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Understanding risk taking behaviour within the context of PTW riders:

A report on rider diversity with regard to attitudes, perceptions and behavioural choices

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Executive summary

The rationale behind this report is to serve as a guide or point of reference for the research work to be undertaken on PTW riders within the 2BeSafe project in general, and WP3 in particular. By providing a comprehensive and concise review of the current literature, as well as outlining relationships with ongoing debates & developments in the field, we hope to provide valuable insight into the complex and heterogeneous domain of PTW riders, their environment and their safety. Aspects related to PTW risk, as demonstrated by accidentology figures have been included using input from WP1 (In-depth accident analysis) of the 2BeSafe project. With regard to diversity, we have as our aim, within the remit of this report, to showcase the spectrum of varied identifications in both bike and rider styles; motivations for risk taking, as well as cross-regional national factors such as legislation, enforcement and cultural preferences. It goes without saying that the more information we have on rider characteristics and motivations, the greater the likelihood that countermeasures can more effectively target the problem.

The report is structured to provide the reader first some perspective into rider and bike diversity, then moving from there towards unpacking the domains of hazard perception and risk taking. Having discussed both these variables in detail, the logical next step in the report is to investigate the correlation between the two, where we look at risk-taking behaviours within the context of motorcycling. Moving from this broader level of analysis, the report then focuses on the specific areas of interest, such as the cognitive, behavioural and societal dimensions influencing rider risk taking. This spans a wide range of highly relevant topics including methods and tools for assessing cognitive aspects of risk taking, to attitudes and personality factors that influence behaviour, and finally a look at legislations and countermeasures proposed by various European states that aim to regulate risk taking behaviour for riders.

In terms of future work, this report will directly feed into the next stage of activities within WP3, where experiments will be designed to investigate more deeply the area of risk perception within the context of PTW riders.

1. Introduction - The Rider & the Bike: Some perspective

1.1. Why Motorcycling?

Why is it relevant to examine rider/bike diversity, rider motivations, or the behavioural and cognitive factors that contribute to their overall safety? We undertake this exercise within the remit of this report because we want to understand why PTW riders are over-represented in the crash statistics, and also ask if this is a product of risky behaviour. Recent studies have shown that there is a positive association between risk-taking behaviour and the likelihood of being involved in road crashes (Gregersen and Bjurulf, 1996; Stevenson et al., 2003). Investigating these risky behaviours and understanding the motivations behind them is crucial to designing safety interventions. In the UK, a motorcyclist is 40 times more likely to be killed than any other type of road user (Department for Transport, 2008). A similar estimate comes from the USA, with PTW riders being 34 times more likely to suffer a fatality (2004 data), and the European Transport Safety Council (2007) reported that 16% of road fatalities across Europe were PTW riders although they accounted for only 2% of roadway exposure. WP1 of the 2BeSafe project provided some insight in relation to rider risk and rider characteristics.

PTW accidents are potentially more dangerous when compared to car accidents. The small size which most times is accompanied by a relatively powerful engine increases risk and severity of accidents, due to greater stability loss at low speeds, difficulty in controlling and coordinating body, type friction loss in pure surface conditions and high acceleration capabilities, as wel as the associated difference & difficulty in braking. Riders must focus on coordinating speed and body lean, and managing traction and control, while navigating various surfaces, curves and conditions. The lack of a protected vehicle compartment means that motorcycle riders and passengers are much more vulnerable to injury in crash situations. Furthermore, the task of operating a motorcycle is much more demanding than operating a passenger vehicle. Moreover, the small size increases the risk of accidents, as car drivers fail to detect them or predict their manoeuvres.

There are currently an estimated 33 million PTWs in circulation in the EU 27 countries, from small 50cc mopeds to powerful motorcycles (ERF 2008). These represent about 14% of the entire European private vehicle fleet (cars and PTWs only), but they account for around 17% of the fatalities.

PTW use varies across EU. Table 1 depicts the portion of PTW per 1000 inhabitants for different European countries; the first place taken by Greece with 150 mopeds (<50 ccm; 45 km/h max. speed) and 100 motorcycles per 1000 inhabitants. In United States, since the mid-1990's, motorcycle use for commuting and recreational purposes has been on the rise, with motorcycle registrations having increased 61 percent between 1996 and 2005 (NHTSA, 2006).

Table 1: PTWs per 1000 inhabitants across Europe (year 2005; source IRTAD).

Country	PTW/1000 inhabitants		
	Mopeds	Motorcycles	Total
Greece	150	101	251
Italy (2004)	90	79	169
Switzerland	24	80	104
Spain	53	42	95
Austria	36	38	74
Czech Rep.	43	31	74
Germany	22	46	68
Netherlands	34	33	67
Portugal	40	14	54
Norway (2004)	32	21	53
Finland	25	27	52
Sweden	18	26	44
France	19	22	41
Belgium		33	33
Denmark	12	18	30
Slovenia	17	7	24
Great Britain	2	19	21
Poland		20	20
Hungary		11	11
Ireland (incl. moped)		8	8

In the recent years, the PTW community has experienced extraordinary growth with the number of PTWs on European roads more than doubling over the last two decades; and PTW sales are expected to continue to increase over the next decade in some countries. This is due, in part, to the re-use of the urban space, which is reducing the space available for cars. In dense urban areas, where traffic density is high, the PTW emerges as a desirable potential candidate for individual trips.

In the last 20 years, the average age of PTW riders killed on the roads has been increasing; motorcycling is no longer a youth phenomenon, due in large part to the high cost of insurance and the cost of equipment, clothing, testing and training. Over the last 5 years, there has been a 41 percent increase in the number PTWs in circulation in Europe. Within the EU Member States, there are now more than 27 million in use, including mopeds, scooters and motorcycles, which range from less than 50cc to over 1000cc in engine size.

1.2. Who are these riders we speak about?

It is important to note the heterogeneity of the population of motorcyclists, both in their riding styles and their motorbikes, as this relates to their motivations to use it as a mode of transport. For many riders, a motorbike is only a means of travel, one among many other alternatives. The perceived advantages of using a PTW range from it being sometimes cheaper than the car (i.e. economic), or effectiveness in overcoming urban congestion and traffic constraints, or simply to find parking. These advantages afforded by riding a motorbike, justify its use over a car, even if the risk of having an accident is greater by doing so. However, this "utilitarian" use of the motorcycle is not the main motivation for most riders. For a large part of motorcyclists, the motorbike is above all a source of pleasure. It is also an object of identification and a means of belonging to a particular community of "bikers", each of which correlates the social representations

and identity models to the motorcycle. While some define it essentially as an instrument of freedom and a means of escape or pleasure, others combine the thrill of speed with the perceived control over a powerful machine in difficult driving conditions, to motivate them to take certain risks.

Table 2 below shows the percentages of motorcycle and moped rider fatalities by age group and gender. Figures show that approximately 30% of the total PTW fatalities are less than 25 years old. Moreover, male fatalities are higher than female fatalities. Meanwhile Table 3 depicts the PTW fatalities observed in the year 2006 by gender and user type (driver/passenger). Less than 8% of fatalities refer to passengers. The fatality rate of passengers is relatively high in Italy and Greece.

Table 2: Percentage of motorcycle and moped rider fatalities by age and gender, 2006.

(Source: CARE Database / EC 2008).

Age group	0-14		15-24		25-44		45-64		>64		%F. from known	Un-known
Gender	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.		
BE	0,0	1,2	3,6	22,9	4,2	43,4	1,8	19,3	0,6	3,0	10,2	0,0
CZ	0,0	0,9	1,7	22,4	2,6	54,3	1,7	12,1	0,0	4,3	6,0	0,0
DK	0,0	2,2	4,4	28,9	4,4	28,9	2,2	17,8	0,0	11,1	11,1	0,0
EE	0,0	0,0	0,0	0,0	0,0	85,7	0,0	14,3	0,0	0,0	0,0	0,0
EL	0,0	0,8	2,2	30,6	3,6	43,7	0,6	11,9	0,0	6,0	6,5	0,6
ES	0,4	1,3	2,2	24,2	3,4	47,2	1,0	13,7	0,3	4,6	7,3	1,8
FR	0,1	0,7	3,5	32,8	2,4	39,1	1,4	16,5	0,5	2,3	7,9	0,7
IE***	0,0	0,0	0,0	25,5	0,0	65,5	0,0	5,5	0,0	0,0	0,0	3,6
IT**	0,3	1,1	2,7	23,3	3,8	45,4	0,8	13,0	0,5	6,1	8,0	3,1
LU****	-	-	-	-	-	-	-	-	-	-	-	-
HU	0,0	0,8	0,8	17,6	2,3	55,7	1,5	17,6	0,0	3,8	4,6	0,0
MT	0,0	0,0	0,0	50,0	0,0	50,0	0,0	0,0	0,0	0,0	0,0	0,0
NL***	0,0	1,1	5,8	20,6	2,1	37,6	1,6	16,9	1,6	12,7	11,1	0,0
AT	0,0	0,7	3,7	20,1	6,0	29,9	2,2	28,4	0,0	9,0	11,9	0,0
PL*	0,0	2,9	1,0	34,3	2,4	38,1	1,0	11,4	0,5	7,1	4,8	1,4
PT	0,0	1,0	2,4	20,0	1,5	44,4	0,5	18,0	0,5	10,7	4,9	1,0
FI	0,0	0,0	2,6	43,6	2,6	25,6	0,0	15,4	0,0	10,3	5,1	0,0
SE	0,0	0,0	1,4	21,4	5,7	31,4	4,3	27,1	0,0	8,6	11,4	0,0
UK*	0,0	1,0	0,5	23,5	2,8	50,9	1,3	17,8	0,2	2,0	4,7	0,2
Moped	0,3	3,0	5,8	37,2	2,0	19,0	1,1	15,5	0,9	13,8	10,0	1,5
Motorcycle	0,1	0,3	1,3	22,0	3,5	52,9	1,2	15,1	0,2	2,0	6,3	1,3
EU-19	0,1	1,0	2,5	26,0	3,1	44,1	1,1	15,2	0,4	5,1	7,3	1,3

*Data from 2005, UK (GB (2006) + NI (2005)) ** Data from 2004 ***Data from 2003 **** Data from 2002

Table 3: Driver and passenger fatalities on motorcycle and mopeds, 2006.

(Source: CARE Database / EC)

Gender	female		male		SUM		
Type of user	driver	passenger	driver	passenger		%driver	%passenger
BE	10	7	146	3	166	94,0%	6,0%
CZ	2	5	104	5	116	91,4%	8,6%
DK	3	2	39	1	45	93,3%	6,7%
EE	0	0	7	0	7	100,0%	0,0%
EL	10	22	431	33	497	88,7%	11,1%
ES	28	30	689	34	788	91,0%	8,1%
FR	49	38	991	28	1.106	94,0%	6,0%
IE***	0	0	50	3	55	90,9%	5,5%
IT**	59	71	1.265	63	1.458	90,8%	9,2%
LU****	0	0	0	0	0	-	-
HU	4	2	121	4	131	95,4%	4,6%
MT	0	0	1	1	2	50,0%	50,0%
NL***	16	5	164	4	189	95,2%	4,8%
AT	12	4	114	4	134	94,0%	6,0%
PL*	2	9	191	8	210	91,9%	8,1%
PT	6	6	210	11	234	92,2%	7,3%
FI	1	1	37	0	39	97,4%	2,6%
SE	6	2	61	1	70	95,7%	4,3%
UK*	20	10	569	14	613	96,1%	3,9%
Moped	115	41	1.284	75	1.517	92,2%	7,7%
Motorcycle	113	172	3.906	143	4.343	92,5%	7,3%
EU-19	234	239	5.173	203	5.860	92,3%	7,5%

* Data from 2005 UK (GB (2006) & NI (2005)) *** Data from 2003 ** Data from2004

Current statistics show that Powered Two Wheeler (PTW) users are over-involved in fatal crashes. The OECD/ECMT International Road Accident Database (IRTAD) shows the total number of road fatalities in the last decade has decreased in EU-14, this has coincided with a corresponding increase in fatalities for PTW riders (see Figure 1).

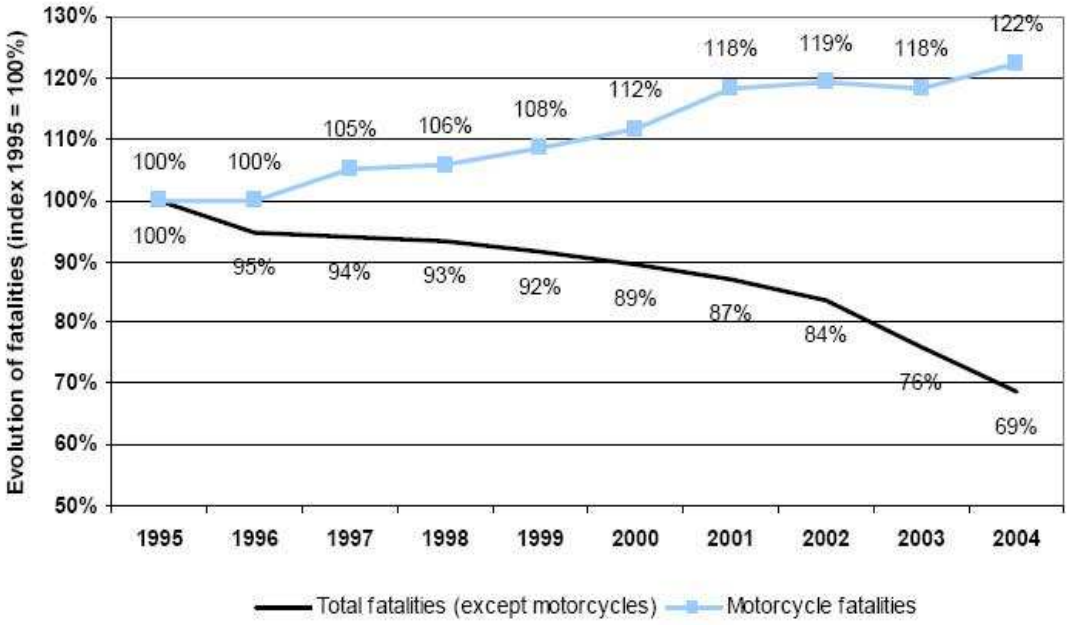

Figure 1: Evolution of total fatalities and motorcycle fatalities in EU-14,1995 - 2004 (Source: CARE)

The risk of having an accident for PTW riders, taking into account vehicle mileage ridden per annum varies considerably between European countries. It can also be seen that the accident risk for PTW riders is much greater than that for car drivers - depending on the country - it is between about 5 and 25 times greater.

PTW safety is significant within Europe. The CARE database indicates that in 2004, for the EU 14, there were 32,951 people killed on EU roads; 3,998 of these were riders and passengers of motorcycles and mopeds (CARE 2006). PTW rider fatalities contribute 22% of all traffic fatalities in 2006 in the EU-14 countries. Compared to the United States, where PTW crashes account for nearly 11 percent of all traffic fatalities in the United States (NCSA, 2007) the percentage is significant.

Figure 2 depicts the number of fatal accidents for cars and motorcycles respectively for different European countries. In 2006 alone, 1417 moped riders (driver/passenger) were killed in the EU-14, while motorcycle fatalities were approximately 3977 for the same year. The numbers show that moped fatalities decrease with an average annual rate of 6% during the last decade. Only, in 2003, mopeds fatalities have exhibited an increase of approximately 3%. For motorcycles, an average increase of 1,4% per year is observed. However, a trend in motorcycle use is not evident for the period of 2002-2006.

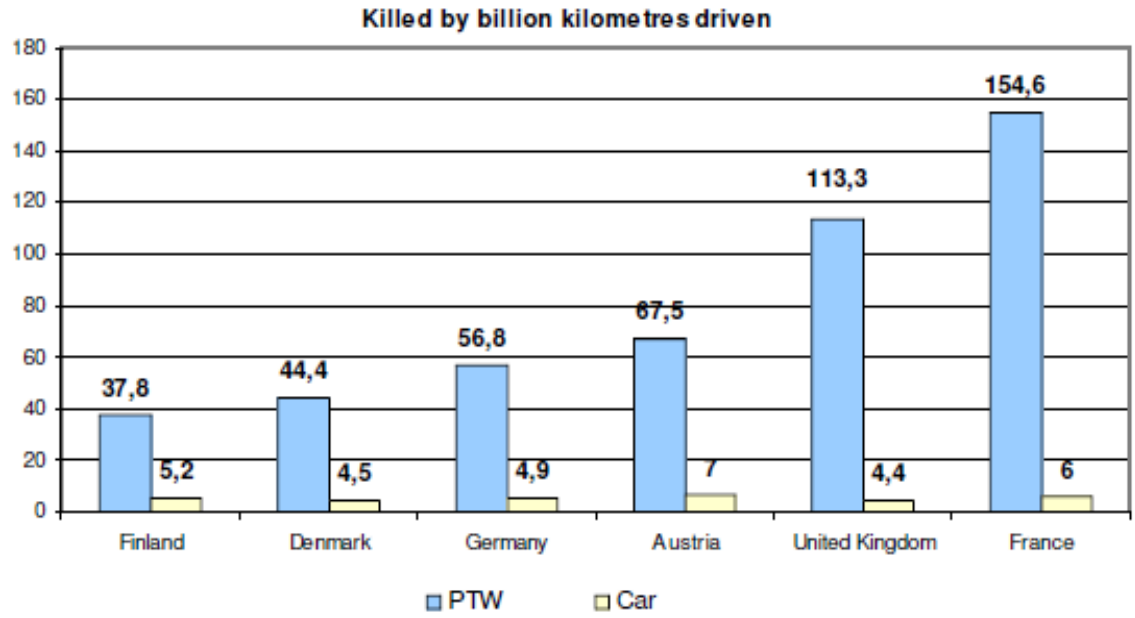

Figure 2: Killed by billion kilometres driven (Source: ONISR)

A number of studies have demonstrated that the risk of motorcyclists having a crash increases as the exposure increases, and decreases with age and riding experience (Chesham et al, 1993; Lin et al., 2003; Sexton et al., 2004; Taylor & Lockwood, 1990). However, variables such as age, experience, exposure and even environment alone can not lead us to improve rider safety. Understanding how rider behaviour is related to accident risk, in conjunction with the above, is highly useful because behaviour is potentially amenable to change via road safety interventions (Elliot et al, 2006). Thus we shift our focus from demographic diversity alone to behavioural diversity, in other words: factors such as riding at unsafe speeds, poor signalling, distraction and so on, that are more indicative of a direct link to risky riding and its consequences. But before we look closely at the details of these behavioural factors, it is advisable to first determine what we mean by hazard and risk? This is the focus of the following chapter.

2. Unpacking Hazard Perception and risk taking

2.1. Introduction

The literature associated with hazard perception testing and training contains several terms that are often used interchangeably, such as hazard and risk. There is also a lack of consensus as to what constitutes the definition of a hazard. In this chapter we unpack the various theoretical interpretations before venturing into the relationship between risk taking and PTW riders.

2.2. Defining hazards and their perception

Mills, Hall, McDonald and Rolls (1998) define a hazard as “any aspect of the road environment or combination of circumstances which exposes an individual to an increased possibility of an accident” (Section 2.1, p.1). Graham and Kinney’s (1980) definition of a hazard is “some potential danger beyond one’s immediate control” (p.13). Benda and Hoyos (1983) state that “a road hazard is the possibility that a mass, i.e. a vehicle, might undergo a change in velocity or direction by colliding with a moving or non-moving object or by swerving off the road” (p.1).

An objective hazard may not necessarily receive attention from a driver. And even if it is noticed, the situation may not be recognised as a hazard. Crick and McKenna (1991) state that hazard perception refers to the ability to identify potentially dangerous traffic situations. Mills et al. (1998) describe it as the ability to “read the road”.

However, a driver may falsely perceive a situation to be hazardous and take unnecessary actions to avoid it, potentially posing hazards to others. Clearly then, perception of a hazard is not enough – the driver must have sufficient training to successfully avoid a hazard, and to do so without, e.g., *creating* hazards for other road users. It is therefore important to examine the factors that contribute to a driver noticing some unusual element to their situation, perceiving it as a hazard and therefore potentially dangerous, and then deciding on and taking appropriate action to avoid a crash.

For the purposes of their study, Mills et al. (1998) classified hazardous situations into those where the driver could be a threat to others and hazards that could be a threat to the driver. They provided a rather extensive but not exhaustive list of hazards. The scenarios were further classified into events occurring in front of the car, something joining the car’s path, and events occurring in opposing traffic.

Motorcyclists share these hazards but are also at risk from situations unique to their context. The reactions required from riders need to be different, as motorcycles handle differently to cars. The extent of potential harm associated with any given hazard is commonly greater for motorcyclists, given their comparative lack of protection.

Benda and Hoyos (1983) note that the evaluation of the hazardousness of a situation by individuals can sometimes be clouded by evaluations of their own risk of experiencing an accident in that situation. A driver may identify a hazard in a situation but judge that they would respond in such a way that the likelihood of an accident would not be increased, and so not alter their driving behaviour significantly. For example, an over-confident driver may drive at high speed through residential streets, believing that they will be able to react quickly enough to avoid any unexpected obstacles, such as a child running into the road.

In a related concept, Finn and Bragg (1986) and Matthews and Moran (1986) talk about acceptance of risk. By simply driving a vehicle most people understand that there is an element of inherent risk. However, individuals vary in the level of risk they are willing to accept. For example, it would be expected that there is more inherent risk in driving at night or in foggy conditions, and individuals vary in their willingness to accept this increased risk level and drive under such conditions. In sum, what we can say is that risk presents us with a measurable concept (both qualitatively & quantitatively), which combines the probability of a change in desirable condition with the extent or degree to which tha thappens. Whereas a hazard/danger can be seen as the unquanitfied possibility of an undesirable state or physical harm.

2.3. Hazard perception and theoretical frameworks

2.3.1. Recognition primed decision making

According to Fitzgerald and Harrison (1999), hazard perception is a skill with cognitive and behavioural aspects that include cognitive workload, automation, and attention. Fitzgerald and Harrison (1999) invoke Klein's (1989, 1993) recognition-primed decision-making model (RPD) to explain hazard perception by drivers of vehicles in dynamic, sensation-rich environments. RPD involves a number of steps between devoting attention to a situation and producing an appropriate behaviour in response.

'Situation recognition' is the first stage of the process, where the situation or context is classified as either novel or familiar, based on comparisons of the current events and stimuli with memories of situations encountered previously. If a match is found and the new event classified as familiar, previous responses and their outcomes can be evaluated for their potential effectiveness in the new situation.

Once a list of potential behaviours or responses is generated, the individual progresses to the second stage of RPD. 'Serial option evaluation' involves testing each possibility in the list of potential responses generated in Stage 1 in a mental simulation of its consequences to determine the most appropriate response. The optimality of this response will depend on the prior experience of the individual. For example, the most technically appropriate response may not be considered as a viable option because the driver has not used it previously, or the response may not have been successful for the driver in a previous situation. Furthermore, the driver may not have been in such a situation at all before.

If the driver has encountered a similar situation previously, the degree of similarity of the prior and current situations is important. For example, the particular actions in emergency braking and swerving to avoid an obstacle will be different depending on weather conditions, type of road surface, and whether the obstacle is dynamic or static (such as an animal versus a lump of wood). If several similar rather than one identical option are available, then time must be devoted to the mental testing of each one and a choice made, theoretically lengthening the response time.

Fitzgerald and Harrison (1999) point out that 'hazard perception' as it is generally viewed only involves the situation recognition phase of RPD – deciding whether the situation is novel or familiar. They suggest that the focus should be on 'hazard behaviour'. As indicated earlier, perceiving a hazard in itself does not allow a driver to avoid an accident, there must be an appropriate behaviour as well. Viewing the process in terms of a complete action (i.e. hazard behaviour rather than just the perception of a hazard) allows for the isolation of factors that can affect the likelihood of avoiding an accident. For example, hazard perception would depend on visual scanning effectiveness but not the effectiveness of the cognitive process of testing and evaluating potential responses. There is however always the possibility of recognition influencing behaviour directly in terms of learned responses. But an inefficient handling of the 'option testing' due to increased cognitive workload may make an accident more likely, and so Fitzgerald and Harrison suggest that this aspect may require particular attention when determining methods of training for novice drivers.

2.3.2. Situational awareness theory

Situational awareness simply refers to an individual's understanding of a dynamic environment. This includes the perception and interpretation of both environmental and personal stimuli, and making predictions of the status of various elements of the situation in the near future. For example, the situational awareness (SA) of a motorcycle rider in a typical traffic situation may be an awareness of where other vehicles are around him, maintaining a suitable speed for the weather and road conditions, being vigilant for obstacles, and making predictions based on that information. An example of the latter might be expecting a particular car to change lanes due to a slow-moving truck in front of it – this judgement is made from observation and prior experience of similar situations.

According to Endsley (1995) there are three steps to SA in a hierarchical structure. Level 1 involves the perception of environmental elements, including sounds, sights, and textures. In Level 2 these stimuli are drawn together in a holistic understanding of the situation. This understanding will be very individualistic as interpretations will depend on the person's goals, motivations and prior knowledge. For example, an aggressive, time-pressured driver will concentrate on different stimuli and make different interpretations while looking for openings in the traffic, whereas a "Sunday driver" will have a different set of motivations and so will analyse the information differently.

From comprehension and understanding, the third level of SA should arise. Level 3 is the prediction of future actions of the various elements within the situation – essentially projecting how things will change. From

these predictions decision making can occur, and Endsley (1995) stresses that this is separate to but dependent on SA. As such, good decisions will be contingent upon making quick and valid predictions. Endsley also suggests that this process is similar to any skill, in that with practice it becomes automatic.

When a skill is mastered it is said to become automatic and require little conscious effort. For example, learning to ride a bike initially requires training and practice, where the beginner must concentrate on each component skill. Once these skills have been mastered one can ride without devoting any attention to the individual skills involved, and indeed may find it difficult to explain the process to a novice.

According to Endsley (1995), the transfer from concentrating on each component skill to automatic ability can occur for any skill or action that is practised often enough to form mental schemas (i.e. frameworks built up of past experiences and knowledge and schema scripts - essentially an accompanying “running sheet” of actions to be performed) in long term memory. Once automatic, it becomes a process of unconscious pattern matching. The elements of a particular stimulus or situation are compared to those in memory, and a relevant schema and its accompanying actions are triggered almost instantly, removing the time required to weigh up the options and make a considered decision.

Clearly the speed and ease of making SA predictions and then decisions depends very much on experience. Due to the relatively rare occurrence of hazards to road users, without regular practice it is likely that few drivers are properly prepared to quickly deal with them.

Endsley (1995) outlines other factors and processes that are important considerations in SA. While scanning the environment a road user will be exposed to a lot of sensory information. The saliency of this information to the individual will determine what aspects receive extra attention. Thus, people are actively involved in the process of information perception and attention.

Directing attention is also a skill that can be practised and improved, and individuals can be taught to divide their attention between multiple stimuli (Damos & Wickens, 1980, cited in Endsley, 1995). Being able to quickly direct attention to and divide attention between stimuli is particularly important for drivers due to the complex and dynamic nature of the information that must be processed in a short time. Regan, Triggs and Deery (1998) have demonstrated that risk perception by novice drivers can be indirectly enhanced through training in attentional control. So rather than only training novices in the hazards to look out for, drivers should be given training in how best to devote attention to these hazard stimuli while still paying attention to the driving process to ensure that all pertinent information will be sufficiently processed.

With increased experience and a history of successful hazard avoidance, a driver’s confidence level will increase, further improving their performance (Endsley, 1995). Conversely, a lack of experience and skill will place stress on the novice driver. While some stress can produce an improvement in performance (Kahneman, 1973; cited in Endsley, 1995), too much stress tends to cause the driver to narrow their focus to a limited number of cues, increasing the likelihood that they will miss important hazard information. In addition, it is suggested that stress may also decrease working memory capacity and retrieval (Endsley, 1995).

Moving from the above definitions and explanations of hazard, its perception and awareness, to the decisions taken as a result, we now look at what this specifically means within the context of motorcycle riders in the following section.

3. Risk taking within the context of motorcyclists

3.1. Motorcycle rider hazard perception

As indicated earlier, motorcycle riders are subject to specific hazards in addition to those that they have in common with car drivers. Riders' evaluation of level of risk also needs to take account of the different performance characteristics of a motorcycle compared with a car and the lower levels of injury protection they have.

It might be expected that lack of experience would be more important for motorcycle riders than it is for car drivers (one reason for which could be lack of passive safety). This might also have some bearing on their hazard perception levels. Lin (1998) studied a sample of 4729 motorcycle riders and found that past crash history and lack of experience were both positively related to an increase in risk of a motorcycle crash. The finding that the younger riders in the Schulz and Kerwien (1990) study were less able to perceive the situation-imminent dangers in various traffic situations than older riders, suggests that there could be much of relevance in the growing literature on hazard perception in car drivers. Traditionally, driver and rider training has tended to pay more attention to control skills than to higher order cognitive skills such as those related to the anticipation, detection and assessment of hazards. The Initial Rider Training (IRT) Project (Initial Rider Training Project: Hazard perception, attitudes and behaviour in riding (2003), TREN-SUB-2003-S07.30333) acknowledged that fact, and in its conclusions issued guidelines for riding training programmes comprising a hazard awareness module. Following an early study by Peltz and Krupat (1974), there has been much interest in hazard perception as a predictor of accidents at a theoretical level, but this has received only limited support at an empirical level. Examples of these would be recent studies based on relatively large samples have given some evidence of a link between hazard perception skills and accidents (Hull and Christie, 1993; McKenna and Horswill, 1999). Despite the interest in the topic regarding car drivers, only a few instances could be found in the literature of an investigation exploring the hazard perception skills of motorcyclists. There is the study by Underwood and Chapman (1998), which compared the hazard perception skills of motorcyclists with those of car drivers, and hypothesised motorcyclists would have superior hazard detection skills. More recently there have also been studies by Horswill and Helman (2003), Liu, Hosking & Lenne (2009). The results of these studies suggest that motorcyclists have slightly faster reaction times in identifying hazards than car drivers, although there was no difference in the overall percentage of hazards identified. This might be explained by motorcyclists having slightly superior abilities, which come with mastering a less stable vehicle. In other words, the experience of riding a vehicle that places them more at risk of an accident may help motorcyclists to develop faster hazard identification skills. However, motorcyclists may also have slightly faster hazard identification skills owing to factors that caused them to choose to ride a motorcycle. The fact that many of the motorcyclists used in this study had experience of driving a car, while the car drivers had no experience of riding a motorcycle is a further complication when it comes to explaining why motorcyclists were found to have slightly faster reaction times to potential hazards.

In this context it is worthy of note that the Taylor and Lockwood (1990) study showed that experience of driving a car had a beneficial effect on the accident liability of motorcyclists. A further explanation of the faster reaction to hazards shown by motorcyclists might have to do with their internalised criterion of what constitutes a potential hazard. Because motorcycles are more difficult than cars to control in an emergency, and because motorcycle riders are much more vulnerable to injury than car drivers, it seems likely that a developing situation on the road will become a potential hazard for a motorcyclist (and require the motorcyclist to consider evasive action) sooner than would be the case for a car driver. Armsby et al. (1989) noted that the types of hazards reported by motorcyclists differed from those reported by other motorists. Regardless of whether nondirective, focussed or critical incident interviews were conducted, over 70% of the hazards mentioned by car drivers with no motorcycle riding experience arose from the behaviour of other road users, rather than features of the road environment. Car drivers who also rode (or had ridden) motorcycles, however, were able to identify specific features of the road, and specific actions of other road users, as hazards to motorcyclists. They conclude that "this might be expected, given that motorcyclists are more at risk from physical deficiencies in the road environment, such as a road surface with low skid resistance, and more vulnerable to injury if they are involved in an accident" (p.56).

As a motorcycle is often an additional mode of transport, many novice riders already possess a car licence and some experience driving a car. A number of studies have examined whether experience as a car driver improves the safety of novice motorcycle riders. One reason for this could be that hazard perception skills learned as a car driver can be used in motorcycle riding. Another reason may be that these novices are older

and their safety has improved as a result of increased maturity, rather than experience.

3.2. Rider Risk Taking

Risk can be defined as “the level of danger associated with a hazard, as perceived by the individual” (Armsby, Boyle and Wright, 1989). By simply operating a vehicle there is an element of of inherent risk, and individuals vary in the level of risk they are willing to accept (Finn and Bragg, 1986; Matthews and Moran, 1986). If risk is the likelihood of the occurrence of a crash, once an individual rider evaluates the level of risk of a situation, a variety of factors will influence the level of risk he is comfortable with. The level of risk accepted will be based in part on the riders’ beliefs about their own level of skill in successfully avoiding the hazard. There may also be differences between perceived and objective levels of risk. For example, a motorcyclist riding in a car driver’s blindspot is at objective risk whether he perceives this risk or not.

The definition of hazard outlined earlier excluded the driver’s behaviour and attitudes, while the concept of risk includes such factors. According to Hoyos (1988), "perceiving a risk means, first of all, perceiving hazards which constitute a risk" (p. 571). Hazards are therefore linked to a subset of risks, and hazard perception is part of risk perception. The literature on motorcycling and risk has mainly been concerned with *objective risk* rather than *perceived risk*, and there are only a limited number of studies relating to the perception of risk in motorcyclists. Mannering and Grodsky (1995) noted the factors that may tend to bias an individual’s perception of risk. These were:

- *Unwarranted optimism:* those who are more optimistic of their riding skill and likelihood of accident involvement are more likely to perceive a lower risk.
- *Anchoring bias:* this refers to tendencies to anchor risk estimates around the notion of overall risk based on riding experiences and general knowledge of overall accident risk. Therefore, involvement in training courses or previous accidents may be likely to affect estimates of perceived risk.
- *Availability bias:* this refers to the assessment of risk based upon disproportionate information. As a result, appropriate probabilities of risk may not be assigned to events which have been disproportionately experienced or recalled.
- *Deliberate under-estimates of risk:* this is the tendency to justify risk-taking behaviour by under-estimating risk deliberately.
- *Under-estimate the variance in accident risk:* this is the over-estimation of lower probability events and the under-estimation of higher probability events.

Another study by Leaman and Fitch (1986) asked 72 British motorcyclists aged between 17-28 years to estimate the risk of having an accident and the risk of being killed in an accident in the next two years. It was found that riders tended to under-estimate the probability of an accident, but riders who knew someone who had suffered a serious motorcycle accident perceived a higher risk of being involved in an accident themselves than riders who did not. For perceived fatality risk, however, it was found that riders over-estimated the risk compared with the national statistical probability. In addition, perceived fatality risk was directly related to the participants’ own yearly accident rate, their total number of accidents, and the knowledge of someone involved in a serious accident. From their results, Leaman and Fitch suggested that prior knowledge of a serious accident is the single most important factor in motorcyclists’ perceptions of risk. This is supported by Chesham *et al*. (1992) who surveyed motorcyclists’ beliefs and behaviour using the Theory of Reasoned Action and the Health Belief Model and found that the only predictor of perceived risk was whether the rider had known a friend or relative killed in a motorcycling accident.

Other studies related to the perception of risk have come from Germany. One, by Rheinberg *et al*. (1986), interviewed 105 male motorcyclists aged between 18-55 years of age. They were able to differentiate between ‘sporty-risky’ riding styles and ‘defensive’ riding styles based upon a factor analysis of various scales on which participants rated their own manner of riding. They found that in comparison with motorcyclists with defensive behaviour, motorcyclists with sporty behaviour tended to give a lower assessment of the general probability of accidents, the probability of having an accident oneself and the probability of serious consequences as a result of an accident.

Another study, by Schulz and Kerwien (1990), used 129 male motorcyclists who were shown videos of 14 traffic situations. The results showed that riders in the younger age group (18-20 years) were less able than older drivers to perceive the situation-imminent dangers in all traffic situations. The attractiveness ratings for risky behaviour showed that younger motorcyclists attributed a higher value to the benefits of dangerous behaviour than did older riders. This greater acceptance of risk by the younger age group was explained by the finding that younger motorcyclists were of the opinion that they are expected to behave in a risky manner by other drivers in their peer group. In other words, the behaviour of younger riders was largely determined

by *role expectations*. On the other hand, it was also found that younger riders regarded their own behaviour as a standard for other riders. Schulz and Kerwien (1990) suggested that these findings provide evidence that acceptance of risk can be traced back to a psychological cost-benefit calculation between attractiveness and dangerousness. In other words, risk acceptance in motorcyclists depends upon the degree of incentive to behave in a risky manner and the degree of estimated danger, with risky traffic behaviour being caused by highly positively valued attractions and by too low an assessment of the danger.

3.2.1. Correlating driver/rider risk factors

Increased risk of injury due to driving (a car) has been related to frequent motor vehicle racing (as a hobby), speeding (20 km/h over the limit) and convictions for traffic offences (Blows, Ameratunga, Ivers, Lo, and Norton, 2005). Speeding is also a risk factor for motorcycle injury (Laapotti et al., 2001; Machin and Sankey, 2008; McKenna and Horswill, 2006; Ulleberg and Rundmo, 2003; Vassallo et al., 2007), as is drinking while riding, not using a helmet while riding, unlicensed riding, running yellow lights, and driving with too little headway (Lin et al., 2003; Rutter and Quine, 1996), and these behaviours are correlated with each other (Beirness and Simpson, 1988; Boyce and Geller, 2002; Jessor, 1987; Jonah et al., 2001). Of 894 adolescent motorcyclists attending public schools in Italy who took part in a questionnaire study (Pileggi, Bianco, Nobile and Angelillo, 2006), 9.9% of the drivers reported smoking while motorcycling, 53.6% talking with the passenger, 20% using cell phone, and 20.7% and 14.3% riding at least once after drinking alcohol or taking drugs, respectively. The odds for operating a motorcycle after consuming alcohol were almost 10 times higher in adolescents. However, according to the Department for Transport, UK (In-Depth Study of Motorcycle Accidents. Department of Transport, UK, November 2004), of the 26,857 motorcyclists involved in injury accidents in 2004, about 46 per cent were tested for excessive blood alcohol content and there were 423 failures (1.6% compared to 2% for all road users). Failure rates were highest among 20 to 24 year-olds, mirroring the situation prevailing for all road users.

The risks of motorcycle injury and death are highest for young riders (Baker et al., 1992; Braddock et al., 1992; Lardelli-Claret et al., 2005; Lin et al., 2003; Shankar et al., 1992), which may be partly due to inexperience, unfamiliarity, or lack of riding exposure (Chesham et al., 1993; Harrison and Christie, 2005). However, an increasingly popular explanation for these fatalities is the risky behaviours the riders adopt and, more specifically, the beliefs and attitudes underlying them. These risk-taking tendencies of riders, however, are specific to motorbike-riding, and when asked to complete a car-driving simulation, riders did not differ from non-riders in risk-taking measures (Horswill and Helman, 2003). Furthermore, risk attitudes of riders during the motorbike simulation did not differ from drivers in the car simulation, suggesting that risky riding behaviour is a characteristic of being on a motorcycle, rather than a characteristic of being a motorcyclist.

The risk-taking behaviours of motorcyclists are also positively correlated with crash experience (Lina, Chang, Paic, and Keyl, 2003; Lin, Huang, Hwang, Wu, and Yen, 2004), and are resistant to change, possibly indicating that the riders see the survival of a crash as a positive outcome and the costs of crashing as less than the excitement of risk-taking. However, when asked to estimate the risk of having an accident and the risk of getting killed in the next two years, riders who knew someone who had suffered a serious motorcycle accident perceived a higher risk of being involved in an accident themselves. In addition, perceived fatality risk is directly related to the riders' own accident rate and their total number of accidents (Leaman and Fitch, 1986). Furthermore, high-risk riders (those who make more risky decisions and are at greater risk of having an accident) have been found to experience a higher mental workload (the effort required to maintain the driving state within a subjective safety zone; Boer, 2005) in a simulated riding experiment (Di Stasi, Álvarez-Valbuena, Cañas, Maldonado, Catena, Antolí, and Candido, 2009). High-risk riders also increase their risk behaviour with increased time in the simulator, suggesting that increased experience and familiarity leads to an increase in risky behaviours.

3.2.2. Perceived Level of Skill & Over-confidence

Much research has shown that drivers (especially young males) are over-confident in their driving abilities and overrate their perceived level of skill, despite having more accidents, leaving shorter gaps and underestimating stopping distances (McCormick, Walkey, and Green, 1986; Matthews & Moran, 1986; Groeger and Brown, 1989; McKenna, Stainer, and Lewis, 1991). An unrealistically high assessment of *technical* driving skills (such as coping with a skid) by young male drivers is associated with multiple-vehicle accidents (Carsten, 2002). Conversely, a high assessment of *defensive* driving skills (such as being aware of surrounding traffic) by both male and female drivers is associated with a low risk of multiple-vehicle accidents, indicating a high degree of observance and carefulness in traffic.

Motorcyclists also rate themselves as confident riders, despite their actual level of skill or crash history (Symmons, Mulvihill and Haworth, 2007; Liu, Hosking, and Lenné, 2009). Liu et al (2009) found that motorcycle riders who had crashed within the previous five years reported increased levels of carelessness and intolerance, a lack of responsibility, and a fast and risky riding style. These attitudes and behaviours could be due to an increased level of confidence, which in turn could have caused the accident or indeed been a consequence of surviving it (e.g. Horvath and Zuckerman, 1992).

3.2.3. Perceived Level of Risk

In relation to driving behaviour, risk perception refers to, "the subjective experience of risk in potential traffic hazards" (Deery, 1999, p. 226). There is one view that risk perception is considered a precursor of actual driving behaviour, whereby high levels of risk decrease the likelihood of an individual carrying out that behaviour (Cohn et al., 1995). While another view purports that pcerceived levels of risk decrease as drivers get older and more experienced (Berger and Persinger, 1980; Johan and Dawson, 1982; Matthews and Moran, 1986; Finn and Bragg, 1986; Mannering & Grodsky, 1995) and generally males' perceived risk is lower than that of females. In contradiction to the view put forward by Cohn et al, there is the view that drivers who speed and motorcyclists who 'filter' through traffic (between cars and on hard shoulders) report a higher level of perceived risk (DeJoy, 1992).

Motorcycle studies have found that the risk perception of adolescent riders corresponded to the actual risk of motorcycle crashes (Reeder et al., 1992), but they neither modified their risk-taking behaviours nor reduced risk-taking levels, even after experiencing a crash or injury (Lin et al., 2004; Mangus et al., 2004).

3.2.4. Personality traits & risky behaviour

How do personality factors ad other individual differences influence risk-taking? Michon (1985) proposed a 3-level hierarchical model, in which one level – the tactical level – is influenced by personality traits such as emotional stability, social responsibility, self-control, sensation-seeking and willingness to take risk. Much empirical evidence has been found in support for the effects of emotional stability (Sommer, Herle, Häusler, Risser, Schützhofer, and Chaloupka, 2008; Arendasy et al., submitted for publication; Burgard, 2005; Cellar et al., 2000; Dahlen & White, 2006; Dahlen et al., 2005; Iversen & Rundmo, 2002; Sommer & Häusler, 2005; Ulleberg, 2002) and sensation seeking (Jonah, 1997) in relation to risky behaviour. Several studies note that high sensation seekers perceive less risk in various driving situations and that perceived risk and risky driving are negatively correlated (Arnett, 1990; Heino et al, 1992; Horvath and Zuckerman, 1993; Yu and Willifold, 1993), suggesting that risk perception may mediate the relationship between sensation seeking and risky driving. This lack of perceived risk by sensation seekers could be due to their (previously mentioned) overrated driving/riding skills, or it could be that the thrill of engaging in the risky behaviour outweighs the potential costs of an accident. This sensation-seeking risky behaviour is reinforced if no negative consequences come of it. Lastly, high sensation seekers are more likely to turn to alcohol as a coping mechanism for stress (Jonah, 1997), making them more likely to drive/ride after drinking. Whereas low sensation seekers take fewer risks, even if they have not actually consumed any alcohol (McMillen et al., 1989). All of these factors interrelate to increase the risky behaviour of sensation seekers. Mannering and Grodsky (1995) suggested that riding a PTW might attract 'thrill seeking' individuals, as riding is considered riskier than other forms of transport (Broughton, 2005; Department for Transport, 2006). Reasons for individuals' risk-seeking behaviour may include an outlet for stress, aggression, expression of independence, a heightening of arousal, or a means of impressing others (Hodgdon, Bragg, and Finn, 1981; Jessor, 1984; and Zuckerman, 1979).

Machin and Sankey, (2008) refer to sensation-seeking as excitement-seeking and have found that it both positively predicts speeding behaviour and is associated with lower Aversion to Risk Taking, which in turn negatively predicts speeding. Vassallo et al. (2007) suggested that driver attitudes about the social acceptability of speeding or risky driving may be the strongest influence on how likely that driver is to speed or take risks whilst driving.

As well as sensation-seeking, high scores on anger and normlessness are positively associated with risk-taking attitudes (Ching-Fu Chen, 2009). Individuals who have high scores on normlessness are likely to have low barriers towards anti-social behaviours, and this is reflected in risk-taking attitudes towards rule violation, speeding, and fun-riding in traffic. Individuals with personality measuring high in anger are assumed to be easily emotionally destabilized, infuriated, and frustrated, and tend to have aggressive attitudes and behaviours in traffic.

Wong, Chung and Huang (2009) suggest that as well as sensation-seeking motorcyclists, there also exist 'ambient' riders who are mature and safe, and 'impatient' riders who lack confidence and traffic awareness. Whereas sensation-seekers are highly comfortable with unsafe riding and highly aware of traffic conditions, ambient riders are confident but uncomfortable with unsafe riding and thus not likely to conduct risky riding behaviours. Impatient riders on the other hand are nervous riders, whose fear of an accident leads them to neglect observing surrounding traffic conditions.

High levels of antisocial behaviour and aggression, and low levels of empathy and anxiety have also been found to predict young drivers' involvement in risky driving and speeding violations. This relates well to self-rated profiles of male bikers, who described themselves as aggressive, dogmatic, sensation-seeking, impulsive, risk-taking, irresponsible and lacking in self-esteem and ambitiousness (Jackson & Wilson, 1993).

Some gender differences in personality traits and risky behaviour have been found. While the risk behaviour of males is strongly influenced by anxiety, females' risk attitudes and behaviour are most influenced by anger and altruism (Chen 2009). Furthermore, compared with young female riders, young male riders are confident of their riding skills, more comfortable with unsafe riding, more interested in the utility gained from unsafe riding, more easily ignoring traffic conditions, and more likely to conduct risky riding behaviours. These features suggest that male riders, compared to female riders, are more sensation seeking as well as impatient.

3.3. The changing nature of motorcycling: Patterns of use and rider characteristics

A recent survey in the UK (Jamson & Chorlton, 2009) was centred on the changing nature of motorcycling over the last decades where increases in motorcycling activity but also in accident risk were found. The questionnaire was answered by a sample of 989 motorcyclists in order to examine their key features, in terms of demographics, the types of motorcycles they ride (ownership and purchasing decisions) and riding activities. The main results of this study are summarised below:

Riders were classified in three groups (long-term, returning and new riders) according to their riding habits. Because a steady rise in the number of motorcycle casualties was found after 1996, this date was chosen as a cut off point. Long-term riders were defined as those who began riding before 1996 and had ridden continuously, without having taken a break of 10 years or more (56% of the sample). Returning riders were defined as those who returned to riding from 1990 onwards having taken a break of 10 years or more (22%). New riders were defined as those who had taken up riding more recently (after 1996). This group accounts both for those who gained their licence at a young age and those who take up motorcycling later in life (22%).

With regard to demographics, about 90.7% of the sample was male (897 motorcyclists, age range 17–85 years, M = 44.3, SD = 12.2); the remaining 9.3% was female (92 motorcyclists, age range 17–74 years, M = 37.9, SD = 12.3). Over half of the male sample was long-term riders, with the remainder split relatively evenly between returning and new riders. The majority of females were new riders and were half as likely as males to be returning riders.

For the trip activity: most of riders (56%) claimed to make both leisure and commuting trips, whilst 30% engaged only in leisure trips. Only 13% of the sample was commuter-only riders. Leisure riders were mostly either long-term riders or returning riders and they tended to own higher capacity machines than commuter riders.

Purchasing decisions: the majority (64%) of motorcycles owned at the time of the survey were second-hand at the time of purchase. New riders valued the economics and convenience of owning a motorcycle whereas long-term riders and returning riders based their decisions more on the leisure and status symbol of the motorcycle. In terms of motorcycle ownership long-term and returning riders dominated ownership of the higher CC motorcycles whilst new riders favoured low powered mopeds and scooters.

Patterns of ownership: using retrospective data, it was found that those motorcyclists who had taken up the activity in recent years, increased the engine size of their machines more quickly, compared to earlier cohorts. As a result, there exists a group of riders who have progressed to large capacity machines relatively quickly, without the steady accumulation of skills and experience that might have previously been the case. The data suggest also that those riders who took up motorcycling 30 years ago were considerably younger, then, than those who took it up more recently. Motorcycles purchased today are much more likely to be purchased for reasons of styling and image compared to previous cohorts who relied on them more as a form of transport.

It emerged that riders of higher capacity motorcycles tend to be male, long-term or returning riders, who ride mostly for leisure purposes. In addition they also drive a car, are of higher socio-economic class and earn a higher income. They are also more likely to attend voluntary motorcycling training courses. This is an important issue since factors such as large engine size and higher speed, result in higher levels of injury severity in motorcycle accidents.

So what are the implications for safety interventions that can be derived from the above points?

There are implications for licensing and further research should investigate whether the ‘‘licence for life” model is appropriate, or whether retraining could help to increase motorcycle safety. There is need to improve motorcycling training, with more specific targeting of new (or returning) leisure riders, but there is also potential for improving the training of car drivers or developing campaigns that focus on the responsibility of the driver to actively search for motorcyclists. There is evidence that the nature of motorcycling appears to be changing. More riders are taking up motorcycling at an older age and engaging in motorcycling as a leisure pursuit. In order to increase motorcycle safety it is therefore necessary to take account of these changing habits and target interventions in the form of specialised training to the appropriate riders, their choice of machine and the situations in which they ride. We will discuss these intervention in greater detail in the following sections.

4. Cognitive, behavioural and social factors in rider diversity, in relation with risk awareness

4.1. Introduction

Having discussed riders and risk at a broader level, we turn our attention in this section of the deliverable to the specific cognitive, behavioural and societal levels that influence rider "risk awareness". Risk awareness is considered here from complementary dimensions: Cognitive and behavioural abilities when riding (i.e. in terms of hazard perception and threat appraisal) on the one hand, and awareness of risk as the results of social factors (like motivation for using a motorbike, attitudes towards road safety, risk-taking and risk acceptance), on the other hand.

In current scientific research, the cognitive, the behavioural and the social dimensions of the risk awareness are studied in separated ways. But it is quite different in the practical reality of riding: motorcyclists regulate their behaviours from both their social identity of "motorcyclist", their attitudes towards risk or risk-taking, their cognitive abilities in hazard detection, their situational awareness of the driving situation as assessed as more or less critical, and from their behavioural abilities (effective or expected) liable to be implemented in order to manage the situational risk, and avoid accident. At least, the driving behaviour implemented by motorcyclists “in situation” (i.e. when riding) is the final result of all these dimensions in a totally nested way.

This section is organised in three parts and will therefore consider the motorcyclist population diversity at three levels: cognitive, behavioural, and societal. In the first part, we will present the cognitive level, which is more particularly focused on hazard perception and criticality assessment of the riding situation. The second sub-section will concern the behavioural level, defined here as a joint consequence of the social and cognitive “awareness of risk”. Here we will look closely at attitudes and motivations on the part of the rider. Finally in the third section we will address societal factors, like social representations, legislation, countermeasures, and educational campaigns designed to bring about improved safety for riders.

Gradually, as we progress on these topics, we will try to identify methods (Questionnaires and video-based methods) for investigating the diversity of the motorcyclist population in terms of risk awareness, as it will be studied through in-depth experiments implemented later in WP3 (Task 3.2) and WP5 (e.g. T 5.1).

4.2. Rider diversity regarding risk awareness at the cognitive level

Riding a motorcycle is a dynamic and complex psychomotor activity demanding simultaneous processing of information on different cognitive levels as well as a variety of physical activities in a constantly varying setting. Therefore, in any road crash involving a motorcycle, the cause may be attributed to a combination of defects or defective performance in a number of factors that are generally grouped under three headings: road environment, human factor and vehicle (Kenny, 1995). A number of contributing factors have been identified in driving: lack of skills based on inexperience, the youthfulness or lack of maturity in the attitudes, and risk-taking of young drivers and driving in unfamiliar environments (Triggs, 2004; Hole, 2007). In the following section we will specifically turn our attention to the cognitive factors underlying risk awareness and resulting choices on the part of the riders.

4.2.1. Synthetic overview of the motorcycling activity

Before discussing the specific question of risk awareness when a critical problem occurs, it is however necessary to briefly introduce the motorcycling activity in normal driving conditions. The figure 8 provides a synthetic overview of this activity considered as an iterative “Perception-Cognition-Action” loop of regulation, between the human rider and the road environment. Indeed, as with any dynamic environment, the road environment requires constant adaptation from the driver. In the general frame, motorcycling can be defined as an activity of regulating and maintaining the status of the dynamic process as a whole (i.e. the driving situation) within the limits of acceptable and safe changes. In terms of mental activities, it requires that riders (i) select relevant information into the surrounding environment, in accordance with both their current goals and the driving task demands, (ii) understand the immediate situation (i.e. mental model elaboration) and anticipate its progression in the more or less long term, (iii) take decisions in order to interact appropriately – via the vehicle – with the road environment and the other road users, and (iv) manage their own resources

(physical, perceptive and cognitive) to satisfy the time constraints of the activity inherent to the dynamic nature of the driving situation. The selective dimension of information collection is especially important as riders cannot take in and process all the information available in the road environment.

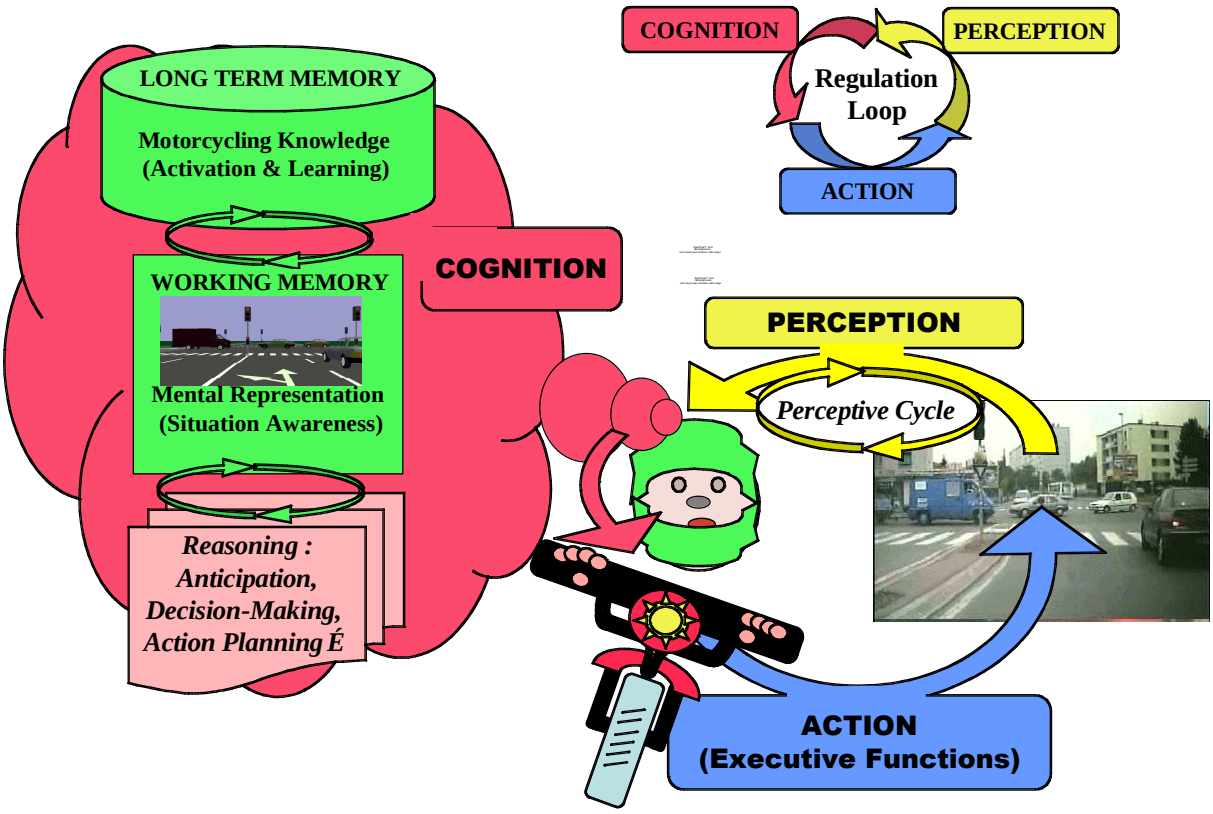

Figure 8: Synthetic overview of the motorcycling activity as a "Perception-Cognition-Action" regulation loop (adapted from COSMODRIVE model; Bellet and al., 2007)

This information is not selected haphazardly, but depends on the aims the riders pursue, their short-term intentions (i.e. tactical goals, such as ''turn left" at a crossroads or "overtake a car") and long-term objectives (i.e. strategic goals, such as reaching their final destination within a given time), the knowledge they possess (stemming from their previous riding experiences) and their attentional resources available at this instant. Information selection is therefore the result of a *perceptive cycle* (Neisser, 1976), whose keystone is the motorcyclist's mental representation of the driving situation. Indeed, from their interaction with the road environment, riders build mental models of the events and objects that surround them (Johnson-Laird, 1983, Norman, 1983). Such representation is built in a working memory, from perceptive information extracted from the road scene on the one hand, and from permanent knowledge stored and activated in the long-term memory, on the other hand. This mental representation provides a meaningful and self-oriented interpretation of the reality, including anticipations of potential evolutions in the current driving situation. They are not copies of objective reality. They potentially diverge from it quite considerably. On the one side, they only contain a tiny amount of the information available in the environment: they focus in priority on useful information in order to act efficiently in current traffic conditions, as a function of the goals pursued by the driver. On the other side, they can also convey much more information than that available in perceptible reality (e.g. keeping in memory information perceived previously but henceforth hidden, formulating inferences of potential future events based on precursive clues, or anticipating the expected effects of an action in progress). From this point of view, it corresponds to the driver's *Situation Awareness*, according to Endsley (1995) definition of this concept: *the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future*. Moreover, this mental representation is "action-oriented" (i.e. the driver doesn't passively observe the road scene as a "spectator", but as an "actor"). It constitutes an *operative image* (i.e. a functionally deformed view of the reality; cf. Ochanine, 1977), a "goal driven" model of the road environment. They are formulated "by" and "for" the action. Therefore they provide *interiorised models of the task* (Leplat, 2004) constructed for the current activity, but which can be stored in Long Term Memory (LTM) and reactivated later in new situations,

for future performances of the same task. Mental representations form the kernel of complex sequences of cognitive processes, ranging from the perception of events to driving behaviours, through intermediate steps of decision-making and activity planning. However, care is required to avoid taking an over-linear and sequential view of this processing string. Although the perception of an unexpected or critical event sometimes triggers the processing sequence, it is more often the action in progress and/or the drivers' intention (the aim they seek to attain in the current situation) that directs their perceptive exploration and information processing. More than a linear sequence of perceptive-cognitive processes, driver's mental activities should be described as an iterative "perception ⇔ cognition ⇔ action" cycle of regulation, organized around the mental representation of the driving situation. In this control loop, perception is constantly fuelled by mental representation, which in turn constantly fuels perception. Once built, these mental models generate perceptive expectations, guide the road environment exploration and the new information processing, and are also the central components of *cognitive cycles* involving decision-taking and anticipating functions (i.e. via mental simulation based on the current state of the world). When an appropriate action to the current driving context has been identified, selected, or cognitively planned, it is implemented by the rider on the motorbike (i.e. *executive functions*) for progressing into the dynamic road environment. From this point of view, mental representations as situational awareness are key elements of the rider's cognition; and an erroneous representation means, potentially, decision-making errors and unsafe driving actions.

4.2.2. The cognitive processes underpinning "Risk Awareness"

From the cognitive point of view, the question of risk awareness directly refers to the motorcyclists' abilities to perceive hazard, but also includes the abilities to adequately assess the criticality of the driving situation in which they dynamically progress. Becoming aware of a hazard occurs in the surroundings (i. e. to detect when an effective risk occurs in the current road environment), is indeed the first cognitive step required to be able to adapt one's behaviour adequately, and then manage the risk and avoid the accident (Bellet, 2006).

We examined hazard perception briefly in the first section of this report and here we return to a more in depth look at the cognitive processes underpinning it. We start by looking at a definition by Crick and McKenna (1992) where they refer to it as the ability to identify dangerous traffic situations. In the same way, Evans and Macdonald (2002) define hazard perception as *the process whereby a road user notices the presence of a hazard* (p.93). However, the term "hazard perception" is widely used, both in the scientific literature and by those interested in improving driver and rider safety. In addition, terms such as hazard and risk are often used interchangeably and definitions of hazards vary. Haworth and Mulvihill (2004) proposed the following definition :

"A hazard is any permanent or transitory, stationary or moving object in the road environment that has the potential to increase the risk of a crash. Hazards exclude characteristics of the rider or the vehicle, which are classed as modifying factors."

This definition focuses on the hazard as an object, and separates the concept of a hazard and the concept of the risk, that is associated with the hazard. From a synthetic view, "Hazard" is related here to a critical event (e.g. a pedestrian suddenly cross the road) or a particular characteristic of the driving situation (e.g. it's raining), and "Risk" is more related to the potential consequences of this event / characteristic, in terms of probability to have an accident.

According to this distinction between "Hazard" as a potential cause and "Risk" as a potential consequence, the Grayson, Maycock, Groeger, Hammond and Field (2003) four-component model of responding to risk (Grayson et al., 2003), Risk awareness could be considered as judgement of criticality close to the Threat Appraisal stage. The underlying principle of this model is that *drivers differ in accident liability because they differ at an individual level; that is, they differ in their abilities to detect and recognise potential hazards, and in their abilities to respond appropriately to those hazards* (p.38). The model has four components:

- Hazard Detection – being aware that a hazard may be present
- Threat Appraisal – evaluating whether the hazard is sufficiently important to merit a response
- Action Selection – having to select a response from one's repertoire of skills
- Implementation – performing the necessary actions involved in the response that has been selected.

This four-component model focuses on the effects of stable personality traits, rather than states of the individual (e.g. sobriety). It is likely that modifying factors such as alcohol, distraction, or fatigue would affect several components of the model, including threat appraisal and implementation (e.g. by lengthening reaction time). By considering (i) the riding activity model presented in figure 8, (ii) the distinction above made between "Hazard" as a potential "Cause" and "Risk" of having an accident as a potential "Consequence", (iii) and the Grayson et al. (2003) four-component model of responding to risk, it is then possible to define risk awareness at the cognitive level like a particular dimension of the rider's situational awareness (i.e. criticality assessment corresponding to the situational dangerousness). Figure 9 integrates this specific cognitive step of risk awareness in the frame of the "Perception-Cognition-Action" model of control of the driving activity in critical driving conditions.

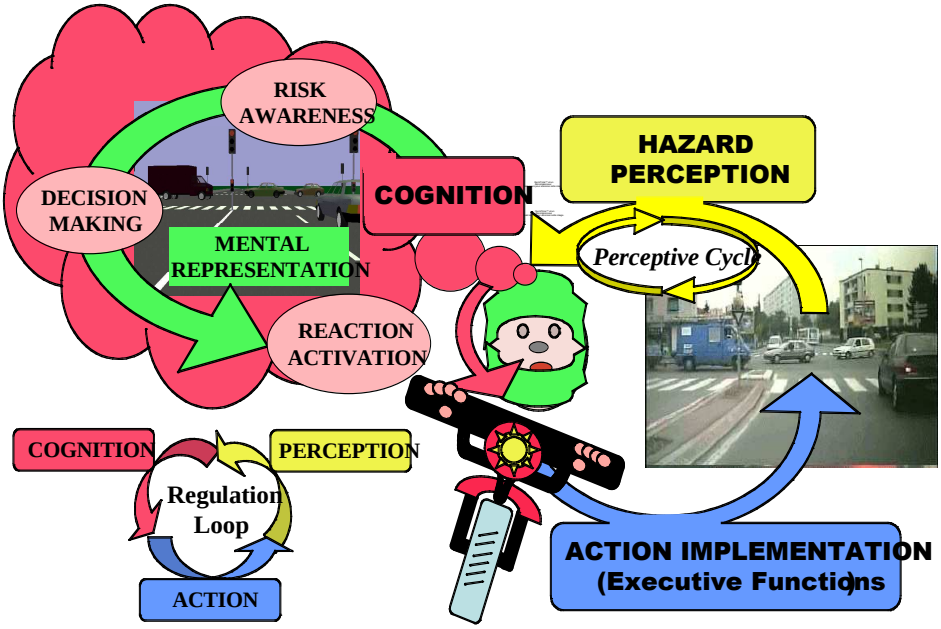

Figure 9: Cognitive steps of Risk Awareness within the "Perception-Cognition-Action" regulation loop (adapted from COSMODRIVE model; Bellet and al., 2007)

When a critical event occurs in the road environment, risk awareness is intimately linked with hazard perception (Horswill and McKenna, 2004), as well as including a threat appraisal (Grayson et al., 2003) and a judgement concerning the driving situation criticality (Banet and Bellet, 2008). From this approach, Risk awareness is here more than hazard perception, because it also includes riders' abilities to anticipate future hazards, or the potentially dangerous progression of the current status of the driving conditions. From this standpoint, risk awareness is clearly a cognitive representation of the potential danger in any given situation, corresponding to the drivers' awareness within a given traffic environment.

4.2.3. Factors influencing the risk awareness at the cognitive level

In this section we discuss some critical factors influencing cognitive abilities, training and the overall riding experience (this includes riding licences, type of riding practice).

Several studies on car-drivers have shown better performances of experienced drivers in terms of visual search, information processing, mental model elaboration & situational awareness, (Mourant & al, 1972, Chapman and Underwood, 1998; Crundall & al, 1999, Underwood 2007, Bailly et al. 2003, Evans T., McDonalds V. 2002). Driving knowledge used by experienced riders allows them to have better perceptive explorations of the road scene (i.e. focused on the most relevant information), thereby increasing their information processing performance and, consequently, providing a more adequate mental model of the

current driving situation (i.e. better understanding and awareness of what occurs on the road).

A recent simulator experiment of Liu, Hosking and Lenné (2009) showed that experienced riders (relative to inexperienced or novice riders) crashed less often, received better performance evaluations, and approached hazards at more appropriate speeds. Interestingly, they also found that some novice riders were overconfident in their riding ability. Several studies concerning car drivers have shown that parallel activities while driving have a negative impact in terms of reaction time, visual strategies, situation awareness and, more generally, risk of an accident. There are of course many other methods available to assess risk awareness, and many of these will be explored in depth both in activity 3.2 within WP3 as well as in WP 4.5. We will briefly look at the CRITIC method below in conjunction with this discussion. However it will be covered in far greater depth within task 3.2.

4.2.4. CRITIC : A Method for studying Risk Awareness at the cognitive level

In order to study riders' risk awareness, a specific methodology has been developed at INRETS (Banet and Bellet, 2008). This method, called CRITIC (for ***C**ommon **R**isk awareness measurement me**T**hod for **I**nter-population **C**omparisons*), is based on the presentation of 21 video sequences (filmed on board a car) of driving situations presenting a potential risk of collision, more or less critical, and at a more or less long term.

Figure 10: CRITIC: a methodological tool for studying drivers' risk awareness abilities, including a *Likert Scale* (on the left, below the road scene view) and an *Osgood Semantic Differential* (on the right); Banet and Bellet, 2008)

These video sequences integrate different categories of situations (e.g. approaching fixed obstacles, approaching intersections, changing lane of a car ahead, following a vehicle, approaching slow vehicles, presence of vulnerable obstacles like pedestrians or cyclists). The participants are asked to stop the sequence when they feel that the situation becomes critical. Moreover, at the end of the sequence, two measurement scales are then submitted to the participants (see figure 10):

A Likert-type scale of criticality: The participants have to assess the level of criticality of the driving situation by moving a cursor sliding along a scale with no graduation. The situation can thus be quantified in terms of criticality on this scale, ranging from 0 % (not critical) to 100 % (high level of criticality).

An Attitude Scale in the form of a Osgood semantic differential : in order to refine the quality of the participants' subjective assessments. This differential is made of 16 antonyms defined for the specific context of driving under critical situation. The use of a semantic differential is complementary to an intensity scale as it helps us investigate the different cognitive sub-dimensions underlying the risk awareness while driving. This semantic differential is made of 4 sub-dimensions: feelings in front of the situation (e.g. to be afraid, surprised, enjoyed), predictability of the situation/events, driving situation characteristics description and feeling of "implication" (antonyms refer to the notion of involvement: the fact of feeling "responsible" for

what is happening and the fact of feeling able to “control” the situation.). Each of these dimensions are respectively assessed through 4 antonyms. The data thus collected is analysed by meshing together these four sub-dimensions to arrive at a composite picture of the subject’s attitude towards risk and criticality.

4.3. The role of Attitudes and Motivations – the behavioural outlook on risk:

Riding a motorbike holds the possibility to satisfy one's needs of freedom, fun, recreation, etc, over and above being a mode of transport. Thus the riding behaviour is influenced not only by the skills or the knowledge a rider has, or the experience gained on the road so far, but also by general motivational and attitudinal aspects. A huge amount of literature exists about car drivers, how attitudes influence the driving behaviour of people. In the current chapter literature about behavioural factors with respect to motorcycle riders is presented. At first an overview of introducing assumptions concerning the behaviour of human being in general respectively motorcycle riders will be given. This is followed by models and theories about how and why drivers/riders behave on the road as they do. The chapter will be finalised by several studies with respect to attitudes and motives related to riding a motorbike.

In their work about the Traffic Safety Checklist Risser and Petica (1998) provide a solid basis concerning motivation and attitudinal aspects of driving behaviour. They connect motivational and attitudinal aspects with considerations about the learning process in general. They distinguish three learning mechanisms – consequences of behaviour, social feedback and generalisation of behaviour. The behaviour of human being – as other living beings as well, by the way - depends very much on the consequences that are expected. If a rider splits lanes for the first time and does not get any negative feedback but rather experiences positive consequences such as experiencing the possibility to move faster, etc., the behaviour will be repeated in future. In real-time traffic social feedback to control behaviour ("stay on your side of the road", "do not go so fast") cannot be given consistently, or not at all, as there are only very restricted possibilities to communicate with each others. Verbal communication is almost fully excluded. However, even if one can make other road users aware of their incorrect behaviour they easily will neglect this information as there is a separation in time (within seconds the time gap for interaction is over) and space. The two mechanisms described above to some extend favour the third one – generalisation. If a rider perceives positive consequences concerning certain types of behaviour – including those connected to tough dynamics and higher speeds - and does not get corrective social feedback he/she might generalise the behaviour to other traffic situations as well.

4.3.1. Road user behavior : some relevant theories and models

In order to describe road user behaviour, it is advisable to divide it into different levels, or areas. This does not only make structured description easier, but it is also of advantage when identifying, discussing, and/or implementing measures to influence behaviour. Models help to identify types of behaviour and behaviour aspects that can be accessed with the help of, e.g., campaigning measures.

The central theoretical basis for behaviour models in studies evaluating attitudes and the subsequent behaviour of motorcyclists derives from the models of Fishbein and Ajzen (1975), the Theory of Reasoned Action respectively the Theory of Planned Behaviour (Ajzen, 1988), and Janz and Becker (1984), the Health Belief Model.

The three central aspects or factors of the Theory of Reasoned Action are the attitude towards the behaviour, subjective norms and the perceived behavioural control. Therefore these three factors constitute the basis for every action.

The Health Belief Model on the other hand defines three distinct dimensions that determine behaviour related to safety considerations. The three dimensions are vulnerability, severity and benefits and barriers.

Based on the theoretical models, as stated above, psychological studies tried to establish models of the behaviour of motorcyclists, but it has to be noted, that a central point of interest of recent studies remains to be car drivers and therefore the scientific data is still quite thin on the topic of motorcyclists.

Whereas the above mentioned theories have not been developed explicitly for the use in the traffic context, the GDE-matrix (Goals for Driver Education; Hatakka et al., 1999) focuses on this very specific research area. It considers reconditions and abilities on a higher level and decisions and actions during driving on a lower level.

- Level 4 (highest level): long term attitudes and values, life style, social background, gender, age and other individual preconditions

- Level 3: aims of driving, when, where, with whom, which mean of transport
- Level 2: driving abilities in situations, decisions making while driving, driving style (anticipatory etc.), and the ability to detect potential dangerous situations
- Level 1: the knowledge of how to drive and the handling of it, especially in critical situations

Goals for life and skills for living (general)	Knowledge about/control over life-goals and personal tendencies affect driving behaviour lifestyle/life situation group norms motives	Risk tendencies acceptance of risk self-enhancement through driving high level of sensation seeking	Self-evaluation / awareness of personal skills of impulse control risk tendency safety-negative motives
Goals and context of driving (trip related)	Knowledge and skills concerning effects of trip goals on driving planning and choosing routes evaluation of requested driving time	Risk connected with driver's condition (moods, BAC etc) purpose of driving driving environment (rural/urban)	Self-evaluation / awareness of personal planning skills typical goals of driving typical risky driving motives
Mastery of traffic situations	Knowledge and skills concerning traffic rules anticipation of course of situation speed adjustment	Risk caused by wrong expectations risk-increasing driving style (e.g. aggressive) unsuitable speed adjustment vulnerable road users	Self-evaluation / awareness of strong and weak points of basic traffic skills personal driving style personal safety margins
Vehicle manoeuvring	Knowledge and skills concerning control of direction and position tyre grip and friction vehicle properties	Risk connected with insufficient skills unsuitable speed adjustment difficult conditions (low friction etc)	Awareness of basic manoeuvring skills skills for hazard situations realistic self-evaluation

Figure 11: The GDE-Matrix – (Source: Ulleberg et al. 2009)

There exists a lot of knowledge about the first two elements. However, relatively little is known about the human factor and its influence on road accidents. In the survey, which was carried out in the framework of this study six variables were defined which were explored as contributors to accident risk: attitudes, personal characteristics, self-reporting riding behaviour, journey type, level of experience and training. A model was developed based on these variables.

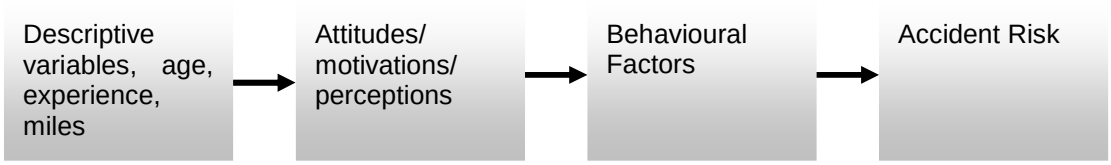

Table 4: Factors affecting the accident risk of motorcyclists

In order to analyse mechanisms underlying motorcycle accidents, aberrant behaviour was considered. The Driver Behaviour Questionnaire by Reason et al. (1990), was adapted to motorcyclists` needs (see Elliot et al., 2003, 2006). The developed questionnaire was called MRBQ (Motorcycle-riding behaviour questionnaire.) It consisted of 43 items relating to specific examples of motorcycle-riding behaviour. The sample comprised motorcyclists involved in an accident and motorcyclists involved not in an accident.

Due to a factor analysis of the data, five-factor were extracted: errors, speed violations, stunts/highly risky behaviours, using safety equipment, errors of control. Analyses of the data showed that accident involved riders were younger and less experienced than non-involved riders. Accident involved motorcyclists reported committing errors, speed violations, stunts and control errors more often than did non-accident involved motorcyclists. The use of safety equipment was higher among higher mileage riders and among accident involved motorcyclists.

A regression analysis indicated that the demographic variables (age, mileage, experience) and errors were the only significant predictors of accident involvement. For car drivers, research has shown that not errors but violations are most strongly associated with accidents. This might be due to the fact that riding a motorcycle is more demanding than driving a car. Thus if you want to reduce the motorcyclists` accident-involvement the number of behaviour errors being made has to be reduced.

4.3.2. Motivation

With regard to riding a motorcycle, motivations come into play that have proven to play an integral role in the ways the vehicle is handled and how the surrounding environment is perceived by the rider and furthermore give insight why this special mode of transport has been chosen in the first place.

Based on literature (Schulz et al., 1991, Haworth, 2000, Risser and Fischer, 1999) different aspects can be determined, ranging from basic psychological needs and desires to effects experienced in the course of riding the motorcycle. The factors are illustrated in the following table.

Table 5: Motivational factors

Hedonism	Positive experiences, fun, joy can even grow until an intensive feeling of pleasure, the attraction of this experience is savoured
Escapism	Riding a motorcycle is used for liberation, to relax and to take off the edge for example after work. One will break out of the daily routine, escape the responsibilities, calm down and find recreation
Dynamic aspects of biking	There is a special appeal due to the experience of acceleration and speed as well as the driving through curves in an extreme slanting position. Riders are seeking for this experience actively.
Performance aspects of biking	To master the vehicle and cope with the physical and psychological demands of riding, and also testing the performance limits of oneself and the machine.
Exhibition riding	Competent riding is not always a 'self-fulfilling goal' and a certain amount of showing-off is intended, particularly when riding is viewed as a sport. Riders want to show there abilities and how well they can handle their motorcycles
Rivalry	Demanding leisure activities are often connected with seek for recognition. The demonstration of ones own competence is done in competition; what counts is who is the better, Riders with this structure of personality are prone for a permanent need to prevail themselves against other road users.
Thrill and adventure seeking	Persons who continuously seeking for border experiences and new stimuli are feeling a physical arousal when they are fulfilling these needs. To ride a motorcycle is offering this stimulus especially when driving fast and sporty.
Flow effects	The experience of the merging of action and awareness is an additional aspect. The attention is focused on a specific field and the self is loosing of importance. The flow of action is undisturbed. There is the full control of the procedure. The rider will be one with his/her bike. This condition has an euphorigenic effect. The dangerous aspect is that the riders are fading out other road users and only concentrate on the moment of driving.
Identification with the vehicle	The motorcycle is seen as an important part of one's life.
Safety behaviour	Besides the feeling to handle dangerous situations due to controlled behaviour of the technology also the wish to drive as safe as possible could be developed. Passive safety equipment, like helmets and co-operative driving style is characterising for these drivers.
Control beliefs	Riders who assess their riding qualifications as perfect, express that they believe that they can control themselves, the vehicle, other road users and the situation all of the time.
Social aspects	The feeling to be part of the «motorcycle-subculture», team spirit, to have fun to drive together, but also the peer pressure within the group is very strong
Economic aspects	Riding a motorbike is cheap compared to other means of transport
Independence	The feeling to go at any time to any place you want to. Motorcyclists feel much more independent than car drivers.
Convenience	The motorcycle is a mean of transport which is easy to handle ('easy to park' and 'manoeuvrability in traffic').
Lonesome Cowboy & Co	Include the feeling to be a hero or the typical lone fighter. Often behave as a macho, a typical male characteristic.
Nonconformity	Sometimes drivers want to feel like the bad boy or the outsider. To be and act differently than the mass and have an own image.

This list derives from surveys and interviews and therefore reflects the attitudes towards riding a motorcycle that can be found in the group of those who are actually riding these vehicles. As said above the list includes

reasons for the modal choice and effects, or expected benefits of the actions.

On the other hand the psychological aspects of certain forms of fulfilment that come with riding a motorcycle are quite similar to those that can be found in evaluations regarding other motorised traffic participants, such as Hedonism, the chasing after the romanticised last independence that lies within driving a motorised vehicle and pushing it and oneself to the limit, are often found irrationalities in evaluations conducted in this field.

In the process of evaluating these factors, regarding use and handling of motorcycles, two studies attempted to classify them and establish category systems to allow better characterisation of motorcyclists based on the above fifteen factors.

In 1991 Schulz et al. were able to establish a category system of three distinct factors. Based on a survey of 376 motorcycle riders and by analysing the scales of each motivational factor and grouping them into three categories they were able to identify pleasure, sport and control as the main aspects of riding a bike. The analysis of this survey data led to two major findings. On the one hand the researchers were able to illustrate that younger riders were more likely to exhibit higher values in the pleasure category and lower values in the category of control. On the other hand it was concluded that the type of motorcycle serves as a direct indication of the motives leading to the modal choice.

In 1982 Walters' study of motivations and attitudes towards motorcycle riding also revealed three different groups of riders. These three groups however are distinguished by their reasons for their modal choice and how responsible or considerate they handle the vehicle. The conclusions of this study show again significant differences in regard to the different age groups and the gender of the participants of the study. While women are more likely to be found in the first group, of those who use their motorcycle mainly for practical reasons, younger riders are more likely to be found in the second group, composed of those who use their motorcycle for pleasure and as a leisure time activity. The third group, mainly composed of those who were considered to be irresponsible riders, primarily consists of very young riders, who are reluctant to follow rules.

Brendicke (1991) found that many riders have had 'a lot of good experiences with their bike and it is a good friend to them'. Hobbs *et al*. (1986) found that 62% of riders believed that riding is a way of life. The motivation to increase self-esteem has been attributed to such riders (Dellen and Bliersbach, 1978) and it has been suggested that this is particularly the case for young adolescent age groups who use the motorcycle to compensate for uncertainties in their developing years (Schulz *et al*., 1991), while for older age groups they may be using the motorcycle to regain their youth and the experiences which they had when riding at an earlier age (the 'born-again bikers' effect).

These motives derive from the desire to form part of a group and the involvement in group activities (e.g. conversations on biking). Schulz (1990) found that motorcycles play an important role in the social status of juvenile riders and the motorcycle is a linking element within the peer group. Also, Brendicke (1991) found that many riders ride a motorcycle in order to spend more time with people with similar interests, and this applied to both younger and older riders. Brendicke (1991), therefore, suggests that motorcycle riding offers an opportunity for social contacts, the motorcycle itself serving as an instrument of contact, a common basis and topic for discussion.

Economic reasons appear to be strong motivators to ride motorcycles. Many motorcyclists express the view that they ride motorcycles because they are cheap to run. Hobbs *et al*. (1986) found that 67% of their sample stated economy as a motivation to ride motorcycles. Economy motivations were more pronounced among young female, compared to young male riders, and featured highly among females of all ages, whilst for male riders, economy motivations were more pronounced among older male riders compared to younger male riders. It should be noted that trends in motorcycle use, i.e. with increasing use of larger-engine bikes for recreational rather than utilisation purposes, appear to indicate that economic aspects today are rather different from what they were in 1986.

Hobbs *et al*., (1986) showed that 39% of riders gave independence as a motive for riding a motorcycle. As a motive, independence seems to apply to female riders more than male riders. In addition, there seems to be no effect of age in independence motives for female riders, whilst for male riders there is an age effect with younger males being more likely to express independence as a motive compared to older males.

For some motorcyclists convenience motives have a significant impact on their perception of motorcycling. Such motives include 'ease of parking' and 'manoeuvrability in traffic'. Hobbs *et al*. (1986) reported that 36% of riders mentioned 'ease in traffic' (manoeuvrability) and 34% expressed 'ease of parking' as motives for riding. Convenience motives were more pronounced in riders over the age of 25. Walters (1982) also showed that this was one of the main advantages for groups of 'practical riders'.

Classifications of motivations

Two investigations have found that the motivations of motorcycle riders can be grouped into three distinct categories. In the first, Schulz *et al*. (1991) conducted a survey which measured the scales of escapism, hedonism, flow, identification with the bike, social aspects, dynamic aspects, performance aspects, exhibition riding, thrill seeking, rivalry, control beliefs and safety behaviour. Inter-correlations between the scales showed that these 12 motivational aspects could be grouped into three broad categories:

- biking for pleasure (escapism, hedonism, flow, identification with the bike, social aspects);
- biking as a fast competitive sport (dynamic aspects, performance aspects, exhibition riding, thrill seeking and rivalry); and
- control over the motorbike (control beliefs and safety behaviour).

Their analysis of rider motivations by age and type of motorcycle revealed that:

- Younger riders were more influenced by riding pleasure (with the exception of social aspect where there were no significant differences).
- Younger riders were more influenced by exhibition riding, rivalry and thrill seeking motives compared to older age groups. However no significant age effects of dynamic aspects or performance aspects.
- Younger riders were less influenced by safety behaviour motives compared to these other motives and compared to older drivers.
- Younger riders had weaker control beliefs than older age groups.

The conclusions drawn from this study were that the type of bike chosen by riders provides clear information on the bikers' motives, the experiences they seek and their concept of riding. However, Schulz *et al*. (1991) pointed out that this is only the case when riders can choose the bike they want (i.e. they may have constraints placed upon their choice of bike – such as money) and, therefore, a variability in the motives within each group (machine type) has to be assumed. One implication is that persuasive communications, tailored to the motivational requirements of the general rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour. Other interventions, such as large scale media campaigns, could also be tailored to the motivational requirements of riders of particular motorcycle types. This will be discussed in greater depth within the section on interventions to follow.

The second investigation that grouped riders motivations into categories was a study by Walters (1982), who conducted 100 in-depth interviews of motorcyclists in Wales to investigate their motivations and attitudes towards riding. She found that 35% of the sample could be classified as those who use a motorcycle for practical reasons, 48% could be classified as those who were enthusiasts and ride for pleasure and 10% could be classified as irresponsible and whose behaviour was considered by others to be immature and irresponsible. Only 7% of the sample could not be classified by these categories.

Motorcyclists who used a motorcycle for practical reasons perceived the main advantages to be economical to run and convenient to use and park. This group of riders was mostly female, and tended to ride smaller bikes for the purpose of short journeys and for travelling to and from work. In addition, such riders disliked the level of arousal generated in the course of riding, and tended to be cautious in their approach to riding in terms of their handling and their use of speed.

Motorcycle enthusiasts were likely to be younger riders, who used their motorcycles for work and also pleasure, and older riders, who had ridden a motorcycle for a long period of time and typically owned a car as an alternative mode of transport. Enthusiasts were found to accept the risk involved in riding, but unlike practical riders, tended to perceive it as a challenge rather than a deterrent. They were motivated by the excitement, exhilaration, and sense of freedom and control which they believed could not be obtained from driving a car. Riders in this category also claimed to be confident in their ability to handle the motorcycle correctly.

Irresponsible riders were found to have a lack of awareness of the risk in motorcycling, were overconfident, and perceived themselves as 'invincible'. Gaining attention, excitement and independence were cited as motivations to behave in such a manner. Such riders were young, typically 17-18 years old. Walters (1982) suggested that training for these riders may be dysfunctional, since making safety rules more explicit may cause these young riders to deliberately set out to break them.

From the social psychology perspective, risk awareness as investigated in this project is more particularly concerned by motivation for using motorbike and type of practice, and then, by the question of attitudes towards risk and risk taking while riding.

In another study, Christmas et al. (2009) developed an original way to categorise riders based on their motivations. The classification of the riders was based on thirty statements. For each statement, the riders rated the things which were important to them about riding, on a five point scale ranking from 'not important at all' to 'very important'. Eight 'motivational factors' were identified from analysis of the responses and used as the basis for the segmentation.

999 out of 1,019 respondents were allocated to seven segments, described as:

- Look-at-me enthusiasts (24% of sample): These are new (or never-grew-up) riders with limited experience but limitless enthusiasm, for who riding is all about self-expression and looking cool.
- Car aspirants (11.2% of sample): These are young people looking forward to getting their first car when age/finances allow – but for the time being just happy to have got their own wheels.
- Performance disciples (8.3% of sample): These are committed, all-year riders with a total focus on high performance riding – and a strong dislike of anything that gets in the way of it.
- Car rejecters (10.1% of sample): These are escapees (a higher propotion of women than in any other segment) from traffic jams, parking tickets, fuel costs and other problems of car use – who don't care for motorcycles, but care for low-cost mobility.
- Performance hobbyists (14.7% of sample): These are solitary, summer-only riders, for whom riding is all about individual experiences and sensations – and who are concerned about what other riders are doing.
- Riding disciples (16.3% of sample) : These are passionate riders for whom riding is a way of life, built on a strong relationship with the bike itself and membership of the wider fraternity of riders.
- Riding hobbyists (14.5% of sample): These are older, summer-only riders who enjoy the social interaction with other riders as much as the riding itself – and who like to look the part.

The segments are listed with respect to their accident liability scores, with Look-at-me Enthusiasts having the highest accident propensity and Riding Hobbyists the lowest.

4.4. Theoretical models concerning attitudes and behaviour

The theoretical models that have been used most extensively in motorcycling research are the Theory of Reasoned Action (TRA) of Fishbein and Ajzen (1975), its recent extension, the Theory of Planned Behaviour (TPB - Ajzen, 1988), and the Health Belief Model (HBM) of Becker and his colleagues (Janz and Becker, 1984).

The Theory of Reasoned Action provides a conceptual and empirical account of the relationships between beliefs, attitudes, intentions and behaviours. The theory predicts that a person's *intention* to perform a behaviour is the immediate determinant of that action. The stronger the intention to engage in a particular behaviour, the more likely it is that the behaviour will be performed. The TRA posits that behavioural intentions are a function of two basic components:

- *attitude towards the behaviour* – this is viewed as a personal factor and it is determined by what the individual believes the outcome of performing the behaviour will be (behavioural beliefs) and the positive or negative evaluation of those outcomes (outcome evaluation).
- *subjective norms* – these are a social influence and they are the person's perception of the social pressures put on him to perform or to not perform the behaviour in question (normative beliefs), weighted by their motivation to comply with these normative beliefs.

The TPB extends the conceptual framework of the TRA to include a further component:

- *perceived behavioural control* – this is the perceived ease or difficulty of performing the behaviour and reflects the perceived likelihood of encountering inhibiting and facilitating factors (control frequency beliefs) weighted by the perceived power of those factors to facilitate or inhibit behaviour (control power beliefs).

Work by Parker and associates (Parker *et al*., 1995) has developed the model further by adding the aspects

of personal norm, affect, habit and personal identity to the theory's three core components, although this has only been used in studies of car drivers, not motorcyclists.

In the Health Belief Model it is proposed that safety related behaviours are accounted for by means of three belief 'dimensions': vulnerability, severity and benefits and barriers. Within the context of motorcycling, vulnerability is concerned with how likely riders believe they are to have accidents; severity concerns the perceived seriousness of the consequences of accidents; and benefits and barriers are the perceived rewards and costs of safe and unsafe riding behaviours.

Although the Health Belief Model offers a slightly different theoretical perspective than the TRA/TPB, a considerable degree of overlap between the two theories can be seen. Recent work on the Health Belief Model has led to the inclusion of three additional factors, locus of control; habit; and social support.

4.4.1. Attitude-behaviour modelling in motorcycle research

Although a large part of the research on attitude-behaviour modelling has focused on car drivers, psychological models have been used in motorcycle research to study safety helmet use, and the social psychological determinants of safe and unsafe motorcycle riding.

Allegrante *et al*. (1980) used the TRA to identify the attitudinal factors that predict behavioural intention to wear a helmet. They found that the TRA predicted 53% of the total variance in behavioural intentions to wear a helmet. It was found that the attitude component of the TRA received the greatest weight in predicting behavioural intentions rather than the subjective norm component. Further analysis revealed differences between intenders and non-intenders to wear a helmet in two attitudinal factors:

- Safety: riders with the intention to wear a helmet had stronger safety beliefs compared to non-intenders (e.g. 'wearing a helmet would prevent head injury and increase visibility and feelings of safety'); and
- Comfort-convenience: riders with the intention to wear a helmet were less likely to express the inconvenience and discomfort possibly associated with helmet use (e.g. 'wearing a helmet would make me feel uncomfortable, hot and impair vision and hearing').

However, no differences were found between intenders and non-intenders in a third attitudinal category, 'social image'. This factor included beliefs such as 'wearing a helmet would make me…. look foolish to other motorcyclists/ appear less adventurous/ look less sexy'.

Rutter and associates (Chesham *et al*., 1991; Chesham *et al*., 1992; Rutter and Quine, 1994; Rutter *et al*., 1993; Rutter *et al*., 1995) have investigated the social psychological determinants of the behaviours associated with accident involvement using the conceptual frameworks of the TRA and the Health-Belief Model (HBM). Rutter and associates conducted a postal survey of 4,100 motorcycle riders. Questionnaires were sent out at two time intervals, twelve months apart. The research findings reported by Rutter and associates have a number of implications. They showed that motorcyclists' beliefs predicted accident related behaviour ('law and rule breaking'). For the TRA, beliefs regarding obeying the law and rules of safe riding and taking care predicted law and rule breaking. Those who were more likely to believe that they should follow the highway code, obey traffic laws, not speed and ride as they were taught were less likely to speed, break traffic laws, break the highway code and ride too close to other vehicles. Those who were more likely to believe that they should concentrate properly, maintain their bike and show consideration to other road users were less likely to engage in these behaviours. For the HBM, perceived vulnerability, the benefit factors of feeling safe, having fun and good bike performance, and the barrier factor risk of accident predicted law and rule breaking. Those riders who had higher perceived vulnerability believed that a benefit of motorcycling was feeling safe and a barrier of motorcycling was risk of having an accident were less likely to engage in law and rule breaking behaviours compared to those who did not hold such beliefs. Also, those riders who believed that the benefits of motorcycling were having fun and having good bike performance were more likely to engage in law and rule breaking.

4.4.2. Attitudes about motorcyclists and other road users

Little research has been conducted into the attitudes and perceptions of motorcyclists towards motorcyclists. One study, Walters (1982) found that 'practical riders' had unfavourable attitudes towards group riding whilst 'rider enthusiasts' were more likely to favour group riding, perceiving this as part of the social element of riding. Such issues were also investigated by Hobbs *et al*. (1986). They found that riders were likely to

support motorcyclists in general.

The small amount of research that has examined motorcyclists' attitudes to other vehicle road users generally shows that riders believe drivers of other vehicles are inconsiderate to motorcyclists on the road. Hobbs *et al*. (1986) found that most motorcyclists in their sample (70%) believed that 'Motorists are inconsiderate to bikers'. Age group comparisons showed a significant effect : very few teenagers held a favourable attitude towards the behaviour of some car drivers. Walters (1982) found that 'practical riders' and 'rider enthusiasts' both commonly believed that the main causes of accidents stemmed from the behaviour of other road users. They tended to claim that a number of potential accidents arose from motorists who do not provide sufficient room for motorcyclists when they have to avoid obstacles on the road (e.g. parked cars). Also, they expressed that no matter how careful they were while riding, they were highly susceptible to accidents because of the behaviour of other road users. They believed that accidents could be avoided if other road users were made more aware of the vulnerability of motorcyclists and exercised more care.

'Practical' motorcyclists also perceived riding to be hazardous and many stated that they did not ride in the winter months and that in poor weather conditions they use other modes of transport. Also, they perceived the hazards involved in riding as anxiety provoking and this was cited as a reason for changing modes of transport in the near future.

4.4.3. Attitudes towards accident involvement

Walters (1982) found in Wales that 'practical riders' and 'rider enthusiasts' believed that accidents stemmed from the behaviour of other road users. In addition, speed, human error and bad road surfaces were cited by such riders as a cause of accidents. However, for rider enthusiasts, speed itself was not perceived as a major cause and it was a typical attitude that they could ride fast but safely. Rider enthusiasts also believed that the majority of motorcycle accidents are the result of lack of experience on the part of the rider and their accident rates showed that most of their accidents occurred in their early stages of learning to ride. Related to this finding was that 'trial and error' was an important part of learning to ride rather than training.

Hobbs *et al.* (1986) study conducted in Great Britain also assessed attitudes towards motorcycle accidents, specifically accident avoidance. These results suggest that about half of riders believe *only they* can take responsibility to reduce their own accident risk, a large amount also believed that other road users have a responsibility. Both older and younger riders take responsibility to reduce *their own* accident risk, but younger riders are more likely to believe that it should not be the sole responsibility of motorcyclists to avoid accidents and other road users should take into consideration motorcyclists vulnerability. This is supported by the findings of Schulz and Kerwien (1990) who found that owing to younger riders under-estimating the dangerousness of a variety of traffic situations and over-estimating their control capabilities, they tended to think that the responsibility for a potential accident rests with other drivers and not themselves.

4.4.4. Risk compensation discussion within the PTW context

No discussion on the role of risk perception and acceptance would be complete without a close look at the work done on risk compensation. It is of great importance to the investigative research work being carried out within WP3 and hence we devote an entire section to it here.

Risk compensation, in the context of transportation research, is when behaviour is adapted to take account of a change in perceived safety. Peltzman (1975) considered safety (or risk) an economic good that can be traded with other goods in the same way. For example, if a car is altered to be safer, then to compensate, driving behaviour may be adapted to go faster, thus trading safety for time.

Many theories of risk compensation have been advocated in past research (e.g. Klebelsberg, 1977; O'Neill, 1977; Evans 1985a,b; Janssen and Tenkink, 1987, 1988; Wilde, 1988; Adams, 1995; Underwood, Jiang and Howarth, 1993). For example, O'Neill (1977) proposed a model of 'danger compensation', which guides 'rational' adaptation of driving behaviour depending on surrounding danger. However, the model was criticised because it relied on driving behaviour always being consistent, and because the concept of acting 'rationally' was not well defined. A more comprehensive cost-benefit model was put forward by Janssen and Tenkink (1987, 1988) who describe risk taking as a consequence of utility maximisation, where accident risk is considered to be only one of the relevant components. One of the most debated risk compensation models in the literature is 'Risk Homeostasis' (Wilde, 1988), named after the self regulatory and unconscious manner in which we maintain our body's temperature. Wilde (1988) hypothesises that we each have a "target level of risk", which is measured on our own "risk thermostat". If the perceived risk of a situation

exceeds our target level, we will act to reduce it. And if the perceived risk is lower than our target level, we will attempt to increase our risk back to our target level through more dangerous actions.

Adams (1995) adopted Wilde's risk homeostasis model to argue that seat belt laws (and other vehicle safety measures) reduced risk for passenger car occupants but increased risk for pedestrians and cyclists, as car drivers were more likely to increase risky driving to compensate for the increased vehicle safety. Adams succinctly stated that "protecting motorists from the consequences of bad driving encourages bad driving".

On the basis of previous work of O'Neill (1977) and Janssen and Tenkink (1987) Underwood, Jiang & Howarth (1993) proposed a more comprehensive risk-compensation model whereby the aim of road users in making a trip is to maximise the benefit of the action. Risk compensation occurs as road users respond to changes in the system so their personal needs are achieved as a result. They propose that expected benefit first increases steadily as risk increases until the point where the risks outweigh the benefits. For example, increasing the speed of a motorbike saves time (increased benefit), until the speed of the bike reaches a level where the risk of being caught by police or loosing control, for example, outweighs the benefit of arriving at the destination on time. There are other situations in which users' benefit, net gain, and margin gain increase enormously above a certain level of risk. For example, sometimes people drive faster send a dying person to hospital in an emergency. Without involving the risk of high speed driving, the patient may die. In these special cases, the users' benefit, net gain, and margin gain curves go up tremendously.

To improve road safety, engineering measures (which change the physical safety conditions) are introduced. One way of doing this is to minimise the severity of an accident if and when it occurs, for example introducing helmet laws for motorcyclists. However, a problem with this is that motorbike riders may over-estimate the safety benefit of the helmet and overcompensate for it by riding in a more risky manner. It has previously been found that motorcycle riders who wore helmets perceived their risk of death as lower and responded with greater risk taking in the form of increased speed (Peltzman 1973; Underwood et al., 1993). Asogwa (1980) investigated motorcyclist fatalities in Anabra State, Nigeria, before and after the introduction of a law mandating the wearing of helmets. Despite high wearing rate (96%), a substantial increase in both fatality rate (17.1%) and injury rate (55%) occurred in a two-year period after the legislation, compared with a two-year period before the legislation. The major reason why this measure had effects in a direction opposite to that intended was that the motorcyclists overestimated the protection afforded by wearing helmets, and then increased their risk taking when wearing them. Wearing a helmet has a safety effect of reducing accident severity in some crashes. However, it has no effect on reducing accident number. This case study indicates that overestimation of safety benefits can be dangerous, as users may be misled towards over-compensatory behaviour, which could reduce the safety effects of an engineering measure or even result in an effect in a direction opposite to that intended.

Hedlund (2000) helpfully sets out four rules for judging the circumstances in which behaviour might or might not change: (1) *If I don't know it's there I won't compensate for a safety measure.* Motorcycle helmets manifestly fail this test, as riders can't escape the fact that their head is, in effect, buried in a large somewhat heavy bucket. (2) *If it doesn't affect me, I won't compensate for a safety measure.* If the motorcyclist feels safer wearing a helmet then compensation is likely to occur. (3) *If I have no reason to change my behaviour, I won't compensate for a safety measure.* Only if the behaviour of motorcyclists is completely unmotivated by concern for safety are they unlikely to compensate for a safety measure such as a helmet. (4) *If my behaviour is tightly controlled I won't compensate for a safety measure.* Riding a motorbike offers considerable freedom to compensate. Hedlund advises "to reduce or eliminate risk compensation, use measures rating low on at least one factor". However, motorbike riding scores high on all four. Conversely, there have been some studies that have shown no evidence of risk compensation in helmet wearing (Lin, Chang, Pai, and Keyl, 2003; Dee, 2009).

One way to reduce the likelihood of risk compensation is to keep the safety changes subtle or hidden, i.e. if the motorbike riders are not aware of a change to the bike, they are unlikely to change their behaviour to compensate for it. An example of this comes from the driving literature, where cars were fitted with studded tyres (Rumar et al, 1976). This increased the safety of the vehicle but due to the drivers' lack of insight into the change, they did not compensate by changing their driving behaviour.

In contrast to the making physical safety changes (engineering measures), motivational measures such as education and traffic laws cannot be traded and thus are less prone to risk compensation. They are specifically designed for shaping habitual and well-practised safety behaviour of the kind that can be carried out in a relatively automatic manner to reduce risk taking. An example of this is the imposition of the nation-wide 55-mile-per hour speed limit in the United States in 1974 was followed by a most dramatic annual traffic fatality reduction. Mela (1979) presented data showing a 15% reduction in total accidents on roads with speed limits of 30 mph and a 25% reduction for roads with speed limits of 45 mph when a four-month period after the introduction of the 55 mph speed limit was compared with the same period in the year prior to the

limit. The introduction of a reduced speed limit is a measure different from the other ones listed above. It actually does not change any physical condition at all. What it does change is human behaviour, by compelling drivers to reduce their risk taking by turning down their speed. Speed limits leave little way for drivers' reactions other than a reduction of their speed and risk taking. In this way, the measure makes risk compensation impossible, and the drivers have to give up some other benefits for safety purposes.

In conjunction with the above discussion, the Risk Homeostasis Theory developed by G.J.S. Wilde (1988) starts from the assumption that when activities are made safer, people have a tendency to let their guard down and hence act in riskier ways. One illustration of this refers to those drivers whose cars are equipped with anti-lock brakes (ABS) taking more risks (assuming that ABS would take care of them) than drivers without such a system (http://psyc.queensu.ca/target/ chapter07.html). This study which was performed by Aschenbrenner et al. in the early eighties demonstrates what might happen when people have a wrong understanding of a new systems' functions.

4.5. Societal factors influence rider risk taking

Having discussed both cognitive and behavioural factors that have a bearing on rider risk taking, it is time now to look at societal contributors within the same context. Within the remit of this report, we will discuss briefly the role of legislation and the question of enforcement of the same. We will then look at some crucial countermeasures in use or being proposed that promise also to influence rider safety. The role of education, training and campaigning will also be discussed within this section as a societal intervention affecting the overall safety of riders and others in their environment.

4.5.1. Legislation

Walters (1982) found that 'practical riders' tended to comply with traffic law and the rules of safe riding. When such rules were broken, these riders said the main reason was to reduce anxiety (e.g. break the speed limit to reduce the anxiety of being late for work). 'Rider enthusiasts' had attitudes, which condoned speeding through busy urban areas but not on long straights of motorway road. Riders breaking traffic rules in this category reported that they did so to generate a feeling of excitement. Rider enthusiasts also acknowledged the importance of courtesy and correct riding procedures as a factor in safe riding, but they reported instances of breaching such practices.

Gosnell (1990) found that, in general, motorcyclists did not believe that they 'are being legislated off the road'. Older riders and female riders were more likely to agree with the law than younger riders and male riders. Hobbs et al. (1986) found that riders' attitudes towards police and legislation were largely positive. Age comparisons in the Hobbs et al. (1986) study showed that for all items regarding the police and legislation, younger riders (<19 years of age) had more negative attitudes. These negative attitudes towards the police and legislation may possibly be attributed to younger riders' desire to rebel against authority.

Research on attitudes to violations has shown that compared to older riders, younger riders appear more likely to believe that having fun is a benefit of law and rule breaking behaviour, and less likely to perceive the risk of an accident as a barrier (Rutter et al., 1995). Gender also seems to have a significant effect, with males reporting fewer negative views concerning the outcomes of drinking and driving and speeding than for females. Gender has also been found to be mediated by beliefs about taking care, with males being more likely than females to have negative beliefs. In addition, males are less likely to perceive feeling safe as a benefit of law and rule breaking compared to females and perceive risk of an accident as a barrier (Rutter et al., 1995).

As an example of how a recent legislation in Portugal had a direct impact on motorcycling activity is presented here: After 18 years the European directive 91/439/CE allowing car divers (licence B, with 25 years old or more) to ride motorcycles until 125cc was transposed to Portuguese legislation in August (Law 78/2009, August, 13). This change has produced a considerable rise in new motorcycle sales between 50cc and 125cc. For example, data from ACAP (Portuguese Automobile Association) report that in November 2009 there was a growth of 192.4% in sales comparing with November 2008. An increase in purchasing of motorcycles by women is also a factor contributing to it. Representing about 5% of the total motorcycle sales before the new law, they represent now, at least, 15% to 20%.

In addition to the fact that legislation varies across Europe, the enforcement or interpretation of the same laws is widely different in each country (for an insightful example, refer to the appendix for a comparative glance at PTW legislation between France & the Czech Republic). This relates more to the social

conventions of rule following in a broader context. So for instance if the norm of rule following behaviour in civil society is deeply entrenched, then the case of transport will not stand out dramatically, with citizens following passive safety directives, such as wearing helmets, observing lane order and signalling protocol. However in other states where the enforcement and follow up procedures are more relaxed within the civil society, it is also natural to find riders and drivers interpreting the directives as suggestions rather than laws. To our knowledge there is no empirical research that has as yet looked at the correlation between cultural rule following and traffic violations. This is of critical importance when considering the effectiveness of interventions being set in place within the European Union, aimed at greater safetly of motorcyclists.

4.5.2. Countermeasures

Proposed as societal interventions, the main objective of countermeasures exists is to provide improved safety for riders. According to literature and studies conducted by Schulz and Walters six different aspects have to be taken into account. These six aspects include protective clothing, conspicuous devices, training, legislation, attitudes towards road users and attitudes towards accident involvement.

With regard to protective clothing and the attitudes towards protective clothing, the analysis shows a connection to gender and self-perception. While women are more likely to actually wear protective clothing, riders attributed to the group of “enthusiastic riders”, as used in the study of Walters, would just use these countermeasures if they would not get into conflict with their self image and their self perception as motorcyclists.

As for conspicuous devices and clothing, the differences that showed up were fairly similar. While a majority of motorcycle riders approved of turning on the lights at daytime, or the implementation of special day time running lights, in order to enhance their conspicuity, especially in the group of enthusiastic riders there is a high rate of motorcycle riders, who refuse to wear special clothing in order to avoid disturbing their perceived self image. Regarding training studies show that a majority of riders is in favour of a formal education and training for motorcycle riders, as found in the study of Hobbs et al.

As for abiding the laws and traffic rules, studies show differences in regard to the different age groups of the motorcycle riders, while the younger ones seem to be the more reckless and irresponsible in this aspect, than the older riders, therefore younger riders are those who more often show negative attitudes towards rules and are more likely to commit violations of laws.

With regard to the attitudes towards other road users motorcyclists shift the responsibility for accidents and other conflicts to other motorised traffic participants, e.g. car drivers and truck drivers. Walters conducted a study in 1982, which showed, that motorcycle riders are likely to allocate the responsibility for the involvement in an accident in other groups of traffic participants. In contrast to this, studies conducted by Hobbs or Schulz showed that especially the older motorcyclists find themselves responsible for reducing the risks of an accident, while the group of younger motorcyclists seems to allocate the responsibility for traffic safety in other road users due to overestimating their own skills and abilities. The perceptions expressed by these groups of riders are to be compared to the occurrence of multiple-vehicle accidents involving a car and a motorcycle (Hurt, 1981, and MAIDS, 2004). MAIDS identified passenger cars as the object most frequently struck in an accident, with car drivers identified as the primary cause factor in over 50% of cases, compared to less than 1% of cases for motorcyclists.

Attitudes towards countermeasures

Protective clothing

Research suggests that motorcycle riders tend to have negative attitudes towards the use of leg protectors. A survey of 600 motorcyclists in Great Britain by Gosnell (1990) found that 37% of riders ‘would choose to use leg protectors’ compared to 51% who would not. Of those saying they would use leg protectors most were older riders (25 years +), female riders, and inexperienced motorcyclists with less than 1 years riding experience. Concerning protective clothing, Walters (1982) found that 48% of her sample of 100 motorcyclists could be classified under a category called ‘rider enthusiasts’ who believed that wearing leathers as a means of protection was an acceptable part of maintaining their ‘self-image’. On the other hand, measures such as reflective clothing (see below) were perceived as detracting from their self-image.

Conspicuity devices

A study by Ravinder (1988) surveyed 496 active motorcyclists in Sydney, Australia and found 91% of motorcyclists believed that 'one of the most important aspects of safe riding is to ensure that the motorcyclist is visible'. However they disagreed about the relative usefulness of various conspicuity devices. Most riders (83%) believed that daytime running lights would increase their conspicuity and 85% believed that given the appropriate legislation they would always use daytime running lights. Similar results were reported by Gosnell (1990). It was found that 68% of riders and 80% of riders over 35 years stated that all new machines should be fitted with daytime running lights. However, fewer riders agreed with wearing reflective clothing, with 59% of riders (74% of older riders) stating that all riders should wear reflective clothing. Hobbs *et al*. (1986) reported different results. More motorcyclists (79%) believed that 'bikers should wear clothing which makes them easily seen' than believed that 'motorcyclists should use their headlights in daylight' (57%). A study by Walters (1982) found that 35% of the sample of 100 motorcyclists could be classified under a category called 'practical riders'. Such riders cited lack of conspicuity as a cause of accidents. In addition, 48% of the sample could be classified under a category called 'rider enthusiasts' who acknowledged that while reflective clothing was 'a good thing', they refused to wear it themselves because it was perceived to be 'silly' or because it detracted from the individual's 'self-image'. However the use of dipped headlights as a means of conspicuity was perceived to be an acceptable part of maintaining the 'self-image' for these riders.

Rider training

As mentioned above, Walters (1982) found that 44% of 'practical riders' had received formal training and perceived it as being beneficial. Among the riders who had not received any training, there was an appreciation that it would be beneficial. 75% of 'rider enthusiasts' believed that experience is the important factor in developing safe riding behaviour and that it is difficult to teach such safe behaviour through training. Only 16% of these riders had experienced any formal training and many had received informal training from friends and/or relatives. A minority of 'rider enthusiasts' believed that training could be useful, but only for the case of the '17 year old who is learning to ride and is irresponsible'.

Hobbs *et al*. (1986) also assessed what motorcycle riders believed should be in a motorcycle-training course for novice riders. The results suggest that the development of road safety, motorcycle maintenance and machine control skills are thought of as important. Nolen and Gregersen (1989) report similar results. They found in a survey of 662 randomly chosen owners of motorcyclists in Great Britain, aged 18-25 years that 75% had never participated in any form of further training for motorcyclists. Despite this, most had positive attitudes towards the effects of extension courses on road safety. The intention to participate in extension courses was found to decrease with increasing fee.

4.5.3. A specific paradigm

Within the European context we can find many disparities within EU member countries in campaigning and education issues. In some countries, e.g. in the United Kingdom, campaigns based on a high degree of realism are often used, which aim to shock viewers into acknowledging certain facts. This method while effective in one context is not necessarily applicable in others. This arises from different cultural and societal environments existing across Europe. That said, at a more general level we can find a lot of points, on how to make successful road safety campaign, and a form of campaign can be customised according to local conditions. Moreover, there are more types of communication campaigns, as stand-alone campaigns, campaigns combined with other supportive activities, mid-term and long term action plans and integrated campaigns. As viable mediums TV, cinema, radio, newspapers, billboards, public performance, presentations, discussions, internet or public space can be used. From this a variety of tools can be employed by road safety campaigners in each country.

Long-term education is proving to be much more effective than stand-alone campaigns. All EU member countries have their own road safety educational programme, which usually starts in maternal school age (4 – 6 years). Regrettably, this education often ends in elementary school and covers only transport behaviour from the pedestrian or bicyclist point-of view. Then in driving schools a road safety topic is overshadowed by driving lessons, so behavioural aspects often take a back seat of topics related to skill and technique. This situation can be improved by the creation of transport behaviour education in high schools, as well as during driving training.

As an example, we turn our attention to the Czech Republic, where we find that motorcycle riders belong to the most vulnerable road user group. There were 118 killed motorcycle riders in 2008 (including moped and small motorcycle riders), which represents 12 % of all persons killed in 2008. Motorcyclists caused 1852 road traffic accidents with 71 persons killed. The causes of road traffic accidents are predominantly speeding,

aggressive driving and risky behaviour of the rider. A great part of motorcycle accidents victims are young and novice riders. This is the reason why that the Czech Ministry of Transport has decided to focus on this group of road users through its various preventive activities. Below the figure presented depicts the proportion of individuals killed in road accidents in the Czech Republic alone in the year 2008.

Figure 12: Source: Czech Ministry of Transport, 2009

In response to the high vulnerability of the rider population, the government thus took on a targeted campaign on young riders. The aim of this initiative was prevention of drinking and riding under the influence of illicit drugs especially after visiting night clubs or other social activities. Fight against speeding and emphasis on wearing helmets were the other messages targeted on this group of road users. In the Czech Republic this is the first preventive project, which works with preciously defined target group. The messages are customised in accordance with their audience. Entertainment and educational medium are combined to keep the campaign engaging as well as effective in changing attitudes and behaviours.

During implementation of this initiative there were representatives of three main parts of the Integrated Rescue System (policemen, firemen and paramedics), which were involved on a spot of a road accident on the same stage. The multimedia show offered visitors a deep emotional experience and informed them about real consequences of a road accident to its victim and their friends and relatives. This initiative is free of charge and it is organised especially for high school students and for pupils of the 9th grade of elementary schools.

Moving from the specific context of the Czech Republic, we also look at other studies, such as the one conducted by Regan et al. (2009) where 31 interviews were carried out in three countries (France, Austria and Australia) in order to give some input about how the safety of motorcycle riders can be increased. The Cognitive Work Analysis methodology was implemented to structure the interview guideline as well as the data analysis. Interviewees mentioned seven priorities, which they associated with riding a bike: safety, efficiency, convenience, timeliness, economy, pleasure and affiliation. According to Regan et al. (2009) safety, was a big issue among the motorcycle riders. Motorcycle riders were fully aware of their vulnerability. They try to increase their safety by using passive protection, adapting their riding style or being as much attentive as possible. Many of the interviewed motorcycle riders liked riding a bike as they reach their destination faster, especially as they are hardly caught in a traffic jam. Related to that issue many riders mentioned to split lanes, not only for saving time, but also for safety reasons. Furthermore some of the riders admitted breaking traffic rules more frequently while riding a bike than while driving a car. Pleasure seemed to be a rather important issue why participants used the bike rather to go by car. Even those participants, who used the bike for commuting only, admitted enjoying the ride to work. Riding a bike seems to provide a more intense experience than driving a car. This is another reason why people appreciate going by bike. Several sensations were mentioned, why participants prefer to go by bike “freedom; the power of the bike; the adrenaline rush on windy roads; a heightened sense of awareness; sounds and smells; the feel of the wind; the relatively unobstructed vision; the forces transmitted through the bike; …..” (Regan et al., 2009). Only few negative sensations were mentioned. Summing up the findings of Regan et al. (2009) motorcycle riders really like the experience of riding a bike, although they seem to be fully aware of the risks on the road.

Different results were investigated by Zehn and Heger (2004). The authors interviewed 131 motorcycle riders about motives of choice of the riding route considering aspects like the route, the driving skills, the sensation of riding as well as general and social aspects. The results showed that accidents are not only related to the

attitudes and the skills of the riders but also to the characteristics of the road.

Schulz et al. (1998, as cited in Bächli-Biétry & Ewert, 2008) showed an influence of the feeling of self-worth on the risk-taking behaviour of motorcycle riders. People with a low self-esteem tended to show a risky driving style, whereas riders who felt self-confident emphasised safety and a defensive driving style. Their findings are based on a survey of 180 riders, who filled in the «Inventar zum Selbstkonzept und Selbstvertrauen» (ISS).

Based on several studies it can be assumed that motorcycle riders have a quite high safety consciousness. Kuschefski et al. (2006, as cited in Bächli-Biétry & Ewert, 2008) interviewed 400 motorcyclists and identified several issues which are important for riders like servicing, participating at rider safety training events, wearing safety gear, interest in safety equipment as well as awareness of risks while riding. Rutter et al. (1992, 1995; as cited in Bächli-Biétry & Ewert, 2008) investigated the attitudes, opinions and beliefs of 4.800 motorcycle riders over the period of one year based on the Health Belief Model (Janz and Becker, 1984) and the Theory of Planned Behaviour (Ajzen and Madden, 1986; as cited in Bächli-Biétry & Ewert, 2008). With a factor analysis, followed by a regression analysis they calculated two factors to be good predictors for the accident risk of riders: behaviour against the law and careless behaviour. Young, male riders seemed to be affected most by those two factors. Lin et al. (2003, as cited in Bächli-Biétry & Ewert, 2008) supported the findings of Rutter et al. (1992, 1995). The history in motorcycle related accidents, the exposure, the risk-taking behaviour as well as the violation against traffic rules were identified as a significant predictor for the accident liability of 17-23 years old College students (Lin et al., 2003). The older and the more experienced the rider was, the less was the risk to get involved in an accident. Furthermore motorcyclists, who were also allowed driving a car, had a smaller accident liability than those who just rode the motorbike.

Chen (2009) studied the relationship between attitudes and riding behaviour of 257 Taiwanese motorcycle riders. Participants were asked to answer several questions with regard to personality, safety attitudes, risky driving behaviour and general information. It was found out that the more riders were willing to take a risk, the greater the probability was to get involved in risky situations. Furthermore the results showed a significant coherency of anger and sensation-seeking with a risk-prone driving style or the violation of traffic rules, whereas anxiety was related to attitudes towards traffic safety.

Wong et al. (2010) interviewed 683 Taiwanese motorcycle riders at the age of 18 to 28 years via an internet survey. Again the authors identified a relation between personality traits and the driving style of a person. Young male riders for instance, were more self confident about their skills, more likely to ignore traffic conditions and show a more risky driving style than female riders.

In summary, road safety campaigns are powerful instruments for decrease road accidents, but they have only limited effectiveness in time. From this reason they are often combined with long-term education, which forms people's thinking and conviction in childhood and adolescence. This approach foster considerate and cautious drivers, to whom is just sometimes reawakened the danger in roads by campaigns. Unfortunately, behaviour factors are often stronger than consciousness of cautious driving, so that's why vision zero is still so far.

5. Conclusions

This deliverable aimed at understanding why motorcycle riders are over-represented in road traffic crashes and, if this fact is caused due to a more risk-affine driving behaviour of this specific road user group as suggested by resent studies (Gregersen and Bjurulf, 1996; Stevenson et al., 2003). It is utterly important to answer this question as the risk of motorcycle riders to be killed in traffic is 34 to 40 times higher than for other road users (figures for US and UK). In Europe motorcycle riders account for 16% of road fatalities, even though their exposure accounts for only 2%. Current deliverable would have been off target, if the group of motorcycle riders would not have been examined in detail as there exists a big heterogeneity in the group of riders with regard to their bikes, their motives as well as their riding behaviour. Furthermore the scenery is changing; more riders are taking up motorcycling at an older age, without having riding experience for many years.

After specifying the several sub-groups of motorcycle riders in the different EU countries, the current report aimed at describing the requirements of the riding task every rider has to tackle. In particular, hazard perception was the requirement, which was focused at; described as ability of the rider to identify dangerous situations. Individual differences in hazard perception as well as in the ability to respond to those hazards have been identified; influenced by the skill level (novice versus experienced rider) and the broadness of the

experience (only car driver versus rider who also drives a car) riders are more likely to be involved in an accident.

From the perspective of cognitive science, the rider builds a mental model of the environment and the events. That model provides a meaningful interpretation of the reality as well as a potential outcome of the current situation. New information is used to improve the model; thus the process can be described as a loop. In short, the rider builds representations of the world he/she is living in and behaves according to them; if those representations are erroneous, they potentially may cause an unsafe riding behaviour. Thus, at the cognitive level risk awareness can be improved by “good practice” experience, e.g. training.

Involving the social science point of view, training needs to be linked to the motives of riders as well, in order to improve the behaviour of riders towards a safe riding style. On the one hand, there is a lack of negative consequences and social feedback in traffic and thus, riders rarely get the chance to learn from their mistakes and on the other hand there are various underlying motives why people ride a bike, which influence their behaviour without noticing it. In literature several reasons have been identified, why people prefer riding a bike instead of using another mode of transport. Next to hedonism, escapism, thrill and sensation seeking, people also enjoy the dynamic or performance aspects of biking, they experience flow effects. Some people chose the bike due to social aspects; they want to belong to a group, whereas others try to experience some kind of independence. There are also economical reasons why people start to go by bike instead of going by car, for instance. Summing up those motives, people ride a bike either for pleasure, as a competitive sport or as they like the feeling of control. Another classification might be to group the riders into those who ride for practical reasons, and those who ride for pleasure. However, talking about riding, in any case implies several underlying aspects, we might not think of at the moment. These aspects might be different for every rider as well, although some patterns have been identified.

Depending on the age, the gender as well as on the driving experience, different motives and attitudes seem to be more or less predominant. Women for instance use the bike more for practical reason but also relate it to a feeling of independence. However, they are the group, who is more willing to wear protecting clothes. Furthermore it was shown, that young riders use their bike predominantly for pleasure and leisure time activities and have a more negative attitude towards rules. Older riders are more willing to wear safety gear compared to young ones. If people are willing to use countermeasures, however, seems pretty much to depend on their self perception and thus, on their self image, but also on the riding experience. In addition, the tendency to use protective clothing can be influenced by geographical and meteorological factors, depending on the country and region. Heavier protective clothing (such as thick layers of fabric or leather) can be uncomfortable in hotter temperatures, potentially leading to exhaustion and distraction.

Concerning risk-taking behaviours motor cycle riders do not differ from car drivers. However, the risk-affine riders, who like to speed and commit other traffic offences, are more likely to be involved in accidents. As already well known for car drivers, the accident liability is higher for young males and those with only little experience. Many riders are over-confident concerning their riding-skills and under-estimate the probability of an accident. Furthermore the responsibility for an accident quite often is shifted to the other motorised road users. However, in general safety seems to be a big issue among the riding population. Motorcyclists have several strategies to improve their safety (irrespective if those strategies really are safe or not). Even though riders seem to shift the blame for an accident to car drivers, many of them seem think that only themselves can avoid an accident. This might be one reason why motorcycle riders agree on the importance of training and its influence on the riding skills. However, although many riders seem to be aware of their responsibility in traffic as well as the need of improving their skills in order to behave safe, they are not taking part in post licence training. Thus, talking about road safety needs to include awareness rising by campaigns and education, what was discussed in the closing chapter.

Summing up, current report provides an overview of theoretical concepts as well as research carried out in the field of motorcycle rider motives, attitudes and risk. It shows that the community of motorcycle riders needs to be examined very thoroughly, as it unites rather heterogeneous groups of riders, with different underlying motives and attitudes that made them riding a bike. Furthermore negative side effects of safety measures have to be cushioned as much as possible in order to avoid compensating behaviour of riders. However, for the further work within the 2BeSafe project current report provides a profound basis. In WP3 (Task 3.2) and WP5 (e.g. T 5.1) we try to investigate the diversity of the motorcyclist population in terms of risk awareness. Therefore already existing questionnaires, video-based methods as well as behaviour observation methods will be adjusted on the basis of the knowledge gained by the literature review of Del. 3.1.

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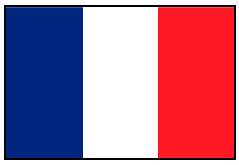
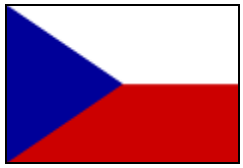
7. Appendix

Comparative Legislation Example:

Legislation – Motorcyclists

FRANCE & CZECH REPUBLIC

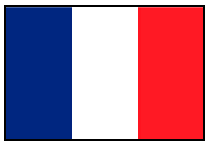
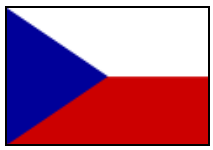
	
1. Headlights Required: Days / Nights	Headlights are compulsory all-day, all-year on for all motor vehicles, including motorcycles.
2. Helmets are mandatory: Article R431-1 of the Highway Code was amended by Decree No. 2006-46 of January 13, 2006 Art. 4 The helmet should be fixed (fine of 135 euros, loss of 3 points on the license) The helmet should be approved (French or European norms. Fined: 135 euros, loss of 3 points on the driving license)	Helmets are mandatory. “Helmet should be properly fixed ON THE HEAD and eyes must be protected when riding (except in rain or snow etc. when visibility could be affected)” Breaking the rule – loss of 2 points (driver starts with 12 points, after one year without violation, 4 lost points can be returned up to max. number of 12). The helmet should be approved.
3. The “gray card”: The gray card is a certificate of registration to the European assigning a registration number to identify a vehicle to know its technical characteristics, the owner's name and address. This document is required to set and maintain outstanding of all motor vehicles travelling on roads open to public traffic (Article R322-1 of the Highway Code).	Not sure about this. This might be similar to Czech “small registration card” of the vehicle:  EVROPSKÉ SPOLEČENSTVÍ OSVĚDČENÍ O REGISTRACI VOZIDLA ČÁST I. ČESKÁ REPUBLIKA A. REGISTRAČNÍ ZNAČKA VOZIDLA 4B34678 B. DATUM PRVNÍ REGISTRACE VOZIDLA 18.7.2006 C.1.1. a C.1.2. PROVOZOVATEL (PŘÍJMENÍ A JMÉNO NEBO OBCHODNÍ JMÉNO) KAREL KOMÁREK C.1.3. MÍSTO TRVALÉHO NEBO POVOLENÉHO POBYTU / SÍDLO KOMÁRKOVA 3, OSTRAVA C.4. PROVOZOVATEL JE VLASTNÍKEM VOZIDLA a) ANO, b) NE ANO I. DATUM 12.03.2008 otisk razítka UAA 000000 PODPIS It states both owner’s name and main car ID-numbers. This is a “small” ID of the car and driver must have it when driving/riding.
4. The probationary driving license Since the 1st March of 2004 all new holders of driver's license (motorcycle, car) who passed the examination are given with a probationary license. The probationary license also covers drivers who have been sentenced to a cancellation of the permit by the judge or whose license has been invalidated by the total loss of points and who want to drive	There is no system of probationary driving license in Czech Republic.

again. The probationary license has a capital of 6 points over a period of three years. This period is reduced to two years for drivers who have followed the chain of early learning driving (accompanied driving). If you have lost any point during the probationary period, your capital is automatically increased to 12 points.	
5. The different types of driving license (see table 5. below) Some additional details on the A1 license Motorcycles 125 cm^3over 15 Hp It is good to know that a 125 cm^3 can be such MTT2 (ie having a power exceeding 25 kW or power to weight ratio greater than 0.16). This applies to some 125 registered time when the 125 cm^3 were not clamped (before December 31, 1984). Thus these bikes could have a capacity exceeding 15 Hp are allowed to drive: any person holding the license B (car), obtained by 1st March, 1980 anyone licensee A1 (light motorcycle) obtained before 1st January, 1985 Any person holding permit A2 or A3 (motorcycles - from 400cc to 400cc and up) obtained between 1 March 1980 and 31 décembre1984. The 125 cm^3 over 15 CVs in circulation after 1 January 1985 must therefore require a permit or A2 or A3. For some, it is even necessary to have 2 years driving A, either because their power exceeds 34 Hp (25 kW), or because their low weight because their power to weight ratio exceeds 0.16 (cf. establishment license).	A1 is quite new group. Historicaly there were only 2 groups for motorcycles: up to 50 cm^3 over 50 cm^3 These have been converted into new groups and all older driving licenses (issued until 2000) have to be changed for new cards before end of 2010.
6. The French B license (commonly called « car license ») and driving on two wheels under 125cc in France and the EU (European Union of 25 member states) : From 2 years driving experience, anybody driving license, obtained before January 1, 2007, can drive on the national territory (French), a motorcycle or scooter with a cylinder capacity not exceeding 125 cm^3 and whose power is restricted to 15Hp or 11 kW: Article R221-8 of the Highway Code. Note that this right is recognized to any person having his normal residence in France, held a national driving license issued by a Member State of the European Community or another State belonging to the Agreement on Economic Area European valid in this State without being required to undergo examinations under the first paragraph of Article R. 221-3. See in this regard the decision of the Ministry of the Equipment of February 8, 1999 - (JD of 2012)	This does not apply in Czech Republic.

concerning the conditions of recognition and exchange of driving licenses issued by states belonging to the European Union and the European Economic Area. Before two years permit B without being in possession of a permit or A1, you can not drive a two-wheeled cylinder capacity not exceeding 50 cm^3. Since 1st January 2007, new licensed cars (B permit) will be required to undergo mandatory training for three hours to drive a 125 cm^3 either a scooter or a motorcycle 125. Introduced in July 1996, the right to any licensee self for over two years to conduct a "light motorcycle » (125 cm^3 is less than 15 Hp) has been tempered. The government has decided to impose the equivalent of a "mandatory training for a minimum of three hours, by a decree No. 2006-1811 of December 23, 2006 published in the Official Gazette of December 31, 2006. This training aims to "educate motorists on the particularity of the conduct of a two-wheeled motorized and risks associated with them, in fact, due to the lack of specific training, these drivers are more exposed to risk of accident during their first time driving, "said Department of Transportation. This obligation concerns motorists who get their driver's license Class B after December 31, 2006 and who wish to drive a 125 cm^3 motorbike from 1 January 2009. Following this training, a certificate will be issued followed by the driving school. Suffice it then to the motorist to go to the prefecture to mention on his driver's license law to drive a 125cc. Failure to comply with this requirement is liable to a breach of 135 € (4th class) and a withdrawal of three points on the license ... "The detention of the vehicle may be required and additional penalties such as suspension of driving license or track an awareness course on road safety, will be decided by the judge," said Road Safety. Permission to drive a motorcycle or scooter with a cylinder capacity not exceeding 125 cm^3 is limited to French territory. Thus, a French owner of the only “B” license (car license) for at least 2 years can not travel abroad riding a 125 cm^3. Contrary to what many people believe this right under our rules of the road does not extend to all states of the European Union (see about this article R 221-8 of the Highway Code). If, however, some EU countries such as Spain, Italy	

and Austria may grant the same right is with requirements that may differ from one country to another. From these texts derive from the EU border by a French example of Germany Only licensee B may drive in Germany a motorcycle or a scooter not exceeding 125 cm^3 and will irregularity with respect to police this country. Such use in case of accident would not be treated as driving without a license with all the adverse consequences that could result if your insurer has previously issued a green card which indicated that you are covered for country you are visiting.	
7. The limited power to 100 Hp (73.6 kW) and motorcycle license Article R311-1 of the Highway Code states that as of January 1st, 1985 the power of a motorcycle shall not exceed 73.6 kilowatts (100 Hp), actually 106 Hp with tolerance of 6%, or 78 kW.	There is no similar limit in CZ – the holder of non-restricted license A (over 21) can ride motorcycle of any power.
9. Motorcycle license « A » or « A1 » and the Expected Learning of Conduct (AAC) : The training benefit of learning early in the conduct applies only to the category of car license (B permit) under section R211-Article 5 of the Highway Code.	There is no system of “acompanied driving” neither for cars, nor for motorcycles.
10. Table of noise limits authorized by law (see table below) Since June 17th, 1999, all new types of vehicles are subject to European norms, in accordance with Directive 97/24/EC. For motorcycles and scooters, the limits currently imposed are as follows:	***similar to France & in all member states of the EU.***

The different types of driving license

				
DRIVING LICENSE	AGE	VEHICLE	AGE	VEHICLE
BSR : Certificate of Road Safety	From 14 years for anyone born after January 1th, 1988	Moped = 2 wheels not exceeding 50 cm^3 whose speed is limited to 45 km / h: Article R 311-1 of the Highway Code	From 15, these mopeds can be driven also by holders of B license(18)	Moped = 2 wheels not exceeding 50 cm^3 whose speed is limited to 45 km / h. Group named AM
A1	**From 16 years minimum**	Motorcycle Light (MTL) more than 50 cm^3 cylinder capacity not exceeding 125 cm^3 and power 11 kW(15 Hp): Article L 311-1 of the Highway Code	**From 16**	equal motorcycle - up to 125 cm^3 or up to 11kW.
A	**From 18 years to 21 years**	Motorcycle (MTT 1) power than 11 kW (15 Hp) and up to 25 kW (34 Hp) and a power / weight ratio not exceeding 0.16 kW / kg (or an empty weight greater than or equal to 156 kg). Access after two years to all motorcycles: Article R 311-1 of the Highway Code	From 18	**Group** named **A** Until 21 years this license is restricted to motorcycles with power not exceeding 25kW, power/weight ratio not exceeding 0,16 – same as in France.
A	**from 21 years or** after 2 years of permit	Automatically granted the right to drive all the bikes (MTT 2) over 34 Hp: Article R 311-1 of the Highway Code	From 21	Group A non-restricted is not granted automatically-applicant must undergo practical driving exam for A-group
B1	**16 years**	motor tricycle (trike) and quadricycles heavy motor whose power does not exceed 15 kilowatts and whose unladen weight does not exceed 550 kilograms: Article R221-4 of the Highway Code	17 years	motor tricycles and quadricycles of cylinder volume HIGHER than 50 cm^3 (or with engine of similar power) or speeds HIGHER than 45 km/h. Weight not exceeding 550kg.

B with two years seniority	**20 years**	Light motorcycle not exceeding 125 cm^3 and power of 11 kW (15 Hp) Only on the National territory: Article L 311-1 of the Highway Code		N/A in Czech Republic – holders of B can ride only 2/wheeler - moped

Table of noise limits authorized by law (Czech Republic)

Vehicle	Limit value of noise (in decibels)
Moped whose speed is less than or equal to 25 km / h	66 dB(A)
Moped with maximum speed exceeding 25 km / h	71 dB (A)
Motorcycle whose engine capacity is between 50 and 80 cm^3	75 dB (A)
Motorcycle whose engine capacity is between 80 and 175 cm^3	77 dB (A)
Motorcycle with an engine displacement exceeding 175 cm^3	80 dB (A)