

## Airbag Jackets for Motorcyclists: Evaluation of Safety and Economic Benefits

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### I. INTRODUCTION

The Protective Innovations of New Equipment for Enhanced Rider Safety (PIONEERS) project was a European Horizon 2020 project that aimed to reduce the number of Powered-Two-Wheeler (PTW) fatalities and severely injured by increasing the safety, performance, comfort and usage rate of Personal Protective Equipment (PPE) and the development of new on-board safety devices. One of the objectives of this project was to assess the safety and economic benefits of the new safety systems and the new testing methods developed throughout the project. The present work focuses on an airbag jacket for motorcyclists and the PTW-PPE communication system.

The objective of this research is to describe the evaluation of the benefits that can be achieved by implementing Airbag Jackets in terms of safety (avoided or mitigated accidents, reduction of morbidity and severity of injuries) and in terms of economic reduction of costs.

### II. METHODS

The societal and economic benefits calculation was based on four steps, as follows.

(1) *The calculation of the distribution of the injuries according to the rider speed of impact without airbag jacket.* In order to establish this distribution, four accident databases were considered: the GIDAS from BAST, the EDA from the University Gustave Eiffel, the InSAFE from the University of Florence, and the database from the University of Munich. Accidents considered were injury cases in urban and rural environments (excluding motorways) with maximum two participating parties. Among 1,313 accidents, 382 accidents concerned a rider with at least one injury in the trunk body region (Thorax, Abdomen, Spine). For each of these accidents, partners provided an estimation of the rider impact speed but not the PTW impact speed. The impact speed of the body region was first considered, when it was available, but if this was not possible, then the impact speed of the rider was taken.

(2) *The determination of the hypothesis of the protection level provided by the airbag jacket in terms of the reduction of injury risk.* Based on works performed on the protection level reached by the airbag jackets [1], three hypotheses were considered for the level of protection and the reduction of injuries. They considered that the airbag jacket provides a level reduction of 1 to the AIS ( $AIS_{new} = AIS_{initial} - 1$ ) for cases where the speed impact is lower than 20 km/h (Hypothesis 1), respectively lower than 30 km/h (Hyp. 2) and lower than 40 km/h (Hyp. 3).

(3) *The new distribution of injuries with airbag jackets according to the three hypotheses defined in step 2.*

(4) *The evaluation of the Economic Benefits in order to estimate how this new PPE can contribute to significant healthcare cost savings.* The methodology was based on the outcome of the European SafetyCube project [2]. Safety CaUsation, Benefits and Efficiency (hereafter SafetyCube) was a European Commission-supported Horizon 2020 Project aimed at supporting policy-makers and stakeholders in their decision-making regarding the selection of safety measures to be implemented. This was done by developing an innovative road safety Decision Support System (DSS). The DSS calculator takes input from the user, regarding the implementation of safety measures, and input generated in the SafetyCube project, regarding safety costs per country in the European Union, to generate an economic evaluation of the implementation of each studied measure. It is not possible to know the rate of implementation of this device in following years, therefore it was considered two scenarios. First, a scenario with low implementation rate of airbag jackets (3% of total riders in Europe), and secondly, a scenario with higher implementation rate (6% of total riders in Europe).

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### III. INITIAL FINDINGS

Based on the data provided by the different partners, it has been possible to calculate the distribution of the estimated rider's trunk impact speed by injury type (slight, serious and fatal), as shown in Fig. 1. The distribution of maximum injury severities for the trunk body region per each accident database is provided in Table I as the estimation of the new AIS for each accident according to the hypotheses considered in step 2 (protection level of airbag jacket). Table II provides Airbag Economic Benefits for the six setups: three protection level hypotheses and two implementation scenarios (low and high implementation).

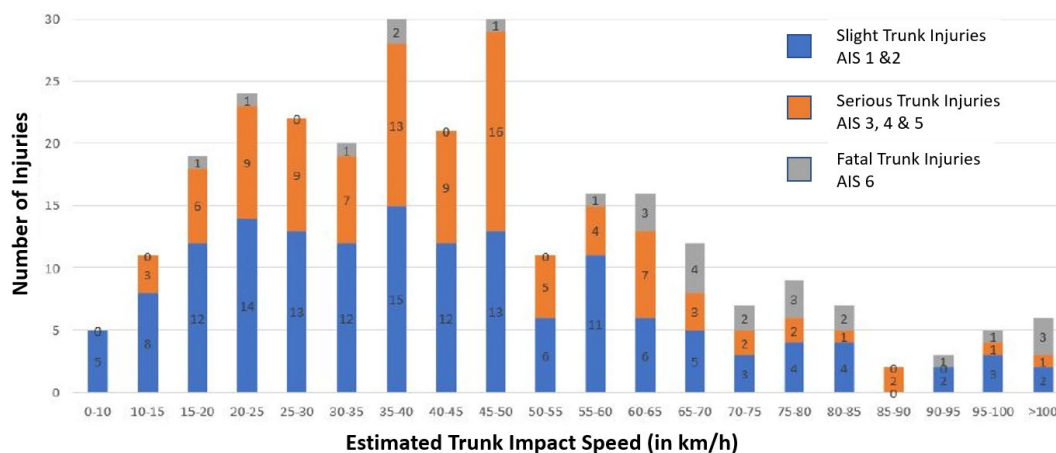


Fig. 1. Estimated rider's trunk impact speed distribution in function of the severity of injuries (slight, serious and fatal injuries).

TABLE I

ORIGINAL AND NEW AIS DISTRIBUTION FOR EACH OF THE HYPOTHESES IN NUMBER AND PERCENTAGE

	original	Hyp. 1: AIS -1 <20km/h	Benefits Hyp. 1 (%)	Hyp. 2: AIS -1 <30km/h	Benefits Hyp. 2 (%)	Hyp. 3: AIS -1 <40km/h	Benefits Hyp. 3 (%)
AIS 0	0	12		32		52	
AIS 1&2 slight injuries	153	151	-1,3	147	-3,9	139	-9,2
AIS3+ serious injuries	203	195	-3,9	179	-11,8	170	-16,3
AIS6 Fatal injuries	26	24	-7,7	24	-7,7	21	-19,2

TABLE II

AIRBAG ECONOMIC BENEFITS  
IN FUNCTION OF THE SIX SETUPS

Airbag setups	Low implement. Rate & Hypothesis 1	Low implement. Rate & Hypothesis 2	Low implement. Rate & Hypothesis 3	High implement. Rate & Hypothesis 1	High implement. Rate & Hypothesis 2	High implement. Rate & Hypothesis 3
Cost (€)	78.931.245 €	78.931.245 €	78.931.245 €	157.862.490 €	157.862.490 €	157.862.490 €
Total Benefits	46.469.832 €	83.847.384 €	149.314.960 €	92.928.679 €	167.661.533 €	298.584.011 €
Net Value	-32.461.413 €	4.916.139 €	70.383.716 €	-64.933.811 €	9.799.043 €	140.721.521 €
Benefit-Cost ratio	0,59%	1,06%	1,89%	0,59%	1,06%	1,89%
Promotion Break even	42,3 €	85,7 €	161,7 €	42,3 €	85,7 €	161,7 €

### IV. DISCUSSION

Considering scenario 2 "high implementation" (the most realistic one), it seems reasonable that European countries promote the use of airbag jackets with an awareness campaign and by promoting the price of €80 to buy this PPE. In a five-year period, this cost will be balanced by savings in health and social costs and Europe could save (in average) at least 26 human lives. In case of a higher rate of implementation like a theoretical 25% implementation among riders, around 110 lives will be saved in Europe. It is also necessary to emphasize that this scenario considers the benefits in only one type of accident, i.e. accidents with trunk injuries in riders, which means 29.1% of total PTW accidents, and where rider impact speed is < 30 km/h. At higher speeds there may be other benefits not studied by the project. All of the evaluations must be considered very carefully. In particular, results from the social and economic evaluations are sensible but should be treated with caution. Beyond these specific evaluations, theoretical methodologies have been defined and could be applied to other systems.

### V. ACKNOWLEDGEMENTS

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 769054.

### VI. REFERENCES

- [1] Deliverable 5.2 of the PIONEERS project, 2020.
- [2] <https://www.safetycube-project.eu>.