

# Transport for Sustainable Development

## TRL's contribution towards meeting sustainable development goals

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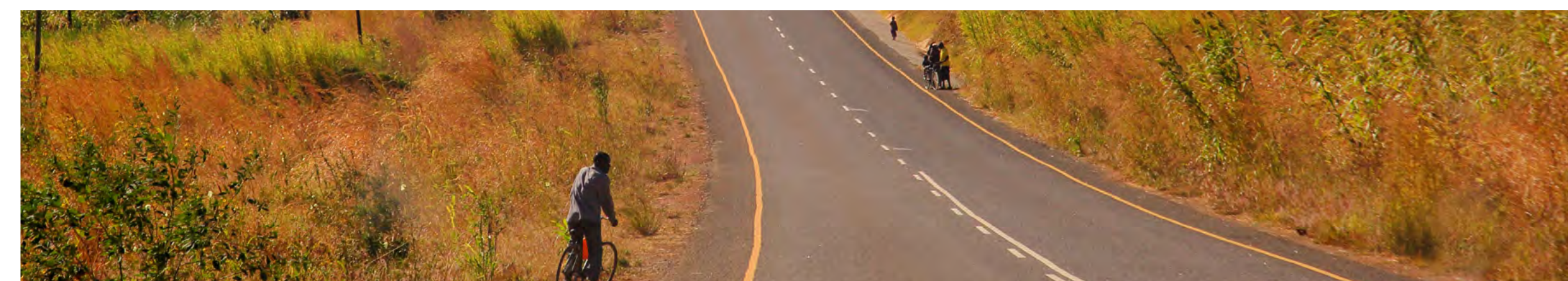
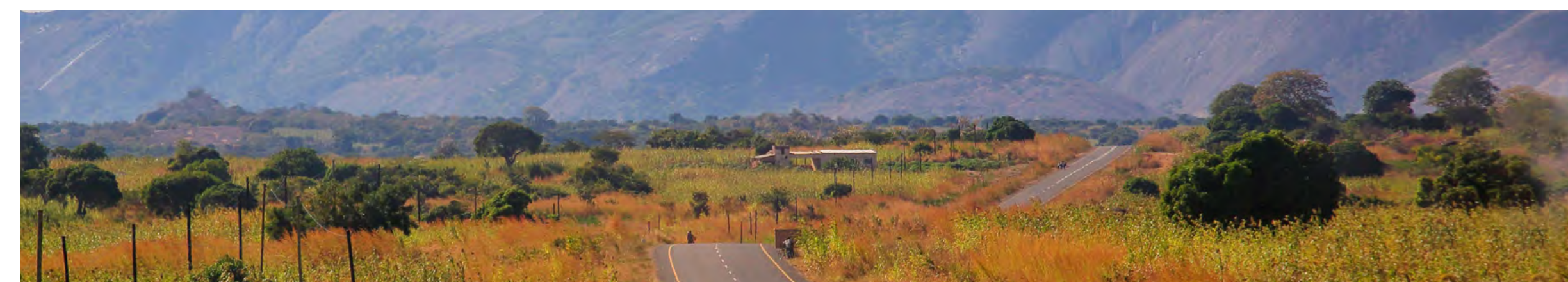
2021



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## Executive Summary

TRL's vision for the future is of clean, efficient transport that is safe, reliable and accessible for everyone, including for countries in the global south; low- and middle-income countries. The Sustainable Development Goals (SDGs) from the United Nations set out 17 goals with a multitude of targets. Many of these relate to transport, and TRL's work directly contributes to achieve the safety and climate related transport goals.

The priority, quite rightly, for the global south is to deal with immediate concerns on poverty, and particularly providing access for rural communities. But what do countries of the global south really want to do? Do they want to follow the global north in motorisation, which we now realise is a large contributor to climate change? More likely they want to find alternative innovative transport solutions that will be cleaner, cheaper, and better suited to the local environment and culture. Countries in the global north are trying to reverse the motorisation trend, having realised the health benefits of active travel, so why encourage the use of cars in the global south? For rural roads, is building a new road for cars and freight the right solution, or can new mobility solutions supplement existing transport systems; maybe drone deliveries are more cost effective? For trunk roads, why not utilise the mobile phone data of road users (that are present on the roads anyway) to capture live information about the road and traffic condition, and potentially to communicate with other road users, instead of investing huge sums in building roadside infrastructure when it will go out of date? Why not build future roads that are flexible and adaptive? The key to success of transport initiatives is to focus efforts in the most cost-effective way, that is suited to the needs of local communities, and that is focussed on reducing casualties and greenhouse gases too.

TRL is a global centre of excellence in transport and innovative mobility solutions. We have an internationally recognised team of scientists, researchers and consultants, who can provide training and upskilling to authorities and businesses throughout the global south. By working together and sharing knowledge and skills we can help to achieve the Sustainable Development Goals for safety and climate change, and help to answer some of these challenging questions.



## Road safety

Every year there are 1.35 million road fatalities, of which 93% occur in the global south despite these countries owning only 60% of the world's vehicles. These deaths are disproportionate. TRL is working across all the Safe System Pillars to help countries tackle this problem:

- **Road safety management** – using data and tools to analyse the collision casualties and determine policy approaches that will focus on the correct casualty groups
- **Safer roads and mobility** – setting standards, assessing new and existing road designs, and providing road asset management systems and software tools
- **Safer vehicles** – identifying the safest vehicles, and developing procurement and policy tools to support their rapid integration into fleets
- **Safer road users** – evaluating and developing education and licencing schemes for drivers, and other interventions to encourage safer behaviours by all road users
- **Post-crash response** – collision investigations to support policy development, and analysis of capability for emergency medical response
- **Speed** – evaluation of appropriate speed limits using an innovative speed assessment tool, and evaluation of speed-related technologies on vehicles

## Road Asset Management

Where roads are required to support economic growth and link communities, well planned, prioritised and specified road maintenance, upgrades, and building are essential for the global south countries to ensure that money is wisely spent on infrastructure. Roads can be a lifeline for communities, stimulate trade, and allow the passage of people and goods across borders. TRL can provide road specification and manuals, asset management, software, and maintenance strategy expertise.

## Climate change

Climate change is estimated to lead to an additional 250 000 deaths per year, and countries with a weaker health and transport infrastructure will find it harder to respond. It is essential that all countries, including those in the global south, contribute to reducing Greenhouse Gas (GHG) emissions from transport. TRL is working in several areas to address emissions:

- **Climate resilience** – standards development and software tools to help assess the resilience of transport infrastructure
- **Sustainable road construction** – design for circularity, evaluation of materials and development of standards to support the use of recycled materials (asphalt, polymers), both in recycling of existing road surfaces, and integration of recycled materials into new surfaces
- **Climate mitigation** – identifying zero emission vehicles' roadmaps, and developing procurement and policy tools to support their more rapid integration into fleets

## Enablers

Digitisation, Automation and New Mobility are enablers that will help to achieve the goals of reduced casualties and emissions more rapidly. By integrating data streams, and adopting new technology intelligently and safely, countries of the global south can gain rapid advantages. This can help them to 'leapfrog' straight to smarter transport systems, without having to go through the stages of development already experienced by the global north.

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**93% of road fatalities occur in the global south**



# 1. The Challenge Sustainable Development Goals

TRL's vision for the future is of clean, efficient transport that is safe, reliable and accessible for everyone. The key word is 'everyone' for this strategic theme around sustainable development, because it encompasses our focus on low- and middle-income countries (LMICs), or the global south, particularly any disadvantaged or more vulnerable road users. We see achieving sustainability in transport as a global challenge, and one in which we will expand our input.

Approximately 1.35 million people die in road collisions each year around the world (World Health Organisation, 2020). A massive 93% of these are from the global south, despite these countries only having about 60% of the world's vehicles. Not only is this a tragedy, but it also costs most countries around 3% of their gross domestic product, so represents an economic burden too.

The World Health Organisation (WHO) has estimated that between 2030 and 2050, climate change might cause approximately 250 000 additional deaths annually, from diarrhoea, malnutrition, malaria and heat stress (World Health Organisation, 2018). Areas with weaker health and transport infrastructure, often the global south, will have less resilience to cope with these changes. Reducing greenhouse gas (GHG) emissions through cleaner transport can result in improved health for the entire world, particularly through reduced air pollution. According to the International Energy Agency (IEA) transport accounts for 22% of total energy-related CO2 emissions (International Energy Agency, 2021).



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**1.35 million people die  
 in road collisions each  
 year around the world**

– World Health Organisation, 2020

The United Nations has published 17 Sustainable Development Goals (SDGs) (United Nations, 2015), several of encompass transport (e.g. 'access to'), although few are specific to transport. Each SDG has associated targets:

SDG #	SDG	SDG targets related to transport
1	No poverty	<b>1.4</b> By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance <b>1.5</b> By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
2	Zero hunger	<b>2.1</b> By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round <b>2.a</b> Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries
3	Good health and well-being	<b>3.6</b> By 2030, halve the number of global deaths and injuries from road traffic collisions <b>3.9</b> By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
4	Quality education	<b>4.3</b> By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
6	Clean water and sanitation	<b>6.1</b> By 2030, achieve universal and equitable access to safe and affordable drinking water for all
7	Affordable and clean energy	<b>7.3</b> By 2030, double the global rate of improvement in energy efficiency
8	Decent work and economic growth	<b>8.8</b> Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
9	Industry, innovation and infrastructure	<b>9.1</b> Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
11	Sustainable cities and communities	<b>11.2</b> By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
12	Responsible consumption and production	<b>12.3</b> By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses <b>12.c</b> Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities <b>12.4</b> By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
13	Climate action	<b>13.1</b> Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries <b>13.3</b> Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning <b>13.a</b> Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly \$100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
14	Life below water	<b>14.1</b> By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
17	Partnerships for the goals	<b>17.5</b> Adopt and implement investment promotion regimes for least developed countries <b>17.11</b> Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020 <b>17.17</b> Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships Data, monitoring and accountability

Our research and consultancy work directly contributes to the achievement of many of these SDGs and this paper sets out some of our capabilities.

## 2. Safety Sustainable Development Goals and targets

There are two Sustainable Development Goals (SDG) targets that are focussed on improving transport safety.



SDG 3, Target 6

By 2030, halve the number of global deaths and injuries from road traffic accidents.

According to (WHO, UNRC, UNRSC, 2021), there are nearly 1.3 million deaths annually in the global south. If nothing changes, estimates indicate another 13 million deaths and 500 million injuries over the next decade



SDG 11, Target 2

By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

In context, (United Nations Department of Economic and Social Affairs, 2018) indicates that 55% of the world's population lives in urban areas. This is expected to increase from 4.2 billion in 2018 by another 2.5 billion, with almost 90% of that growth happening in Africa and Asia.

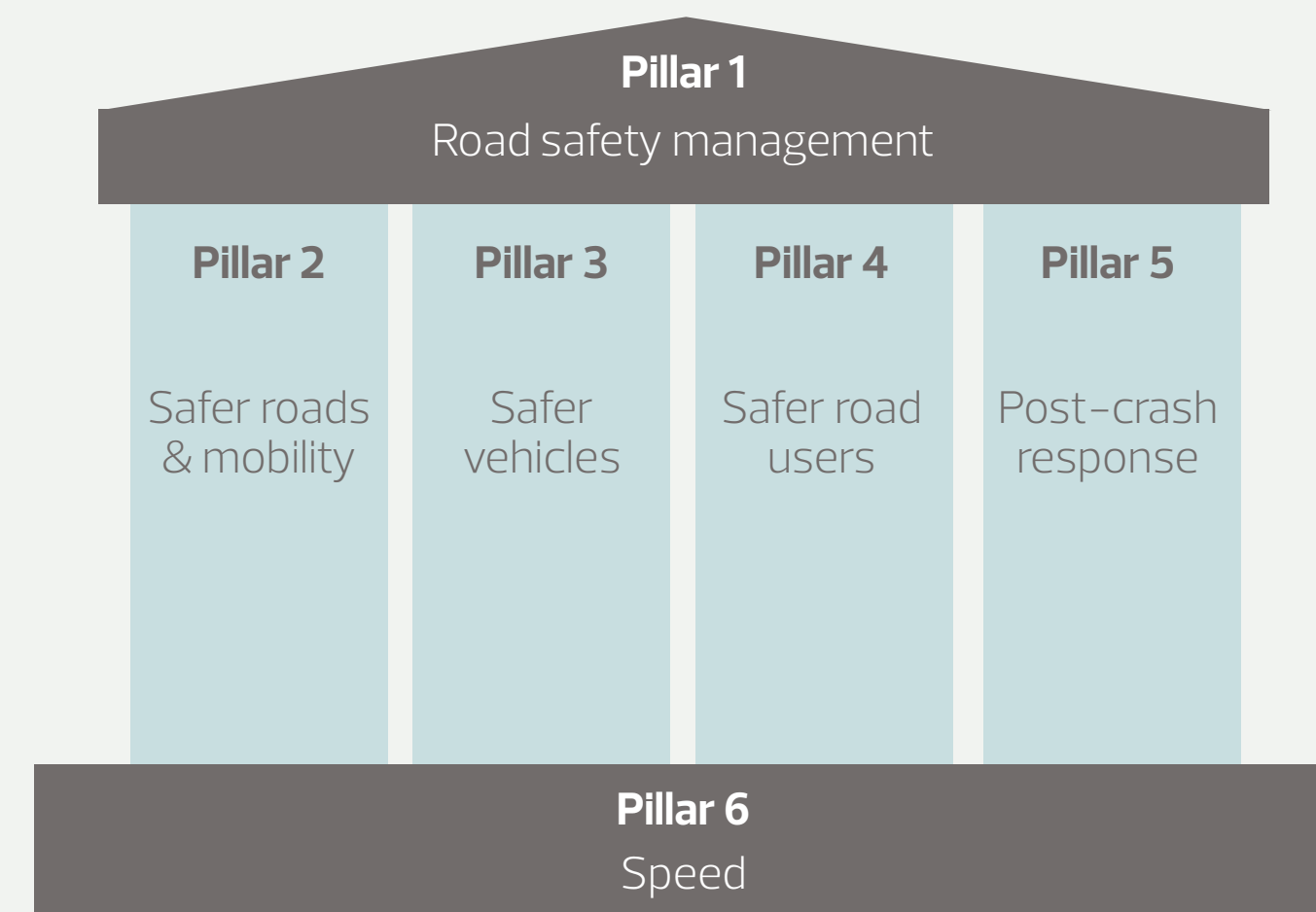


## Safe Systems approach

Recognizing the importance of road safety, governments voted unanimously for a Second Decade of Action for Road Safety 2021–2030 with the explicit target to reduce road deaths and injuries by at least 50% during that period. The global plan, released at the launch of the decade, calls upon an integrated Safe Systems approach (WHO, UNRC, UNRSC, 2021).

The 'Safe System' approach describes the range of things necessary to bring about reductions in death and injury. Simply, the Safe System approach says we need safe users in safe vehicles, traveling on safe infrastructure at safe speeds, and with a good emergency response when crashes do occur, if we are to achieve a safe transport system. The Safe System Pillars form the focus for stakeholders to approach the development of Safe Systems strategies from different technical areas. The Safe Systems approach reflects the need for all stakeholders to act together to improve road safety; only collaborative working will achieve the major reductions in risks and casualties that are required globally. Following the six Safe System Pillars enables a road authority to construct a structured approach for delivering road safety against a defined set of objectives, targets and KPIs. Setting targets is an influential aspect of achieving a systemic reduction in casualties.

### The Safe System Pillars



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**Setting targets is an influential aspect of achieving a systemic reduction in casualties**



# Road safety management



Good data and data systems are fundamental to the Safe Systems approach, so this Pillar over-arches the others. It includes use of collision incident reporting and a range of exposure data. This oversight and data management is essential for guiding strategy development, risk identification, and to evaluate the performance of interventions and strategy. Without good management and organisation of the responses, the impacts of a safety strategy will be limited at best. For the global south the use of data can help to select the most cost-effective strategies to reduce casualties, but many countries still do not have good collision data to help understand where to start. Many countries rely on estimates for road casualty numbers, so proper counting of road casualties, with a system for recording injury severity, would be an essential improvement. We must use innovative means to capture the relevant data from new sources, rather than to see the lack of data as a barrier. Furthermore, to build a policy to reduce those casualty numbers, we need to have a good understanding of the scenarios in which they occur, locations, vehicles involved and their interactions, the causation and contributory factors, etc.

## Key questions to be addressed

- What is the size of the current casualty problem?
- What are the most common collision circumstances?
- What about the most severe incidents?
- What safety measures are available to help tackle the casualties? How effectively will they reduce the casualties? What will it cost?
- Using the casualty information combined with the safety measure effectiveness, what is the prioritised and costed safety strategy?

## Case study

### iMAAP case study

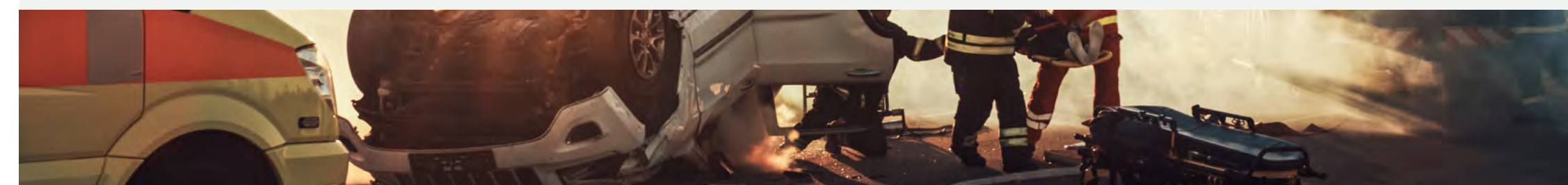
Fifteen percent of global road collision fatalities happen in India. In Himachal Pradesh, India, we designed, developed and implemented an innovative new data system to streamline and centralise the management of road traffic crash data for states in India.

We developed a customised version of our iMAAP software that was linked to a range of government and police IT systems. The police can record traffic collision and casualty data using iMAAP mobile software on tablet devices and the data can be transmitted into the core iMAAP system, available for immediate analysis.

The analysis modules in the system enable managers developing strategy, or engineers, to identify commonalities in the collisions occurring at a site and to select the right countermeasure quickly. It's a powerful analytical tool that helps to identify trends and clusters. It can help prioritise competing schemes based on full economic appraisal and also perform statistically valid before and after evaluation of implemented solutions.

### TRL can offer:

- iMAAP is a web-based collision analysis software system, plus support and training for iMAAP implementation
- Development of innovative datasets to capture relevant management information
- Assessment of existing road safety capacity; available data sources, existing policies and standards, organisations and stakeholders, and levels of experience amongst the staff
- Safe system case study evaluating the current status of road safety and setting future plans and actions
- Economic appraisal and assistance with developing costed, targeted strategies to reduce casualties
- Assistance with setting up road safety institutions to provide oversight
- Training and upskilling of in-country staff



## Safer road infrastructure

The constructed road environment generally requires very substantial investments for road construction and upgrades. Much of the development is about allowing higher speeds of travel and/or increasing capacity, however this increases exposure to collision and injury risk, and can ultimately lead to increased casualties. The societal burden of these casualties is huge. This makes it essential to build roads safely from the start, because it has a major impact on the safety of all road user groups. There are a multitude of standards and tools available to support safer roads.

### Key questions to be addressed

- What are the requirements of the road? What standards need to be met?
- How can the road be built at lower cost? Can recycled materials reduce the cost and make the road more sustainable?
- How can the road construction improve safety for the road users? What are the cost implications and how does it compare to the costed societal benefit of saving deaths and injuries?



### Case study

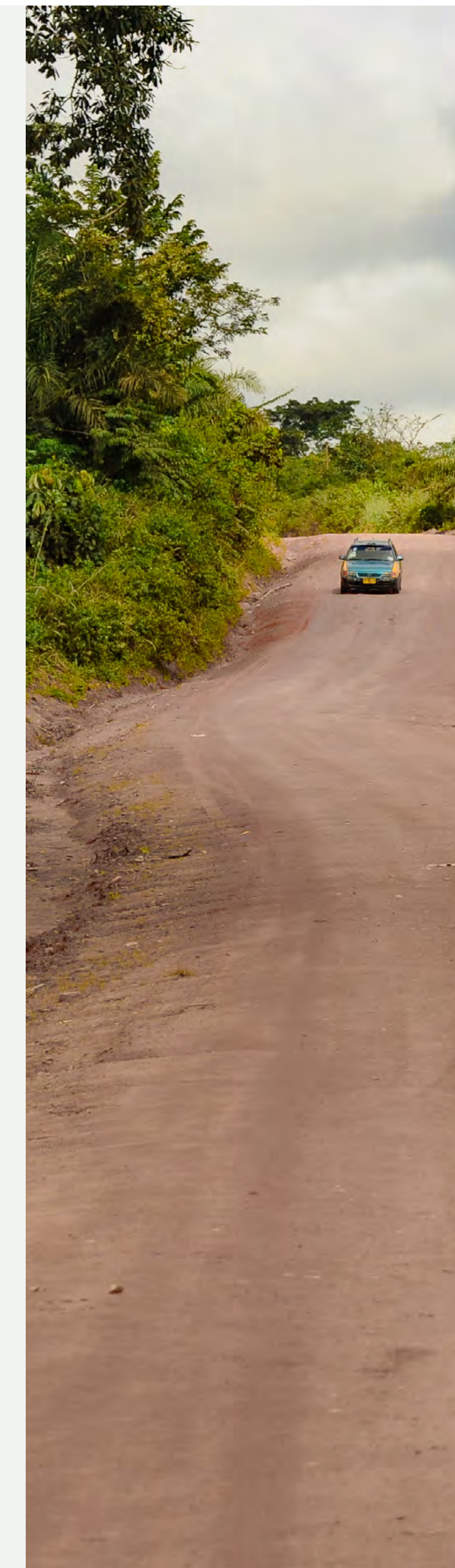
#### iRAP case study

The International Road Assessment Programme (iRAP) is a charity founded in 2006 and is the umbrella organisation for road assessment programmes worldwide. TRL is the only UK Centre of Excellence to support users of the iRAP model. We undertake core model development, coding, and independent quality control of coding fulfilled by other parties. We have been contributing to its design since 2006, and applying its star rating not just in the UK but in Qatar, Ukraine and as part of the planning process for the Channel Tunnel.

iRAP enables the users to plan for upgrades and assess the cost-benefit impact of modifications to existing infrastructure features. The iRAP model is also effectively used to test new road schemes early on so that they achieve the highest star rating by design. Although the model creates impartial evidence to support investment decisions, an eyes-on review and sense check by local highways engineers is always valuable.

#### TRL can offer:

- Road notes, manuals and guidance
- [iRAP Centre of Excellence](#) and able to provide advice and training to implement iRAP
- Road Safety Audit
- Safer Roads Investment Plans
- Training and upskilling of in-country staff



## Safer vehicles



Global deaths went up from 1.15M in 2000 to 1.35M in 2016 (World Health Organisation, 2018). The Global North however has seen a reduction in Killed and Serious Injuries (KSIs) over the last thirty years and this is mainly due to improvements in secondary safety features of vehicle design (reduction of the severity of injury outcomes during a collision). We are now seeing primary safety systems (e.g. crash avoidance) leading the next phase of vehicle safety improvements. However, the fleets of vehicles in the global south often lag in terms of the vehicle safety available. The challenge for the global south is to get the available safer vehicles into their national fleets, via a combination of raising standards of imported used and new vehicles, plus improving any in-country built vehicles. Fleet operators, such as public transport operators and businesses, are particularly influential here. Two of every three new car sales are to corporate fleets in some countries (Deloitte Insights, 2017).

TRL has experience in assessing the impact of current and future safety features through new and second-hand vehicles, control of which continues to be a major challenge. These features are increasingly relevant to protection of Vulnerable Road Users (VRUs), which often represent one of the largest casualty groups.

### Key questions to be addressed

- What standards are set for vehicles? How can vehicle safety standards be improved whilst also supporting the domestic manufactured vehicle market to benefit at an affordable price?
- Are there any vehicle import standards? How can they be improved to complement the existing fleet and supporting the domestic vehicle market?
- What are the casualty groups that will benefit from vehicle safety improvements? Can the benefits, and costs, be quantified to help inform safety strategy development? What about wider societal and environmental benefits of improving safety?
- What procurement policy and tools can be implemented to support fleet operators?

## Case study

### Bloomberg Philanthropies case study

Given our extensive experience in the development of regulation of crashworthiness and crash avoidance safety systems, TRL were commissioned by Bloomberg Philanthropies to examine the effect of vehicle safety standards in Latin American countries. Four countries (Argentina, Brazil, Chile and Mexico) were used in the case study. The three vehicle standards examined were:

1. Minimum standards for crashworthiness, i.e. regulations that help to protect occupants in front and side impact crashes;
2. Electronic Stability Control (ESC) for crash avoidance; and
3. Pedestrian protection measures to improve safety for Vulnerable Road Users (VRUs) including pedestrians and bicyclists.

A cost-benefit study showed that in total, if Argentina, Brazil, Chile, and Mexico adopted the full set of priority vehicle safety standards from 2020, more than 25 000 lives could be saved and over 170 000 serious injuries prevented, by 2030. The benefit-to-cost ratios predicted for the VRU measures indicate these should also be implemented in the region. A delay in implementation by any of the countries would mean that the full level of benefit is not realised.

### TRL can offer:

- Technical support and development of regulatory texts
- Consumer test program development
- Procurement policy standards and tools
- Practical guidance and advice about procurement
- Modelling the costs and benefits of vehicle safety improvements in fleets
- Training and upskilling of in-country staff



## Safer road users

Users play a critical role in the Safe System. While their vulnerability and imperfection underpin the requirement for the system to absorb human error and misjudgement, it does not void the user from responsibility. Evidence-based driver training, licensing and awareness raising, supported by clear and consistent enforcement of the road rules is effective. Road users do need to be informed how to use the road system correctly and they must be made aware of their role and responsibilities as part of a national road safety culture.

### Key questions to be addressed

- What regulations and road user codes exist?
- How can users be integrated as part of the system and be a part of the solution?
- How is enforcement managed?
- How are road users trained and licensed?
- How can other road users be supported, trained and educated?



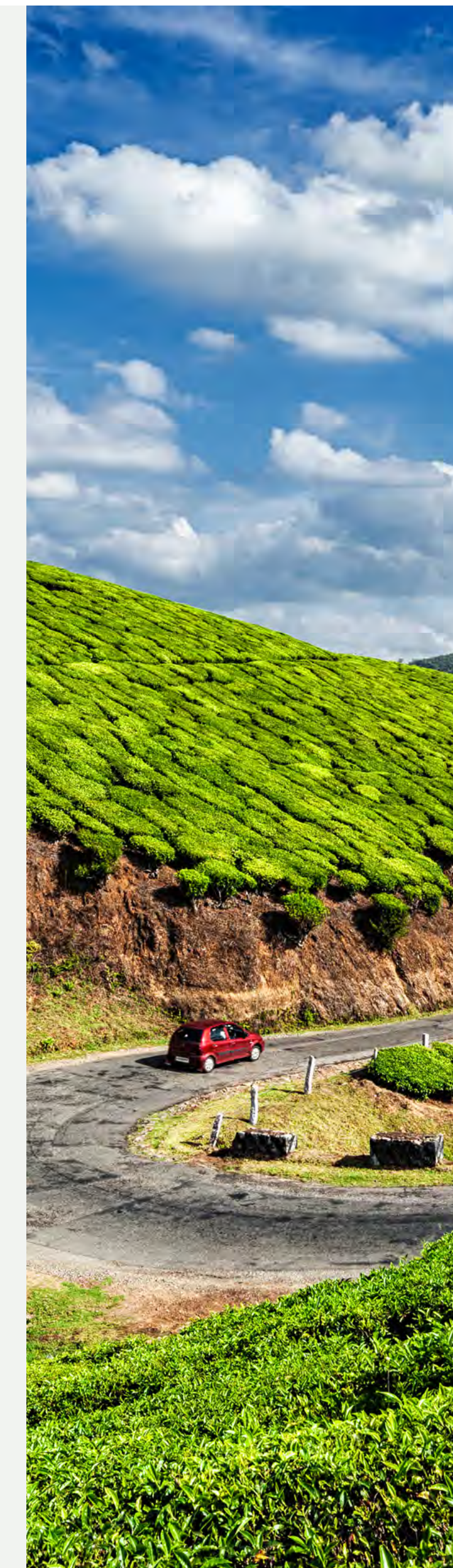
## Case study

### Kerala case study

In 2019, TRL delivered a traffic safety enforcement strategy for the Government of Kerala in support of developing a 'Safety Corridor from Vettu Road junction (near to Kazhakoottam) and Adoor on MC Road (SH-1)'. This project began with developing a baseline of the casualty types, severity levels, and circumstances of the collisions. Site observations revealed a list of traffic violations that could be linked to the incidence of crashes. Following a stakeholder workshop reviewing the baseline findings, the enforcement strategy was then developed. This had a main objective of deterrence to violations by creating a highly visible traffic safety enforcement environment, to enhance the actual and perceived level of enforcement on the corridor. Any successful enforcement relies on the high degree of perception of 'chances of getting caught and if caught, chances of getting penalised are high'. The strategy included awareness campaigns, enforcement infrastructure and equipment, and a continuous evaluation. Training was provided to 30 trainers and a further 174 police staff.

### TRL can offer:

- Drive Profiler tool for evaluating driver risk
- Development of driver licencing schemes
- Expertise in evaluating the impact of new road user safety schemes
- Development of regulation and codes for road users
- Development and evaluation of effective community-based road safety campaigns
- Guidance on training school curricula
- Development of enforcement strategy and campaigns, including guidance on implementation and training of officers
- Training and upskilling of in-country staff



## Post-crash response

This Pillar covers both the emergency response to a collision, and the investigation after the collision too. For emergency response the time gap between injury in a crash and receiving competent roadside medical assistance and safe movement to a good emergency medical facility is vital to survival and also an improved chance of full recovery. In countries where medical facilities tend to be overburdened and ambulance systems absent or often inefficient and underfunded, this post-crash care is challenging.

The post-crash investigation includes how the police and fire services manage the scene and report on the incident. In-depth crash investigation programmes are also included. These teams investigate a small number of collisions in detail leading to significant new knowledge on injury outcome severity and the factors leading to crashes. The key point in post-crash investigation is that lessons can be learned from incidents to help inform all other aspects of the road safety pillars, including training programs, safety policy, procurement, innovation and design.

### Key questions to be addressed

- What post-collision investigations are currently taking place? Can they be improved?
- What can in-depth investigations reveal about collision circumstances? How can findings be used to inform road safety policy development?
- What measures can be taken to improve emergency service response times?

### Case study

#### iMAAP case study

The Engineers in India reported that the time to identify and respond to black spots has reduced from six months down to one month or less. This is due to TRL's innovative use of mobile devices for data capture at the scene of collisions, to help record valuable information in the immediate aftermath of incidents. This provides rapid data sharing to help inform future strategies as part of the Management Pillar.

We developed a customised version of our iMAAP software that was linked to a range of government and police IT systems. The police can record traffic collision and casualty data using iMAAP mobile software on tablet devices and the data can be transmitted into the core iMAAP system, available for immediate analysis.

#### TRL can offer:

- Guidance on improvement to investigation procedures
- Assisting the development of in-depth investigation procedures and teams
- Assessing the capacity and funding of the emergency medical response ability
- Development of improvement plans for emergency medical response
- Training and upskilling of in-country staff



# Speed



Crashes are more likely to occur at high speeds since human reaction times decrease, braking distances increase, and loss of control is more likely. There is a power relationship between the speed of vehicles and the energy released in a crash. This means increasing the speed by a small percentage results in a far higher relative increase in severity of the injuries that will result. As with the 'Road safety management' Pillar, Speed also overarches the other Pillars. Speed was added as an additional Pillar for the Second Decade of Action because the reduction of collision energies below those that will cause KSIs is fundamental.

## Key questions to be addressed

- What speed control measures are already in place?
- How can they be improved? Which are most effective?
- What is the cost of implementation for changes to speed control measures? How many casualties will be prevented, and what is the societal and environmental benefit of speed reduction?
- What is the most appropriate speed limit for a given section of road?
- How can communities be empowered to support and benefit from reduced vehicle speeds in populous areas?

## Case study

### iRAP case study

TRL has developed a Speed Management Assessment Tool which is powered by iRAP coding data. Our tool takes iRAP Star Rating data, which currently is only relevant to the Roads/Infrastructure Pillar, and repurposes it to assist stakeholders in managing speed in robust 'intelligence-led' ways.

This tool enables speed management to be scientifically based on data and evidence. It gives clear guidance on how appropriate the current traffic speeds are in the context of:

- Posted speed:** The current speed limit
- Safe speed:** the Safe System recommended maximum given the road users present on the road and the types of collision that can occur
- Functional speed:** the ideal speed limit and traffic speed in relation to the road hierarchy
- Credible speed:** the speeds that traffic is actually selecting on the road

It also gives guidance on the locations where enforcement is required, including automated camera-based approaches, manual mobile speed policing, and engineering changes. The output of the tool communicates the issues simply and clearly for the non-expert.

### TRL can offer:

- Research into the relationship between speed and the likelihood of collisions and the severity of injury outcomes
- Evaluation of road speed limits and control measures
- Evaluation of vehicle technologies and road user training and education to reduce and control speed
- Development of Safety Performance Indicators (SPIs) for speed
- Speed Limit Assessment tool based on iRAP coding data



## 3. Road Infrastructure Sustainable Development Goals and targets



### SDG 9, Target 1

Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

TRL actually developed one of the indicators for this SDG, which is 9.1.1 Proportion of the rural population who live within 2 km of an all-season road. In context, Uganda has 72% served, whereas neighbouring Zambia has 34%.

This indicator used to be measured using household surveys, but our methodology uses geospatial techniques instead, to make it more sustainable, consistent, simple and operationally relevant. The RAI was adopted as UN SDG Indicator 9.1.1 in 2016, and the World Bank is custodian of that indicator. There is a visualisation of the RAI at <https://rai.azavea.com/>

TRL has since developed Supplemental Guidelines to the World Bank methodology providing additional detailed guidance for calculation of the RAI (Workman & McPherson, 2019)



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**Roads can be a lifeline for communities, so their proper maintenance is essential**

# Road Asset Management

For the global south countries road investment is a huge expenditure of precious funds, whether on a new build road or rehabilitation/upgrade of an existing road. Funding for these projects must be wisely allocated, to ensure both longevity of the road, its climate resilience, and that it is as safe as possible for its users. Roads can also represent passage across borders, stimulation of trade, and access to much needed education, healthcare, or supplies. Roads can be a lifeline for communities, so their proper maintenance is essential.

## Key questions to be addressed

- How can information on road networks be more easily and cost-effectively collected?
- How should spending on road assets and maintenance be prioritised?
- How can road asset data from disparate and legacy management systems be used to inform future planning?
- How can road planning and maintenance be refined to facilitate appropriate development of transport services?
- How can the design of roads be optimised for the local conditions, whilst ensuring safety?
- How should the materials and construction methods be specified?
- Is a road the right solution, or can new mobility solutions supplement existing transport systems?

## TRL can offer:

- Road notes, design standards, manuals and guidance
- Remote sensing to support mapping and road condition assessment
- Development and application of Geographic Information Systems (GIS)
- Suite of software tools for economic appraisal (HDM-4), digital road asset management (iROADS), junction and signal design, and traffic control
- Maintenance strategy and quality assurance
- Asset survey and investigations
- Training and upskilling of in-country staff

## Case study

### Rural Access Index case study

The Rural Access Index (RAI) is a measure of access by the World Bank and has been incorporated into the Sustainable Development Goals (SDGs) as indicator 9.1.1. This measures the proportion of the rural population living within 2 km of an all-season road, using GIS layers and relying on three data sources: population, road network location and road condition. Open GIS data are used for population and road location/mapping, but there are challenges to define the all-season status of roads. Every country measures road condition differently and against different parameters, and condition does not necessarily indicate the all-season status of a road, so establishing the all-season status between countries can be challenging. <https://rai.azavea.com/> provides an interactive mapping of the RAI that TRL developed.

Sustainability depends on the data collection being kept simple and undemanding on local resources. TRL delivered cutting-edge research (Workman and McPherson, 2021) to refine the GIS methodology for assessing the RAI, to make it more sustainable, repeatable and consistent by using geospatial data and tools, based on trials in four countries – Ghana, Malawi, Myanmar and Nepal – which were selected for their diversity of environment and data. The GIS procedures are relatively straightforward and should be implementable by a competent GIS technician; specialist expertise and extensive experience in GIS should not be necessary. The calculation tool being developed is being integrated into the United Nations Global Platform (UNGP), which will make measurement simple and quick and will give countries the independence to carry out the measurement with minimal support.





# 4. Decarbonisation & Climate Resilience

## Sustainable Development Goals and targets

There are a number of SDG targets that relate to the resilience of transport to climate changes and global shocks:



### SDG 1, Target 5

By 2030 build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters



### SDG 9, Target 1

Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

### SDG 9, Target a

Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States



### SDG 3, Target 3

By 2030 end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

### SDG 3, Target d

Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

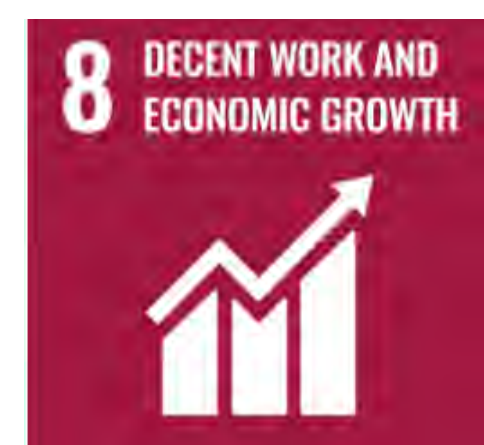


### SDG 11, Target 5

By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

### SDG 11, Target b

By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels



### SDG 8, Target 9

By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products



### SDG 13, Target 1

Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

### SDG 13, Target 2

Integrate climate change measures into national policies, strategies and planning

### SDG 13, Target 3

Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

## Climate resilience

Transport of people and goods is an essential component of modern society, and when incidents occur that disrupt transport the effects can be widely felt in terms of casualties, traffic flows, and increased emissions. These effects have an economic and social impact, and it can be significant if the travel disruption is widespread and long-term. Resilience refers to the ability of the infrastructure to withstand potential threats, and the ability to rapidly recover from disruptive events. Climate change is making these events more frequent and more extreme, with less time to respond (Reeves et al., 2019). The effects of climate change are more harshly felt in the countries of the global south, making resilience a key area of focus.

### Key questions to be addressed

- What redundancy, reliability, resistance, and recovery ability does the transport system already have? What does it need for the future?
- What climate can be predicted for the future, and how does that alter the performance needed of the road infrastructure?
- How can resilience, or the potential to become more resilient, be monitored?
- What options exist for improving the resilience? What is the cost-benefit ratio, and what are the wider costs associated? What appraisal period is used and what risks are considered?
- How can climate resilience be embedded into infrastructure management, e.g. at proposal and appraisal stage, in detailed design and construction phases, and in maintenance and operation?



### Case study

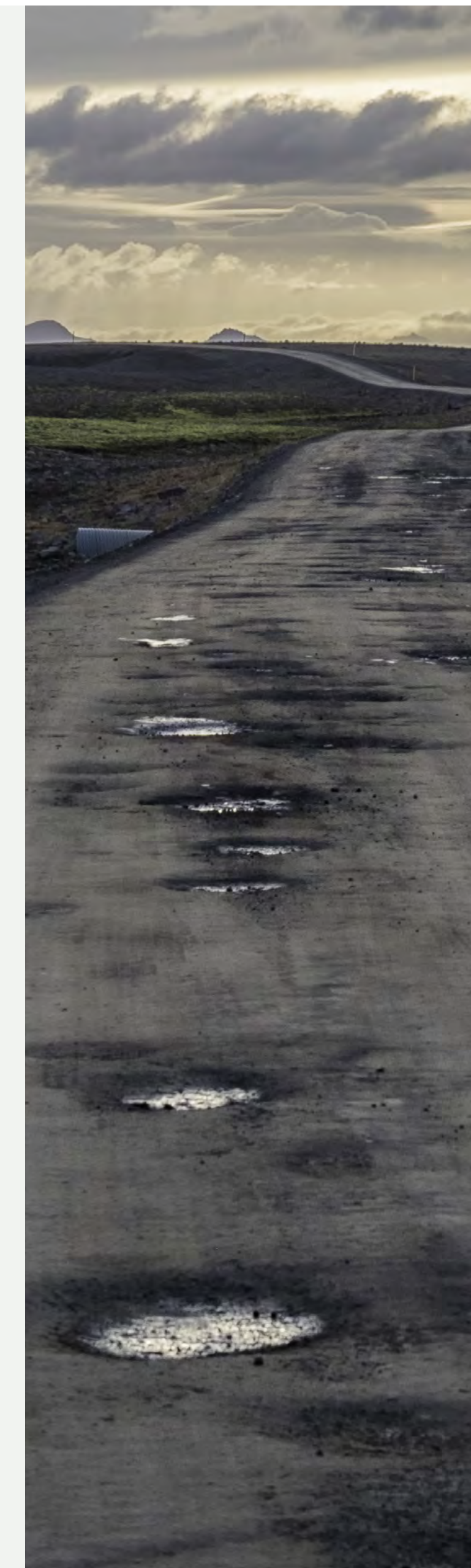
#### Kerala case study

TRL supported the Kerala Public Works Department with the upgrade of their existing road maintenance management system to a web-based system and introduced new climate and disaster management functionality. TRL has incorporated basic building blocks of climate and disaster management functionality, and produced a roadmap for further development and implementation, covering climate projections, hazard mapping, and a new climate risk assessment and vulnerability process including geotechnical and drainage inspections incorporating ISO 14090/14092 principles.

The roadmap and methodology that TRL is building into its existing iROADS asset management system is extensible to all roads agencies and can be tailored to LMICs depending on availability of local data and data models. There are many open source and commercially available data platforms available that can also be incorporated seamlessly into existing asset management system solutions.

#### TRL can offer:

- Revision of road standards to meet changing climate needs
- Evaluation of options to upgrade roads to become more resilient, including cost-benefit analysis
- Development of software tools to support assessment and monitoring of climate resilience and climate disaster management
- Training and upskilling of in-country staff



## Climate mitigation: Circularity of transport infrastructure

Road construction is demanding in terms of the material resources used. Transport infrastructure must embed cradle-to-grave circularity principles to mitigate its whole-life cycle carbon emissions. Recycled materials used in construction can help to decouple transport system development from the consumption of finite resources. Recycled materials can refer to the recycling of existing materials (stone, bitumen) taken from the road, and/or to the use of recycled materials into the road layers (such as polymers, rubber, glass etc). The use of recycled materials is the status quo in some countries, but for some in the global south this is an interesting opportunity to both save cost, and to help become more sustainable. Exhaustive consumption of construction raw materials (sand, aggregates) around island-nations can critically jeopardise their survival due to exacerbated coastal erosion. Considering these system dynamics is a part of a circular economy; a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.

The circularity of transport is not limited to the road surfaces, it related to all forms of transport. This includes rail and underground services, as well as more modern and even future transport, such as electric road systems infrastructure and [hyperloop](#).

### Key questions to be addressed

- How can transport infrastructure be designed to incorporate circularity principles?
- What are the materials that minimise embodied carbon emissions?
- What materials are present in the existing road, and how can they be extracted during maintenance and recycled for further use?
- What recycled and new low carbon materials are present locally that can be incorporated into built infrastructure? What is the impact of life-cycle costs, and what is the quantified environmental benefit?
- Can low-cost recycled surfacings be used to extend the lifespan of the road and reduce maintenance?
- What will the effect of climate change be on any recycled materials?



### Case study

#### asPECT case study

TRL has a long tradition of undertaking research and providing practical guidance into the use of recycled materials in various road pavement layers. For example, our research into using reclaimed asphalt in surface courses demonstrated significant savings in the use of high-quality aggregates and reductions in CO<sub>2</sub> whilst achieving a similar level of performance to virgin materials. The practical experience and knowledge gained in undertaking this research was used to help us produce Road Note 43, A Best Practice Guide for Recycling into Surface Course. This document includes guidance for engineers on specifying, designing and producing recycled asphalt as well as a design method for asphalt mixtures taking into account the binder content and properties of the reclaimed asphalt. We have also undertaken extensive work on recycled asphalt roadbases and have produced a design guide and specification for in-situ recycling into the deeper, structural layers of the pavement.

The asphalt Pavement Embodied Carbon Tool (asPECT) is a carbon footprinting tool for asphalt road pavements. It was first developed in 2009 as part of a programme of work funded by the collaborative research programme, funded jointly by Highways England, the Mineral Products Association and Eurobitume UK and was updated in 2014. (Reeves et al., 2020) summarises a review of asPECT covering the constants used in the tool and the way in which the tool deals with the allocation of the benefits of utilising recycled materials. The report also reviews how carbon and life cycle analysis (LCA) tools are used in several other countries and considers the potential of converting asPECT into an Environmental Product Declaration (EPD) generator.

#### TRL can offer:

- [Asphalt Pavement Embodied Carbon Tool \(asPECT\)](#)
- Review of material properties
- Research into the use of locally available materials and revision of standards and specifications accordingly, to facilitate savings in material production and haulage
- Testing of materials for their recyclability; quantifying the carbon emissions of the materials and process, before, during and after implementation
- Evaluation of performance/degradation of road materials in use
- Cost-benefit analysis of the recycled materials use, including the circular economy
- Revision/ writing of road standards and manuals to specify recycled materials
- Training and upskilling of in-country staff

## Climate mitigation: Vehicles

Vehicles are a large contributor to global Greenhouse Gas (GHG) emissions. Many nations are now moving towards low- or zero-emission fleets, for example by banning internal combustion engines by a certain target year. However, for countries in the global south their vehicles are often imported used rather than new, and consequently the vehicle fleets are much older, meaning it will be much longer before they can expect to see this change to lower emission vehicles. The challenge is therefore how to develop environmentally friendly fleets sooner, but without driving up costs to an unmanageable level, and align this with their industrial strategies to maximize economic growth. For example, the implementation of charging infrastructure for electric vehicles, and ensuring sufficiently stable supply of the electricity are key factors that must also be planned for.

Fleet operators have a key role here, particularly since the majority of vehicles are often fleet-owned. If fleet procurement managers can be required or influenced to adopt greener vehicles, then a greater effect can be achieved as these vehicles will likely end up in the used-vehicle market within a country in the longer run.

### Key questions to be addressed

- Which vehicles are the most environmentally friendly? What policy and procurement options can help to promote to increase their fleet penetration most quickly?
- Is retrofitting existing vehicles good value-for-money?
- Are there tools to encourage more environmentally friendly driving styles that are effective?
- What will regulatory/policy/procurement options cost to implement? What is the cost-benefit ratio? What are the predicted savings going to achieve in terms of GHG reductions?
- Is there a correlation between vehicles with the highest safety standards and the lowest emissions?
- How to promote greener vehicles without ramping up vehicle costs, and without stifling in-country industry?
- What will the cheaper models in a range offer in terms of emissions reduction? Will their performance be as good as the top-end models? And will they be as safe?
- What is the longevity of the environmental performance, given that vehicles entering fleets in the global south are more often used?



### Case study

#### TfL case study

TRL led a project on vehicle procurement for Transport for London (TfL) to explore greener and safer vehicle technologies available for procurement, ranging from motorcycles and cars, though to buses and heavy goods vehicles. A market review was used to generate a roadmap of when technologies and features are expected to be available for procurement, for each of the vehicle categories. A scoring mechanism was developed for these technologies and features to allow comparative assessment of their usefulness in developing public procurement policy. This was combined with a modelling tool to show the estimated effect on casualties and emissions in the future.

Other authorities, cities, and fleet operators can use a similar approach to help them select greener and safer vehicles for procurement, or to help them determine the influence of different interventions to promote the vehicles. The modelling could be extended in many ways, for example to cover operational costs, insurance claims, or into a full cost-benefit analysis. These scoring and modelling tools could be used for low- and middle-income countries to help stimulate engagement with greener vehicles procurement as a first step on the route leading up to regulation, or to complement regulation and encourage higher performance.

#### TRL can offer:

- Technical support and writing of regulatory texts
- Procurement policy standards and tools
- Practical guidance and advice about procurement
- Modelling the costs and benefits of improving emissions reduction in fleets
- Training and upskilling of in-country staff
- End-to-end operational safety and framework
- Risk assessments of zero emission vehicles (e.g. hydrogen, electric roads)
- Monitoring and evaluation of zero emission vehicles (road, rail, shipping)
- Attitudinal surveys and stakeholder engagement
- Vehicle data analytic decarbonisation services
- Alternative fuels and decarbonisation strategies



## 5. Enablers of more sustainable transport development

Digitisation, Automation and New Mobility are enablers of change in transport, and if carefully applied can be transformative in the global south.

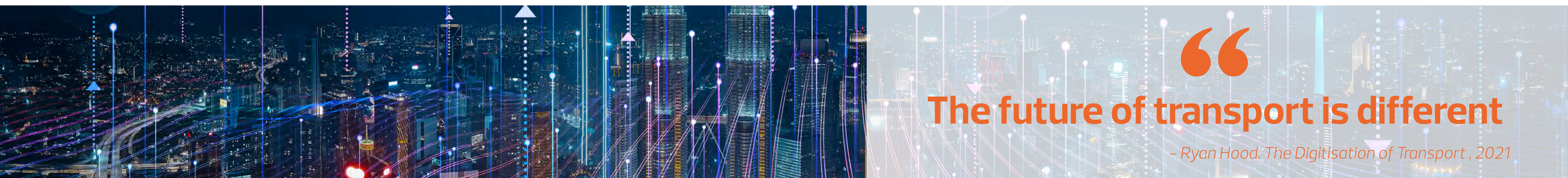
### Digitisation of transport

It is important for the global south to harness innovation, connectivity and emerging digital technologies to create a more integrated, efficient and sustainable transport system. TRL can offer horizon scanning of digitisation opportunities to identify where countries can use data and connectivity to avoid other more costly interventions.

It is possible that the mobile phones used by people in cars will enable a host of opportunities that are not feasible based on the vehicle, because vehicles are often older and of a lower technological standard with fewer sensors in the global south. The key is to harness this available resource to help transport systems, for example with mapping of rural road networks and enabling a faster post-crash response or even gathering collision data to inform investigations.

For countries in the global south the operational technology or fixed digital infrastructure alongside roads (used by road operators) might be of lower maturity, or even non-existent due to cost and scale. It is possible that wireless solutions may offer new opportunities to avoid the costs of this fixed infrastructure, but reliable wireless connectivity (cellular or satcom) is a key enabler for this.

[Read more about Digitisation of Transport in the paper by Ryan Hood, Head of Digitisation.](#)



## Automation of transport

The future of transport is increasingly focussed on automation of vehicles. Predictions often cite potential benefits from reduced collisions and injuries, by removing driver errors, and the reduced emissions achieved by smoothing driving and traffic flows. These automation technologies are gradually being incorporated into regulations to make them legal on roads in various countries, although we can anticipate it will be many years before full automation is achieved on vehicles, and that it will take even longer to penetrate through global fleets.

During this current phase of automated vehicle development, the countries of the global south should not dismiss automated vehicles as something too far in the future to be concerned with. Their road environments represent very different and more challenging conditions for the automated vehicle engineers to try and develop the capability of the vehicle algorithms to cope with. A vehicle developed for a European city might well struggle to respond appropriately in an Indian city. For example, the road edges would be more often obscured making it harder for vehicles to identify the road lanes, the mix of traffic is different as is the driving style, and the VRUs are much closer to the road edges. As such these roads will represent areas where testing and trials will be carried out during vehicle development, and countries of the global south will want to ensure these trials are safety operated and do not add to their casualty burden.

TRL has extensive experience in running automated vehicle trials, developing safety cases, and has even written BSI standards about preparing for trials and testing as well as the deployment of vehicles, so we can offer guidance and training on automation of future vehicles. We have developed a simple software tool that helps road authorities determine whether a trial is operationally safe to proceed, with no technical knowledge needed. TRL also has the [Smart Mobility Living Lab in London](#). We can offer our experience in developing a living lab, running trials and delivering test services, developing test vehicles, developing a digital twin model and running simulations, and using a driver simulator.



[Read more about Automation in Transport in the paper by Camilla Fowler, Head of Automation.](#)

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**By advancing the capability and reliability of the automated driving system we can minimise or eliminate the need for human intervention or control**

*– Camilla Fowler, Automation of Transport, 2021*



## New mobility

In many ways the transport systems in high income countries are now more damaging than they need to be to the environment, to the economy, and to people. We are seeing a swing back towards active travel, and removing vehicles from the road. Many global south countries already have many people using active travel, so any future developments need to continue to support those modes of travel.

New mobility encompasses the new, emerging and alternative means of moving people and goods, including active travel, new technologies, business models and on-demand services. The key is in enabling the right mix of existing transport and new mobility solutions together, including:



TRL is expertly placed to support the global south with the transition to New Mobility, for example:

- Research, analysis and expert advice to inform development of regulations and standards for new mobility technologies
- Feasibility studies and user mapping to understand demand and inform design and applications of new mobility solutions
- Trials of new mobility solutions for urban areas, whether in isolation (e.g. trialling e-scooters or dockless bike sharing schemes) or in combination (e.g. designing and trialling a new multi-modal Mobility Hub)
- Trials in rural settings including examining solutions for the 'last-mile' issues, which in practice is often be much longer than a mile in rural locations
- Infrastructure auditing and planning to increase active travel modes using our street auditing software tools for assessing the quality of street environments

[Read more about New Mobility in the paper by George Beard, Head of New Mobility.](#)



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**We must recognise the pivotal moment facing the industry and wider society and we must be creative in forming our future**  
 – George Beard, New Mobility Strategy, 2021

## 6. Capacity Building and Institutional Development

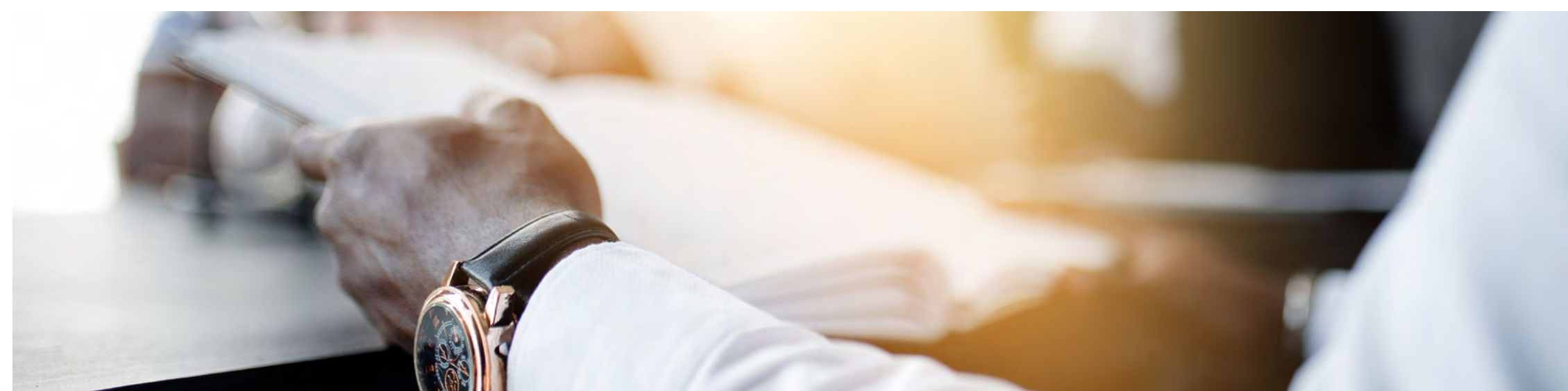
### Training and capacity building

Training, upskilling, and capacity building are important for countries of the global south to ensure that knowledge and skills are developed quickly and efficiently and can be shared more widely through teams. In every section above, TRL can offer advice, consultancy, training and 'train the trainer' schemes, and knowledge sharing seminars.

Capacity building and training are a core aspect of many projects we undertake, and it needs careful consideration and planning to ensure sustainability and knowledge transfer. In some cases a Training Needs Assessment (TNA) will be necessary to accurately identify the gaps in knowledge and how they can be filled. This would be complemented by a review of staffing levels, institutional arrangements, and staff job descriptions. It is also important to select appropriate people to be trained and to ensure that training is effective.

A successful project will be judged on its ability to build capacity, so that countries can continue to apply the technology cost-effectively using their own resources. To support this process at project level it may be necessary to identify and train dedicated counterpart staff from the recipient organisation who can champion the recommended solutions and facilitate their successful wider implementation.

An important part of capacity building is the dissemination of research results. This needs to be done through the appropriate channels and to a targeted audience that is appropriate for the receipt of research outputs. TRL disseminates research outputs through papers and presentations at regional conferences in the global south, as well as via industry journals.



### Case study

#### Training case study

The Nigeria Infrastructure Advisory Facility Phase 2 (NIAF II) projects involved extensive training and capacity building activities, over different technical topics. This work has left a long legacy of impact for Nigeria. The first example was that the TRL team carried out a pilot study to train supervisors and labourers in routine labour-based road maintenance in 3 States. They prepared presentations, training materials, programmes and assessments for the pilot. The TRL staff also managed an international team of trainers to educate and support the local communities in labour-based maintenance principles. The project included a workshop in Abuja for the senior stakeholders from each State in order to update on progress, discuss issues and motivate the States to fully embrace the programme.

Secondly, for work on mapping and assessment of rural road networks, TRL experts trained local staff to assess images of rural earth and gravel roads to record condition. As a last example of our capacity building in Nigeria, a journey times pilot survey was focussed on urban and rural locations near Kaduna in northern Nigeria. The study was designed to test the methodology of Journey Times surveys in Nigeria and assess the feasibility of using this type of data as a monitoring tool for NIAF II. The work involved selecting and training a local consultant to undertake the surveys, and developing appropriate forms and guidelines, as well as analysis of the results and producing a final report.





## Institutional Development

TRL has been involved in several institutional reviews of roads and research organisations, to help form and develop the appropriate institutional structures for development and change. When considering the use of new technologies and processes, and building capacity in new areas, it is often necessary to consider institutional structures and processes to check that they are appropriate and the expected outcomes will be realised.

In our experience, wholesale institutional change is disruptive and risks the effective uptake of new technology, so we use our experience of capacity building for road research centres and institutions in the global south to recommend appropriate and sustainable institutional changes where necessary. It is important that changes are sustainable and can be incorporated into the local road authority's existing processes and procedures where possible.

Research is under-recognised as a career in many global south countries, and some institutions struggle to recruit appropriate and committed staff to undertake road research. It is often seen as a career with limited options to progress, so it is important to put in place a career structure that demonstrates the potential for motivated and committed staff who are interested in research.

Institutional change does not happen quickly, and the change needs to be recognised and supported at all levels. This may require institutional reform at the highest level so that research can maintain independent and impartial status and not be beholden to a particular Ministry or department.



### Case study

#### Road Research Centre case study

TRL provided support to the Ethiopian Roads Authority (ERA) to establish a new Road Research Centre (RRC), providing them with the frameworks, training plans, and business plans to put research into the core of the road sector development.

In more detail, this work included concept designs for a new building, institutional support and advice to RRC staff. A Training Needs Assessment was completed, and short- and long-term training plans for the RRC were developed. We consolidated the training materials for use by ERA on an ongoing basis to develop the capacity of the organisation, and created 5- and 10-year business plans, plus a long-term strategic vision. We collected and prioritised research proposals and prioritised them according to ERA's requirements, and oversaw the transition from the existing research activities to the new programme.

In an extension project TRL provided support to RRC at ERA to build capacity of the RRC. This included preparing four short training courses that could be carried out by the local staff, a quality control guideline, and support to carry out RRC research projects with local resources.



## 7. About TRL

### **Our mission: Creating clean, easy, efficient transport that is safe and reliable for everyone**

TRL is a team of expert scientists, engineers and specialists working together with our clients and partners to create the future of transport.

- We publish software that helps the world's largest cities, and many smaller towns too, reduce pollution, carbon footprint and congestion with advanced traffic management, better road design and good asset management
- We conduct leading edge research into infrastructure, vehicles and human behaviours which enables safer, cleaner, more efficient transport
- We deliver detailed incident investigation, structural survey and other high value field services to help clients to improve the service they give their customers
- We work with universities and other partners to invest in basic and applied research that will underpin future needs
- We have built, with partners from government and industry, the Smart Mobility Living Lab: the world's first physical and virtual testbed in a global megacity (London) that lets companies test new mobility products and services safely on live public roads
- Established in 1933 as the UK government's Road Research Laboratory, the renamed TRL was privatised in 1996 and today has more than 1000 clients in many countries. Our headquarters are in Crowthorne House, near Bracknell, and we have offices in Birmingham, Edinburgh, London, Germany and India

### **Transport Research Foundation (TRF)**

The TRL group of companies is owned by the Transport Research Foundation: a non-profit distributing company that enables our experts to give independent advice without influence from shareholders or finance companies.



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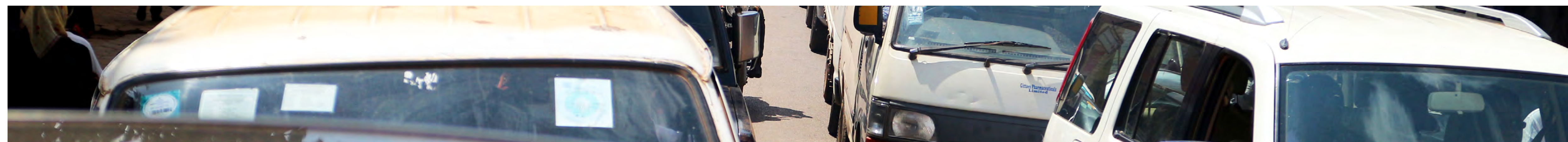
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TRL's vision for the future is of clean, efficient transport that is safe, reliable and accessible for everyone, including for countries in the global south; low- and middle-income countries. The Sustainable Development Goals (SDGs) from the United Nations set out 17 goals with a multitude of targets. Many of these relate to transport, and TRL's work directly contributes to achieve the safety and climate related transport goals.

The research priority areas are:

- **Road safety** – how to reduce the burden of global road fatalities, 1.25 million (93%) of which are in the global south
- **Road asset management** – how to most efficiently and effectively manage roads in countries with scarce material and financial resources
- **Decarbonisation & climate resilience** – how to improve climate resilience and most effectively mitigate climate effects that are felt to extremes in the global south
- **Enablers of more sustainable transport development** – how to tap into the opportunities afforded by digitisation of transport, automation of transport and new mobility, to best suit the challenges and needs of the global south countries
- **Capacity building and institutional development** – how to build in-country skills so that any projects and initiatives have the longevity to become truly effective

TRL is a global centre of excellence in transport and innovative mobility solutions. We have an internationally recognised team of scientists, researchers and consultants, who can provide training and upskilling to authorities and businesses throughout the global south. By working together and sharing knowledge and skills we can help to achieve the Sustainable Development Goals for safety and climate change.

