Risk assessment method for Light Electric Vehicles (LEVs)

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Abstract

The European ambition for traffic safety is getting as closely as possible to zero traffic deaths in 2050 as well as halving the number of deaths and serious injuries in traffic between 2021 and 2030. In the Netherlands we aim for zero traffic casualties in 2050 (Ministerie van IenW, 2018). In the meantime, we are looking for innovative ways to meet our mobility needs in a sustainable and durable way. This asks for explicit policy measures and the safe introduction of new vehicle types, such as light electrical vehicles and self-driving vehicles. To ensure that the introduction of new vehicles on the public road does not jeopardize our goals for traffic safety, knowledge on the (un)safety of these vehicles is required. This concerns the technical safety as well as traffic safety. Technical safety relates to the quality and performance of the materials and systems of which the vehicle consists, such as tire profiles and brakes. Possible risks in the interaction between the vehicle, the vehicle operator and the traffic environment define the vehicle's traffic (un)safety. We will present a method based on which possible traffic safety risks can be assessed before a vehicle is introduced to the public road.

Keywords

Risk Assessment; Light Electric Vehicles; Road Safety

Background

In 2018 a tragic accident with an electric handcart equipped for carrying children (a 'Stint') took place in The Netherlands which led to the death of four small children. Related to this accident, the Dutch Safety Board published a report (Dutch Safety Board, 2018) in which they advised the following: 1. Carry out an integrated risk assessment and monitor the developments, 2. Introduce additional measures for already admitted vehicles if necessary, and 3. Revise the admittance of new vehicles. Following this report, in the Netherlands new national admittance regulations for light electric vehicles (LEVs) have recently been developed which will probably be entered into force at the beginning of 2024. In the meantime the new admittance procedures have already been implemented. These procedures include technical inspections and driving tests conducted by the Netherlands Vehicles authority for each individual new vehicle. Additionally, for each new vehicle type a risk assessment concerning the interaction between the vehicle, its operator and the traffic environment in which it is operated should be carried out. SWOV was tasked to develop a method for this risk assessment. Due to a lack of objective accident data an expert evaluation was found to be the most appropriate and feasible method for identifying potential risks. A practical method enabling a systematic and diligent identification of risks that could result in injuries was therefore developed. The method is based on the principles of sustainable safety and closely links to the approach SWOV adopts when assessing risks concerning the human-vehicle interactions for trials with automated vehicles on the public road (Boele, et al., 2015).

Risk assessment method

The risk assessment aims to identify risks that may arise in the interaction between vehicle, vehicle operator and traffic environment. This involves the injury risk for the vehicle operator and possible passengers as well as for other road users. Experts in the field of interaction between vehicles, vehicle operator and the traffic environment identify risks that could result in injuries. Subsequently, for each risk a qualitative scoring system is used to assess whether the risk is likely to arise and how it relates to injury severity.

Risk Types

Two of the Sustainably Safety principles are used as the starting point for identifying what risks LEVs can pose for operators, passengers and other road users: psychologics (appropriateness of road user competences) and biomechanics (appropriateness of speed, mass and size, and road user protection against injury). Derived from these principles, the following risks should be assessed and substantiated (text with green outline taken from De Goede et al., 2019):

Vehicle

Ergonomics of vehicle design: what potential risks are involved in the vehicle design, considering the way the operator is supposed to operate the vehicle?
Conspicuity: what potential risks are involved in the conspicuity to other road users?
Improper use: what potential risks of improper use do certain vehicle characteristics induce?

Operator

Experience and competence:

- What potential risks are involved in operating (braking, accelerating, steering) the vehicle without prior training?
- What potential risks are involved in the possible lack of relevant user experience with a similar vehicle, impeding safe driving task performance?
- If the vehicle is (also) intended for a particular user group: what potential risks are involved in the design of the vehicle not fitting well with possible physical impairments of this user group?

Interaction with other road-users

Recognisability and predictability: what potential risks are involved in a possible mismatch between vehicle movements (for example the way in which the vehicle corners or sways) and expectations of other road users concerning the vehicle?
Distraction: what potential risks are involved in possible conspicuous or distracting vehicle characteristics?

(Bio)mechanics

Road position: what potential risks are involved in the planned road position, considering the characteristics (size, mass, planned construction speed, and operator & passenger protection) of the vehicle and of other road users that may be present?
Collision protection: what potential injury severity risks are involved in a possible lack of operator & passenger protection when colliding with other (motorised, vulnerable) road users?
Crashworthiness: in case of a collision, what potential injury risks for other road users are induced by the design, weight and planned construction speed of the vehicle?

Above categories and several related examples are included in a risk table, which experts should use as a guideline when identifying and scoring risks.

Risk assessment process steps

From start to finish, the proposed method for the entire risk assessment will consist of the following steps:

1. Selection of experts

A minimum of five experts with specific knowledge on the interaction between vehicles, drivers (riders) and the traffic environment are selected and invited to participate.

2. Preparation

During the preparation phase participating experts are asked to go through documentation which is provided to them. The documentation consists of reports provided by the manufacturer as well as on the technical test results as reported by the Netherlands Vehicles authority. Finally the participants can check out and experience the vehicle that is being assessed.

3. Risk assessment

The risk assessment itself consists of two steps:

- Individual assessment by several experts of the risks involved in using the vehicle on public roads.
- A joint discussion by the experts of the individually identified risks.

4. Scoring

Individual scoring of the probability and seriousness of each identified risk: each expert scores the identified risks for probability of occurrence and consequent injury severity. Scores can be * = small,** = medium or *** = large. For each risk the modus of the scores is defined. Most relevant risks are then defined as those risks that have a minimum score of ** for both score-types.

5. Report

The report consists of a description of the vehicle, the method and the risks identified by the experts and the associated scores (probability of occurrence, injury severity).

The result is an overview of relevant risks that, in terms of traffic safety, should be mitigated before introducing the concerning vehicle type to the public road.

Risk assessment method in practice

The method has first been taken into practice in 2020 and has so far been applied to the electric handcart ('BSO-bus') (De Goede et al., 2020) and the electric scooter (De Goede et al., 2021).

Electric handcart ('BSO-bus').

Shortly after the accident in 2018 the 'BSO-bus' has been prohibited from driving on the Dutch public roads. Consequently, based on different technical investigation reports, adjustments have been made to the 'BSO-bus'. In 2020 the Ministry of Infrastructure and Water Management asked SWOV to assess this adjusted version of the 'BSO-bus' using the risk assessment method. Subsequently, eight risks have been identified of which the risk as well as the consequences have been estimated as medium or large. These risks relate to: the position and protection of the driver, the vehicle's maximum load, the task load of the driver, the vehicle's dimensions and weight, and passengers' protection. No further adjustments to the vehicle have been made in response to the risk assessments and the adjusted 'BSO-bus' was admitted to the road in 2020. Nonetheless, with the re-introduction of the 'BSO-bus' a covenant[1] has been closed between the Minister of Infrastructure and Water Management and childcare organisations. One of the covenant's most important measure is the agreement to use safe routes as much as possible when transporting children with a BSO-bus. Safe routes entail roads with intersections equipped with a traffic control system and roads with either separate bike paths or a maximum speed limit of 30 km/h.

[1] https://zoek.officielebekendmakingen.nl/stcrt-2019-38237.pdf

Electric scooters

Electric scooters are currently not allowed on public roads in the Netherlands. However, in 2021 the Ministry of Infrastructure and Water Management asked SWOV to assess this vehicle type using the risk assessment method. Based on this assessment, 19 relevant risks were identified, which relate to: balance, visibility, improper use of the vehicle, the driver's risk perception, and the increased vehicle diversity on bike paths. In response to the risk assessment as well as the technical assessment by RDW, possible adjustments of requirements, both technically and related to safe usage, are currently being discussed.

Conclusion

Inherent to the admission of new vehicles is the fact that little to no objective data exist on the usage and traffic safety of these vehicles. Although the method does not provide objective quantitative results, we believe that a risk assessment based on an expert judgment currently is the best available method to assess road safety risks before admittance onto the public roads. However, it should be noted that not all risks caused by the complex interaction between a vehicle, its operator and the environment can be (sufficiently) assessed in advance. Additionally, the future frequency of use of a particular vehicle is difficult to predict. Therefore, monitoring newly (and potentially provisionally) admitted vehicles remains a necessary part of managing the safety of the traffic system. Monitoring should focus specific attention to the identified risks that cannot be countered by changing a vehicle's design or adjusting user and/or usage rules. Moreover, data acquired through monitoring should also be used to validate SWOV's risk assessment method.

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