Pertanika J. Sci. & Technol. 25 (1): 171 - 180 (2017)

SCIENCE & TECHNOLOGY

Journal homepage: http://www.pertanika.upm.edu.my/

Car Annual Vehicle Kilometer Travelled Estimated from Car Manufacturer Data – An Improved Method

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ABSTRACT

In 2013, 632 602 private cars were involved in road crashes, this amounting to 64% of all road crashes on Malaysian roads. Risk is often used to quantifying the level of road safety whilst exposure is an essential component of risk measurement. The calculation of VKT (vehicle kilometre travel) in this study using odometer reading data obtained from automobile manufacturer is used for cars. This average in 2013 was 24,129 kilometres, the highest recorded in Selangor with 28,575 kilometres and the lowest at 16,342 kilometres a year, in Johor. This method is believed to be reliable with a high yielding number of samples as well as a good representative set of samples for Malaysia.

Keywords: Average annual kilometre travelled, car, fatality index, motorcar, vehicle kilometre travelled

INTRODUCTION

Cars as the highest registered number of vehicles are undeniably the most preferred mode of transport for Malaysians. The number of registered vehicle increased by 100% within the past 10 years, where figures now reach more than 10 million in 2013. Aligned with the increasing number of cars on the road, the number of cars involved in crashes also increased. In 2013, 632 602 private cars were involved in road crashes. Figure 1 shows the number of registered private vehicle and number of private vehicle involved in crashes for the past ten years.

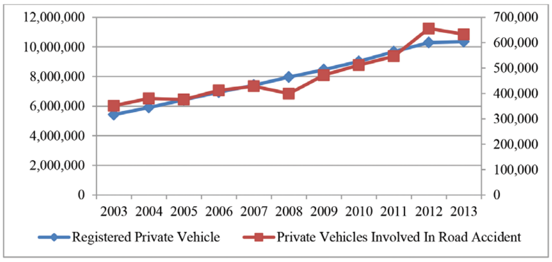

Figure 1. Profile of yearly registered private vehicle

Article history:
Received: 02 March 2016
Accepted: 14 December 2016

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ISSN: 0128-7680

In applying or adopting necessary countermeasures, it is important to understand their exposure on the road. Road safety performance indicators play an important role in explaining the situation. Road safety performance indicators are defined as any measurements that are related to crashes or injury. These indicators are used to indicate road safety level and provide a clearer picture for road safety performance. Risk is often used as a way of quantifying the level of road safety (Hakkert & Braimaister, 2002) as well as to improve transport safety (Hakkert & Braimaister, 2002). Hauer defined risk as the probability of a crash occurring (Hauer, 1982), where the risk of a crash occurring can be estimated by dividing the number of crashes by the road user exposure to the opportunity for a crash to occur (Wundersitz & Hutchinson, 2008).

Exposure as a measure of the number of opportunities for crashes or injuries to occur is an essential component of risk measurement. Exposure is often used as the denominator when calculating crash rates to estimate crash or injury risk. The common measure of exposure is distance travel that enables disaggregation by travel and demographic group for significant comparisons. It is crucial to look into exposure measures to better identify countermeasures for improvement of transport safety. These countermeasures may be designed to reduce the risk of exposure, the risk of a crash, or the risk of an injury or death once a crash has occurred (Hakkert & Braimaister, 2002). An acceptable and useful distance travelled measurement is vehicle kilometre travel also known as VKT. It is the measurement of how far a vehicle normally travels in a year term. It is internationally a well-established indicator and is accepted by most developed countries. Total VKT provides a proxy measure of the overall pressure on the environment from all forms of road transport (NZ Ministry, 2009). However, the estimation of VKT is not as straightforward as the traffic flow. VKT has always been a difficult indicator, because it is not measured directly, rather it is always estimated (Collins, 2001).

The main VKT estimation methods can be classified into two categories namely traffic measurement methods and non–traffic measurement methods (Kumapley & Fricker, 1996). The traffic measurement VKT estimation methods are more preferable than the non-traffic measurement methods, because the former methods are based on actual data for vehicle movement (Environmental Protection Agency, 1992). Under these two categories, there are four basic methods. The two types of traffic measurement methods are odometer readings (vehicle-based method) and traffic counts (road-based method), while non–traffic measurement methods consist of household or driver survey method and fuel sales method (Azevedo & Cardoso, 2009).

White in 1976 estimated Vehicle Kilometer Travel by inspection receipt which includes previous and current odometer reading. Then inspection receipt was selected and the vehicle owners were surveyed via mail questionnaire for driving exposure information (White, 1976). Pekka on the other hand, used traffic count to estimate Vehicle Kilometer Travel and a study was done to introduce the method used to execute data collection at various level of a road network (Pekka & Pekka, 1999). The National Transport Commission Australia estimated Vehicle Kilometer Travel using volume count on arterial and municipal roads (ARRB, 2005). A study done in Australia estimated quarterly VKT by vehicle type by fuel type from the state fuel sales data for all eight states in Australia (Hossain & Gargett, 2011).

In Malaysia, the Vehicle Kilometer Travel indicator development started in 2004 and since then has improved on method of data collection in ensuring the reliability of the data. In 2004, the VKT data were collected using household survey in the state of Selangor (Mohd Fauzi, 2004). The survey was divided into two stages; the first stage involved a face-to-face interview with the respondents, and in the second stage respondents were followed up with a telephone call after a period of 3 months. Nurshaeza also adopted the same method carried out in the year 2006 (Nur Shaeza, Radin Umar, Kulanthayan & Dadang, 2006). Although the respondent rates were high (71%), the studies revealed several shortcomings such as high operating cost, time consuming and requires a significant number of manpower.

In 2007, Nurulhuda adopted the use of postcard survey to obtain the odometer readings (Nurulhuda, Akmalia, Ho & Jamilah, 2013). This method is recognized to be cost effective with the ability to reach a wider area of coverage, thus reaching out to all states in Malaysia. The same postcard method was again adopted for the calculation of the 2010 VKT value. However, the slow response rate (re-mailing of the postcards by respondents) is a concern, and is recorded as a weakness in the postcard survey method for VKT.

This paper discusses the use of a different method in the calculation of VKT where secondary data is acquired from car manufacturer in estimating the VKT value for motorcar. This study also highlights the fatality index values.

METHODOLOGY

The calculation of VKT for car is by using odometer reading data from car manufacturers. Based on new motor vehicle sales reported by Malaysian Automotive Association for 2009 until 2013, Perodua surpass with 30.6% car selling in Malaysia while Proton able to have 24.7% car sales for the past five years (Malaysian Automotive Association, 2013). The press release statement also stated that the imported Toyota car recorded up to 15.2% of car sales for the five years (Malaysian Automotive Association, 2013). Collectively, these three car brands recorded a total of more than 70% of all new car sales in Malaysia. 44 other car brands shared the remaining 30%.

The odometer reading of a car were recorded when the car is serviced at their respective service centre. The data were then sent to headquarters for storage. The odometer readings were collected from headquarters of Perodua, Proton and Toyota. These data were recorded by the respective car manufacturers from all their service centres. Throughout Malaysia, there are about 176 service centres for Perodua, 280 service centres for Proton and Toyota has 76 service centres. The variables requested from the service centres through respective car manufacturers were current odometer reading, current date, registration date, car model, and service centre branch. The data were requested for those who came for service from January to March 2013. This includes both cars that were sent for first time service, as well as older cars sent for service. Based on the data provided, on average, the age of cars that were sent to service centres were 2 years old. A total of 239,916 data was been provided by Proton while Perodua and Toyota provided 91,596 and 189,622 data respectively. The total number of sample collected is 521,134 data.

The Average Annual Kilometer Travelled (AAKT) value is calculated based on formula below:

$$\text{AAKT} = \frac{\text{Current Odometer Reading}}{\text{Current Service Data - Registration Date}} \times 365 days \tag{1}$$

The formula will give the average annual kilometre travelled based on their brands. The vehicle kilometre travelled (VKT) for a car will be calculated using expression below:

$$\text{VKT} = \frac{\text{Total Kilometer Travelled}}{\text{Total Samples}} \times \text{Registered Car Number} \tag{2}$$

The fatality indices were also calculated based on formula below:

$$\text{Death per 100,000 population} = \frac{\text{Fatality}}{\text{Population}} \times 100000 \tag{3}$$

$$\text{Death per 10,000 vehicles registered} = \frac{\text{Fatality}}{\text{Registered Vehicle}} \times 10000 \tag{4}$$

$$\text{Death per billion VKT} = \frac{\text{Fatality}}{\text{VKT}} \times 1000000000 \tag{5}$$

RESULTS AND DISCUSSION

Vehicle Kilometer Travelled

A total of 521,134 vehicles were involved in the calculation of the VKT index. Table 1 shows the average annual kilometre travelled (AAKT) by brands. On average, a Proton user drove 22,048 kilometres a year whilst a Perodua user drove a bit further with 27,994 kilometres a year. A Toyota user drove approximately 24,895 kilometres a year.

Table 1
Relationship between EMG Signal and Weight of Subject

Car Brands	Number of Sample	AAKT (km)
Proton	239,916	22,048
Perodua	91,596	27,994
Toyota	189,622	24,895
Total	521,134	24,129

The average annual kilometre car travelled for year 2013 is 24,129 kilometres. Average annual kilometre car travelled for the year 2007 is 19,135 (Nurulhuda, Akmalia, Sharifah Allyana & Hussain, 2014). The AAKT value for the year 2008 was also calculated based on odometer readings. In comparison, a difference of more than 4500 kilometres can be observed. This increase is fairly high compared to National Travel Survey done by Department of Transport United Kingdom reported that their average distance travelled was reduced by 4% on 2012 (Lyndsey, 2013). An annual estimate of total VKT in Australia shows the total growth of 14.1 per cent during the last decade; 2001–2010 (Hossain & Gargett, 2011). In the 2008 postcard method, a response rate of 28% was obtained, giving a total of 1052 odometer readings. The difference on the method used to collect the odometer readings may considerably affect the ability to justly compare VKT readings between 2008 and 2013 without further data verification.

Table 2 shows the average annual kilometre travelled by engine size. The result shows that cars with bigger engine size travel more kilometres compared to smaller engine size. However, the average annual kilometre travelled for cars with engine sizes smaller or equal to 1.3 cubic centimetres (cc) is higher (25,133 km) than car that has engine size between 1.4 to 1.8 cc, where the AAKT is only 22,868. Engine size has always been associated with fuel consumptions where analysis of EPA data on 1977 automobiles shows that rate of fuel consumption increases with the increase of engine size, a consequences of the increase of automobile weight (Essenhigh et al., 1979). Based on the results, there is the possibility that cars with smaller engine size consume less fuel whilst travelling the same distance as cars that consumes more fuel. This translates into; for the same amount of fuel used, smaller engine cars travel more kilometres than bigger engine cars. Users with car engine size more than 1.8 cc, usually has higher income, which may give insight the higher kilometre travelled compared to those with less than 1.3 cc.

Table 2

Average Annual Kilometer Travelled by Engine Size

Engine Size	AAKT
≤ 1.3 cc	25,133
1.4-1.8 cc	22,868
>1.8 cc	31,605

Table 3 compiles the average annual kilometre travelled and the vehicle kilometre travelled by states. The highest average kilometre travelled is in Selangor with 28,575 kilometres while the lowest kilometre a car travelled is in Johor with only 16,342 kilometres a year. The number of registered cars in Selangor is higher, ranking at number three amongst all states in Malaysia. Considering that Selangor has the largest economic activity in Malaysia with good infrastructure development such as newer highways built, it is predictable that Selangor recorded the highest VKT reading. In addition, number of registered car in Selangor is also in the higher range, i.e. more than 1 million vehicle kilometre travelled, where Selangor ranked number three. On the other hand, Johor recorded the lowest number of kilometre travelled, which did not match the indicators Johor recorded, such as the high number of registered vehicles. The best assumption one can make is that people of Johor do not extensively travel out of state, which differs from the travel pattern of people in Selangor and Kuala Lumpur.

Table 3
Vehicle kilometre travelled by states

State	Kilometre Travelled (km)	AAKT (km)	Registered Car	VKT
Perlis	26,472,108.30	25,953.00	21,229	550,956,237
Kedah	621,423,233.30	22,692.90	300,868	6,827,567,437
Penang	620,520,721.40	20,979.80	1,024,197	21,487,448,221
Perak	970,021,871.30	24,933.10	699,651	17,444,468,348
Selangor	4,135,331,288.50	28,575.90	1,037,243	29,640,152,244
Wilayah Persekutuan	1,119,215,232.70	25,569.80	3,442,319	88,019,408,366
Negeri Sembilan	479,982,755.60	24,619.60	312,156	7,685,155,858
Melaka	473,455,909.80	23,551.50	310,169	7,304,945,204
Johor	1,046,923,415.90	16,342.30	1,339,446	21,889,628,366
Pahang	747,786,379.50	27,919.10	346,939	9,686,224,635
Kelantan	352,266,433.60	22,601.50	273,140	6,173,373,710
Terengganu	300,537,789.80	23,461.20	188,275	4,417,157,430
Sabah	935,051,240.30	22,821.20	556,699	12,704,539,219
Sarawak	745,488,271.20	20,737.40	683,244	14,168,704,126
Total	12,574,476,651.10	24,129.10	10,535,575	254,213,942,733

Vehicle kilometre travelled by states

Road Fatality Index

Fatality index shows trends in death rates and is used to measure road safety performance. The three types of fatality index indicators are extensively used in transport safety are fatalities per billion VKT, fatalities per 100,000 population and fatalities per 10,000 vehicles. Table 4 show the number of fatalities for the year 2013, the death per 100,000 populations and per 10,000 vehicles registered. When viewing fatality numbers alone, Johor recorded the highest number of road fatality while the least is Perlis. Nevertheless, death per 100,000 populations and 10,000 registered vehicles indicates different results. The result shows that Pahang had the highest index while Johor is placed in the bottom three. Index per 10,000 vehicles show the same results with Pahang ranked at first while Johor ranked at eighth. It is interesting to highlight that the use of a different denominator yields a different standpoint of road safety.

Table 4
Fatalities Index by State

State	Fatalities	Death per 100,000 population	Death per 10,000 vehicles registered	Death per billion VKT
Perlis	72	30.0	1.1	
Kedah	517	25.7	4.4	
Penang	381	23.1	1.8	
Perak	770	31.5	4.3	
Selangor	1019	17.6	4.8	
Wilayah Persekutuan	243	4.2	0.5	
Negeri Sembilan	396	36.7	4.5	
Melaka	258	30.4	2.5	12.2
Johor	1128	32.3	4.2	
Pahang	592	37.7	6.3	
Kelantan	378	22.6	5.0	
Terengganu	320	28.4	2.6	
Sabah	420	12.0	4.1	
Sarawak	421	16.1	2.0	
Total	6915	23.1	2.9	

Note: The death per billion VKT by state cannot be calculated due to unobtainability of VKT data by state for all vehicle types.

The fatality index per billion VKT for car was also calculated. This indicator is to describe the safety quality of road traffic (IRTAD, 2014). In general, for the year 2012, Malaysia ranked at number 21 out of 23 countries based on data recorded by IRTAD. Fatality index per billion VKT for all vehicles is 12.2 for the year 2013 whilst the government's target is to reduce the fatality index to 10 fatalities per billion VKT by year 2010 (Ministry of Transport, 2006). In the event that only cars are considered, the fatality index per billion VKT for car is 5.5. This was calculated to be that there are 6 deaths per every billion kilometre car travelled on Malaysian roads for the year 2013.

CONCLUSION

The average annual kilometre a car travelled in 2013 increased around 4994 kilometres from the average in 2007. The is due to ease of access and increased of distance between home and work place, encouraging people to travel more. An in-depth study on these factors needs to be done to better understand this trend.

ACKNOWLEDGEMENTS

This research was funded by a research grant from Malaysian Institute Road Safety Research (MIROS). We record our appreciation to Proton Holdings Berhad, the Perusahaan Otomobil Kedua Sendirian Berhad (PERODUA) and Toyota Malaysia Sdn. Bhd for providing all the odometer readings. A very special appreciation goes out to all drivers who contributed indirectly towards the completion of this study and to the staff of MIROS who helped with the preparation of facilities required for the study.

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