Accident Analysis and Prevention xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia

Matjaž Šraml, Tomaž Tollazzi, Marko Renčelj*

University of Maribor, Faculty for Civil Engineering, Smetanova 17, 2000 Maribor, Slovenia

ARTICLE INFO

Article history:
Received 30 July 2010
Received in revised form
22 November 2011
Accepted 31 December 2011

Keywords:
Powered two-wheelers (PTWs)
Dangerous sections
Safety of PTW riders in Slovenia

ABSTRACT

Due to the 2006 European research report on powered two-wheelers (PTWs) riders' traffic safety, Slovenia represents the highest risk for PTW riders in the European Union. Namely, in Slovenia we have the largest number of PTW riders' deaths per billion travelled kilometers in 2006. Since then the traffic safety situation in the field of PTW riders in Slovenia has been improving and we will discuss that phenomenon in the present paper.

The paper identifies and analyzes the causes that led to such a critical situation. Further, the evaluation of activities that were carried out to improve the road safety for powered two-wheeler riders in Slovenia in the last past years are discussed. In conclusion a selection of measures and actions is presented that already has been and also should be carried out in the future.

1. Introduction

Riders of powered two-wheelers (PTWs) in the European Union (EU) are generally one of the most vulnerable groups of road users. What particularly concerns is the fact that the degree of difficulty of traffic accidents involving PTW riders is very high. Risk of traffic accident fatalities for PTW riders is 18 times higher than for the car drivers. Royal Society for the Prevention of Accidents (2010) reports that the level of traffic safety risk rises with the age of PTW riders. Until 1996, PTW riders accounted for 9.5% of all road accident fatalities in 2006, 6200 PTW riders died in traffic accidents in the EU, what already represents 16% of all road accident fatalities. On the other hand, PTW riders travelled only 2% of total travelled kilometers (ETSC, 2007).

There are 27 million mopeds and motorcycles with an engine of 50 cc or more registered in the countries of the EU (FEMA, 2007). Over the last five years a significant increase in the number of vehicles by 41% was recorded, while in the last 20 years the number was doubled. Travelled kilometers of different types of road vehicles for the last decade in the EU countries show a disproportionate increase of the number of kilometers travelled by PTWs for 49%, while for the other types of vehicles the increase is only 15%, which highlights the increasing use of motorcycles not only in urban areas but also in road traffic (ETSC, 2008b). Indeed, increased use of motorbikes and scooters is a result of some advantages that this type of in-service provides: less need for surface transport infrastructure, less traffic jams (the PTWs in comparison with other vehicles during peak traffic congestion require 16–48% less time to transport the same way), reduced fuel consumption (compared with other vehicles the fuel consumption for the same route is 55–81% lower), less space required for parking, etc.

PTWs are generally dynamical unstable vehicles, therefore the possibility for an accident is higher than that with other vehicles on the road. However, the influence of PTW riders is also very important, especially their psycho-physical capabilities. Lately, a lot of effort has been done concerning higher road safety of PTW riders in the EU. The EU financed several projects, e.g. investigation of accidentology (MAIDS, RIDER, etc.), improvement of passive safety (APROSYS SP4), understanding the sociology of riders (MAIDS, 2-BE-SAFE, etc.), advanced telematics for enhancing the safety and comfort of motorcycle riders (SAFERIDER). There are also some papers, e.g. official document on "Road safety as a right and responsibility for all" – a blueprint for the EU's 4th Road Safety Action Program 2010–2020 (ETSC, 2008a), and projects about road infrastructure safety of PTWs, e.g. RANKERS, RISER, GINA, Guidelines to Black Spot Management.

According to the report (ETSC, 2007) on "Road safety performance index", that ranked the safety of PTW riders in Europe, Slovenia "won" the first place: we have the largest number of PTW riders deaths per billion travelled kilometers in 2006 (more than 350, while the EU average was 86). Another very concerning fact is that we have the highest ratio of death rate per billion kilometers ridden by PTW riders to corresponding rate for car drivers in 2006 (ETSC, 2007) (more than 50, EU average 18). These two facts indicate that "PTW problem" in Slovenia needs to be discussed, well studied, and carefully treated.

* Corresponding author. Tel.: +386 22294372; fax: +386 22524179.
E-mail addresses: sraml.matjaz@uni-mb.si (M. Šraml), tomaz.tollazzi@uni-mb.si (T. Tollazzi), marko.rencelj@uni-mb.si (M. Renčelj).

0001-4575/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2011.12.013

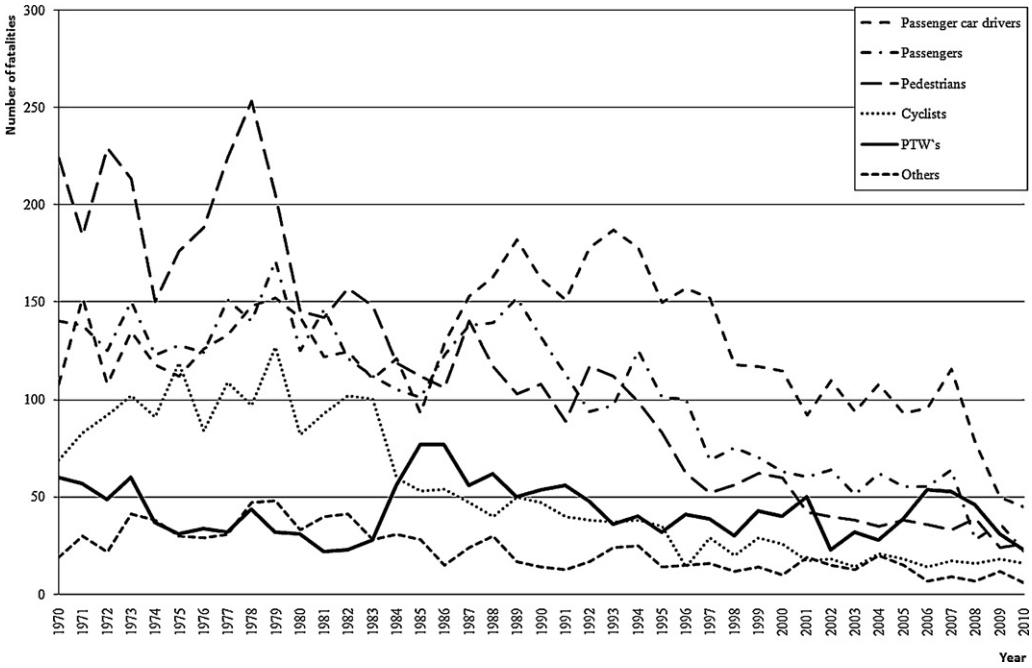

Fig. 1. Number of fatalities in road traffic in Slovenia in the period 1970–2010.

Regarding the development of traffic safety or road accidents and its consequences, Slovenia is rather unsteady country. There are two main reasons proving this fact:

- drastic change of number of road accidents and their consequences in the last 10 years;
- the so-called migration of road accidents with seriously injured and death casualties – considerable change in proportion regarding the individual traffic participants.

Statistical results for road accidents in Slovenia (in the period 1970–2010, see Fig. 1) showed that in the last 41 years there has been 18,805 fatalities, or in more detail, 620 fatalities in year 1970; the highest value of fatalities was in the year 1979 (735) and the lowest in the year 2010 (138). While in the analyzed period the number of fatalities – regarding different types of road participants – diminished and only the number of deaths of PTW riders remained stable throughout the period – with a significant increase in the last 10 years (from year 2000 to 2010): the average number of fatalities of PTW riders in the period 1970–2000 was 20.3 per year, while in the period 2000–2010 nearly every year the number of deaths of PTW riders was higher than the average value. Moreover, at almost 50% reduction of all fatalities (in road accidents) in the period 2002–2010 (see Fig. 2), the number of fatalities concerning

Fig. 2. Number of all fatalities and PTW's fatalities in the period 2002–2010, index value regarding year 2002.

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

Fig. 3. Proportion of PTW riders fatalities in the period 2002–2010.

PTW riders increased (index 100 for the year 2002) till year 2006. This is what should worry Slovenian experts dealing with traffic safety, particularly with the safety of PTW riders.

In the year 1970 PTW riders were among all participants in road accidents at the lowest level of fatalities, with only 9.68% of all fatalities in road accidents (36.13% pedestrians, 22.58% passengers, 17.42% passenger vehicle drivers, 11.13% cyclists, 9.68% PTW riders, and 3.06% other participants in road accidents). While the situation in year 2010 was completely different: PTW riders were equivalent to 16.7% of all fatalities in road accidents, they were in the third place after drivers and passengers of personal vehicles (18.84% pedestrians, 15.94% passengers, 32.61% personal vehicle drivers, 11.59% cyclists, 16.7% PTW riders, and 4.35% other participants in road accidents). Between years 2002 and 2010 (see Fig. 3) the proportion of PTW riders fatalities that died in traffic accidents increased from 8.5% to 16.7% (with the highest number of 21.5% in year 2008) – which was an emergency situation.

2. Causes for critical traffic safety situation of PTW riders in Slovenia

A road safety problem with PTW riders in Slovenia became prominent after year 2002. Since then we have recorded a significant increase in the number of traffic accidents with the involving PTWs: the number of fatalities of PTWs is, almost every year, substantially above the long-term average.

In order to establish causes that brought us to such a critical situation in the field of road safety of PTW riders the Ministry of Transport of Republic of Slovenia made a call for a research project. The objective of this project was to establish the causes for low level of road safety of PTW riders, evaluate the effects of already taken measures and suggest further measures. In this paper we expose main findings of this research project which our research group completed in 2010 at the University of Maribor, Faculty of Civil Engineering (Tollazzi et al., 2010).

In order to find real causes of accidents of PTW riders on public roads in Slovenia we derived from the cybernetic system "the driver – the vehicle and the environment (roads)". In our research we established the following causes which have a significant influence on bad traffic safety of PTW riders on Slovenian roads:

- number of registered PTWs;
- travelled kilometers per year;
- age of PTW riders involved in traffic accidents;
- dangerous road sections.

2.1. Number of registered PTWs

The diagram on Fig. 4 shows that (in Slovenia) from year 2002 the number of registered passenger cars increased by 18.7% while during the same period the number of registered PTWs increased by value of 79.8%. Moreover, number of registered L3 vehicles (according to MAIDS L1 represent mopeds and mofas while L3 represent motorcycles) increased in the same period by four times. That means an increase in the proportion of registered PTWs with respect to all registered motor vehicles from 5.04% in the year 2002 to 6.78% in the year 2010.

Other road participants (drivers of personal vehicles, bus drivers, as well as cyclists and pedestrians) did not expect such a drastic increase of number of registered PTWs on Slovenian roads and consequently did not pay enough attention to PTW riders as equal road participants. All this can cause problems and road accidents can occur due to the overlooked PTW riders, misjudged riders' speed, etc.

2.2. Travelled kilometers per year

Because of the increased number of registered PTWs the number of travelled kilometers of PTWs has also risen. A substantial increase of travelled kilometers per year on the national road network during the last decade has been noticed (see Fig. 5). For passenger cars there has been an increase of travelled kilometers from year 2002 to 2010 – on the national road network – for 23.2%. The value of travelled kilometers of PTW users is much higher – it has more than doubled in period 2002–2010.

2.3. Age of PTW riders involved in traffic accidents

Analysis for the period 2005–2008 (see Fig. 6) shows that in most accidents involving PTW riders the drivers are aged in the range of 18–44, with a significant emphasis from the age group of 24–34.

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

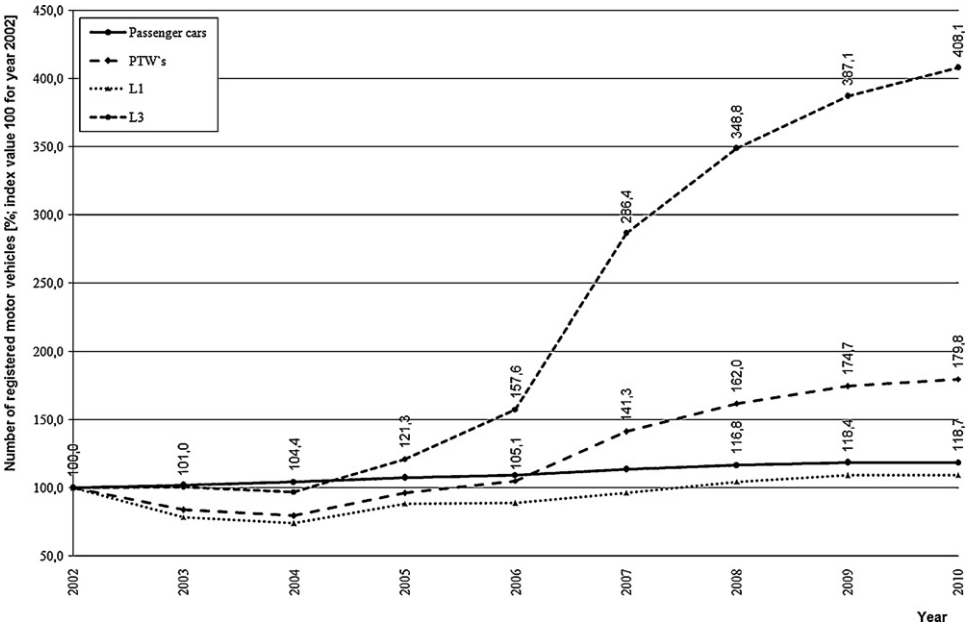

Fig. 4. Number of registered motor vehicles in the period 2002–2010, index value regarding year 2002.

2.4. Dangerous and potentially dangerous road sections

Within the already mentioned research project (Tollazzi et al., 2010) we also try to find roads/road sections on state roads in Slovenia, which could be (somehow) unsafe for PTW riders.

In the context of determining these road sections we started from two main origins: (i) first we tried to find road sections with higher number of PTW accidents (than on comparable ones) and secondly (ii) to discover potentially dangerous road sections (road sections with higher portion of PTWs than on comparable ones). For these analyses we used already available data, that is data about traffic system and PTW traffic in Slovenia (source: Slovenian Road Agency) and data about PTW accidents (source: statistical database, Ministry of the Interior, Police).

Dividing the unsafe sections on two main categories (dangerous and potentially dangerous road sections) is also meaningful in terms of road management: in these sections where the number of traffic accidents with PTW drivers involved is higher than that in other comparable segments, it is reasonable to think about short-term (immediate) actions.

On road sections which were identified as potentially dangerous it is reasonable to think of preventive action, e.g. installation of traffic signs and signals to inform participants on the road section that a larger number of PTW drivers are present in the structure of traffic flow.

2.4.1. Identification of dangerous road sections

When searching for reasons for low level of traffic safety of PTW riders in Slovenia, one of our main goals was to find infrastructure

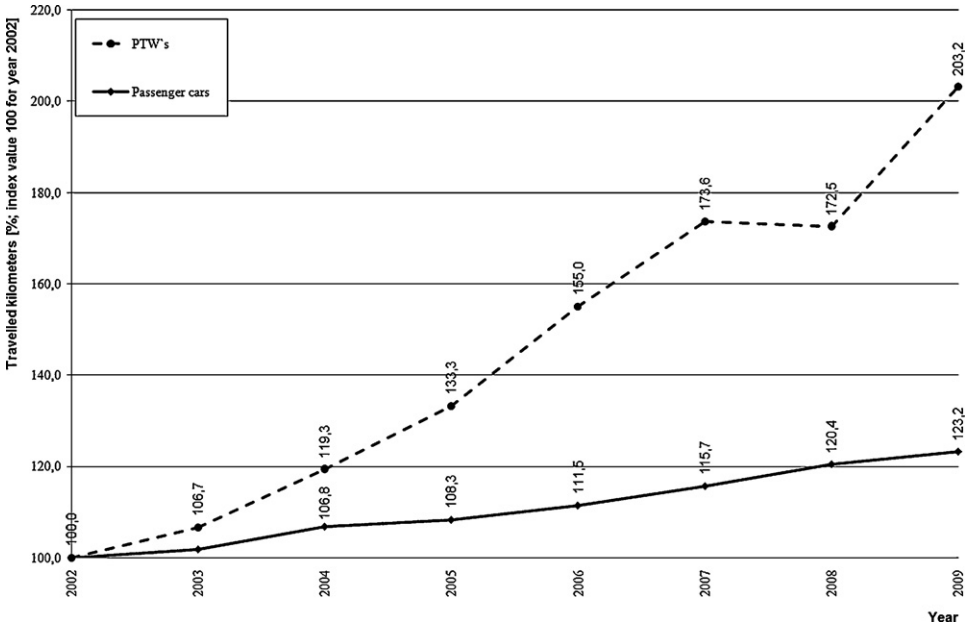

Fig. 5. Travelled kilometers (passenger cars, PTWs) in the period 2002–2009, index value regarding year 2002.

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

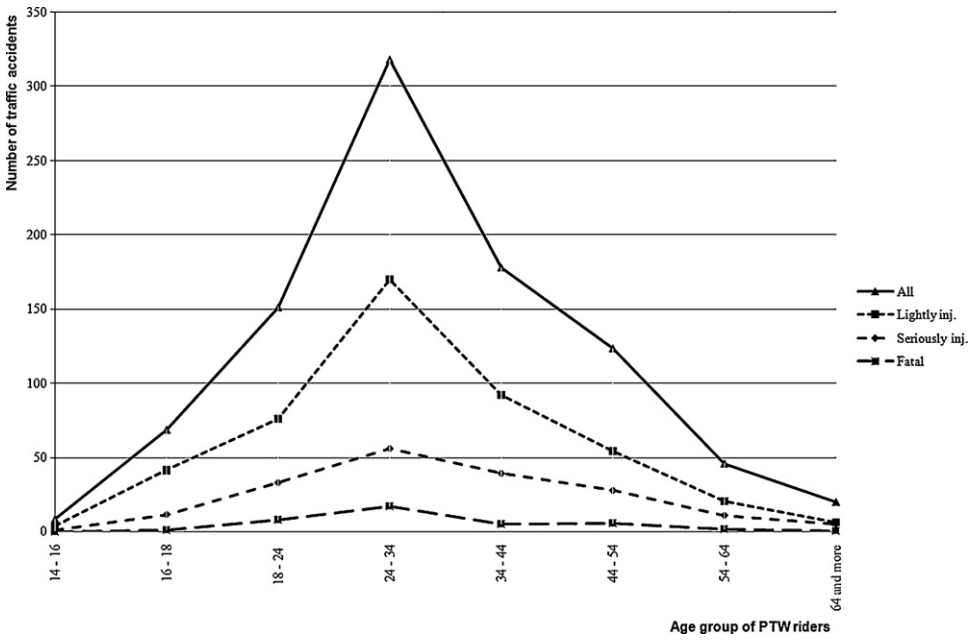

Fig. 6. Age classes of PTW riders involved in traffic accidents (separately for different type of accidents), summarized for the period 2005–2008.

related causes. According to that we (i) determined the location on state roads in Slovenia with high concentration of PTW riders traffic accidents, (ii) exposed causes for these accidents, and (iii) recommended measures for the elimination of the causes of accidents arising from the road infrastructure (design, construction, and maintenance).

As a road section with high concentration of PTW riders traffic accidents in our research project (Tollazzi et al., 2010) we defined a road segment where more traffic accidents with PTW riders have occurred over certain period of time as in other comparable road sections. For these analyses we used the so-called sliding window method (Elvik, 2008). In our case it was appropriate to use window of fixed length (1.0 km) which was moved forward one step at a time (each step corresponding to the length of 100 m). As a result of the performed analyses we obtained the most critical sections on the national road network in Slovenia where over the period 2003–2008 traffic accidents condensation involving PTW riders occurred.

The analysis showed that in the period 2003–2008 two road sections (length of 1 km) stood out, namely the sections where 33 and 23 traffic accidents with PTW riders involved occurred. On the other analyzed road sections there were 10 (and less) accidents with PTW riders involved in the same period of time. These two road sections represent regional roads with low traffic volume (AADT less than 2000 vehicles per day), settled in the hilly terrain (curved road alignment, small radius of horizontal curves, etc.). Subsequent analysis showed that these (and similar) road sections are used by PTW riders in Slovenia to exploit the wanton driving and testing driving capabilities (driving fast through curves, etc.).

2.4.2. Identification of potentially dangerous road sections

In order to find potentially dangerous sections of national roads we performed the identification of these segments where number and/or proportion of PTWs in traffic flow is the highest (Tollazzi et al., 2010).

As a basis for this identification of potentially dangerous sections in the national road network in Slovenia we analyzed database about motorized traffic on the national road network in 2007 (DRSC, 2010).

Identification of potentially dangerous road sections was performed on the basis of two criteria: (i) the absolute number of PTWs in the traffic flow and (ii) the proportion of PTWs in the traffic flow.

The results of the analysis showed that the largest share of PTWs in the traffic flow occur at low-volume tourist recreational roads. Share of PTWs on these roads is relatively high: the top 10 road sections have share of PTWs from 6.8 to 71.8%. Additionally, AADT on these roads are below 1000 vehicles per day. Furthermore, it has to be pointed out that traffic accidents on these sections are relatively rare.

2.5. Summary of findings

Based on the data analysis of traffic accidents with PTW riders on Slovenian roads in the period 2006–2008 (Tollazzi et al., 2010) the following key findings may be pointed out:

- for PTW riders in Slovenia the risk of being killed in a traffic crash is 40 times higher than that for a car occupant;
- although in all traffic accidents with injured participants PTW riders were involved in only 6.5% of these accidents, accidents with PTW participants resulted in 71% of all injuries;
- proportion of fatalities of PTW riders (compared with all fatalities in traffic accidents) in urban areas is 13% and outside these areas 26%;
- accidents where PTW riders were involved mainly occur on the main and regional state roads and in urban areas with street system;
- among accidents of PTW riders there is almost 43% of the so-called individual (solo) PTW riders accident in which no other vehicles are involved; collisions of PTW riders with passenger cars represent 29% of PTW riders' accidents;
- in accidents where PTW riders were involved there were 62% accidents with PTW riders causing the traffic accidents;
- most of the accidents (92%) involving PTW riders occurred on the so-called "open roads" (road sections), on dry road surface; main cause of accidents is unadjusted speed (53%);
- PTW riders were equipped with helmets in most traffic accidents;
- typical for accidents with PTW riders involved is that in most cases the riders hold their driving license for less than 3 years.

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

3. Activities for improving traffic safety of PTW riders in Slovenia

As pointed out in Section 1, critical traffic safety of PTW riders in Slovenia revealed an alarming situation that requires appropriate and immediate actions. Improved traffic safety situation of PTW riders in Slovenia, as reflected from the recent years (see Fig. 2), is mostly attributable to the measures implemented by:

- the National Road Safety Program (NRSP), time period 2007–2011;
- the Ministry of the Interior Affairs (Police);
- the Slovenian Road Agency.

3.1. The National Road Safety Program for the period 2007–2011

The NRSP pays additional attention also to traffic safety of PTW riders in Slovenia. To improve the traffic safety the following activities were defined:

- implementation of programs for novice drivers (also for PTW riders), e.g. practice of safe driving, workshops about traffic safety, teaching about psycho-social relations between participants in road traffic, etc.;
- organizing workshops (or other forms) to pass on experiences about safe driving, promotion of strategies for safer driving (experiences as advice, workshops at motorcycle clubs, etc.);
- implementation of monitoring program for novice drivers (additional obligations after the final exam);
- control over the use of safety helmets;
- control at locations where accidents with PTW riders involved are frequent;
- promotion of the integration of PTW riders in motorcycle clubs.

3.2. Measures of the Slovenian Ministry of the Interior Affairs (Police)

Slovenian Police is, according to the National Road Safety Program (2007–2011), actively involved in the implementation of PTW safety improvement. The following activities were defined:

- systematic control over participants in road traffic who frequently break the road traffic regulations;
- police presence at critical road sections, and in critical periods of time (particularly regarding the time of seasons), where traffic accidents with PTW riders involved were the most frequent;
- traffic control with helicopter and additional video-surveillance system;
- more intense traffic controls in cities and settlements;
- co-organization of workshops, etc.

3.3. Measures of the Slovenian Road Agency

Slovenian Road Agency is also actively involved in implementing measures to improve traffic safety for PTW riders. The measures are primarily orientated to ensure safe road infrastructure for PTW riders. Implemented measures include:

- installation of additional security elements for PTWs (see Fig. 8) on existing guardrails (in the period from 2005 to 2010 implemented at total length of 16.1 km);
- installation of traffic signs which warn PTW riders on a dangerous road section (in the period from 2005 to 2010 there were 62 signs installed);
- installation of traffic signs which warn drivers on "black spot" location (in 2010 there were five signs installed);
- installation of permanent (fixed) speed cameras (two of them were installed in 2010);
- testing installation of additional road markings on critical road sections (additional warning for PTW riders, sign for speed limit, etc.);
- realization of a research project "Measures to improve traffic safety of PTW riders in Slovenia" (Tollazzi et al., 2010); the project aimed to identify causes for critical traffic safety of PTW riders and for potential locations with congestion of traffic accidents involving PTW riders on the national road network; the project also proposed measures for improving traffic safety of PTW riders in Slovenia.

We have to point out that there are also some other activities that support improvement of traffic safety of PTW riders in Slovenia, for example civil associations campaigns, medias (various publications, brochures, information on the internet, etc.).

4. Proposal of further actions to improve traffic safety of PTW riders in Slovenia

Some road safety problems have persisted for a long time in nearly all motorized countries, suggesting that they are not easily solved (Elvik, 2010). The current situation in the field of road safety in Slovenia is – despite the highly ambitious plans – still not satisfactory. It has to be admitted that traffic safety in Slovenia has been improved during the last few years but we still have not achieved the objectives of reducing road accidents, injured participants, or dead casualties – also within PTW riders.

According to the main findings presented in the manuscript and taking into account the conclusions of the performed research (Tollazzi et al., 2010) we may therefore re-summarize those main causes and factors that mainly contributed to the critical traffic safety of PTW riders in Slovenia:

- from the year 2002 (and especially in the last five years) we have noticed extreme increase of the number of registered PTW (see Fig. 4 for details); consequently this results in more PTW users on the roads with some negative effect: other users in road traffic are not yet completely accustomed to adopt/accept PTW riders on our roads as permanent participants;
- geographical position of Slovenia indicates reasons for large amount of transit traffic which results in several foreign drivers on Slovenian roads, especially during the summer; in conjunction with this fact we should mention different characteristics of drivers, e.g. travelling on unknown roads, etc.;
- climatic conditions in Slovenia limit PTW usage to the period of five months (from May to September); consequently the number of travelled kilometers by PTWs in Slovenia is relatively small; that also means that PTWs riders have difficulties to obtain necessary experiences;
- especially young PTW riders are using Slovenian roads as a racing track: the fact is that in Slovenia there are currently no suitable racing tracks for PTW riders (or any others);
- "racing" of PTW riders occurs primarily on the sections that are identified as attractive for PTW users: sections with low traffic volume, "wrapped" road with curved road serpentines, etc.; these road sections were in most cases identified as sections with increased traffic accident condensation, i.e. dangerous sections;
- driving schools in Slovenia, in most cases, do not posses appropriate facilities, i.e. driving polygons where PTW users can – during the process of obtaining a driving license – test all potentially

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

Fig. 7. Marking a dangerous road section for PTW riders with additional traffic sign.

dangerous situations and improve their skills of riding PTWs after obtaining a driving license;
- following the performed analysis of identifying dangerous road sections on Slovenian roads we can conclude that no particular irregularities of the road infrastructure (the geometric elements of road, cross fall, traffic signalization, and equipment) were identified; therefore, we can establish that the road infrastructure is not the main reason for traffic accidents condensation, involving PTW riders, on particular dangerous road section.

Present findings represent our proposals to improve the existing traffic safety of PTW riders in Slovenia. Nevertheless, regarding the results from the analysis about PTW riders' safety, we suggest some additional measures/actions for improving traffic safety situation of PTW riders in Slovenia. The proposed process has two main directions:

(i) the so-called "immediately actions" (which attempt to calm the current situation):
   - installing non-traffic signalization at dangerous sections for additional attention of PTW riders;
   - the introduction of additional definitions in the regulations and legislation relating to road design in order to reduce the possibility of continued occurrence of traffic accidents with PTW riders;

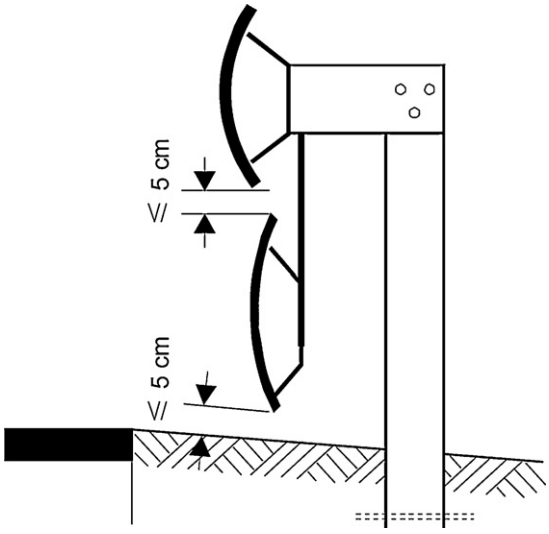

Fig. 8. Guardrail with additional protection for PTW riders: schematic sketch.

Fig. 9. Guardrail with additional protection for PTW riders: application on road section.

(ii) "preventive action" (in order to prevent the continuation of current situation in the future):
   - issue of booklets dealing with road safety for PTW riders, intended for all motorized road users;
   - introduction of additional definitions in the regulations and legislation relating to road design in order to reduce the risk of accidents with PTW riders in the future.

At this moment installation of non-traffic signalization for PTW riders is being applied to all national roads with dangerous and potentially dangerous sections to warn all PTW riders about possible dangerous sections (see Fig. 7). On these sections some fatalities already occurred in the past.

Technical specifications for the security fence setting (DRSC, 2008) are added to legislation that provide for mandatory installation means and methods for installing additional blades on a steel security fence on dangerous locations on existing roads to prevent serious injury or fatalities of PTW riders (see Figs. 8 and 9).

Under the jurisdiction of the Ministry of Transport of Slovenia a third brochure has been issued in order to improve road safety for PTW riders (DRSC, 2009). The leaflets deal with the strength of PTW riders on road safety problem, the dynamics of the motorcycle driving, braking distance, braking process, correct driving at the time of raining, suggestions of the police, etc. These brochures also include interviews with media personalities that are also PTW drivers.

5. Conclusion

The results of the analysis of statistical data on road safety of PTW riders for the period 2002–2010, presented in this paper, are alarming, especially for the period 2002–2006.

Therefore, we have systematically analyzed main causes for critical traffic safety situation of PTW riders in Slovenia, with main focus on dangerous road sections. We can summarize the following key findings: (i) although PTW riders were involved in only 6.5% of all traffic accidents with injured participants, accidents with PTW participants resulted in 71% of all injuries; (ii) proportion of fatalities of PTW riders (if compared with all fatalities in traffic accidents) is 13% in urban areas and 26% outside urban areas; (iii) among accidents of PTW riders there is almost 43% of the so-called individual (solo) PTW riders accidents in which no other vehicles are involved; (iv) most of the accidents (92%) involving PTW riders occurred on the so-called "open roads" (road sections), on dry road surface; main cause of accidents is unadjusted speed (53%).

Following these facts, we have implemented different measures and activities which should improve PTW riders traffic safety, e.g.: (i) implementation of programs for novice PTW riders; (ii) organizing workshops to pass on experiences about safe driving and

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013

promotion of strategies for safer driving; (iii) control over the use of safety helmets; (iv) control at locations where accidents with PTW riders involved are frequent; (v) systematic control over participants in road traffic, who frequently break the road traffic regulations; (vi) police presence at critical road sections, and in critical periods of time, where traffic accidents with PTW riders involved were the most frequent; (vii) traffic control with helicopter and additional video-surveillance system; (viii) installation of additional security elements for PTWs (see Fig. 8) on existing guardrails; (ix) installation of traffic signs which warn PTW riders on a dangerous road section; (x) installation of traffic signs which warn drivers on "black spot" location; (xi) installation of permanent (fixed) speed cameras; (xii) testing installation of additional road markings on critical road sections (additional warning for PTW riders, sign for speed limit, etc.).

Although several activities have been described to improve PTW's safety, the main goal of this paper was to deal with a detailed proposed approach to improve the existing situations and measures for the immediate and long-term improvement of road safety for PTW riders. Two levels of possible improvements (solutions) are proposed. First is the so-called level of "immediately actions", which deals with immediate actions, covering the implementation of physical and administrative measures and the introduction supplement with the existing regulations on road equipment. The second level represents a set of preventive measures which would reduce the number of motorcycle accidents in the near future. At that point we have to emphasize that the trend of improving PTW's traffic safety due to the number of PTW riders fatalities in the last five years (2007–2011) is significantly improving, especially if compared with critical situation till year 2006 when the number of fatalities concerning PTW riders increased enormously (see diagram on Fig. 2).

Finally, we suggest further systematical monitoring of PTW riders safety, starting from analysis of the causes and results of implemented measures, in Europe and Slovenia.

References

Royal Society for the Prevention of Accidents (ROSPA), 2010. Road Safety Resources for Motorcyclists, http://www.rospa.com/roadsafety/resources/motorcyclists/ (retrieved 15.07.10).

European Transport Safety Council (ETSC), 2007. Road Safety Performance Index (PIN), PIN Flash 7 – Reducing Motorcyclist Deaths in Europe, http://www.etsc.eu/documents/copy_of_copy_of_copy_of_PIN%20Flash%207%20Reducing%20motorcyclist%20deaths%20in%20Europe.pdf (retrieved 15.07.10).

Federation of European Motorcyclists Associations (FEMA), 2007. A European Agenda for Motorcycle Safety, http://www.fema.ridersrights.org/docs/EAMS2007.pdf (retrieved 15.07.10).

European Transport Safety Council (ETSC), 2008b. Road Safety Performance Index (PIN), 2nd Road Safety PIN Annual Report, http://www.etsc.eu/documents/copy_of_copy_of_2nd%20PIN%20Annual%20Report%202008.pdf (retrieved 15.07.10).

Elvik, R., 2008. A survey of operational definitions of hazardous road locations in some European countries. Accident Analysis and Prevention 40, 1830–1835.

Elvik, R., 2010. Why some road safety problems are more difficult to solve than others. Accident Analysis and Prevention 42, 1089–1096.

Ministry of Transport, Slovenian Roads Agency (DRSC), 2010. Traffic Data, http://www.dc.gov.si/si/promet/ (retrieved 15.07.10).

European Transport Safety Council (ETSC), 2008a. Policy Papers, "Road Safety as a Right and Responsibility for All" – A Blueprint for the EU's 4th Road Safety Action Programme 2010–2020, http://www.etsc.eu/documents/Blueprint_for_a_4th%20Road_Safety_Action_Programme_ETSC_Sept%2008.pdf (retrieved 15.07.10).

Tollazzi, T., et al., 2010. Ukrepi za izboljšanje ravni prometne varnosti voznikov koles z motorjem in motornih koles (Provisions for improvement level of traffic safety moped drivers and PTW riders). Research Project for Ministry of Transport, Slovenian Roads Agency.

Ministry of Transport, Slovenian Roads Agency (DRSC), 2008. Technical specification, Varnostne ograje – Pogoji in način postavitve (Security fence – conditions and methods for application). http://www.dc.gov.si/si/ceste/tehnicne_specifikacije_za_ceste/izdane_ts/ (retrieved 15.07.10).

Ministry of Transport, Slovenian Roads Agency (DRSC), 2009. Publication for PTW Riders, http://www.supermotorist.si/images/stories/pdf/brosura_hitrost.pdf (retrieved 15.07.10).

Please cite this article in press as: Šraml, M., et al., Traffic safety analysis of powered two-wheelers (PTWs) in Slovenia. Accid. Anal. Prev. (2012), doi:10.1016/j.aap.2011.12.013