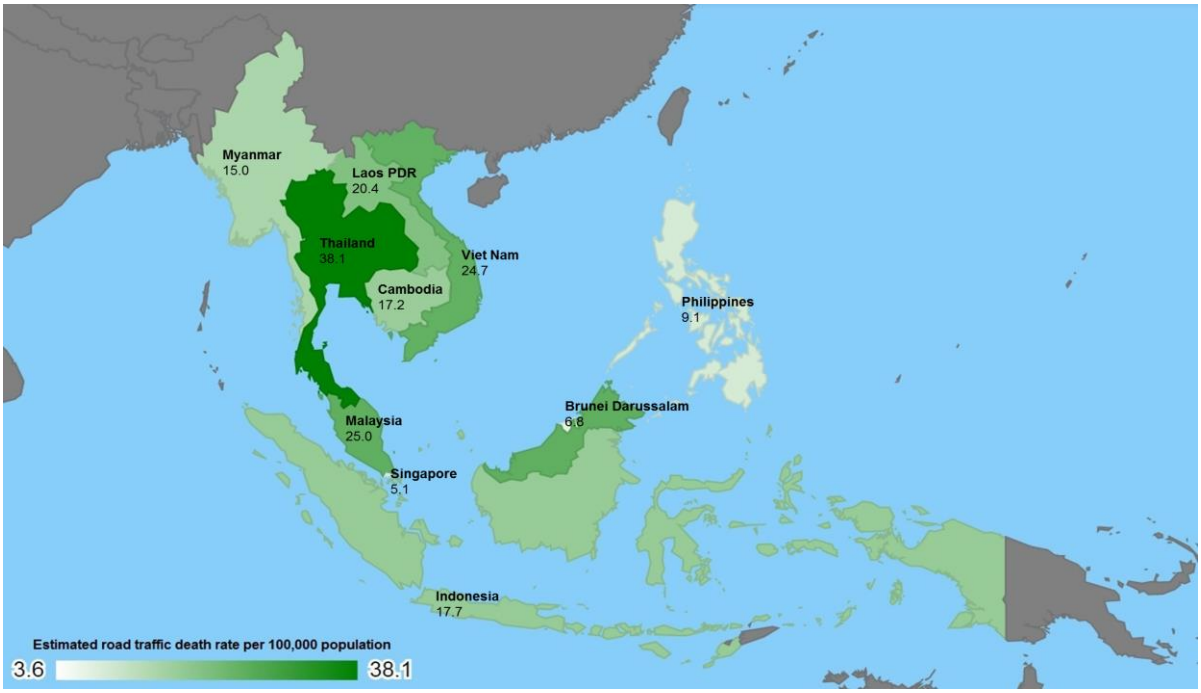


Figure 2. Road fatalities per 100,000 population in ASEAN.

Across ASEAN the motorization rates (including 2- and 3-wheelers) are high in Brunei and Malaysia (>700 per 1,000 population) but low in Myanmar and the Philippines (<100). Motorized 2- and 3-wheelers comprise the majority of vehicles in most ASEAN countries and this is unlikely to change because of their advantages in congested cities (See Figure 3). Yet reliance on these vehicles is associated with higher road fatality rates as shown in Figure 3. The pattern of use of these vehicles – often as family transport – makes it even more imperative that the road safety strategy should focus on addressing the vulnerability of users to road trauma (WHO, 2013). Figure 4 shows the strong relationship between fatalities and the prevalence of motorized 2-and 3-wheelers in the ASEAN region.

Methodology

The methodological approach for the development of this case study was a discussion of the five pillars proposed by The Decade of Action for Road Safety through a literature review. The road safety outcomes across the ASEAN countries were gathered directly from the WHO Global Road Safety Report (2013). The data by country were transformed using the proposed Road Safety Maturity Index. Independently, values for each pillar with an overall score by country were calculated and ranged from zero to approximately 100 percent.

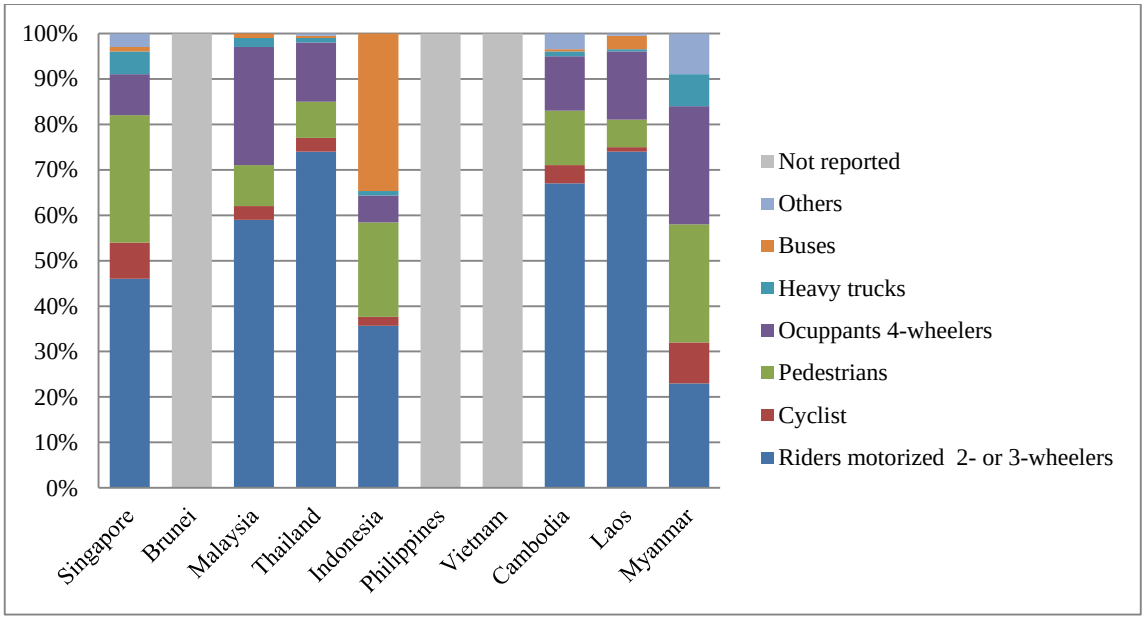
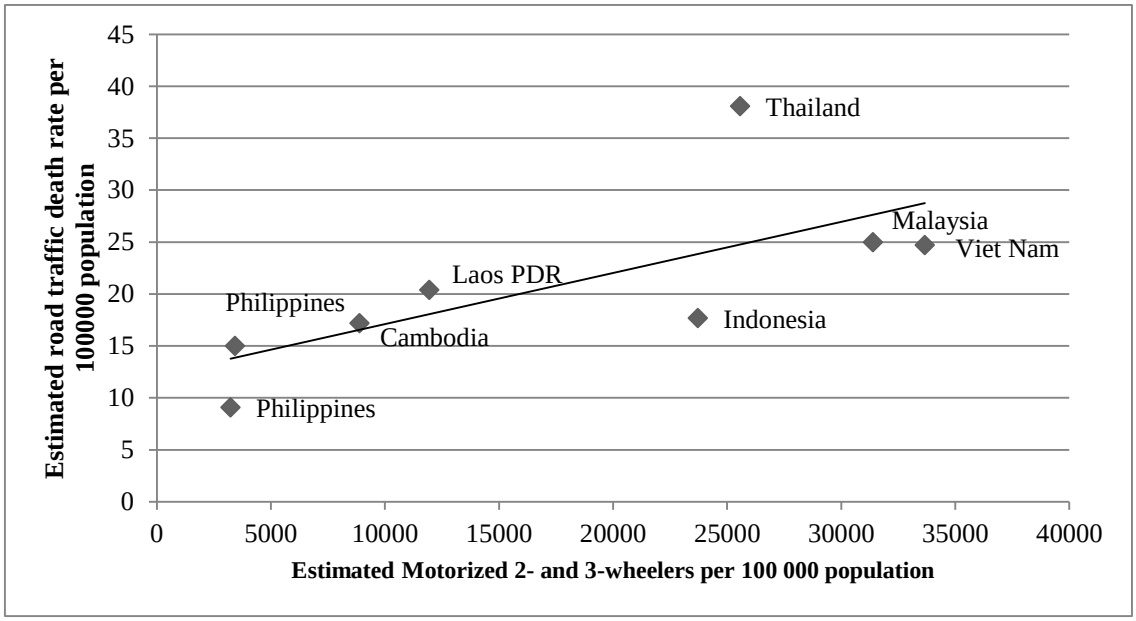


Figure 3. Vehicle composition in the ASEAN community



*Adapted from World Health Organization (No data available for Singapore and Brunei)

Figure 4. The number of road fatalities and the number of motorized two- and three-wheelers per 100,000 population

Results and Discussion

In Figure 5 the scores for each of the five pillars and the overall index by country are presented. The discussion of the main results related to each of the five pillars and its implications for the ASEAN countries are presented in the following sections.

Overall, the results showed that the ASEAN region has a medium-high road safety maturity level (62%). At a country-level, Malaysia ranks first (76%) owing to its consistent

performance across the five pillars. Philippines (73%) and Viet Nam (72%) rank second and third respectively. The single most striking observation to emerge from the data comparison was that the overall score on the index did not seem to correlate well with the fatality rate. To illustrate, Singapore (71%) and Brunei (49%), both countries with the lowest road fatalities per 100,000 population, rank fourth and eight while Thailand, with the worst performance in fatalities, ranks sixth.

Looking more closely at individual pillars, it can be seen that the Pillar 4 "Safer Road Users" (39%) receives the lowest score among all of the pillars for the ASEAN region. This result was expected given that 80% of the countries are in the low to middle level of economic development. This is particularly true for Singapore; the country with the highest Per Capita Income (PCI) has the best performance in this pillar (74%). This finding is consistent with those of other studies that indicate the need to intensify the intervention on road users for countries in the early stages of economic development (Nantulya & Reich, 2003). However, these findings cannot be extrapolated to other high income countries like Brunei Darussalam; which has one of the lowest scores for enforcement (19%) but still a low level of fatalities per population. It should be noted that although the PCI values of Brunei Darussalam and Singapore were similar, the values of registered vehicles per 1,000 population and road density were very different. In estimates from the The World Bank (2014), Singapore has 230 vehicles per 1,000 population (2011 est.) while Brunei has only 46 vehicles per 1,000 population (2011 est.). Also, Singapore has 481 km. of road per 100 sq. km of land area (2011 est.) while Brunei has only 54 km. of road per 100 sq. km of land area (2011 est.). These differences are the most probable reasons for the low rate of road fatalities in Brunei Darussalam (Haque, 2011).

Pillar 1 "Road safety management" (81%) has the highest score among the pillars. The most common reason for losing points was because, generally, the national road safety strategy was only partially funded. Only Philippines (100%) has a perfect score in the Pillar 1, which may have influenced the low number of fatalities registered, by regional standards. This is supported by evidence showing that a road safety strategy for prevention will reduce road trauma (Bener, Abu-Zidan, Bensiali, Al-Mulla, & Jadaan, 2003). On the other hand, Indonesia (50%) has the worst score in the Pillar 1, because of the lack of a lead agency and only a partially funded road safety strategy. This situation has also been recently criticised by WHO (2015).

Pillar 2 "Safer road and Mobility" (65%), Pillar 3 "Safer Vehicles" (55%), and Pillar 5 "Post-crash response" (69%) show a medium-high maturity level. As shown in the Figure 4, Thailand scored poorly on Pillar 2 (20%), and this is a feature that has been reported by other researchers as one priority for the country (Islam & Kanitpong, 2008). Safe infrastructure, public transport promotion, and protection of vulnerable road user have been frequently linked with lower fatalities (Turner & Smith, 2013; Vesper et al., 2013), a challenge that is particularly urgent in Thailand at a regional and international level. The score on Pillar 3 was particularly low in Indonesia (0%) with no vehicle standards applied or vehicle regulations for seat-belts. However, with the recent creation of the ASEAN NCAP, some improvements have been achieved in this matter (Ward, 2014). Finally, performance on Pillar 5 "Post-crash response" was poor in low-income countries such as Laos PDR and Myanmar. This inequality in post-crash services due to economic development is frequently reported in the literature (Fleiter & Senserrick, 2015) and particularly in Myanmar (Thwe, Kanitpong, & Jiwattanakulpaisarn, 2013).

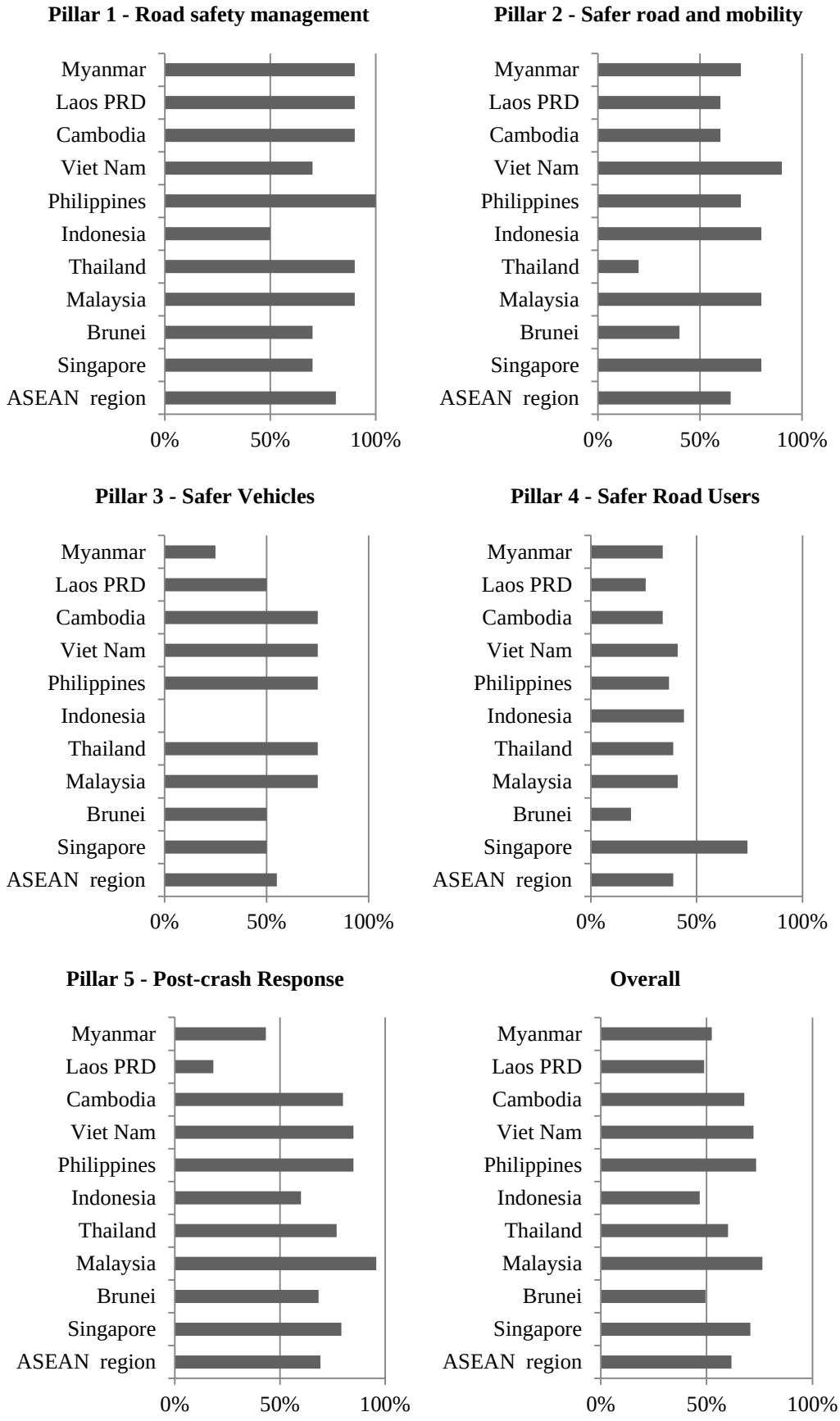


Figure 5. Road Safety Maturity Index values in ASEAN countries

Conclusions

A new index for comparing road safety maturity was developed and applied in a case study of the ASEAN countries. The Global status report on road safety 2013 provided the data for the index. This is the most consistent and complete source of road safety indicators world-wide. The results allowed differences to be identified, performance compared among countries, and improvement opportunities to be detected. Overall, the region has a medium-high maturity level; however, there are profound differences between countries. Some of these differences are explained by socio-economic factors that should be utilized in combination with the road safety outcomes (Klungboonkrong & Faiboun, 2014).

The results of the road safety maturity index were utilized for comparing the performance across countries and across pillars. Generally, the results were justified with the literature and no inexplicable findings were reported. However, the lack of consistency between the index and fatality rates needs to be considered in detail in future research. A possible explanation for this might be that the most of the pillars only include the existence of policies. This is insufficient since it ignores the two vital aspects of public policy, formulation and implementation (Egonmwan, 1984). A reasonable approach for tackling this issue is to start measuring degree of implementation and compliance with the policies and include this information in the later editions of the Global status report on road safety.

The benchmark results allow different jurisdictions to learn from others as a basis for developing measures and programmes which are aimed at increasing their own performance (Wegman & Oppe, 2010). The index could also be used to compare road safety developments over time between countries. Two main subjects for further research are identified throughout this paper. Firstly, it is necessary to examine the explanatory power of the index for fatalities, this could be achieved with a theory-base weighting for the variables inside and among pillars. Secondly, single measurements using binary methodology (report/no report) need an estimation of the degree of implementation.

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