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Written By	Ron Schindler (Chalmers)	14-06-2021
Checked by	András Bálint (Chalmers) Henning Wittig (Fraunhofer) Per Elofsson (Scania)	23-06-2021
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Additional author(s) and contributing partners

Name	Organisation
Giuseppe Cordua	IVECO
Mario Perez	IDIADA

Publishable Executive Summary

The scope of this deliverable is to describe the safety benefit assessment activities completed within Task 5.4 of WP5 of the AEROFLEX project. The expected performance of the integrated safety systems developed in Task 5.3 will be used to identify the improved safety provided to the target population (using the background information of task 5.1, 5.2 and 5.3).

For the benefit assessment of the active safety systems, a modified version of a statistical method called the 'dose-response model' is used. The two input functions in this model are the crash distribution, representing the number of crashes at different values of a crash severity parameter (e.g. ego speed), and the injury risk function, representing the risk of an injury of a given severity (e.g. fatal injury) at various values of the same crash severity parameter. In the dose-response model, the crash distribution and injury risk curves are combined to obtain information on the number of injured people in specific crash situations.

In our modification of this model, the safety system performance, in combination with the original crash distribution from the database, results in a "new" crash distribution that aims at representing the new state of the world with the safety systems fully implemented. This new crash distribution will represent a state where certain crashes are avoided by the active safety systems while other crashes may be mitigated or unchanged. This modified crash distribution will then be combined with the injury risk curves obtained from the analysis of the German In-Depth Accident Study (GIDAS) data to get the "new" injury distribution and number of injured people. These results of the "new" situation can be compared to the original situation in order to estimate the system performance based on the change of injuries as a result of the implementation of the system.

The data used for the modelling is from the GIDAS database from the years 2000 to 2020. In order to obtain representative information on a European level, the GIDAS data is extrapolated using the Community database on road accidents (CARE). The extrapolation uses the weighting factor method explained in AEROFLEX Deliverable 5.1. The variables used for the weighting are injury level, crash location (urban or rural), whether the crash happened at a junction or not and the type of the crash opponent.

For each of the different active safety systems, use cases, i.e. frequent scenarios where the systems are expected to provide benefit, were identified. For each of these use cases (e.g. rear-end crashes, right turn crashes), crash distribution and injury risk curves were created, based on both unweighted and EU-weighted GIDAS data. The crash parameters used in the injury risk curves (i.e. injury severity predictors) were chosen based on how well they fit the data available from the simulations and crash databases. Separate injury risk curves are provided for ego and opponent vehicle as well as MAIS3+f injuries (corresponding to serious and fatal injuries) and fatalities separately, resulting in overall four injury distributions per crash scenario. The injury risk curves are modelled through logistic regression. The crash distributions are either modelled through a lognormal distribution (where only one predictor taking nonnegative values is used) or a multivariate normal distribution (where two predictors are used).

The presented results describe the projected safety benefits of the proposed active safety systems within the given use case under the conditions that the systems have 100% market penetration and are activated and working 100% of the time. For each system, the overall performance is calculated based on how many crashes and injuries the system avoided, compared to the current situation without the system, in percent.

For the Autonomous Emergency Brake (AEB) system, layouts 1 and 2 in combination with data fusion avoid the highest number of crashes, while the same layouts with a radar sensor have the highest overall number of avoided injuries and fatalities. As a result from this analysis, an AEB system that uses a radar sensor placed according to layout 1 or 2 (i.e. below or within the front radiator grille) has shown the highest potential on a European level to reduce the number of crashes (up to 85.4%)

and injuries (up to 69.8%) in rear-end, crossing and turning crashes, based on the data that was available for modelling.

For the Side Guard Warning (SGW) system, layout 4 is able to avoid the highest number of crashes and MAIS3+f injuries and is only slightly worse performing than layouts 5 to 7 when it comes to the avoidance of fatal injuries. Therefore, the SGW system with layout 4 (one sensor placed in front of the front wheelhouse) has shown the highest potential for reducing the number of crashes (up to 93.4%) and injuries (up to 97.0%) in VRU related crashes.

For the Lane Support System (LSS), all three proposed implementations as well as layouts have shown the same performance in the simulations for reducing the number of crashes (up to 53.3%) and injuries (up to 29.3%) in lane change scenarios.

The numbers calculated represent an ideal state of the world, with ideal sensor performance and 100% market penetration of the systems. While the latter will take considerable time to be achieved, the first will potentially never be fully reached. As a result, the actual reductions achieved by these systems are expected to be lower, approaching the identified potential slowly over the coming decades.

In addition to the reduced number of crashes as a result from the implementation of active safety systems, road users will also benefit from the improved passive safety, based on the changes in the front-end structure that have been proposed in WP5.3. The studies described within Deliverable 5.3 have shown how the extended front-end design of the truck can reduce intrusions into the car by up to 91.7% in crashes. Furthermore, it can reduce pelvis impact forces by up to 74.1% and keep head injury criterion (HIC) values below the Euro NCAP threshold of 650 in crashes with vulnerable road users (VRU). However, the mapping of these improvements onto crash data and extrapolation to a European level, providing the number of injuries that could be avoided, is presenting a significant hurdle at this point. While improvements are expected to show benefits in traffic, quantifying those in the same way as with the active safety systems has not been possible in this context. Due to the low number of cases available from the GIDAS database, no sufficiently strong association between intrusions and injury severity outcomes in crashes could be made. Additionally, the small sample size did not allow finding reliable links between impact velocity, acceleration, HIC and injury outcome. We therefore recommend further studies in the future, that look in more detail into the proactive prediction of benefits of passive safety systems. In combination with the improvements provided by active safety systems, the approach of integrated safety can provide a better understanding of how the number of injuries, and thereby burden on society, can be quantified and further reduced in the future.

Furthermore, trucks with an extended front-end design, that are equipped with the crash-energy absorbing structures, could be subjected to a specific test protocol aiming at assessing the trucks front-end aggressiveness towards other road users, especially cars and VRUs. A “New Truck Assessment Program (Euro NTAP)” could be created, similar to the one introduced by Euro NCAP for passenger cars, to push for an increasing implementation of both active and passive safety systems in heavy trucks.

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Project partners:

#	Partner	Partner Full Name
1	MAN	MAN TRUCK & BUS AG
2	DAF	DAF Trucks NV
3	IVECO	IVECO S.p.A
4	SCANIA	SCANIA CV AB
5	VOLVO	VOLVO TECHNOLOGY AB
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22	MHH	MEDIZINISCHE HOCHSCHULE HANNOVER
23	UIRR	UNION INTERNATIONALE DES SOCIETES DE TRANSPORT COMBINE RAIL-ROUTE SCRL
25	ZF	ZF CV Systems Hannover GmbH
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