Title: Implications for safety and planning of a sharp increase in moped and scooter use

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Paper presented at the International Conference on Safety and Mobility of Vulnerable Road Users
Jerusalem, Israel, May 30 – June 2, 2010

Abstract

The last decade has seen a rapid increase in the use of mopeds and scooters in some cities where they have traditionally been uncommon. One such city is Brisbane, the capital city of the Australian State of Queensland, where a 50cc moped may be ridden on a car licence, while riders of larger scooters require a motorcycle licence. The first study reported here observed stationary powered two-wheelers (PTWs) in designated parking areas at six-monthly intervals from August 2008. Over one third of all PTWs observed were either mopeds (22%) or larger scooters (14%), while the majority were motorcycles (64%) (n = 2037). Focus groups were then held to explore riders' perspectives on safety and transport planning issues. Parking availability, traffic congestion, cost, time-efficiency were frequently mentioned motivating factors. Moped riders were younger and less experienced and less likely to have undertaken or value rider training, and less likely to wear protective clothing.

Keywords: Moped, Scooter, Safety, Rider characteristics, Rider licensing, Australia

1. Introduction

Much has been written about the substantial increases in powered two-wheeler (PTW) sales and usage and the coincident increases in crashes and rider injury over the last decade in many developed countries, including the United States, United Kingdom and Australia, (Johnston et al., 2008; Morris, 2009; Broughton and Walker, 2009). Yet the trends are by no means uniform at the level of PTW type. Many European countries where mopeds and scooters were traditionally popular have experienced reductions in sales of these vehicles (ACEM, 2008a), while the reverse trend has been observed in other countries with

traditionally few of these vehicles such as Canada (Motorcycle and Moped Industry Council, 2009) and Australia (FCAI, 2008). In Australia, scooter and moped sales have tripled since 2004, and the sales growth of these vehicles has generally exceeded that of other PTW types over the last decade (FCAI, 2008; Haworth and Nielson, 2008), particularly in the State of Queensland, where moped use is permitted for car licence holders. A fourfold increase in reported Queensland moped crashes from 2001-2005 (Haworth and Nielson, 2008) has triggered research into moped and scooter safety, and associated implications for transport management and planning. Local motorcycle safety research and international moped safety research may be of limited value to understanding this new phenomenon. The rider and vehicle characteristics of moped and scooter riders in Australia differ from those of Australian motorcycle riders and differences in legislation, environment and culture exist between Australia and Europe in terms of moped and scooter use (Haworth et al., 2009a). A clearer understanding of moped and scooter use in Australia is required if attendant safety and transport planning issues are to be identified and appropriately addressed.

1.1 Vehicle definitions and licensing

The term ‘scooter’ is used to describe PTWs with a ‘step-through’ chassis design and (usually) automatic transmission, though there is no official definition of a ‘scooter’ in Australia or elsewhere (Haworth et al., 2009a; Motorcycle Safety Foundation, 2000). While definitions vary across countries, a scooter may be categorised as ‘moped’ or ‘motorcycle’ in Australia. Current Australian Design Rules (ADR) define a ‘moped’ as a LA (or LB) Category powered vehicle with 2 (or 3) wheels, a maximum engine cylinder capacity of 50cc AND a maximum speed of 50km/h (Australian Government, 2008). Electric mopeds are also

limited to 50km/h. Scooters exceeding LA/LB moped specifications are categorised as LC (2 wheel) or LE (3 wheel) motorcycles. The LA moped definition is similar to European and North American definitions, with some variations: in Europe a L1 moped may be pedal-assisted (ACEM, 2008b) and in North America a moped may be of 'bicycle-like design' (Morris, 2009) or a 'motor assisted bicycle' (Ontario Ministry of Transportation, 2009).

While vehicle definitions are consistent nationally, licensing regimes differ across Australia's eight State and Territory governments. In New South Wales, Victoria, Tasmania and the Australian Capital Territory, a motorcycle licence is required to ride a LA moped or LC/LE scooter (New South Wales offers an automatic motorcycle licence). In Queensland, South Australia, Western Australia and the Northern Territory, LA moped use is permitted on a car driver's licence, while LC/LE scooter riders require a motorcycle licence (Queensland offers an automatic motorcycle licence). In the latter jurisdictions mopeds are therefore currently accessible to people with no motorcycling experience, skills, or training, but rider licensing has recently been proposed for Queensland moped riders (Queensland Transport 2008).

1.2 Safety of mopeds and scooters

Some studies have recently compared safety of mopeds and scooters with that of motorcycles (Faberi et al., 2004; Haworth and Nielson, 2008). The European MAIDS study found that crash involvement of these PTW types was similar after accounting for exposure (ACEM, 2008b). Research in the United Kingdom found that motorcycles with engine size above 125cc had a 15% lower crash risk than those with smaller engines (Sexton et al., 2004), suggesting mopeds were more likely to be crash-involved than larger PTWs. MAIDS data reveal that 17.8% of crashed mopeds visually inspected had been modified to increase

performance, compared with 12.3% in exposure data, suggesting that modified mopeds may be over-involved in crashes (ACEM, 2008b). There is no reliable information on such practices in Australia, though the topic is covered frequently in online forums and other websites. Research in Australia has been unable to estimate moped and scooter crash risk relative to that of motorcycles due to insufficient usage data (Haworth et al., 2008).

Many studies have reported lower injury severity among scooter, moped and light motorcycle riders compared to other PTW riders, partly due to lower travelling speeds and subsequent impacts (Sexton et al., 2004; Bostrom et al., 2002; de Lapparent, 2006; Langley et al., 2000; Otte et al., 1998). However, other research shows little support for these findings (Haworth et al., 2008; Kopjar, 1999) and there are contextual differences which need to be considered (i.e. rural/urban, licensing age, helmet laws). Research in Australia indicates low risk perception and use of protective apparel among scooter and moped riders when compared with motorcyclists (de Rome and Stanford, 2006), although there is generally good compliance by all riders with Australia's mandatory helmet use laws for public roads.

While males usually account for 90% or more of motorcycle riders in developed countries, moped and scooter riding is relatively more popular with females (ACEM, 2008b; Haworth et al., 2009b). From 2001 to 2005 in Queensland, 37.9% of crashed moped riders were female, compared with 7.2% in motorcycle crashes (Haworth et al., 2008). Similar findings have been reported for other developed countries (Kim et al., 1995; Matzsch and Karlsson, 1986).

The Netherlands and Portugal are among the few jurisdictions where a formal evaluation of moped rider training and skills testing has been conducted. The initial evaluation of compulsory training and testing in the Netherlands found short term benefits which were largely eroded by the time of follow-up testing eleven months later (Goldenbeld et al., 2004).

Since 1996 Netherlands moped riders have been required to gain a moped certificate through successful completion of a theory test, but this policy measure has apparently not reduced moped rider crash involvement (Steg and van Brussel, 2009). In 1999 Portugal implemented an 18 hour moped rider training program which included theory and practical training, and a psychological intervention. Contrary to the expectation that training would reduce moped rider crashes, evaluation showed that in the four years after commencement, 52% of the experimental group (trained riders, n=190) reported crashes, compared with 31% in the control group (untrained riders, n=84) (Antonio and Matos, 2008).

1.3 Objectives

This research aimed to address current gaps in knowledge regarding moped and scooter use in Australia and other jurisdictions where their use is increasing from a low level. A series of repeated observations were undertaken to quantify the distribution of PTW types in Brisbane's central business district (CBD), measuring changes over 24 months. This has provided an estimation of the mixture of PTW types in use as well as a baseline for measuring future trends, including those which may result from any future changes to licensing requirements. A focus group study was used to explore rider motivations, beliefs and attitudes regarding safety, providing a qualitative context for the observation data. The focus group study also informed development of an online scooter and moped rider survey, targeting a larger sample of riders across Queensland.

2. Methods

2.1 Observational study

A five phase observational study was used to identify distribution of PTW types in the Brisbane CBD. Brisbane, which has approximately two million residents, was chosen as the site of the research due to its high concentration of moped and scooter activity. According to previous research, approximately thirty percent of Queensland moped crashes occur in the city of Brisbane (Haworth and Nielson, 2008). Data were first collected in August 2008, and thereafter at six-monthly intervals to observe any potential changes. Stationary PTWs were observed in thirteen designated parking areas on single weekdays during business hours (9am – 5pm). Twelve of these were council-designated public motorcycle parking areas, while one was located on university grounds. The public parking areas represented twelve of seventeen identified on Brisbane City Council's online map of 'inner city motorcycle parking' (Brisbane City Council, 2010). Of the twelve council-designated areas, two were metered 'pay and display' areas and ten were free parking areas. Five outlying and smaller areas were excluded.

Location, vehicle make, model, year of manufacture, engine capacity and PTW type were recorded. PTWs were allocated to one of five main categories and eleven sub-categories adapted from type classifications within the US National Agenda for Motorcycle Safety (NAMS) (Motorcycle Safety Foundation, 2000). Final allocation to categories took place during the process of data entry after confirmation of the design and purpose of particular models. Information was obtained from registration labels, vehicle compliance plates and/or manufacturer's labels, decals and badges. Notes were taken for missing registration labels and/or plates, and for vehicles registered interstate. Data collection was only undertaken during fine weather, and Mondays, Fridays and days adjoining public holidays were avoided as Australian workers are more likely to take unscheduled leave from work on these days.

2.2 Focus groups

Four focus groups with Brisbane moped and scooter riders were held in March 2009. The study sought a roughly equal participation of moped and scooters riders, to allow comparisons between them and to ensure coverage of all relevant issues. A semi-structured design was used, with open-ended questions intended to explore key issues identified in previous research (Coxon, 2002; de Rome et al., 2002), including but not limited to: Riding purpose and motivations; Perceived hazards and related issues; Risk taking; Riders' experiences and travel patterns; Attitudes and beliefs regarding rider licensing, training and education; Use and knowledge of protective apparel. These topics provided the organisational structure for thematic analysis of the data. Data were recorded both manually by written notes and digitally by voice recorder and were later transcribed in full. Ethics approval for the study was granted by Queensland University of Technology's Human Research Ethics Committee.

Two recruitment methods were used to assemble four groups each of six to eight riders: a message posted at an online forum for scooter enthusiasts; and 58 A4 colour flyers placed on roughly equal numbers of mopeds and scooters in CBD parking areas in February 2009. The riders recruited included commuters to Brisbane's CBD, university students attending a city campus, members of an online scooter forum, and scooter or moped retailers who were also active riders. Participants were each given AU$50 to compensate for their time.

A total of 23 riders participated in four focus group discussions of approximately two hours duration. Participants ranged in age from early twenties to early sixties, including sixteen males (70%) and seven females (30%). Seventeen riders were recruited through flyers distributed in CBD parking areas, three were recruited by direct contact at a retail scooter

shop, with the remaining three responding to an online forum message. Eleven participants were moped riders, seven of whom had been riding for between one and five years. Scooter riders were comparatively older and more experienced on average, with seven of twelve participants having ridden some type of PTW for at least twenty years.

3. Results

3.1 Observational study results

Approximately 500 motorcycles, mopeds and scooters were observed in each of the four phases of the study to date, with slight increases in the number of units observed at each successive phase. Only twelve parking areas were included during the first phase. Brisbane City Council established a new parking area between phases one and two (September 2008) and this was subsequently incorporated into the study. Mopeds and scooters collectively comprised over one third of all PTWs observed (Table 1). There was no significant change in distribution of PTW type between data collection phases [χ^2 (9) = 10.395, p = .319].

INSERT TABLE 1 HERE

The parking areas observed during each study phase were generally filled to or beyond capacity. It was common to find three smaller PTWs occupying two marked spaces (owners would not be penalised for this providing they were within the boundary of the overall area). One of the two metered parking areas was obviously under-utilised in comparison with all others. This area comprised 25 marked spaces, which were occupied to 53% capacity on average across the four phases. Mopeds and scooters comprised a relatively small proportion of total units observed at this site compared with other areas (26.4%, n = 53). A one-way

ANOVA test revealed a significant difference between the age of motorcycles compared to mopeds and scooters [F (2, 1875) = 102.12, p <0.001]. Motorcycles (M = 7.96) were substantially older than mopeds (M = 4.48) and scooters (M = 3.93).

PTWs were allocated to one of five main categories and eleven sub-categories adapted from NAMS motorcycle type classifications (Motorcycle Safety Foundation, 2000). Figure 1 illustrates the prevalence of mopeds (21%) and scooters (14%) in the overall mix of PTW types, where mopeds are second only to sport motorcycles as the most frequently observed sub-category (the two least frequently observed sub-categories are excluded from Figure 1). The additional scooter/moped sub-category represents the 31 (1.5%) vehicles missing sufficient visual identifiers to determine whether they were LA or LC category vehicles.

INSERT FIGURE 1 HERE

3.2 Focus group results

3.2.1 Riding purpose and motivations

Participants generally travelled less than 100 kilometres per week, with the exception of two riders of larger scooters who rode extensively for touring or commuting. The primary purpose for riding was commuting to and from work or study. Participants also often used a moped or scooter for short trips to other places such as shops and entertainment venues. Some participants rode for recreation, but none were primarily recreational riders. A moped or scooter was a second vehicle for most participants as they also had regular access to a car. Mopeds were sometimes shared among family and friends, though this did not appear to be the case with larger scooters which require a motorcycle licence.

When asked about motivations for riding, responses typically mentioned multiple factors including cost, time-efficiency, practicality and enjoyment. Compared to public transport, the overall cost of moped or scooter use, including vehicle purchase, fuel and parking expenses, was considered the cheaper long-term option by all participants. Although mopeds and scooters were seen as time-efficient, commuters to the CBD noted that it was difficult to find a parking space after 8 AM, which may be up to an hour before they actually started work.

Some participants also rode motorcycles or had done so in the past. Those who had done so suggested that mopeds and scooters were more practical than motorcycles, at least in city areas, particularly in terms of manoeuvrability and storage space. The automatic transmission of mopeds and scooters was also said to be advantageous and relatively easy to use.

Participants generally claimed to enjoy riding, and although some said that they felt uncomfortable or unsafe in certain situations, nobody said that they did not enjoy riding overall. The experience of riding was said to offer a sense of freedom, heightened awareness and engagement with the outside world in comparison with car driving. Certain conditions such as poor weather appeared to reduce enjoyment levels generally, but one participant claimed that wet weather actually enhanced the riding experience for him.

Environmental considerations were occasionally mentioned as a secondary motivating factor, but not as a primary motivator for any participant. Fuel consumption, pollution and traffic congestion were mentioned as environmental problems which moped or scooter use could help to address, but these issues alone were apparently not significant motivators for riding.

3.2.2 Perceived hazards and related safety issues

All participants saw other vehicles as the primary threat to rider safety and the main hazard to be negotiated. Larger vehicles were seen as a greater threat than small cars. Key issues in relation to other vehicles were rider conspicuity, driver distraction and vigilance, lane positioning and proximity to other vehicles, aggressive behaviour of other drivers, and ability to keep up with traffic flows. This last point was particularly important for moped riders, who thought that the 50 km/h moped restriction is hazardous in speed zones of 60 km/h or above. The view that the moped speed restriction should be increased to 60km/h was frequently expressed. Some moped riders claimed that their moped was capable of speeds well above 50 km/h without any performance modifications. Defensive riding techniques were acknowledged as useful for reducing risk of collision with other vehicles. Techniques mentioned included maintaining buffer zones and adequate braking distance, and positioning oneself in traffic so as to maximise the chances of being seen by others. Opinions differed on the issue of rider conspicuity, with some participants stressing the importance of high visibility clothing while others claimed that this was of little value as many other road users simply failed to see them because they did not look.

Poor and contaminated road surfaces were mentioned frequently as being potentially hazardous, yet riders did not generally seek to avoid routes where these were known to exist. The particular vulnerability of small-wheeled mopeds and scooters to poor road surfaces was raised by several participants. Some riders expressed limited knowledge or had been misinformed as to how their vehicle might perform under certain conditions or through certain actions and in some instances this had apparently led to the adoption of unsafe riding practices. In particular, some young and inexperienced moped riders were reluctant or fearful concerning the use of front brakes, due to something they had heard from another rider.

Occasional deliberate risk-taking was acknowledged by several riders. Such behaviour included speeding, lane splitting or filtering through traffic and following too closely behind other vehicles. In the context of surrounding traffic flows it was generally thought that speeding was often a safer option than remaining at or below the speed limit. Following too closely behind other vehicles was said to be often difficult to avoid in congested traffic. The laws surrounding lane splitting (through moving traffic) and filtering (through stationary traffic) were poorly understood by some participants, thought the latter behaviour was thought considerably safer and more acceptable. Some male riders had engaged in sensation-seeking behaviour in the past, particularly competitive riding with groups of friends, which one participant described as 'stupid'. There was some knowledge expressed of how to modify a moped to increase engine power output, such as fitting aftermarket exhaust systems or removing 'restrictors'. Some riders had spoken to mechanics about carrying out such work, and at least one mechanic had refused to modify a moped as it is illegal to do so.

A number of riders spoke of involvement in low-speed crashes, one of which was said to result in serious injury. Participants had been involved variously in crashes with other vehicles and in single vehicle crashes, including some where riders claimed to be avoiding another road user. Crashes apparently occurred mostly due to other vehicles failing to yield, and to poor vehicle handling skills and road positioning on the part of riders. Some riders who had not crashed were unsure as to whether or not they would ride again after such an event, while some who had crashed and sustained injury continued to ride. When discussing various aspects of hazard perception and safety awareness, a sense of optimism was nearly always present among participants despite, perhaps ironically, a universal awareness of vulnerability. There was a general belief that hazards and risks are sufficiently manageable, and that riders' ability to do this increases with time and experience.

3.2.3 Rider licensing, training and education resources

When discussing rider training and the potential introduction of mandatory moped rider licensing in Queensland, participants clearly differed depending on whether or not they held a motorcycle licence and had therefore (usually) undertaken training. Moped riders without a motorcycle licence suggested that mandatory training and licensing was unnecessary as a moped is limited to low speeds and is easy to operate compared to motorcycles. By contrast, trained riders were adamant that training enhances rider safety regardless of the PTW type, but they also stressed that the benefits of training are only fully realised over time. It was clear that trained and licensed riders had better theoretical knowledge of safe riding practices when compared with moped riders who only held a car licence.

The objection of moped riders to mandatory licensing and associated training was apparently not founded solely on the belief that they would not benefit from it, nor that it would necessarily impose an unnecessary financial burden. On the question of whether or not they would be prepared to undertake a rider training or education course, answers seemed to relate to the perceived level of inconvenience this would impose. One rider said that they would be prepared to watch a video, but not attend a training program. Another rider said that they would take a short course of one or two hours, but would not commit to a full day of training.

When asked about educational resources concerning rider safety, approximately half of participants said that they rarely or never sought to obtain such information. Moped riders were largely unaware of where to source information on motorcycle and/or scooter safety and none of them appeared to have actively sought such information. If any such information was to be sought, interactive, online, video and other easily accessible formats were usually

preferred. On the whole participants who had not undertaken rider training seemed to derive their safety awareness largely from personal experience, or otherwise anecdotally.

3.2.4 Protective apparel

Discussions on use of protective apparel revolved around the perceived danger of not doing so, on inconvenience and discomfort, and the projected image as perceived by others. Some participants suggested that the limited speed of mopeds did not warrant going 'overboard' on protective apparel, and moped riders were less inclined than riders of larger scooters to wear any form of protection. The cost of protective apparel was prohibitive to some participants, but others responded to such claims by suggesting that certain items are less expensive than some riders believe. With few exceptions, participants expressed little knowledge of how to evaluate the quality or protective value of individual items. Some participants admitted to prioritising fashion and immediate comfort over protection, while others who did wear protective clothing appeared sometimes to be self-conscious about being 'overdressed'. As stated above, some riders sought to make themselves highly conspicuous by wearing bright or fluorescent colours and these riders were not particularly concerned about image. Others thought that conspicuity made little difference as they would often not be seen anyway.

4. Discussion

The observation study results confirm that mopeds and larger scooters represent a substantial proportion of PTWs in Brisbane's CBD. The high proportion of larger scooters relative to mopeds was surprising given sales and registration data showing increases in moped usage,

and considering the absence of a specific PTW licence for moped use. Despite provision of a new parking area in September 2008, PTW parking pressure remains intense in Brisbane's CBD with numbers continuing to increase thereafter with no further provision of spaces.

The motivations for moped and scooter use in Brisbane are consistent with those outlined in other research and are similar to those which drive motorcycle use (Kim et al., 1995; Faberi et al., 2004; FEMA, 2007; Broughton and Walker, 2009). However, mopeds and scooters were often said to be comparatively more practical in terms of size, manoeuvrability and storage space. The combined costs of vehicle purchase, fuel and city parking were seen to be substantially lower than public transport or cars in the long term, while scooter or moped use also offered greater perceived benefits in personal mobility, convenience and enjoyment. The possibility of a smaller environmental 'footprint' compared to car use seemed to reinforce other motivations for moped or scooter use rather than act as a primary driver in itself.

Qualitative research with Australian motorcyclists has previously discussed their belief that hazards and risks can be sufficiently negotiated and managed, and that ability to do this is directly related to experience (Natalier, 2001). Hence there may be similarities between motorcyclists and moped/scooter riders in this regard. The contention that hazard perception and response improves with experience has academic support, raising the question of whether hazard perception training can help to improve novice rider safety (Hosking et al., 2010). Both the Federation of European Motorcyclists Association (FEMA) and the Association of European Motorcycle Manufacturers (ACEM) advocate training for all novice riders, including moped riders (ACEM, 2010; FEMA, 2007). ACEM notes particular concerns regarding rider skills and decision making, and braking in particular, which training may help to address (ACEM, 2010). They do not suggest that testing should necessarily follow for all PTW classes, but this is clearly the common approach taken to validate rider skills and

knowledge. Given that some untrained moped riders in focus groups showed limited understanding of correct braking techniques and optimum lane positioning, and that trained riders tended to value training highly, it is tempting to argue that some training would benefit many riders. Unfortunately, due to the lack of rigorous evaluations to date, the potential impact of any particular moped rider training or education program remains unclear. Moped rider training evaluations from the Netherlands and Portugal are not highly supportive (Goldenbeld et al., 2004; Antonio and Matos, 2008). A survey has been developed to further investigate these and other issues with a larger sample of moped and scooter riders.

Despite detailed visual examination, some PTWs could not be identified as either mopeds or scooters. For certain models it is difficult to discriminate the two types of PTW when they are stationary, while it is also difficult if not impossible to discern whether a vehicle may have been modified from external examination. Given that MAIDS data suggest that illegal moped modifications may represent a risk factor for moped crashes (ACEM, 2008b), policing and enforcement of moped restrictions appears to present a considerable challenge for authorities.

4.1 Implications

The lack of a licence requirement for moped use other than the existing car licence requirement may not have been a substantial issue when there were relatively few mopeds in use. However, given the increased sales and usage of mopeds in Queensland, rider licensing now needs further examination. Although moped crashes are known to have increased substantially in Queensland between 2001 and 2005, an analysis of more recent crash data is warranted. The low top speed of mopeds may also require further investigation regarding the safety of particular routes taken. Given that PTW parking areas in inner Brisbane are often

filled to capacity, their use is now potentially constrained, raising the question of whether the supply of parking areas should be increased in order to meet demand. The extent to which parking availability actually motivates PTW use in Brisbane is not currently known and is a specific question within the rider survey mentioned above.

4.2 Limitations

Inclusion of all designated CBD parking areas was beyond the scope of the observation study. A lack of visible identifiers meant that it was not possible to distinguish mopeds from larger scooters in some cases during observation data collection. This was the case for only 1.5% of all PTWs observed and is therefore considered a minor limitation. It was not possible to reliably detect moped performance modifications by external examination.

Participants in the focus group study may not have been a representative sample of riders and the views they expressed may not necessarily reflect those of Brisbane moped and scooter riders generally. There is also the potential for some self-report bias. However, the diversity of participants' background and experience has likely ensured coverage of a wide range of topics and issues which would be relevant to most riders.

Acknowledgements

This research was undertaken as part of a PhD program with supplementary funding from the Queensland Department of Transport and Main Roads.

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Table 1

Powered two-wheelers (PTWs) observed by data collection phase, Brisbane 2008 - 2010

PTW type	Data collection phase									
	Aug 2008		Feb 2009		Aug 2009		Feb 2010		All phases	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Motorcycle	295	61.1	315	64.2	344	65.3	340	63.4	1295	**63.6**
Moped or scooter	188	38.9	176	35.8	183	34.7	196	36.6	742	**36.4**
Total	483	23.7	491	24.1	527	25.9	536	26.3	**2037**	100.0

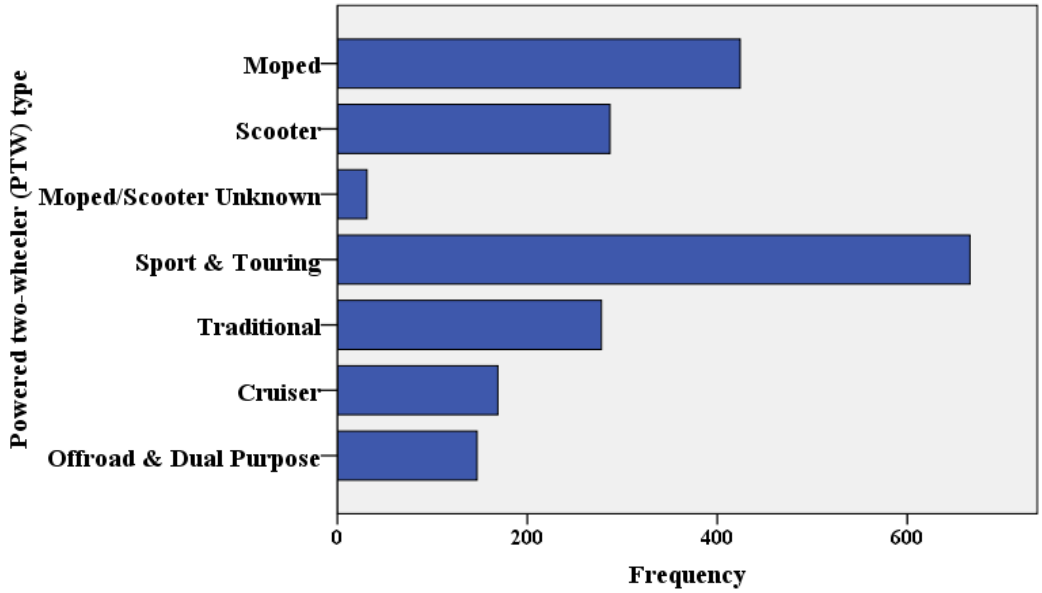

Fig. 1. Aggregate count of PTW types observed in Brisbane CBD parking areas, 2008 – 2010