



Utilization of probe powered two-wheeler vehicles to realize a safe mobile society



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ABSTRACT

Approximately 300 million powered two-wheeler vehicles (PTWs) are currently in possession around the world, and PTWs bear the role of personal mobility especially in regions of Southeast Asia, where motorization is rapidly expanding, while they are also coming into focus as a type of vehicle that is better for the environment. This paper presents past efforts to utilize PTWs and their current situation. In addition, the possibility of realizing safe mobility by equipping PTWs with probes is examined.

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1. Trends and issues in PTW usage

1.1. Trends in PTW usage on the world's roads

According to statistical data, the annual global production of four-wheeled vehicles (including passenger vehicles, buses, and trucks) reached 84.14 million (2012), with 1.07108 billion in possession (2011) [1]. Meanwhile, the annual global production of PTWs reached a total of 59.379 million (2011) in the key countries indicated in Table 1 [1] with nearly 300 million in possession in key countries (2008–2011) [1,2]. As shown in Table 2 [1], the adoption of PTWs is notable in Southeast Asia at a ratio of three persons per vehicle in Malaysia (2011) and Vietnam (2009) and four persons per vehicle in Thailand (2011) and Indonesia (2009). This indicates the large role PTWs play as modes of personal transportation in these countries.

With regard to the actual usage of PTWs in Southeast Asia, Fukuda et al. investigated the usage situation in Thailand, Vietnam, and so on, and conducted a macro-analysis of the relationships among income level, public transportation, road maintenance, and PTW ownership, and forecast future shifts in PTW adoption in the literature [3,4]. These studies also show the position PTW taxis (for example, motorcycle taxis called “soi-bikes” in Thailand) occupy as the terminal transportation

means in Southeast Asian cities. As shown in Table 2, PTW usage demonstrates an upward trend, which requires the establishment of traffic capacity estimation approaches and construction strategies for road facilities that consider PTWs, such as PTW wait zones. There has also been a need for traffic facility design and allocation plans using PTW taxis as means of urban transportation [4].

1.2. PTW trends in road traffic in Japan

In 2012, there were approximately 400,000 PTWs sold in Japan, continuing a trend of about 400,000 sold annually over the past several years. Of the approximately 12 million PTWs in possession in Japan, 8.48 million, or over 70%, are in the category of 125 cm³ displacement or less. This category of PTWs is used for commuting to work/school, for delivery services such as post, newspapers, and messengers, for police patrols, and so on [5]. It is known that PTWs occupy one-third the area that four-wheeled vehicles do [6]. The average number of passengers per vehicle on weekdays in Japan is about 1.3 [7]. These facts indicate that switching to PTWs from four-wheeled vehicles ridden by one passenger in metropolitan areas where traffic is severe could potentially increase average speeds by 35% and increase the traffic capacity of roads, making road utilization more efficient [6].

Energy issues have materialized in Japan since the Tohoku earthquake of March 11, 2011. Sub-125 cm³ displacement category PTWs have a distinct advantage in fuel efficiency over four-wheeled vehicles and large-displacement PTWs (Fig. 1). On the other hand, drivers who acquire a normal driver's license for four-wheeled vehicles in Japan can only operate PTWs of 50 cm³ displacement or less. This category of vehicles is restricted by law to maximum speeds of 30 km/h on public roads and must take a two-step process to make right-hand turns on roads with three lanes or more each way (under the left-hand traffic

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Table 1
World motor vehicle statistics.

Global production numbers of motorcycles by country/region		
Country/region	2011	
Austria	48,710	
Czech Republic	1,155	
France	74,359	
Germany	110,084	
Italy	414,000	
Spain	95,399	
United Kingdom	23,886	
Russia	–	
Brazil	2,136,891	
China	27,005,224	
India	15,453,619	
Indonesia	8,006,293	
Japan	639,187	
Malaysia	498,076	
Pakistan	858,576	
Philippines	762,947	
South Korea	–	
Taiwan	1,207,428	
Thailand	2,043,039	
Total	59,378,873	

Global numbers of motorcycles in possession by country/region		
Year	Country/region	Number
2011	Italy	8,610,000
2011	Spain	4,070,032
2011	France	3,439,417
2011	United Kingdom	1,468,800
2011	Netherlands	1,269,433
2011	Switzerland	833,891
2011	Austria	712,635
2011	Poland	2,102,175
2011	Czech Republic	944,171
2009	Russia	4,710,000
2011	Turkey	2,527,190
2009	United States	7,929,724
2009	Mexico	1,201,046
2009	Colombia	2,630,391
2011	China	102,602,397
2009	Indonesia	52,433,132
2011	Japan	12,205,926
2011	Thailand	18,152,469
2011	Taiwan	15,173,602
2011	Malaysia	9,986,919
2009	Vietnam	25,414,689
2009	South Korea	1,820,729
2009	Pakistan	5,607,334
2011	Philippines	3,760,893
	Total	289,606,995

Documentation: Motorcycle industry associations, etc. Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Internal Affairs and Communications, ACEM, FAMI, etc.

rules). To operate a 125 cm³ displacement class PTW that complies with international standards and follows the maximum speed limit of four-wheeled vehicles, a special PTW license for normal PTWs (limited to compact types) must be acquired separately. Therefore, the number of drivers licensed to operate 125 cm³ displacement PTWs is 236,000, a limited number in proportion to the 81.49 million people licensed to drive in Japan [8]. In contrast, to reduce the burden of acquiring a normal PTW license in addition to the four-wheeled driver's license, there has been a proposal from the industry for a specific training curriculum [9]. Revision of the training system in the future is expected to promote the use of this category.

With regard to micro-analysis of PTWs in operation, a common observation in Japan, where predominantly four-wheeled vehicles occupy traffic, is the sight of PTWs driving in between four-wheeled vehicles on congested arterial roads. It is suggested that establishing PTW lanes or having PTWs share bus lanes would regulate PTW traffic and thereby support efficient transportation while improving safety [10,11,12].

Table 2
Global motorcycle adoption rate by country (number of persons per vehicle).

Year	Country	Adoption rate (persons)
2011	Malaysia	3
2009	Vietnam	3
2011	Thailand	4
2009	Indonesia	4
2011	Italy	7
2011	Switzerland	9
2011	Japan	10
2011	Spain	11
2011	Austria	12
2011	Netherlands	13
2011	China	13

Documentation: Ministry of Land, Infrastructure, Transport and Tourism, Ministry of Internal Affairs and Communications, ACEM, FAMI, etc.

Global population documentation: OECD, United Nations

1.3. PTW accidents

Infrastructure maintenance has been unable to keep pace with the rapid increase of vehicles in developing countries in Southeast Asia, and there have been instances where drivers, pedestrians, and other traffic participants are unable to adapt awareness and competency amid changes in road traffic. The result has been a high rate of traffic fatalities per capita in developing nations [13]. The rate of traffic fatalities involving motorcycles (including three-wheeled vehicles) in Southeast Asia overall is 33% higher than the global average (Fig. 2; [13]). Although in these statistics, three-wheeled vehicles and PTWs are classified under the same category, the countries where there are high rates of PTW adoption (Table 2) show significantly higher fatality rates in motorcycle accidents: 59% in Malaysia, 74% in Thailand, and 32% in India [13]. Therefore, it can be deduced that PTW accidents constitute the major proportion of motorcycle accidents. Moreover, the statistical data of these traffic accidents in developing nations often have disputable accuracy or poor quality, prompting a trial switch to technology such as traffic accident statistics in Japan or databases that are linked to medical institution data on traffic accidents in Europe.

To reduce traffic accidents, accident data must be analyzed and effective safety measures implemented. In Japan, analyses of PTW accident data from 2002 to 2011 have been reported [14,15]. These macro-analyses have shown that the types of accidents with a large number of fatalities over the entire data cycle have been right-hand turns (under left-hand traffic rules) into oncoming traffic in cities [16]. Among these accidents, there are characteristics according to vehicle type, such as many cases of accidents involving oncoming four-wheeled vehicles that are merging laterally onto roads, 50 cm³ or lower displacement PTWs, which are often driven on the leftmost lane, and higher-performance PTWs exceeding 125 cm³ displacement often being involved in head-on collisions during right-hand turns [14]. Micro-analysis of each accident shows that it is necessary to reduce

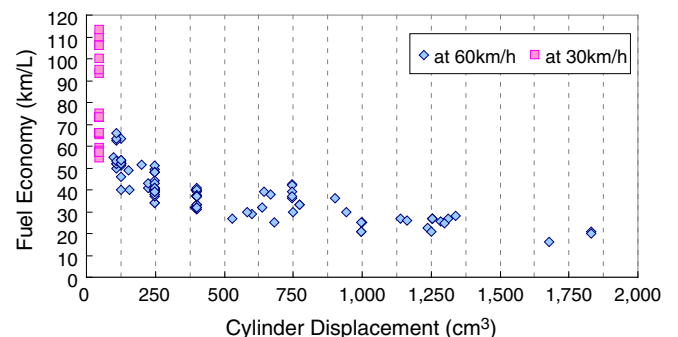


Fig. 1. PTWs fuel economy in steady state (2013 Manufacturer Model, Japan).

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