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Analysis of Technical Errors Made by Motorcycle Riders

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Abstract

This article analyses road traffic accidents caused by motorcycle riders' technical errors. It presents an accident table that links the nature of the accidents to the causes of the accident. The connection provides a comprehensive overview of the typical motorcycle accidents that can be extended to events that have occurred. With this in mind, a conclusion can be drawn in the sense that an accident could have been avoided by a proper reaction of the motorcycle rider, and it would also make suggestions for developing a methodology for motorcycling education. Currently, motorcycling on the domestic road network is a hobby rather than a means of everyday travel, but the 10% participation rate in accidents certainly justifies the need to investigate this mode of transport. Today's state-of-the-art and technically well-equipped high-performance motorcycles require efficient vehicle handling and road use preparation. Therefore, drivers need to be able to respond appropriately to the challenges of our accelerated traffic.

Keywords

traffic safety, motorcycle accidents, education, new type approaches

1 Introduction

The target set in the White Paper of the European Union, which is to reduce the number of road fatalities by 50% by 2020 compared to the base in 2011, requires further intervention and efforts in several areas (European Commission, 2011). From 2009–2018, an average of 6.5% of people were injured in accidents and 8.2% of fatalities involved motorcyclists supporting the exploration of the specific causes of motorcycle accidents. The human factor plays a primary role in motorcycle accidents that occur. Therefore, in addition to breaking the rules, driving errors also play a significant role. The development of driver training will be used, and the preparation for driving will also determine the development of driver competencies for motorcyclists. In Hungary, in 2016, the cumulative share of deaths of unprotected road users (pedestrians, cyclists, motorcyclists, and motorcyclists) (47.7%) was slightly higher than the proportion of those killed in cars or drivers (47.3%) (Holló, 2017). The main objectives of the research are to determine the types of motorcycle accidents that are likely to be caused by motorcycle driver fault based on the nature and cause of the accident used in the Hungarian Central Statistical Office statistical datasheet and to determine the types of accidents that can be significantly reduced by driving training. Accidents involve "personal" physical injury and emotional and psychological factors. As a bone can heal, a concussion may go away, but the accident, rescue, location, and not-so-terrible pictures will remain for the rest of our lives. The severity of the problem can be approached from multiple angles.

Lack of experience in driving a car, age-specific characteristics, excessive risk-taking, the role of peer pressure, distraction, overestimation of one's abilities and the "abilities" of a vehicle and experiencing a sense of independence and freedom while driving a motorcycle can be a starting point (Holló et al., 2018).

2 Vehicles

Vehicle movement depends on the following:

- vehicle performance, dynamic properties;
- traffic conditions, including track characteristics, natural (weather) conditions, the composition of the vehicles involved, traffic volume, and traffic management;
- interferences (crosswinds, icing, track errors, accidents);
- and active control by the driver.

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Two essential features can be defined:

- the situation analysis, evaluation, decision and intervention sequence depends on the driver's physical and psycho-physiological load;
- response time depends on the driver's practical experience and skills.

An experienced driver is continually following his or her predetermined goal during his or her activity, successfully reducing the range of situations that may arise in a conflict situation, being able to assess possible motion situations accurately and keeping the vehicle as a kind of tracking system for a series of situations that is, to drive the vehicle safely and in the correct direction for your destination. On the other hand, some drivers are not prepared or fit to drive modern high-performance motorcycles today (Rohács et al., 2015).

Our research aim is to develop objective measurement capabilities for motorcycle riders' capabilities and an evaluation system to identify competency gaps that need to be strengthened for safer driving. The evaluation needs to be based on the accident statistics table of the Central Statistical Office, which was used to compare the types (nature) and the causes of accidents.

3 Presentation of the research method

The basis of the research is the statistical data of the HCSO, as well as the database of the Transport Suitability and Examination Center.

Elements of the test:

- probability of a technical fault in accidents in the CSO statistical database;
- validation of accidental probability values based on a 100-item representative sample;
- determination of the number of motorcycle accidents according to the nature of the accident and its primary cause;
- weighing the number of accidents with the probability of a driving error;
- identify the types of accidents that are most important for accident reduction.

The probability of driving errors in the occurrence of accidents is different, and these were considered on a five-point scale (Table 1).

4 Results of the research

First, we present Table 2 based on the nature of the accidents in the Hungarian Central Statistical Office database (field JAAA020) and the primary cause (field JAAA027).

Table 1 Probability of driving error

Value	Qualification
0	Cannot be determined
1	No connection
2	Low probability
3	Medium probability
4	High probability

The JAAA020 column of Table 2 lists 86 road traffic accident types, while the JAAA027 row contains 100 accident causes. We made a subjective comparison of these by using a qualifying value in the field at the intersection of the column and row of Table 2, which makes it probable that the accident-related driving technique errors are based on statistical data. Due to its large size, Table 2 should be divided into sections.

5 Motorcycle accident table

Table 2 is compiled based on the investigation of 100 motorcycle accidents. Real accident records and site drawings allow you to determine the causes and types of accidents. Entering their numbers at the appropriate intersections of Table 2, using the notation system in Table 3, gives Table 4.

Comparison of Tables 3 and 4 shows that the nature and cause of the vertical 106 (catch-up accident with two or more participants, one stopped) and horizontal 113 (inappropriate use of speed in traffic conditions) The accident rate is the highest at the intersection of the field, indicating that related competencies need to be strengthened during education.

The above example assigns the highest motorcycle crashes to code 4, a safe driving error code. It can be concluded from the improper application of speed and the catch-up accident that the driver did not pay sufficient attention to the traffic environment and did not use the service braking system effectively. It can be stated that these abilities should be strengthened when obtaining a motorcycle driving license or during driving instruction.

6 Practical implementation of statistical data

Due to the continuously and dynamically increasing use of motorcycles, their increasing performance and the motorcycle culture in its developing phase, the analysis and prevention of motorcycle accidents is an important topic. Motorcycle traffic is booming in Hungary and on the roads of Europe, but we can still talk about the emerging motorcycling culture in Hungary. It is imperative to get the best possible foundation and the proper knowledge for those who want to ride a motorbike and can develop their practical experience later. However, this requires

Table 2 Evaluation of specific accidents on the rating plate

		JAAA027						
		Inappropriate speed for vehicle and load	Inappropriate speed for road type and surface condition	inappropriate speed for traffic conditions	Inappropriate speed for weather conditions and visibility	Inappropriate speed for priority rules	The inappropriate speed at the speed limit	Inappropriate speed, other
JAAA020		111	112	113	114	115	116	117
101	Collison, from behind the vehicle, is overtaking left	3	3	3	3	3	3	3
102	Collison from behind, both vehicles overtaking	3	3	3	3	3	3	3
103	Collison from behind, the vehicle is changing lanes from right to left	4	4	4	4	4	4	4
104	Collison of two vehicles, both are lane changing	4	4	4	4	4	4	4
105	Rear-end collision with at least two moving vehicles	4	4	4	4	4	4	4
106	Rear-end collision with at least two vehicles, and one is stopped	4	4	4	4	4	4	4
107	Collison with reversing vehicle	4	4	4	4	4	4	4
108	Collison with starting vehicle from the right side	2	2	2	2	2	2	2
109	Collison between a side-by-side moving vehicle	4	4	4	4	4	4	4
110	Other accidents between moving vehicles going ahead	3	3	3	3	3	3	3
111	Collison from behind, vehicle is overtaking from right	4	4	4	4	4	4	4
113	Collison from behind, vehicle is changing lanes from left to right	4	4	4	4	4	4	4
118	Collison with starting vehicle from the left side	0	0	0	0	0	0	0

Table 3 Motorcycle accident ratio chart

Motorcycle accident rate	
1	Low
2–9	Medium
10 +	High

Table 4 Detail from motorcycle accident rate table

	JAAA027						
JAAA020	111	112	113	114	115	116	117
101			1		1		1
102							1
103							
104							
105		7	18	2		3	
106		5	25	1		6	2
107							
108						1	
109			2				
110		4	5			2	2
111							
113						1	
118						2	

transport professionals with high professional background and appropriate practical knowledge.

Motorcycle driving requires more care, attention and self-control than driving a car. Motorcyclists need to be more powerful and are one of the most vulnerable participants in traffic. According to the prevailing EU position, the risk of death of a motorcyclist (auxiliary motorcycle) is 18 times higher than that of a car driver. This particular risk factor is due to the lack of passive safety features specific to the car, limited visibility due to differences in size, driver technical error and engine instability.

Our research examines the practical implementation of the training from the point of view of both the student and the vocational teacher and discusses the legal framework and the efficiency of their application. It looks into the basics of vocational teacher training and the strict conditions of participation in the training, and based on my own experience; it makes subjective formulations and suggestions for the more efficient operation of the system. It develops a different assessment and rating method that can objectively measure abilities and changes in abilities during practice and examination.

To drive a motorcycle in this category, you must meet certain age and skill requirements in addition to engine performance. In the case of a teenager, not only physical abilities but, in many cases, other essential abilities are also lacking to drive and keep various power-driven vehicles. Paragraphs 10 to 13 of Directive 2006/126/EC of the European Parliament and the Council on driving licenses provide the need to increase the age limit and obtain progressive driving licenses (European Parliament, 2006). Therefore, the legislator also makes motorcycling subject to age and skill requirements in the vehicle category.

Regarding age, you must be at least 14 in the "AM" category. The subcategory A1 may be driven only after age 16, and the motorcycle (tricycle or quad) of the subcategory A2 and the restricted category A may be driven only after 18. A person not experienced in motorcycle driving may not drive a category A motorcycle before age 24. However, here too, one can get an A2 license, as anyone who has gained two years of experience after getting it - overwriting the 24-year limit - can get an A grade by 20.

The concession also existed in earlier regulations. The "A" category, which was available from the age of 21, could be registered from the age of 18 if the driver had a restricted category "A" or a subcategory "A1" for two years. We would point out that before January 19, 2013, the legislator required an 'A' restricted driving license and an 'A1' driving license to obtain an 'A' earlier, and, after the change, made it compulsory to practice driving. This is uncontrollable, but the legislator emphasises the importance of obtaining management practice. So, by age 20, the highest-performing engine that gets the "A2" subcategory at the age of 18 has not been close to a motorcycle for two years, but raising the age limit is undoubtedly welcome. The two years a young person can get an "A" category later than the previous regulation count heavily on the mental maturity needed to drive a high-powered motorcycle.

As a matter of proficiency, Government Decree 326/2011 (XII. 28) already effectively stipulates that only a person who holds a valid registration for a vehicle of subcategory A2 or who has been registered for two years may obtain a valid registration if he or she is 24 years old and has passed a particular exam in his or her category of driving skills (Government of Hungary, 2011).

7 Development of personal injury motorcycle accidents

The first of the relevant and required statistics is the review of the number of personal injury accidents caused by motorcyclists (Government of Hungary, 2011), the largest category of motorcyclists involved (Table 5).

Table 5 Injuries caused by motorcycle riders in road traffic accidents between 2010 and 2017

	Caused an accident	All	%
2010	571	16 308	3.50%
2011	668	15 827	4.22%
2012	681	15 174	4.49%
2013	658	15 691	4.19%
2014	597	15 847	3.77%
2015	638	16 331	3.91%
2016	639	16 627	3.84%
2017	600	16 489	3.64%

The causes of accidents must also be mentioned (Fig. 1). Table 6 below shows the percentage of causes of motorcycle accidents that occurred. Based on these, in most cases, improper speed selection led to the incident. This is not particularly surprising for two-wheelers that typically run at higher speeds (Matijošius, 2022).

The problem is not just the failure to comply with the speed limits. Accidents where relative speeding leads to conflict, can also be included here. (So the vehicle's speed remains within the permissible limits, but in terms of traffic, visibility, weather and road conditions, the wrong choice of speed leads to the accident. This is not an independent cause but plays a significant role in the accident.)

It should also be noted that, in addition to changing direction, driving, cornering (18%) and overtaking (7%),

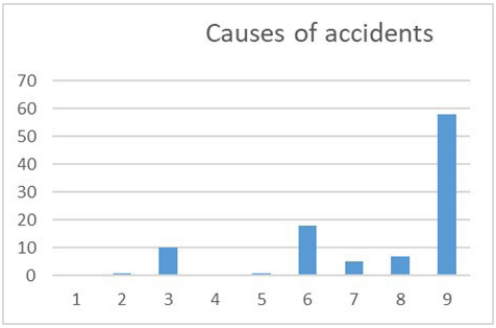


Fig. 1 Cause of accidents (source: Table 6)

Table 6 Causes of motorcyclist accidents in 2013, broken down by cause (%)

1. Vehicle fault	0%
2. Other reasons	1%
3. Other driver faults	10%
4. Lighting	0%
5. Obligation to stop	1%
6. Turn-off	18%
7. Not giving priority	5%
8. Irregular overtaking	6%
9. Overspeed	58%

mostly motorcycle drivers are the cause of the accident. The number of conflicts caused by a vehicle fault is not statistically measurable. There has been a slight decline since 2013, but now it is more stagnant (Table 6).

8 Motorcycle traffic safety programs in our country

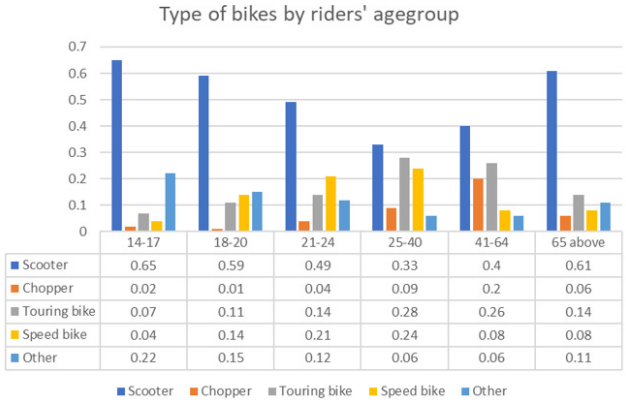
In 2012, with the support of the ORFK-OBB, a unique initiative so far, a survey of riders was conducted on roadside checks, from which it was possible to infer the riders' driving routine and show the kilometres travelled. The survey shows that 62% of those surveyed drive less than 5,000 kilometres a year. Based on this, most people sit on motorbikes only casually and do short distances on these occasions. 24% drive 5–10,000 kilometres per year, and 6% of respondents do 10–15,000 kilometres per season.

The proportion of motorcyclists riding over 15,000 kilometres (i.e. the group likely to travel all year long and long distances, thus becoming a routine driver) is only 8%. Comparing the number of kilometres travelled and the age, the 41–64 age group is the most active: the average distance travelled is 7,762 kilometres per year. They are followed by the 25–40 age group, with 6643 km per year. The questionnaire also examined the relationship between vehicle type, cylinder capacity and driver age. Based on these, it can be said that scooters are the most typical vehicle type in motorcycling, with 40% of respondents declaring it to be their means of transport. 24% of those completing the questionnaire sat on a touring motorbike, 17% on a speed bike and 10% on a chopper.

Examining the types used by different age groups, it is unsurprising that the youngest 14-auxiliary motorbikes almost exclusively power 17-year-olds. The legislative environment will likely play a role in this, as these young people cannot even drive a big engine. As the age progresses, the proportion of scooters decreases and the number of touring and speed bikes increases: 52% of 25- to 40-year-old motorcyclists already drive this type. The trend reverses after the 40s: most mature drivers, who are ripe for routine traffic, switch to a lower-performance chopper or sit on a scooter again. Moreover, for those over 65, the scooter is once again dominant (Fig. 2).

Accordingly, the classification based on cylinder capacity is not surprising: vehicles under 250 cc are present at 44%, most of which are scooters. Engines offset 29% for large engines under 750 cc over 750 cc, which has a 27% share.

Due to the high level of attention paid to motor vehicle accidents and the poorly improving accident statistics, 2012 was designated the Year of Motorcyclists.



	14-17	18-20	21-24	25-40	41-64	65 above
Scooter	0.65	0.59	0.49	0.33	0.4	0.61
Chopper	0.02	0.01	0.04	0.09	0.2	0.06
Touring bike	0.07	0.11	0.14	0.28	0.26	0.14
Speed bike	0.04	0.14	0.21	0.24	0.08	0.08
Other	0.22	0.15	0.12	0.06	0.06	0.11

Fig. 2 Types of the engine by age group

Since then, several events have been held for the sake of motor safety:

- with the support of ORFK-OBB, the following billboard was placed at 35 locations alongside highways (mainly motorways) in 2012 (Torok and Pauer, 2022);
- the European Motorcyclists' Forum was held in Brussels on 5–6 March 2014, in connection with which a round table discussion / technical discussion was organized in Hungary on the current problems of motorcycle transport organized by KTI Nonprofit Kft. And the ITS Hungary Association (Cao, 2022);
- surveys conducted by ORFK-OBB and KTI are also based on recognizing the importance of protective clothing (Fig. 3);
- motor safety events related to road safety are taking place in more and more places in the country, for example, BalatonRide launched by ORFK-OBB, and more and more motor traffic safety days in the summer season are appearing;
- besides, the ORFK-OBB supports schoolchildren's driving licenses through the SuliMoped program, which requires children to acquire a higher level of knowledge of transport (Baranyai and Sipos, 2022).

9 Education methodology

In addition to existing road safety programs, developing the training methodology could achieve better results in the auxiliary and motorbike categories (Lakatos et al, 2016).

Fig. 3 ORFK-OBB: motorcyclist in protective clothing

This new approach focuses on providing a training program that prepares and helps motorcycle learner drivers to become safer on the road after obtaining a driver's license.

To do this, you need to look at the process of becoming a transport specialist. A simple flow chart illustrates this.

This process needs to be analyzed to gain a more detailed insight into the motorcyclist education and training system and to examine the adequacy of legislation, the effectiveness of VET training, and the extent to which the end-user is involved (Fig. 4):

The training of transport specialists (vocational trainers) is provided on the 24/2005. (IV. 21.) GKM is governed by the Decree on the detailed rules for the training and examination of drivers and road transport professionals (Ministry of Economy and Transport, 2005). The regulation's framework curriculum sets out the syllabus and examination requirements for the training and education of drivers training professionals. Prospective vocational educators should acquire the knowledge and skills necessary to maintain direct employment with students in the context of on-the-job training, to develop conscious traffic education, to improve road safety, and develop cultured and safe traffic morale.

The training of vocational trainers is provided by the legal successor of the National Transport Authority, the Transport Suitability and Examination Center. It can be seen that the authority is striving for high-quality training, and several legislative amendments have been made to this end. However, motorcycle specialist training has a severe shortcoming: it does not oblige VET instructors to teach motorcyclists instead of car drivers. This significantly hinders training development and does not allow the introduction of the other training system.

Apart from the fact that the training and further training of vocational trainers requires development and modernization, so is the routine exam with a track and a practical set of tasks (Fig. 5).

The current test track is outdated, does not contain objective elements, and only three tasks do not justify the preparedness to join the road traffic. However, it should

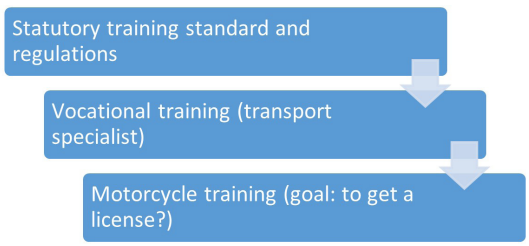


Fig. 4 Training flow chart

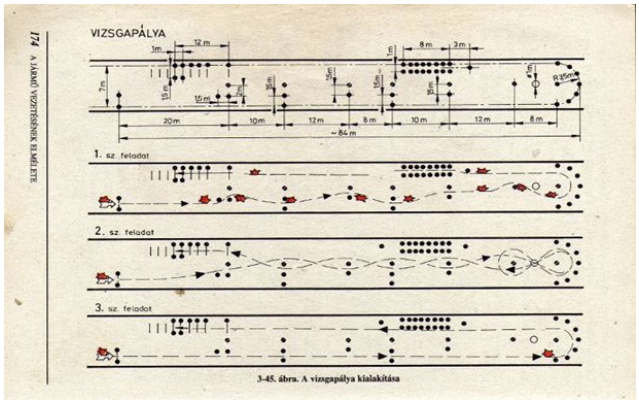


Fig. 5 Category A practical test course

be noted that there was a positive change. With intensive braking practice #3, the stopping distance from 50 km/h was reduced from 24 meters to 12 meters, which was justified.

If we are to meet the requirements and goals of the framework curriculum, we will need a new career path that follows and faithfully reflects the functional mapping of advanced theoretical knowledge. The subjective method, which has been used exclusively so far, cannot be ruled out; However, this kind of subjectivity can be accurately supplemented with objective elements, which can give a much more accurate result (Fig. 6).

10 Conclusion

There is a worldwide trend towards increasing speed limits. This is often met with populist reasons, and modern vehicles are often said to be capable of higher speeds. This is true, but it must be remembered that the speed of collision that the human body can withstand without death or serious injury has not changed. All scientific studies show that any speed increase will impair road safety if other factors remain unchanged. (They often seek to offset the adverse effects by tightening police controls or

Fig. 6 Braking exercise on a modern track with a speedometer

infrastructure interventions (Jima and Sipos, 2022).

The accidental statistical analysis supports the finding that a significant proportion of motor vehicle accidents are attributable to driver errors in driving. Therefore, we need to look at what factors can be traced back to the causes of accidents and how we know whether they can be prevented at all (Jaber et al., 2022).

Following the initial training of VET teachers, to maintain the professional standards set out in the framework curriculum, a framework for further training should be established with the regulatory authority. The training aims to maintain the level of professional theoretical knowledge, introduce the possible changes in the law, and develop motor driving and technical practice. It is also a monitoring and evaluation system that allows the competent authority to ascertain that the instructor has the right motorcycle driving experience.

Significant results in motorcyclist education could be achieved if it were legally required that the instructor should participate in motorcycle instruction. Current legal norms allow car use, so most vocational trainers carry out teaching activities while sitting in the car. *It is impossible to do effective and useful practical training because this eliminated presentation as a didactic method.* Besides, it is impossible to show students, for example, how to drive in a bus lane or rank ahead of a stationary vehicle while driving.

Of course, such a demanding system can only be implemented if economic conditions provide the right motivation. Those who choose this profession are guaranteed a decent living wage and do not need to resort to "tricks" to earn a decent profit. Unfortunately, the economic side is looking the wrong way when we look at the opportunities offered by the market, and we see that driving schools often promise prices below each other, almost to the point where they cannot afford a course even at a cost. This is an absolute consequence of the significant deterioration in the level of training, and the instructor can only compensate for this by introducing extra hours.

An appropriate official fixed price and mandatory motorcycle training by instructors would provide the student with the necessary motivation to provide a higher level of service at a higher cost and would provide a sense of confidence that the primary purpose is not it should be obtained in the shortest possible time, but in order to acquire the stable and safe motoring bases most efficiently.

Similar motivation should be given to riders regarding further training opportunities. There is no requirement for further training, and each rider can decide whether to attend driving or technical training. At the national level, several schools or sole proprietorships offer in-service training to riders.

Regular use of these services, that is to say, the participation of already licensed riders in driving technical training is essential to enable those wishing to learn to improve their practical knowledge and positive benefits continuously and to reduce the number of motor vehicle accidents on the road.

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