23. ITS and technology

Introduction

Technological innovation, especially Intelligent Transport Systems (ITS), is transforming the way we approach traffic safety. ITS applications range from in-vehicle safety systems, advanced driver assistance systems (ADAS), and real-time traffic management to infrastructure-based safety enhancements. Technology alone cannot eliminate crashes. However, it significantly supports the Safe System approach by providing warnings to road users on hazardous situations (e.g. road, traffic and weather conditions). incidents and accidents down the road, and supporting the drivers with their driving task (e.g. lane-keeping, emergency braking). ITS and other safety technologies should not be treated as isolated interventions but integrated across all traffic safety pillars (road safety management, safe roads, safe vehicles, safe speeds, and safe road users).

Learning outcomes

After completing this module, the students should be able to:

- Explain the key types and functions of ITS technologies related to traffic safety.
- Compare and evaluate ITS solutions for potential effectiveness and scalability in LMIC contexts.
- Propose an integrated ITS-based traffic safety strategy for a selected corridor or city.

Key messages to learners

- **What ITS is.** Intelligent Transportation Systems integrate information and communication technologies into vehicles, infrastructure, and users to improve the efficiency, safety, sustainability, and reliability of transport. Within road safety, ITS enables proactive crash prevention through real-time monitoring, automated enforcement, and driver assistance, reducing fatalities rather than only responding after crashes occur.
- **Six technology families.** Safety-relevant technologies fall into six groups: vehicle-based (ADAS, event data recorders, alcohol interlocks); infrastructure-based (sensors, cameras, smart signals); enforcement (speed and red-light cameras, ANPR, radar/lidar); communication (V2V, V2I, V2X, telematics); data and AI (crash analytics, real-time traffic platforms); and human-centric (driver monitoring for fatigue, distraction, and drowsiness).
- **Active versus passive safety.** Active technologies prevent crashes before they occur (ABS, ESC, AEB, ACC, LDW, ISA, signal coordination, ITS warnings). Passive technologies reduce injury during or after a crash (seat belts, airbags, crumple zones, rollover protection, side-impact bars, child restraints). Both matter—active tools shift the system toward prevention, passive tools protect when prevention fails.
- **Predictive and real-time safety management.** Adaptive traffic signals (SCATS/SCOOT), CCTV with AI-based incident detection, and Cooperative ITS (C-ITS) with V2X communication move urban road safety from reactive response to predictive intervention across road users, vehicles, and infrastructure.
- **Operationalising Safe System principles.** In-vehicle AEB, ISA, and LDW, combined with variable message signs, dynamic speed limits, and geo-fencing, embed redundancy, speed

management, and real-time feedback. Field trials in Sweden and Norway demonstrate how geo-fencing can hold buses and trucks below 30 km/h inside protected zones such as school areas and city centres.

- **Data-driven enforcement, analysis, and planning.** Speed and red-light cameras, ANPR, vehicle telematics, floating-car data, and ITS-enabled Traffic Management Centres (TMCs) support black-spot identification, near-miss analysis, coordinated enforcement, adaptive traffic control, and benchmarking of fleet operator safety performance.
- **Protecting vulnerable road users.** Pedestrian detection systems, V2P links within V2X, pedestrian countdown timers, and mobile tools such as ride-hailing driver scoring apps target the users most at risk, especially in LMICs where pedestrians, cyclists, and motorcyclists account for the majority of road fatalities.
- **Standardised communication protocols.** C-ITS, DSRC, and 5G are the backbone of interoperability. Without common standards, vehicles, infrastructure, public agencies, private operators, and cross-border systems cannot exchange data reliably, which limits the safety benefit of any individual deployment.
- **Equity and inclusion risks.** Technology can exacerbate inequalities if designed only for mainstream users. Inclusive design is needed so that low-income users, older adults, and people with disabilities can benefit from ITS, rather than being further excluded from safe mobility as systems become more automated and digital.
- **Conditions for impact in LMICs.** ITS delivers safety gains only when paired with strong governance, public awareness, infrastructure readiness, and trust in the technology's added value. Common barriers include funding constraints, legacy infrastructure, skills gaps, and weak regulatory frameworks; LMIC strategies should address these explicitly, rather than assume technology alone solves the problem.

Learning activities

Exercise 1

Classify the following technologies as passive and active safety technologies:

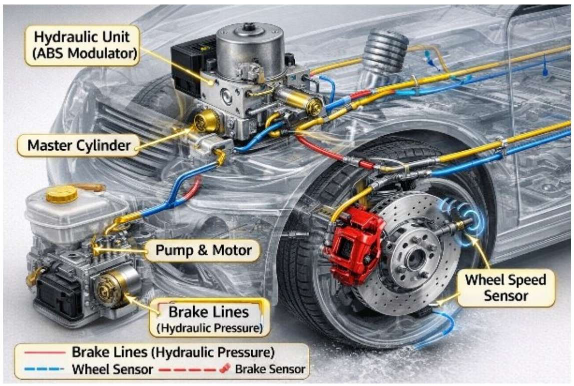
Note: *Seatbelt image adapted from Florida Highway Safety; Airbag image adapted from HowStuffWorks; Lane departure warning image adapted from automotive industry materials; Intelligent speed assistance image adapted from European Transport Safety Council; Anti-lock braking system image adapted from automotive educational resources; Crumple zone image adapted from vehicle safety educational materials; Driver monitoring system image adapted from automotive technology sources; Pedestrian detection image adapted from Volvo Cars. All images are used for educational purposes only. Replace with openly licensed alternatives where possible.*

Seatbelt

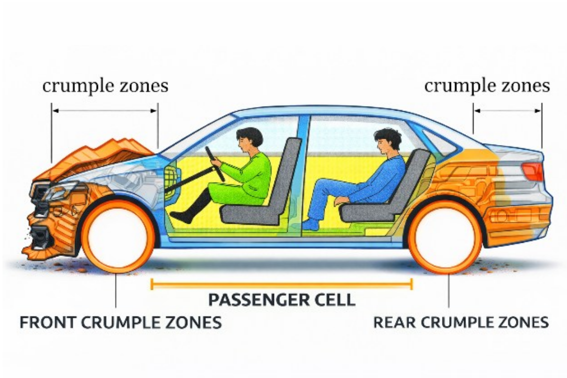
Airbag

Lane departure warning

Intelligent speed assistance



Anti-lock braking system



Crumple zone

Driver monitoring systems (fatigue detection)

Pedestrian detection sensors

Exercise 2

Discuss in the class:

- Which ITS solution offers the best balance of cost and scalability and impact for low- and middle-income countries (LMIC) context?
- What challenges could hinder implementation of these ITS solution in the LMICs and your country in particular?

Assessment quiz

Question 1

Which of the following best describes the primary role of Intelligent Transport Systems (ITS) in traffic safety?

a. to eliminate all road crashes through automation (incorrect)
b. to enable proactive crash prevention and support the Safe System approach (correct)
c. to replace all traditional traffic management methods (incorrect)
d. to increase vehicle speeds on urban roads (incorrect)

Comment (shown after the answer has been given):

ITS does not aim to eliminate all crashes or replace traditional methods. Its primary value is enabling proactive, data-driven crash prevention within the broader Safe System framework, which accepts that humans make mistakes and designs systems to reduce the severity of outcomes.

Question 2

Which of the following is an example of an active safety technology?

a. airbags (incorrect)
b. crumple zones (incorrect)
c. lane departure warning systems (correct)
d. child safety restraints. (incorrect)

Comment (shown after the answer has been given):

Active safety technologies work to prevent crashes before they happen (e.g., lane departure warning, AEB, ESC). Passive safety technologies (e.g., airbags, crumple zones, seatbelts, child restraints) only activate during or after a crash to reduce injury severity. The key distinction is prevention versus protection.

Question 3

Why is it important to ensure standardized communication protocols (such as C-ITS, DSRC, or 5G) in ITS deployment?

a. to make vehicles faster (incorrect)
b. to ensure seamless integration and cooperation among different ITS components and stakeholders (correct)
c. to reduce the cost of infrastructure (incorrect)
d. to prevent human error. (incorrect)

Comment (shown after the answer has been given):

Standardized protocols like C-ITS, DSRC, and 5G are essential for interoperability. Without them, vehicles, infrastructure, and services from different manufacturers or jurisdictions cannot exchange data reliably. This is especially critical for cross-border operations and public-private cooperation.

Question 4

What is a potential risk if ITS technologies are not designed with inclusivity in mind?

a. increased vehicle emissions (incorrect)
b. exacerbation of inequalities among road users (correct)
c. higher traffic congestion (incorrect)
d. reduced data collection. (incorrect)

Comment (shown after the answer has been given):

If ITS solutions are designed only for newer vehicles, smartphone users, or higher-income areas, they can widen the safety gap for low-income groups, elderly people, persons with disabilities, and rural communities. Inclusive design and equitable deployment are necessary to avoid reinforcing existing inequalities.

Question 5

Which of the following ITS applications is specifically used for speed management in high-risk areas like school zones?

a. Adaptive cruise control (incorrect)
b. Variable message sign boards and intelligent speed assistance (correct)
c. Black boxes/event data recorders (incorrect)
d. Alcohol detection systems (incorrect)

Comment (shown after the answer has been given):

Variable message signs and intelligent speed assistance (ISA) are specifically designed for dynamic, location-based speed management. They can adjust limits in real time based on context (e.g., school hours, weather). Adaptive cruise control is a driver comfort feature, not a targeted enforcement or zone-management tool.

Recommended reading and resources for students

- Booker, N., Dolce, G., & Obi, S. P. (2024). The Safe System Approach and technology—what works? *Frontiers in Public Health*, 12. https://doi.org/10.3389/fpubh.2024.1457616
- Godthelp, H. (2023). Towards a safe system in low- and middle-income countries: vehicles that guide drivers on self-explaining roads. *Traffic Safety Research*, 5, e000029. https://doi.org/10.55329/avnw4364
- ITF. (2021). *Artificial Intelligence in proactive road infrastructure safety management* (Roundtable report 187). International Transport Forum. https://doi.org/10.1787/04509d3f-en

Recommended (additional) reading for teacher

- Bazzan, A. L. C., & Klügl, F. (2014). *Introduction to intelligent systems in traffic and transportation*. Springer. https://doi.org/10.1007/978-3-031-01565-6
- Borden, K., LaBahn, M., Milliken, M., & Ortega, S. (2017). *Improving road safety with Intelligent Transportation Systems*. New Mexico Department of Transportation. https://digital.wpi.edu/downloads/jd472w82z
- SAE. (2021). *Recommended practice, taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles* (Standard J3016_202104). SAE International. https://doi.org/10.4271/J3016_202104
- Belin, M.-Å., & Vadeby, A. (2023). Speed and technology: different modus of operandi. In K. Edvardsson Björnberg, S. O. Hansson, M.-Å. Belin, & C. Tingvall (Eds.), *The Vision Zero handbook: theory, technology and management for a zero casualty policy* (pp. 971–994). Springer. https://doi.org/10.1007/978-3-030-76505-7_37
- Lie, A., Tingvall, C., Håkansson, M., & Boström, O. (2023). Automated vehicles: how do they relate to Vision Zero. In K. Edvardsson Björnberg, S. O. Hansson, M.-Å. Belin, & C. Tingvall (Eds.), *The Vision Zero handbook: theory, technology and management for a zero casualty policy* (pp. 1057–1071). Springer. https://doi.org/10.1007/978-3-030-76505-7_39

Prepared by experts

In case you have specific questions, need a discussion partner, or just want feedback on your lecture materials, you may reach out the authors of this module. Please, put ‘AfroSAFE curriculum’ in the email subject.

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