On the “ITS” Road Toward Vision Zero

Exploring the assessment framework approach developed for smart motorways in England.

This article is the second in a series examining how intelligent transport systems can become part of the Vision Zero road safety solution.

> Vision Zero is rooted in the position that serious injury and death are not acceptable consequences of mobility. Serious injury and death are preventable within the worldwide road transportation system.

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In the Safe System approach, the interaction and interdependencies that exist between people, spaces and vehicles take place within the context of an evidence-based road-safety-management system. This understanding moves our thinking toward a more collaborative environment characterised by pre-emptive safety through incident prevention.

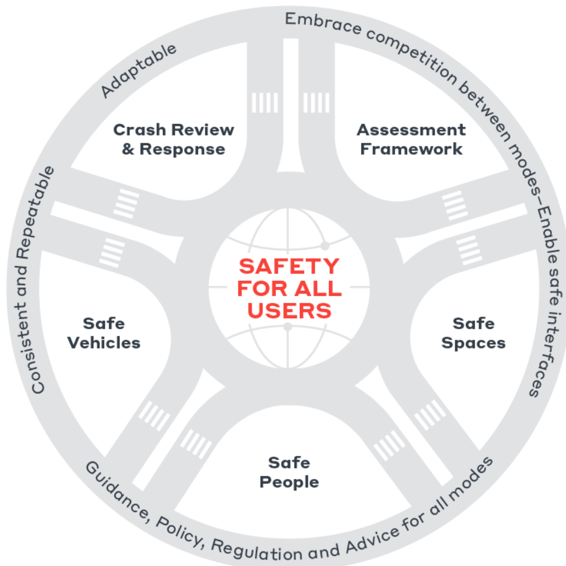

Figure 1 - The data-led intelligent transport system (ITS) whole-system approach considers diverse aspects—to develop safe transport systems for all users.

The overall management system relies on an effective assessment framework to tie together the various road-safety elements and to recognize and understand the related interfaces and interdependencies.

Effective intelligent transport systems combine people, processes, infrastructure, vehicles, technology and associated data to form efficient and safe environments for the movement of people and goods. It is when ITS is considered in this holistic manner—rather than focusing solely on the technological aspects—that it achieves the most beneficial outcomes. Without this system-based approach, potentially beneficial changes to individual aspects can have adverse impacts on other parts, and therefore on the overall system. Introducing a new technology, for example, may create an unintended negative impact on safety if it has not been considered holistically.

Embracing Holistic Thinking

Thinking holistically is then the first step in providing safe systems. How communities currently form that holistic view and put it into practice varies around the world according to local context. In the United States, for example, this all-inclusive approach is the foundation of what is called Transportation Systems Management and Operations (TSMO). The TSMO philosophy is embraced and encouraged by agencies of all sizes and scopes, and focuses on integrating planning, funding decisions (or programming) and design with operations and maintenance to holistically manage the transportation network and optimise existing infrastructure. Within the TSMO context, optimising the existing network considers all the operational goals of an agency. Safety is usually the top goal of transportation agencies throughout the country. As part of this TSMO process, many agencies will more actively conduct a safety analysis early in the planning process, and with the input and engagement of operations personnel who might have more first-hand awareness of the needs. The analysis will allow planners to more effectively apply countermeasures that are crucial in decreasing the number of collisions, reducing congestion and maintaining the efficiency of the transportation system.

Highways England has put in place a formal and comprehensive assessment framework approach that is integral to the long-established ITS whole-system perspective. This approach enables the safety implications of any potential change or intervention within a transport network to be evaluated prior to implementation using existing qualitative and quantitative data. The predicted outcome is validated when in operation.

Improving Safety

Combining the Vision Zero paradigm—based on shared responsibility among the road-transport-system users and system designers[1]—with an ITS data-led whole-system approach creates the best range of solutions. According to Vision Zero,[2] if road users fail to comply with established rules—due to a lack of knowledge, acceptance or ability—system designers must take the necessary further steps to counteract people being killed or seriously injured. In the United Kingdom, the Highways England smart motorways M42 Active Traffic Management (ATM) Pilot demonstrated that the creation of a controlled environment[3] supports safe-system design and encourages compliant human behaviour. A look at the details of the M42 ATM scheme reveals the vital role of a comprehensive, systematic and data-led assessment framework in achieving a higher standard of safety. The development of smart motorways in England, starting with the ATM Pilot in 2006, has relied upon the alignment of ITS with the Safe System approach of shared responsibility that lies at the heart of Vision Zero.

UK Smart Motorways M42 ATM Pilot Pioneers a Formal and Comprehensive Assessment Framework

A formal and comprehensive safety risk assessment framework approach was

[1] System designers – according to the Vision Zero approach - include policymakers, politicians/government officials, infrastructure owners and operators, planners, engineers and road designers, vehicle manufacturers, trauma and hospital care providers, plus any other provider and enforcer of the road transport system. Each contributes important knowledge and expertise to help make and keep roads safe.

[2] *Vision Zero: Setting a Higher Standard for Road Safety*, WSP, pp.10-11

[3] A controlled environment is where the combination of infrastructure and technology "results in motorists who concentrate on (and trust in) the information being provided and they react and behave as necessary…regularly updated information/reassurance as to the status of the road and this results in more compliant driver behaviour." *Revue Routes Roads* magazine, issue No. 353-353, pp. 131-137, PIARC World Road Association

developed in England under the auspices of the smart motorways M42 ATM Pilot—in the early 2000s. This ground-breaking scheme on the motorway/freeway in the midlands region of England was designed to make better use of the carriageway space, relieve congestion and improve journey time reliability. The scheme introduced a new operational regime where the hard shoulder would be open to traffic at times of congestion. It was necessary to demonstrate that this new regime could operate safely—hence a means of demonstrating that safe operation was required.

The scheme was set in the context of a significant rail disaster in England, Great Heck 2001, which resulted from a vehicle leaving the motorway and coming to rest on a railway track in the path of an oncoming train. It remains the worst rail disaster of the 21st century in the United Kingdom. The road and rail networks had each been designed for safe operation but not necessarily designed as a joined-up system. This disaster resulted in cross-industry interest, greater collaboration and a realisation that safety should be considered in a more systematic and holistic way than had been undertaken previously.

The M42 ATM scheme was one of the first of its kind on which a formal and comprehensive assessment of operational safety risk was used—to assess, analyse and determine the risk profile on the network and then to predict the risk profile on the same piece of network following implementation of the scheme with mitigations in place. This measure was undertaken to ensure that the design addressed all the significant hazards that had been identified, assessed and quantified. The mitigations comprised a suite of infrastructure interventions and process/procedural changes, many of which were not included in the standards current at that time.

Understanding User Behaviour Within the System

Through the M42 ATM scheme, it was recognised that the right information needed to be provided to the user at the right place, at the right time and in the most appropriate way/format to achieve the required and desired outcomes.

Speed management, a key component of the Vision Zero model, was a critical aspect within the design of the safe-system interventions—compliance, rather than enforcement, was the driving force to create a controlled environment where users intuitively understood what to do safely. While speed cameras were deployed across the 14-km scheme length, the combination of driver education, signs and markings, and the perception that enforcement was prevalent created the controlled environment and encouraged the compliant behaviour that was necessary to achieve the required and desired scheme outcomes.

Understanding the Most Important Hazards

A comprehensive hazard log was drafted—made up of some 150 hazards. The hazards were all scored using the methodology shown in Figure 2 (on the next page).

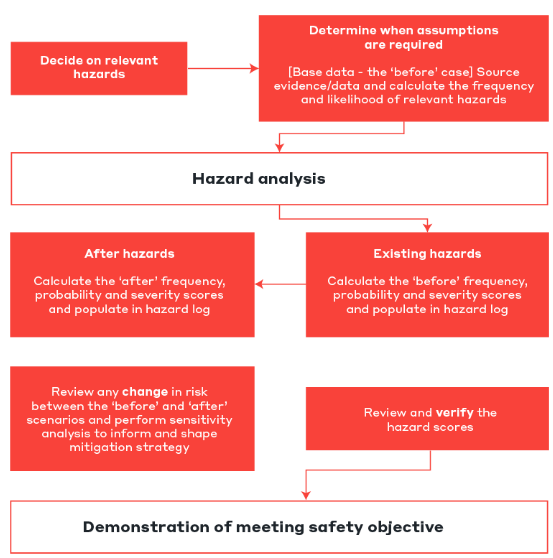

Figure 2 – Methodology used to score hazards

This assessment clearly demonstrated that the majority of energy should be concentrated in mitigating the highest risks, as this would make the biggest difference. It redirected energies away from the technology and focused efforts on understanding the foundations of the risk profile that exist on the highway, which is fundamentally shaped by user behaviours (travelling too fast for the conditions, too close and not keeping in lane).

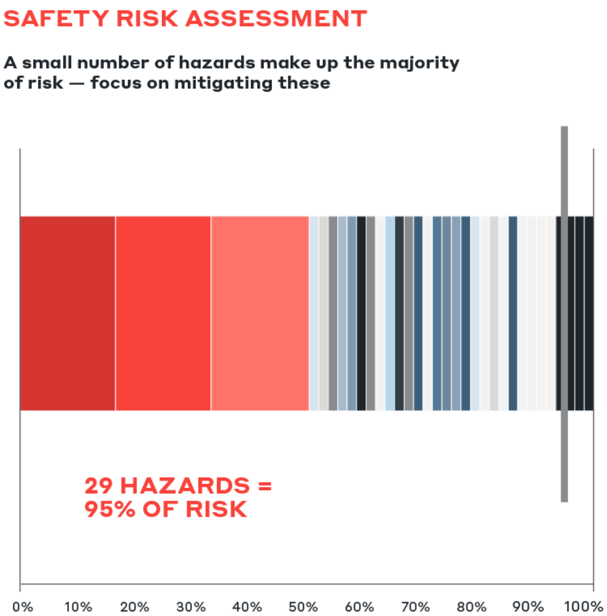

Figure 3 - Hazard Profile
(produced by WSP for Highways England)

WSP, with Highways England, developed a standardised evidence-based approach, the fundamentals of which are to:

— determine the safety baseline
— clearly define the safety objectives
— consider all the user populations that are affected (road workers, road users and others such as neighbouring residents)
— match the level of complexity of the safety risk assessment with the proposed intervention/project
— design appropriate mitigations
— test and check the effectiveness of the methodology, the solution and the mitigations through monitoring
— demonstrate achievement of the safety objectives

Validation by Results
The assessment framework has stood the test of time and been subject to much scrutiny—it has been evaluated on many schemes using post-opening data—giving confidence in the correlation between predicted and actual outcomes. A body of data has been built up over some 20 years—this data, both quantitative and qualitative, is regularly checked and tested (validating and verifying the assumptions behind the data and the scoring)—continuing to demonstrate a conservative approach that stands up to scrutiny.

The successful implementation of the M42 ATM Pilot led to the publication of the standard for safety risk assessment on England's strategic road network. This standard considered and drew on best practice in a variety of domains, including rail, and system safety (IEC61508). It has recently been refreshed by Highways England, and WSP were members of the drafting panel for the updated standard: GG 104[4] Requirements for safety risk assessment.

This multi-faceted framework is applicable to all projects and is required to be used on all activities that are undertaken by Highways England.

Adoption for New Modes and New Mobility
WSP has used and adapted this hazard log approach for other modes and transport systems—including tunnels, connected and

[4] GG 104 Requirements for safety risk assessment, Highways England

automated vehicles (CAVs) and, more recently, to consider e-scooters in town centres. The hazard log approach was undertaken as part of the Armidale Region Driverless initiative (ARDi) in Australia. The ARDi brought a CAV shuttle trial to rural New South Wales, with WSP providing support on elements of safety assurance, road safety and infrastructure risk and mitigations.

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An effective assessment framework creates an evidenced-based understanding of road system interfaces and interdependencies, and it presents the risk profile with the associated hazards. The evaluation of potential changes prior to implementation supports proper attention to user needs, informs design updates and ensures the best use of technology applications. The framework focuses attention on areas that fundamentally advance the safety of the transport system—to prevent serious injury and death and thereby achieve a higher standard of road safety.

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