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Ex ante assessment of safety issues of new technologies in transport

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Abstract

New technologies in traffic can produce a range of unknown and unplanned deviations which require attention when assessing such technologies for market implementation. Current assessment methods focus on expected and usually desired effects and do not include identification and analyses of all kinds of other effects resulting from processes other than the desired processes. In this paper a method called HAZOP (Hazard and Operability analysis), originally developed for identifying unintended safety problems in chemical processes, is introduced and applied in order to analyse the added value of this method for large scale pilots with intelligent transport systems. The paper discusses the additional potential safety problems which the HAZOP identifies, that should be analysed before implementation of intelligent speed adaptation in daily traffic can be considered.

Keywords: Road safety; Ex ante evaluation; New technologies; ISA; Policy making

1. Introduction

A great number of ITS applications have been studied in demonstration projects and field trials. These projects have involved a variety of ITS functions supporting, for example vehicle control (lane departure warning, headway control and speed control), driver control (alcohol, drowsiness, illness) or flow control (fully automated systems on dedicated lanes). Field trials can have various objectives such as demonstration of a new device, testing the applicability of the technology in real traffic, measuring effects on traffic flow, environment and safety and acceptance of use of a new device. Results and conclusions of these demonstration projects feed discussions on the introduction of such systems in daily traffic. It is therefore important that the results give an appropriate prediction of the effects of using ITS applications in real traffic. Moreover, the use of the results of the field trials for drawing conclusions on implementation in daily traffic requires that all important effects have been studied during one of these trials. Safety in this respect is a special phenomenon, since it, different

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from for example optimising capacity, often deals with effects resulting from processes that differ from the intended traffic processes. Review of the literature (Jagtman, 2004) shows that there has been a lack of attention to the safety issues relating to unintended uses or effects of such new technologies. The input of safety issues studied as a result requires attention. This paper describes an approach that focuses on identification of safety issues for all kinds of road safety measures, including ITS based applications. We will discuss the added value of our procedure for a large scale field trial. This study forms part of a larger doctoral research into the proactive assessment of proposed new technology both in-car and road side (see Jagtman, 2004).

2. Inadequacies in ex ante evaluation of ITS applications in traffic

A number of safety-related effects can occur as a result of processes other than the intended operating processes. The possibility of getting into operational modes different from the intention of an ITS application is a recognised phenomenon in safety science. Process models (e.g., MacDonald, 1972; Kjellén and Larsson, 1981; Hale and Glendon, 1987) describe a sequence in which a traffic system may shift away from the intended or normal process in a series of steps which finally lead, if uncorrected, to accidents. These models distinguish a normal or desired process in which hazards that are built into an activity or technology are controlled within certain defined boundaries. The models recognise that dynamic systems are constantly changing and may at some point get into states outside the defined intended process or state, in which the risks are increased. Deviations may be the result of failures of the control measures, unintended use of them, or unanticipated side effects of them, which can have effects on safety. These can counteract or contribute to the originally intended safety effects. Possible contradictory effects were for instance shown in the ABS Munich taxicab example (Wilde, 1994) in which drivers used up the increased safety margin by driving faster and braking later.

With more sophisticated ITS application we can also expect effects resulting from deviations from the intended operation of such applications. For example, comfort devices such as adaptive cruise control (ACC) can be used in more situations than the limited circumstances described by the manufacturers. Manuals of various ACC systems explain that the devices should be used "only on straight, dry or open roads in non high-density conditions", "in motorway environments where traffic is moving relatively smoothly" and "in road and traffic conditions which make it appropriate to maintain a steady speed for a prolonged period" (BMW, 2002; Mercedes Benz, undated; Nissan, undated). The same manuals instruct that the ACC devices not to be used "in city driving, heavy traffic, on curvy, winding roads, slippery roads or roads with sharp curves such as off-ramps, in inclement weather such as snow, strong rain or fog, or when entering interchanges, services/parking areas or toll booth". All of the devices are operable only above 30 or 40 km/h. As a result of the considerable operability restrictions of the system and the possibility to use the system above these speeds there are many situations in which the driver can use such a device which do not comply with the limited conditions in which it should be used.

Since safety effects arise not only from the intended traffic processes but also from deviating processes, we should assess both types of processes and their effects when deciding on approval and implementation of ITS applications. Despite the recognition that such deviations occur, current evaluation practice focuses mainly on evaluating only whether the device is functioning, whether the driver is able to use the device properly and whether network effects occur, all according to the device's intentions. For ex ante evaluations of ITS applications guidelines are used that fall back on prescribed criteria or scenarios (e.g., European Commission DG XIII, 1998; Stevens et al., 1999; Draskóczy et al., 1998; SAE, 2000). These prescribed criteria or scenarios are based on current knowledge. The approaches do not explicitly incorporate the identification of the full scope of safety effects that may occur both as a result of the intended operating process of the application and from deviations from these processes. This may not lead to problems for established and well-known technologies, where there is considerable collected experience about deviations and unintended use, but offers no help to cope with safety issues in new technologies that are unforeseen, such as those resulting from deviations. The maturity of ITS applications is in such a phase that it is doubtful whether the scope of safety effects is fully known. As a result it is uncertain to what extent the important effects are included in evaluation studies. In this respect the ETSC (1999) adds that although safety evaluations have been performed, the currently used criteria and safety evaluation procedures cannot guarantee any safety benefits. To meet this problem a more proactive strategy in evaluating the safety of these new measures prior to their implementation seems neces-