Transport Decarbonisation Index (TDI) Benchmarking Report

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Abstract

The Transport Decarbonisation Index (TDI) Benchmarking Report provides insights into the development and application of the TDI, a diagnostic tool designed to assess transport performance and support policy development in low- and middle-income countries (LMICs) across Africa and South Asia. The TDI evaluates transport systems based on key dimensions, including emissions, governance, finance, and infrastructure, with a focus on identifying barriers to decarbonisation and sustainability. The report outlines the methodology, the results of pilot testing in 12 countries and the challenges encountered during the assessment.

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Abbreviations/Acronyms

A-S-I-F	Activity-structure-intensity-factor of emissions
ATO	Asian Transport Outlook
BAU	Business as usual
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EDGAR	Emissions Database for Global Atmospheric Research
EU	European Union
GDP	Gross domestic product
GHG	Greenhouse gas
HVT	High-volume transport
IEA	International Energy Agency
IRF	International Road Federation
ITF	International Transport Forum
ITDP	Institute for Transportation and Development Policy
LDV	Light-duty vehicle
LMICs	Low- and middle-income countries
LT-LEDS	Long-Term Low Emission Development Strategy
Mt	Million tonnes
NDC	Nationally Determined Contribution
SDG	Sustainable Development Goal
SuM4All	Sustainable Mobility for All
TDI	Transport Decarbonisation Index
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
USD	United States dollar
WoS	Web of Science
ZEV	Zero-emission vehicle

Executive Summary

To achieve global climate targets, it is essential for low- and middle-income countries (LMICs) to decarbonise their transport sectors while also addressing critical socio-economic issues. However, many LMICs lack the capacity, data and policy frameworks necessary to implement sustainable transport solutions.

The Transport Decarbonisation Index (TDI) Benchmarking Report presents the application of a diagnostic tool to transport systems of 12 LMICs in Sub-Saharan Africa and South Asia. The piloting demonstrates the importance of tailored transport assessments, revealing both the potential and challenges in aligning national transport performance with global decarbonisation and sustainability agendas.

The TDI methodology follows a structured approach, combining quantitative and qualitative indicators to capture the complexity of transport systems. The methodology intends to ensure adaptability to data availability while maintaining robustness. The comprehensive indicator assessment is structured across eight dimensions, such as passenger and freight transport, emissions, governance and finance. In selecting the indicators, a balance has been struck between the need for minimal coverage and pragmatism regarding data availability. Additionally, the selection has been guided by interpretability for user understanding and relevance for measuring progress towards net-zero surface transport, both within and across countries.

Pilot testing was conducted in 12 countries across two phases, which confirmed the relevance of the framework, revealed significant data gaps, and highlighted barriers to decarbonisation. The results reveal substantial variability across dimensions such as public transport investment, freight efficiency, emissions and clean energy. The TDI identifies areas requiring attention, helping policymakers prioritise actions to reduce emissions and improve transport sustainability. By aligning transport strategies with global climate commitments, including the Paris Agreement and Sustainable Development Goals (SDGs), the TDI enables countries to take informed steps towards achieving net zero by 2050.

The application of the TDI demonstrates its ability to support engagement with relevant stakeholders while fostering collaboration and mutual learning. It offers actionable recommendations linked to the lowest-scoring dimensions, presenting illustrative, non-prescriptive policy actions to promote sustainable, low-carbon transport.

The Benchmarking Report critically examines the limitations of transport indices, highlighting issues related to data usage, selection, and the potential for misinterpretation. It emphasises the TDI's role as a policymaking support tool within a broader process. By addressing critical challenges and enabling informed decision-making, the TDI provides a practical and scalable solution for advancing sustainable transport in LMICs.

The report concludes that future efforts can enhance data availability and improve the practical application of the TDI. The project encourages countries to strengthen their own data collection initiatives and establish benchmarking and tracking mechanisms. It demonstrates that the TDI is a valuable tool for tracking progress, benchmarking performance and informing policy decisions. The piloting process has been instrumental in refining the TDI methodology and completing all stages of the indicator assessment. Future iterations could focus on further improvements, including additional aspects, an enhanced structure and expanded features.

1 Introduction

1.1 Current challenges of transport in LMICs

A systemic transformation in transport and mobility is urgently needed, particularly in low- and middle-income countries (LMICs) across Sub-Saharan Africa and South Asia. These regions face mounting challenges driven by rapid population growth, rising private motorisation and an underperforming transport sector. Yet, much of the world's population still lacks access to affordable, sustainable and resilient transport systems. Without targeted interventions, greenhouse gas emissions from transport will continue to rise, undermining global climate goals and contributing to socio-economic disparities.

The transport sector contributed 15.9% of global greenhouse gas emissions in 2023, making it the second-largest emitter after the power sector. Transport emissions saw the highest annual increase among major economic sectors, growing 3.7% from 2022 to 2023 (European commission et al. 2024). LMICs have overtaken high-income countries as the primary source of national transport emissions, driven largely by surface transport modes (e.g., road, rail, inland waterway as defined in *2.2 Importance of surface transport*). Road transport alone accounts for more than three-quarters (76%) of transport greenhouse gas emissions globally, while waterborne transport contributes 11% and railways 1%. The growth in emissions from surface transport in LMICs, particularly in South Asia and Sub-Saharan Africa, is expected to outpace the global average in the coming decades, emphasising the need for immediate action.

To achieve global climate targets, it is essential for LMICs to decarbonise their transport sectors while also addressing critical socio-economic issues. Achieving a decarbonised transport system by 2050 will require a 90% reduction in transport carbon dioxide (CO_2) emissions (compared to 2020 levels), with road vehicles contributing the largest share (SLOCAT 2023). Yet decarbonisation in LMICs must be pursued holistically, balancing emission reductions with the need for transport growth to support economic development. At the same time, countries in these regions face challenges beyond emissions: high rates of road fatalities, severe air pollution, limited transport infrastructure and restricted access to essential services.

However, many LMICs lack the capacity, data and policy frameworks necessary to implement sustainable transport solutions. Compared to other regions, there are far fewer transport assessments and studies focusing on Africa and South Asia, exacerbating the data gap in areas such as fleet composition, vehicle use and fuel consumption. Without reliable data, designing and implementing effective policies becomes even more challenging. This report introduces the Transport Decarbonisation Index (TDI), which is designed to address these gaps for LMICs by assessing transport performance, providing insights and developing related policy recommendations.

1.2 Objectives of the TDI

The High Volume Transport Applied Research Programme (HVT) initiated the research project around the Transport Decarbonisation Index – a comprehensive indicator assessment on the decarbonisation of transport – to support LMICs in decarbonising their surface transport. The TDI can be an important tool for policy makers in developing targeted emission reduction actions and supporting LMICs in fulfilling their climate pledges, with the ultimate goals of achieving net zero greenhouse gas emissions by 2050 and supporting international efforts to limit global warming to 1.5 degrees Celsius above pre-industrial levels. The TDI has been realised as a diagnostic toolkit that stakeholders can apply to assess a country's transport performance.

Key objectives and research questions

The objectives of the TDI are as follows:

- To assist LMICs in Africa and South Asia in reducing greenhouse gas emissions in surface transport by providing a diagnostic toolkit.
- To assess a country's condition (such as energy and infrastructure readiness) with respect to the achievement of net zero emissions by 2050.
- To enable comparisons with other countries and tracking of long-term progress.
- To better understand which measures are most effective for countries' specific circumstances, taking into account factors such as development status and transport system characteristics.
- To not only diagnose decarbonisation efforts, but also measure progress and indicate if more stringent measures are required.

The underlying assumption of this research project is that improved evidence and a surface transport assessment tailored to LMICs will lead to more effective and impactful transport policies. Utilising the TDI and its insights is expected to support the strengthening of transport strategies and other policy frameworks, including countries' Nationally Determined Contributions (NDCs) towards reducing emissions under the Paris Agreement on climate change. By evaluating a country's transport performance, the assessment helps identify priority areas and the most suitable policies to address them.

The key research question focuses on how to measure transport performance in LMICs to guide towards a more sustainable and decarbonised system, given the challenges with capacity and data availability in these countries. The study explores methods that account for the complexity of the transport sector while relying on limited information. Another critical question is how to ensure that the assessment adds value and is actionable for relevant stakeholders, particularly in framing the TDI's scoring narrative.

The TDI contributes to advancing knowledge on transport assessments in LMICs by highlighting key benchmarks for sustainability and decarbonisation. The index underwent multiple iterations, refined through pilot testing and feedback from stakeholders. This report presents the outcomes of the final phase, which focused on application, presentation and dissemination. It also addresses the limitations of assessments and discusses the challenges encountered during the TDI's development.

This Benchmarking Report provides the results of the TDI pilot testing, conducted in two phases as a crucial step towards finalising the methodology. Applying the TDI to selected countries in the two target regions has ensured the robustness of the indicator framework and confirmed the relevance of the chosen metrics. Furthermore, the piloting process revealed significant data gaps and challenges, offering valuable insights for future policy development.

How can the TDI help in policy making?

The lack of reliable data presents a significant barrier to the effective design and implementation of policies on transport sustainability and decarbonisation, hindering informed decision making and targeted interventions. In recognition of this, the TDI strives to kick off a virtuous circle of empowering policy makers in agenda setting, policy formulation and the alignment of national policies with global climate and sustainability agendas. The TDI provides a comprehensive, data-driven assessment of a country's transport system, along with an overview of its key strengths and areas needing improvement.

Importantly, the TDI is intended not to blame or shame countries with lower scores, but to foster mutual learning and to inspire collaboration in achieving transport decarbonisation and sustainability goals. As such, a low score is to be interpreted as an indicator of untapped decarbonisation potential, guiding policy makers in prioritising policy and financing efforts. By viewing the TDI scores as a catalyst for targeted action, countries can build partnerships, mobilise resources, and shape effective policies in line with global frameworks, including the Paris Agreement and the United Nations (UN) 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).

In particular, countries using the index can leverage their scores to attract partnerships with multilateral development banks, climate finance institutions and private sector investors. LMICs are often prevented from attracting international climate finance due to a lack of sufficient understanding and technical capacity to develop bankable projects. The TDI can play a pivotal role in overcoming this by providing countries with detailed knowledge of the specific gaps in the transport systems, thereby stirring their attention towards high-impact mitigation and adaptation policies and supporting the preparation of targeted funding proposals.

The possibility of using the TDI to assess long-term progress in reducing transport-related emissions, in turn, can prove particularly beneficial in supporting policy makers' reporting obligations vis-à-vis financial institutions. Not least, the ability to report in a transparent manner any progress achieved over time in decarbonising transport systems signals a country's commitment to climate change and sustainability objectives, while placing it at a competitive advantage when it comes to accessing technical assistance and capacity building programmes.

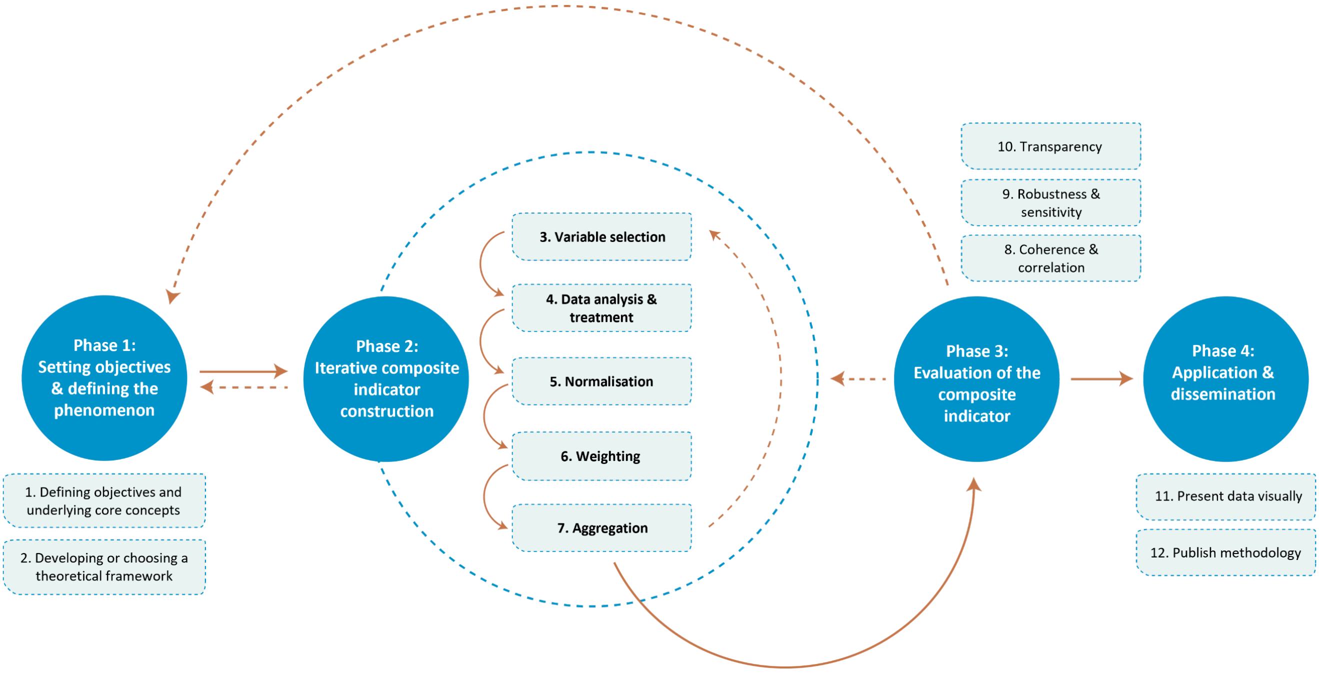
The TDI's function of serving as a benchmark of national progress against global standards can enable lower-scoring countries to adopt proven solutions in similar contexts, thereby fast-tracking their progress towards net zero emissions by mid-century. Notably, the index can serve as a starting point and premise for dialogue among policy makers, industry, academics, and civil society, fostering a more collaborative approach to developing evidence-based, time-sensitive and targeted policies to advance the decarbonisation and sustainability of surface transport.

Unleashing the full potential of the TDI and maximising its benefits for policy makers will require a cautious approach to the dissemination of its scoring results, tailoring them to the knowledge and data literacy of its target audience while ensuring the inclusion of all affected stakeholders. Only then will it be possible to ensure that the results conveyed by the TDI are accessible as well as actionable for its various user groups.

1.3 Guiding principles

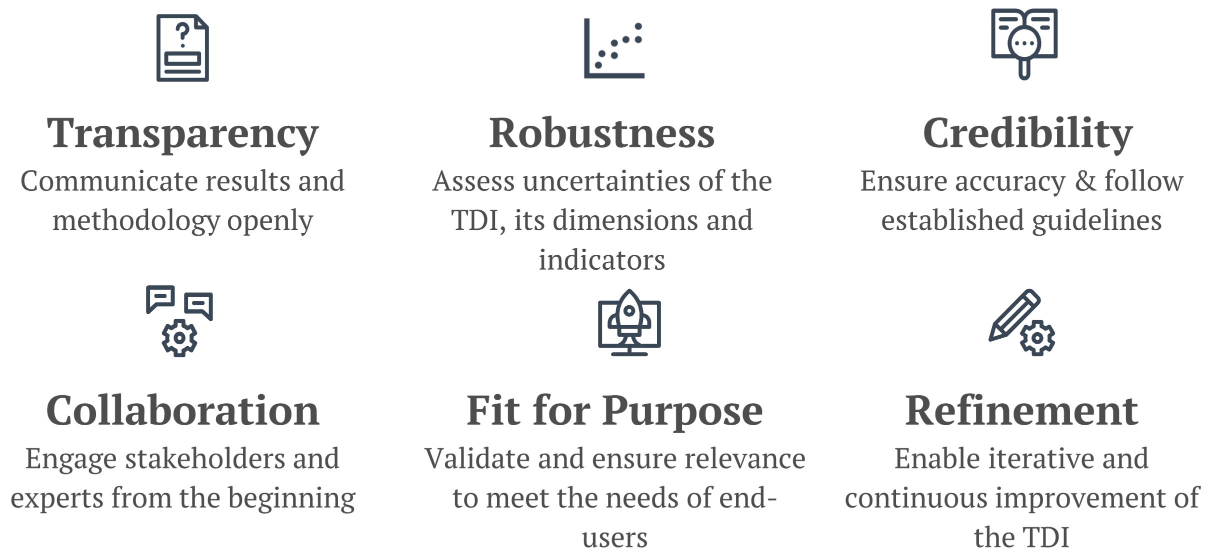
The development of the TDI follows a structured four-phase approach (see Figure 1) (Mejia *et al.* 2024). These phases are: 1) setting objectives and defining the phenomenon, 2) iterative composite indicator construction, 3) evaluation of the composite indicator, and 4) application and dissemination of the TDI results and supporting documents. This approach builds upon comprehensive guidelines, such as those developed by the UN Economic Commission for Europe (UNECE 2022) and Nardo *et al.* (2008).

Figure 1: Four-phase methodology of TDI development



The initial literature review identified six overall criteria that guided the development of the TDI (see Figure 2).

Figure 2: Guiding principles and quality criteria for the development of the TDI



The methodology was developed using an iterative approach, based on a process that covered steps ranging from a comprehensive literature review and the development of a State of Knowledge Report (Mejia *et al.* 2024), to initial conceptualisations, the draft methodology and data source report and consultations, a multi-stakeholder practitioner workshop and a stakeholder review workshop.

The application of the TDI in this Benchmarking Report is based on the final draft of the TDI methodology (see section 3.2 “Methodology of the TDI”). The methodology outlines every step towards the benchmarking of a country.

All project outputs can be found on the official project website, https://transport-links.com/funded-projects/transport-decarbonisation-index-tdi.

1.4 Structure of the Benchmarking Report

The primary purpose of the Benchmarking Report is to share and discuss the results of the TDI piloting. The report provides discussion on country-specific information, the results of the TDI analysis and major challenges arising during the piloting. It covers the results for all 12 countries for which the TDI methodology has been applied. The piloting is a key component of the project, aimed at understanding the realities of transport data in LMICs across the two target regions and developing a set of indicators that capture the complexity of transport systems.

In addition, this Benchmarking Report presents the key steps and takeaways of the respective project stages. The methodology is outlined and the results are critically discussed. Beyond the piloting results, the report also discusses limitations and challenges of transport assessments in general. The report is organised into the following sections:

Section 1 introduces the Benchmarking Report, outlining the starting point of the project and the problem statement. The section explains all necessary information about the project, its guiding principles and the structure of the report.

Section 2 shares the key takeaways from the research around transport assessments in preparation of the TDI. It shows the practical implications for the TDI based on an in-depth literature review and stakeholder engagement.

Section 3 explains the TDI, offering a complete understanding of its objectives, underlying concepts, methodology, indicators and features. It describes the assessment applied to the pilot countries.

Section 4 outlines the scope of the benchmarking. It gives an overview of the two piloting phases and the countries involved. The section also explains the approach taken for each piloting phase, including country selection criteria and the support activities provided. The country overview highlights key information, such as population, income group, and climate-related transport ambitions, to introduce each country’s efforts on sustainability and climate action.

Section 5 presents and discusses the TDI results for the piloting countries. This section begins with an overview of the results, followed by individual country results and a discussion of these findings.

Section 6 concludes the Benchmarking Report by summarising the key lessons learned during the piloting phase.

2 Research insights

This section outlines the major insights gained through review of the transport assessment literature, of the role of surface transport in decarbonisation and of the various analysed data sources. This review formed the basis for the framework and approach of the TDI. Each topic concludes with practical implications that were considered during the index development.

2.1 Stock-taking of transport assessments

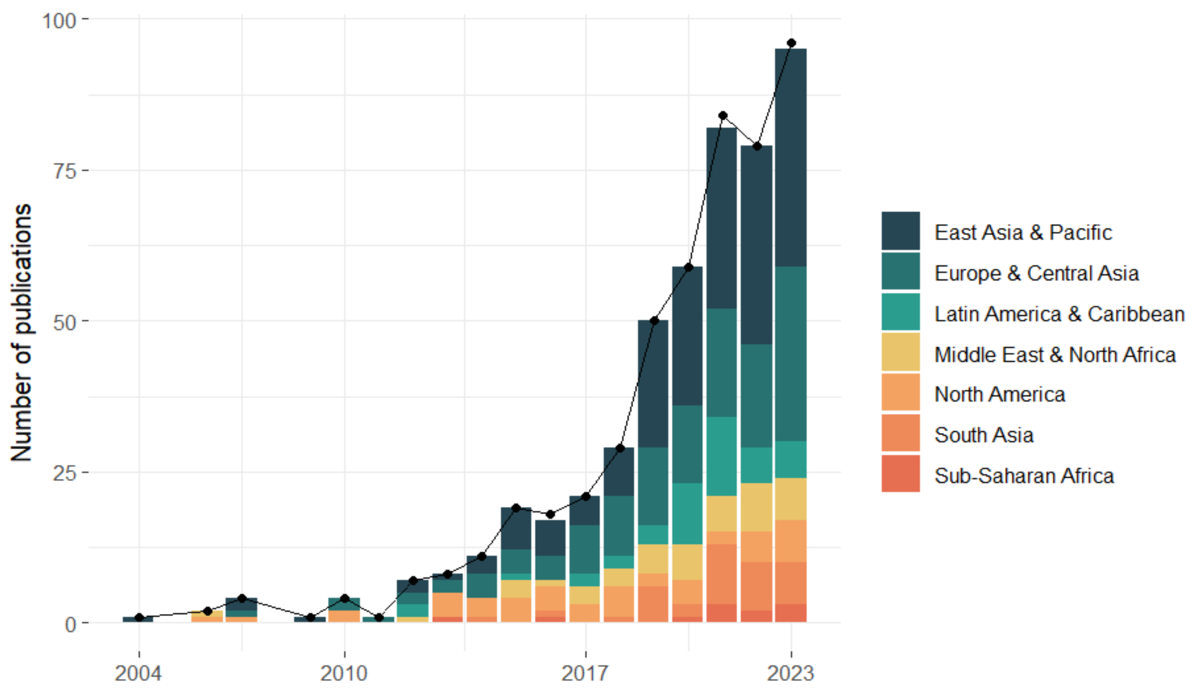
The research undertaken for the TDI included a detailed review of existing indexes and transport assessment frameworks. A bibliometric analysis of scientific literature was conducted using the Web of Science (WoS) platform, leveraging the “Bibliometrix” package in R (Aria and Cuccurullo 2017). Search terms were organised into three categories: 1) indices and composite indicators, 2) surface transport and 3) sustainability and decarbonisation.

In addition to the review of academic literature, the study team analysed relevant indexes from grey literature to identify useful approaches, elements and data sources for developing the TDI. The review extended beyond the transport sector, drawing insights from other domains. The Google search function served as the primary tool for identifying relevant frameworks, with specific keyword combinations used to guide a focused but comprehensive exploration. Key searches included: “surface transport” AND “decarbonisation”, “transport” AND “decarbonisation”, “mobility” AND “decarbonisation” and “decarbonisation index”.

The WoS search targeted the Topic ("TS") variable, encompassing titles, abstracts and keywords. After the removal of duplicates and articles not directly relevant to surface transport, the final sample included 497 publications (see Figure 3).

The analysis revealed a growing body of scientific work in this area, starting with a single publication in 2004 and reaching a peak of 95 publications in 2023. Regionally, most of the publications originated from East Asia and the Pacific (179 publications), whereas contributions from South Asia and Sub-Saharan Africa remained relatively modest, with 36 and 11 publications, respectively.

Figure 3: Scientific literature on sustainability indexes, by region, 2004-2023



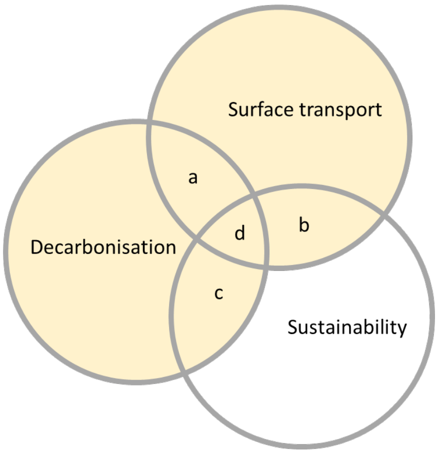
Source: Andrieu et al. 2024.

The bibliometric analysis of the scientific literature reveals a significant increase over time in the enthusiasm of the scientific community to study indexes on surface transport. However, this increase in the scientific literature was observed mostly for East Asia and Europe.

Also, the collection of information regarding indexes inherently included those related to sustainability in general. Figure 4 visualises the general thematic coverage of the search for relevant indexes in the grey literature. The research team prioritised searching for indexes that relate directly to either surface transport or decarbonisation. Using Google indexes related to surface transport (in many cases, transport in general) either may (section “a” in the figure) or may not (section “b”) include dimensions or indicators related to decarbonisation. On the other hand, decarbonisation indexes may (section “a”) or may not (section “c”) include dimensions or indicators related to surface transport.

The team also looked into the sustainability dimensions of such indexes (sections “c”, “b” and “d”). However, due to resource constraints, the analysis did not prioritise the inclusion of broader sustainability indexes that touched only partially on surface transport and/or decarbonisation, in order to focus on the indexes most closely linked to the objective of developing a TDI.

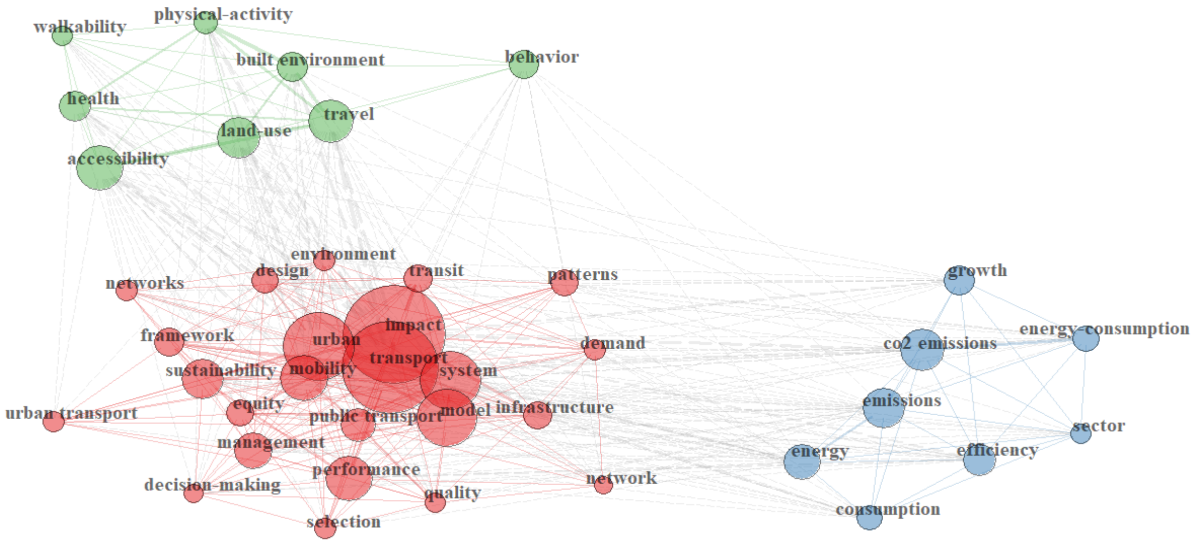
Figure 4: General thematic coverage used in the review of relevant indexes



It is understood that the surface TDI is meant to be implemented at the country level. However, the study team also included indexes focused on the urban and corporate levels whose procedural elements were considered as potentially useful for the development of a TDI methodology.

Figure 5 presents a network visualisation that highlights three distinct thematic clusters within the literature, identified through the frequency of keyword co-occurrence. The first cluster includes terms related to performance, management, impact, urban transport, and mobility, highlighting some of the most frequently occurring keywords. The second cluster focuses on energy consumption, efficiency, and emissions, while the third cluster revolves around behaviour, walkability, health, and accessibility, among others. One can infer that these clusters represent relevant themes and goals, which might be useful in formulating the surface TDI methodology later on. These clusters may be thematically dominant and shed light on what is frequently analysed using indexes in sustainable transport.

Figure 5: Keyword co-occurrences



Source: Andrieu et al. 2024.

Practical implications for the TDI

The in-depth review of the literature on methodological approaches for indicator assessments identified four core phases: 1) setting objectives and defining the phenomenon, 2) iterative construction of composite indicators, 3) assessment of the composite indicator and 4) application, presentation and dissemination. Sufficient time and resources was allocated to the first phase, as establishing clear objectives is crucial for a robust indicator assessment. A strong theoretical framework is essential to capture the substance, intent and procedures involved.

The literature highlights the importance of engaging stakeholders from the outset to ensure the relevance of the indicator and to foster a sense of ownership among end-users. For the TDI, this implies that the development process should be concept-inclusive, not merely data-driven. It requires clarifying the “what”, “why”, and “how”, as well as engaging with stakeholders to understand the complexities and interrelationships within surface transport systems and their progress towards decarbonisation.

Selecting variables and indicators must consider factors such as soundness, timeliness, accessibility and comparability. The iterative nature of indicator development allows for refining dimensions, indicators and construction methods. The TDI should ideally provide insights towards the advancement of transport policies and measures.

Although decarbonisation is a key focus, the TDI acknowledges that transport decisions are part of a broader sustainability framework. It recognises the importance of other transport benefits, such as integration, access, economic development and road safety. Situating decarbonisation within this wider context ensures that the TDI offers a holistic and comprehensive view of transport systems.

2.2 Importance of surface transport

Building on the findings of the literature review and on the objectives of the TDI project, surface transport is defined as encompassing both passenger and freight transport by road, rail and inland waterways. This includes transport that is private, public, semi-private/public or informal. Air, maritime and pipeline transport are excluded from this definition.

The scope of the TDI is restricted to surface transport activities and emissions within a country and does not cover international aviation and international shipping. This is due in part to the goal of the TDI, which is to assist LMIC governments in the target regions (South Asia and Sub-Saharan Africa) to identify key barriers to surface transport decarbonisation and to provide evidence for policy makers to develop targeted emission reduction actions. In some cases, references to international transport may be made, due to the relevance of the specific concepts or to the lack of disaggregated information to isolate domestic transport.

Surface transport modes account for very high shares of the total transport greenhouse gas emissions in the target regions – 97% in Sub-Saharan Africa and 98% in South Asia – compared to a global average of 88%. As a whole, surface transport contributes 9% of the total greenhouse gas emissions in Sub-Saharan Africa and 8% in South Asia, compared to 13% globally.

Since the 1970s, road transport has been the primary driver of long-term emission growth. In contrast, greenhouse gas emissions from railways have declined over the same period, due largely to technological advancements in the sector. However, starting in the early 2000s, emissions from waterborne navigation have grown at the fastest rate, increasing 1.7% annually, while road transport emissions have grown 1.6% annually.

Freight transport is a major cause of growing transport emissions. Freight accounted for 42% of the global CO_2 emissions from transport in 2019, whereas passenger transport contributed 58%. Surface freight transport accounted for an estimated one-third of freight activity that year, but it contributed nearly three-quarters of the global emissions from freight transport. In contrast, passenger surface transport accounted for 92% of passenger activity in 2020 but contributed just 83% of CO_2 emissions from passenger transport in 2019 (ITF 2021).

On average, in the LMICs of South Asia and of Sub-Saharan Africa, the shares of surface transport modes in greenhouse gas emissions are lower than the global average of 13.5%. In South Asia, surface transport modes contribute 7.9% of total emissions, whereas in Sub-Saharan Africa they contribute 9.1%. However, the growth in emissions in these regions has been much faster compared to the global average. For example, since 1970, transport emissions in general have increased more than 7 times in South Asia (with road transport emissions growing nearly 18 times) and more than 9 times in Sub-Saharan Africa.

2.3 General data sources

The research team conducted an overview of publicly available data sources that can be used to assess a country’s transport performance. It also reviewed reports with regional and global data to aid in interpreting national datasets. This list aims to help users easily identify relevant datasets and extract values necessary for developing indicators. However, many of these data sources provide “raw” data, which must be processed and adjusted for use in an index context. Additionally, incomplete country coverage limits the data’s applicability, often requiring supplemental datasets to fill gaps. The primary goal of this overview is to offer guidance and to help address data gaps.

The team identified more than 50 potential data sources spanning the national, regional and local levels. The review provided a high-level summary of these sources, outlining the landscape of transport data. It was organised according to the geographic scale of the databases, covering global (values available for all countries), regional (e.g., Africa, Asia), national (country-level data) and local (sub-national, city or urban-level data). Each table specified the geographic scope, frequency of updates and key data points for each database.

The review focused on major databases that cover multiple jurisdictions – ranging from several countries to multiple cities – and that are publicly accessible. Most of these databases allow the reproduction and use of their data, making them valuable for the TDI and enabling users to perform their own assessments. While many countries also have national statistical institutes and reporting mechanisms, obtaining detailed data from these sources is often time-consuming and raises issues of compatibility across countries.

The lists of data sources can be found in Appendix 1 of this report.

Global and regional level

The research team identified relevant transport and climate databases at the global, regional, and national levels, focusing on those that provide historical data on energy demand, electric vehicles, renewable energy, supply chains and transport activity (both passenger and freight). Priority was given to datasets with recent data that are updated frequently, although in some cases the latest available data varied by country. Some databases, such as the International Transport Forum's (ITF) Transport Outlook, and the *Emissions Gap Report* from the UN Environment Programme (UNEP), offer valuable insights into global future trends. The research team did not use any data sources in this project that did not have national-level data.

National level

National data was the most relevant to the development of a TDI indicators database, since this database is constructed at the national level. National datasets related to transport decarbonisation cover a larger diversity of topics than the global, regional or local databases. Regional efforts (focused on national data within the region) – such as the *Asian Transport Outlook* (ATO) and the European Union's (EU) *EU Transport in Figures* – have extensive databases for major transport-related indicators. The World Bank provides a collection of datasets at the national level.

During the COVID-19 pandemic in 2020 and 2021, the Institute for Transportation and Development Policy (ITDP) provided a number of important indicators of sustainable urban travel, such as transit system lengths. The large technology companies Apple and Google have released mobility-focused indications for the national and city level. These datasets are useful to capture the mobility changes during the pandemic as compared to the pre-COVID-19 situation in 2019. However, these data efforts have been discontinued.

Sub-national / local level

A few city-level datasets are available that cover several cities across countries. Much of the covered data focuses on public transport and transport mode share. In some cases, these may contain enough of the urban travel within a country to be useful as an approximation of the total national urban travel, or even total national travel. For example, metro rail systems exist mainly in larger cities, which may be fully covered in an urban transport database.

Practical implications for the TDI

Overall, the stocktaking of relevant data sources revealed a significant amount of available data. However, the coverage for the two target regions lags behind other regions, such as Europe and North America. The TDI must remain responsive to the needs and data availability in the target regions. The benchmarking exercise confirmed that data in these regions are more limited than elsewhere.

Through its dimensions, the TDI captures both the current state of transport – such as greenhouse gas emission levels – and the progress in actions and commitments, reflected in the governance dimension. Collaboration with existing initiatives will be essential to enhancing the relevance of the TDI, encouraging its adoption and ensuring its long-term sustainability.

3 Framework of the TDI

3.1 Key aspects

The purpose of the Transport Decarbonisation Index is to help policy makers in the LMICs of South Asia and Sub-Saharan Africa identify key barriers to sustainable, low carbon surface transport, and to assist them in identifying potential actions to improve the sustainability and efficiency of a country's transport system. As such, the research team outlined a set of key aspects and the scope of the database (see Table 1).

Table 1: Key aspects of the TDI

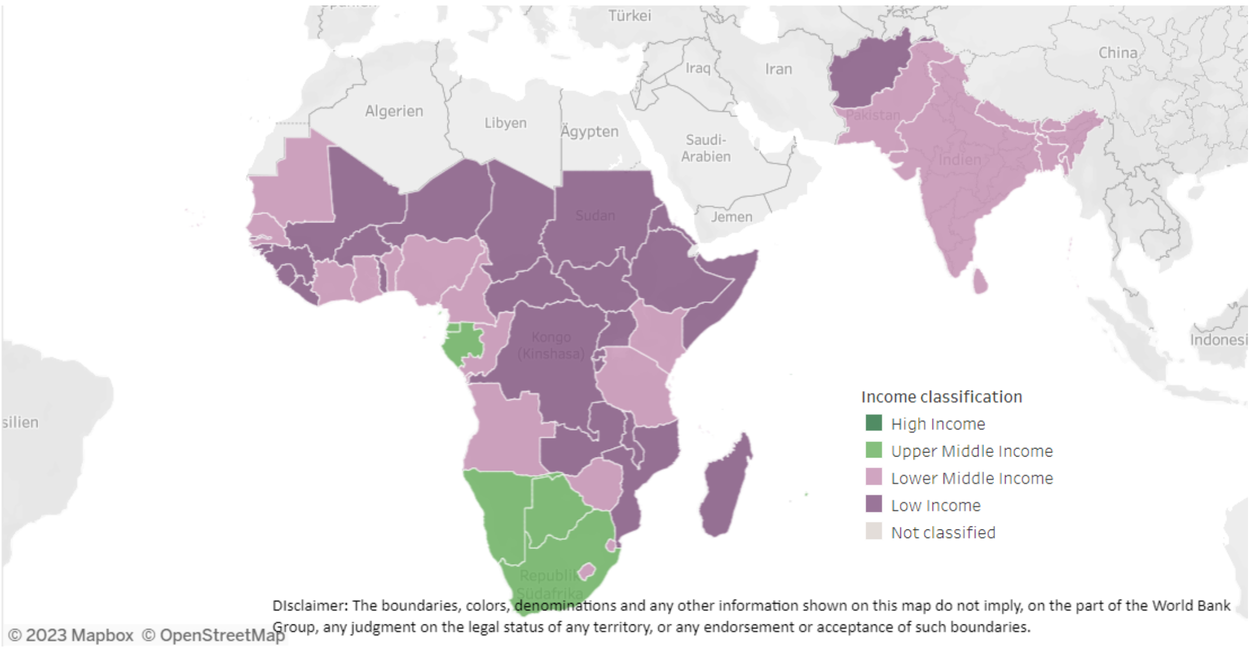
Aspect	Description
End-user group	• Priority 1: Policy makers, transport community and practitioners. • Priority 2: Academia, finance and private sector.
Time orientation	• Current status and historical development.
Coverage	• Emission status. • Transport system status. • Combination of local and national level.
Stage in decision making	• Assisting LMICs to gain a better insight into which measures may be most effective given their circumstances, and enabling measurement and verification of the performance of surface transport. • Supporting the identification of issues and areas that require more attention in the transition to net zero emissions in surface transport. • Using the TDI as a tool to create transparency on the current status of sustainability and decarbonisation efforts to support agenda setting, policy formulation and the alignment of policy decisions. • Addressing challenges in applying the TDI, which indicate the need for required improvements on data collection and sharing.
Index applications	• Describing and reviewing a country's transport performance with a view towards achieving net zero emissions by 2050, comparing it with other countries and tracking progress over the years. • Ensuring that the TDI assessment toolkit is widely available and user-friendly. Effectively communicating the TDI to potential end-user groups to enhance its applicability. • Supporting the open provision of the TDI spreadsheet tool and methodology to enable own analysis.
Application approach	• Self-assessment indicator tool. • Guidance material (on using the tool and on the methodology).
Synergies and partnerships	• Designing the TDI as a collaborative initiative that builds and enhances partnerships with existing platforms and efforts, rather than as an isolated endeavour. • Linking the indicators closely to specific data sources is a first pragmatic step. Using the Asian Transport Outlook database is particularly valuable for South Asia. The ATO database provides a structured framework that not only helps in collecting the required data, but also serves as a model for structuring similar data collection frameworks in African countries. We envision that efforts similar to the ATO will be beneficial for the African region, where data availability is

	challenging. In the medium term, this approach could inspire the creation of a similar database for the African region. • Partnering with existing indexes such as the Sustainable Urban Transport Index (SUTI) and the Sustainable Cities Index offers the opportunity to leverage synergies and ensure mutual benefits. • Other examples for initiating partnerships to overcome data gaps and challenges include OpenStreetMap, Sustainable Mobility for All (SuM4All) with a focus on SDG tracking, and the Transport Data Commons Initiative (TDCI), which undertakes data collection in Asia and Africa. • Finally, the data collected and generated by the TDI hold potential for future initiatives, as these data enable the modelling of development projections and trajectories.

Scope of the TDI

The TDI's geographic scope is set on the target regions of Sub-Saharan Africa and South Asia, as these are key focus regions of the HVT research projects and of the UK Foreign, Commonwealth and Development Office's activities around transport. According to the World Bank classification of countries by income level, most countries in these two regions fall in the categories of either low income or lower-middle income (see Figure 6).

Figure 6: World Bank country classification by income level



Source: Hamadeh et al. 2022.

The TDI focuses on surface transport, which is defined as encompassing passenger and freight transport by road, rail and inland waterways. In addition, surface transport can be private, public, semi-private/public or informal. Air, maritime and pipeline transport are excluded from this definition.

Concepts towards sustainable transport

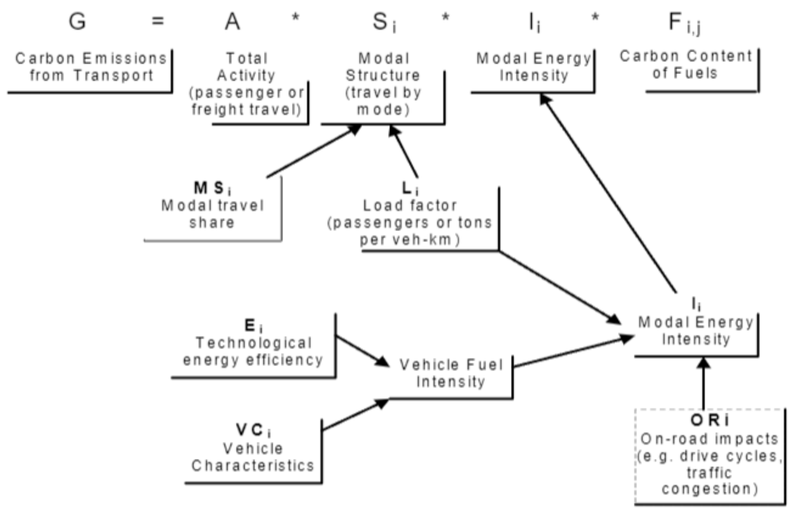
Based on the consultations and the review of the state of knowledge, the TDI is designed to cover a range of relevant topics (see Figure 7). These include considerations related to the A-S-I-F framework (activity-structure-intensity-factor of emissions; explained below), such as transport modes and technologies, energy system readiness, infrastructure quality, and emission pathways and targets. The TDI also aims to capture readiness and action aspects related to rural accessibility and access to low carbon transport modes, the financial and policy landscape supporting decarbonisation efforts, and user perspectives. Moreover, the context of each country should be taken into account, for example with regard to the level of development or geographical advantages and disadvantages.

Figure 7: Themes covered in the TDI

Transport Modes and Technologies	Emission Pathways & Targets	Energy System Readiness	Political Commitment & Finance
Infrastructure	Societal dynamics	Accessibility & Affordability	Structural context of LMICs

The A-S-I-F framework was selected as a reference for identifying relevant determinants of greenhouse gas emissions (see Figure 8) (Schipper, Cordeiro and Ng 2007). Hence, the TDI concept explores the viability of integrating indicators related to the total passenger and freight transport activity, the structure of transport modes, the energy intensity of modes and the carbon content of fuels of target countries.

Figure 8: A-S-I-F framework



Source: Schipper, Cordeiro and Ng 2007.

The analysis of keyword co-occurrences and frequencies, conducted in the State of Knowledge Report, shed light on the thematically dominant areas in the academic research focused on indexes and sustainable surface transport. In addition to terms such as emissions, energy consumption, efficiency, and growth, other concepts such as urban mobility, accessibility, transit and walkability were identified. Furthermore, members of the TDI Project Advisory Group have emphasised that decisions in the transport sector extend beyond decarbonisation. Linking the TDI to wider benefits such as accessibility, economic development, air quality and road safety is important to enable a holistic and comprehensive view of transport progress.

3.2 Methodology of the TDI

The TDI follows a multi-step approach, as laid out in Figure 1. The methodology follows a comprehensive framework for assessing transport in LMICs. It combines quantitative and qualitative aspects into relevant indicators to capture the complexity of transport systems, focusing on both current performance (e.g., emission levels, share of rail in passenger and freight transport, etc.) and future commitments (e.g., targets in NDCs, vehicle emission standards, etc.). The methodology aims to balance robustness with flexibility, allowing application in countries that have varying data availability.

This section lays out the key components, from defining dimensions to selecting indicators and data sources, handling data gaps, and applying normalisation, weighting and aggregation. It also elaborates on the connection to policy guidance and provides an explanation of the spreadsheet toolkit.

Dimension

Based on the substance and intention defined above, core components and indicators for the index were developed, based on existing best practices and development pathways. The TDI is structured around eight dimensions, all considered important to measure transport sustainability and decarbonisation:

- Passenger transport and mobility system
- Passenger vehicles
- Freight system and vehicles
- Emissions
- Finance and economics
- Governance
- Energy
- Context

These eight dimensions reflect the key characteristics of transport, climate and sustainability. They translate the themes captured in Figure 7 based on the identified indicators and relevance for policy making. Passenger transport and passenger vehicles account for 58% of global greenhouse gas emissions, with the remaining emissions coming from freight transport (SLOCAT 2023). The impact of passenger and freight transport is interrelated to emissions and energy-related vectors. The most significant policies and activities are associated with finance and governance. Additional aspects are reflected in the context dimension.

During the benchmarking, an additional dimension on demographic indicators was collected, capturing data necessary for normalisation – that is, calculating relative scores on a per capita or per gross domestic product (GDP) basis.

Indicators

For each dimension, indicators were identified that are aligned with the TDI's objectives and key aspects and that would enable annual tracking of progress within and across countries.

In balancing the need for minimal coverage with pragmatism regarding data availability, the team prioritised indicators drawn from international databases that have coverage across at least 100 countries, annual updates, and recent coverage (ideally including data at least from the past five years and more preferably through the past year or two), across the majority of LMICs. Restricting the effort to these parameters ensures that countries using the TDI are able to:

- identify and ideally address key data in national data collection and reporting;
- track progress over time; and
- compare performance across similar countries.

However, a major trade-off arises from the decision to restrict data collection, validation and scoring efforts to international databases. This is the risk of not considering highly relevant and valid indicators that are not systematically reported and collected globally, but that are, in many instances, collected and available at a national level.

Table 2 provides an overview of the structure of the TDI, including the eight dimensions, the respective envisioned indicators, and how these are denominated, scored and weighted in the process. The weighting is divided equally across the available indicators, and thus may deviate from the values provided in the table.

Table 2: Overall structure of the TDI

Dimension	Indicator	Denomination	Scoring	Weighting
1. Passenger transport and mobility system	Share of collective transport (bus, rail etc.) in national passenger transport activity	–	% (0-1)	0.14
	Public transport (bus, rail) system extent	per capita based on urban population	0-5 (bins) *	0.14
	Share of population near frequent public transport	per capita based on urban population	0-5 (bins) *	0.14
	Share of population near protected bikeways	–	0-5 (bins) *	0.14
	Walkability score	–	0-5 (bins) *	0.14
	Infrastructure investment	per capita	0-1	0.14
	Rural transport access	–	0-1	0.14
2. Passenger vehicles	Passenger vehicle CO_2	–	0-1	0.25
	Light-duty zero-emission vehicle sales	–	% (0-1)	0.25
	Two-/three-wheeler zero-emission vehicle sales	–	% (0-1)	0.25
	Bus zero-emission vehicle sales	–	% (0-1)	0.25
3. Freight system and vehicles	Share of rail and inland water in national freight activity	–	0-1	0.33
	Truck vehicle emissions ratings	–	1-4 (bins) (ordinal variable)	0.33
	Share of zero-emission vehicles in truck sales	–	% (0-1)	0.33
4. Emissions	Total transport CO_2	per capita	1-5 (bins) *	0.5
	Historical transport CO_2 growth	–	1-5 (bins) *	0.5
	Fossil fuel subsidies	per capita	1-5 (bins) *	0.5

Dimension	Indicator	Denomination	Scoring	Weighting
5. Finance and economics	Climate-related official development assistance	per capita	1-5 (bins) *	0.5
6. Governance	Transport climate targets	–	1-5 (bins) (ordinal ranking)	0.33
	Clean fuels regulatory policy strength	–	0-5 (bins) (ordinal variable)	0.33
	Vehicle pollutant emissions standards	–	1-4 (bins) (ordinal variable)	0.33
7. Energy	Share of renewables in electricity generation	–	% (0-1)	0.2
	Share of zero-emission fuels in transport	–	% (0-1)	0.2
	Carbon intensity of electricity	–	0-1	0.2
	Road transport fuel prices (diesel)	–	1-5 (bins) *	0.2
	Road transport fuel prices (petrol)	–	1-5 (bins) *	0.2
8. Context	Share of paved road infrastructure	–	% (0-1)	0.25
	Deaths attributed to ambient air pollution	per capita	0-1	0.25
	Road traffic fatalities	per capita	0-1	0.25
	Awareness and support for climate policies	–	% (0-1)	0.25

* Indicates "binning" approach where data are grouped and then scores are applied, such as a four-bin method where data are sorted by quartile. The final score is then applied to each bin.

The criteria for selecting indicators can be applied similarly to selecting the right data sources to ensure that the data used in the TDI are credible, accessible and reliable. This framework for the evaluation and selection of the final set of indicators and data sources is based on the above criteria and guided by literature sources such as Joumard and Gudmundsson (2010).

Data sources

The piloting phases explored a wide range of potential large-scale databases, all of which are commonly accepted and include data from multiple countries. Some of the advantages of using such databases include the consistent, robust methodology applied across all countries, their sustainability and future-proof nature, and their generally high-quality data and stringent typologies for specific aspects. A detailed discussion of global, large-scale databases as compared to national datasets is provided in section 5.3.

An example of an emerging data platform is the Transport Data Commons Initiative (TDCI). The TDCI is envisioned to be a common data platform, allowing for openly available and accessible data on transport. Multi-stakeholder efforts are focused on addressing data gaps in LMICs and on improving the data quality by providing a space for storing, editing and accessing open transport data (TDCI 2024). The TDI can benefit from the data efforts of the TDCI and use the collected data to feed indicators.

The TDI "short list" developed in this project, which contains national-level data for multiple countries, is presented in Table 3. These sources have been vetted for both data quality and the value added to the TDI. This short list offers a flexible selection that can serve as a guidance dataset for TDI users.

Table 3: Overview of sources for TDI indicators

Dimension	Indicator	Potential source
1. Passenger transport and mobility system	Share of collective transport (bus, rail etc.) in national passenger transport activity	Various data sources (ATO Database and national sources)
	Public transport (bus, rail) system extent	ITDP Rapid Transit Database
	Share of population near frequent public transport	ITDP Atlas
	Share of population near protected bikeways	ITDP Atlas
	Walkability score	ITDP Pedestrians First City Measurements
	Infrastructure investment	World Bank – Investment in transport with private participation
	Rural transport access	World Bank – Rural Access Index
2. Passenger vehicles	Passenger vehicle CO_2	International Council on Clean Transportation
	Light-duty zero-emission vehicle sales	International Energy Agency (IEA) – Global EV Data Explorer
	Two-/three-wheeler zero-emission vehicle sales	IEA – Global EV Data Explorer
	Bus zero-emission vehicle sales	IEA – Global EV Data Explorer
3. Freight system and vehicles	Share of rail in national freight activity (tonne-kilometres)	Various data sources (ATO Database and national sources)
	Truck vehicle emissions ratings	International Road Federation (IRF) World Road Statistics
	Share of zero-emission vehicles in truck sales	IEA – Global EV Data Explorer
4. Emissions	Total transport CO_2	EDGAR – Emissions Database for Global Atmospheric Research
	Historical transport CO_2 growth	EDGAR – Emissions Database for Global Atmospheric Research
5. Finance and economics	Fossil fuel subsidies	International Monetary Fund (IMF) – 2023 update International Institute for Sustainable

Dimension	Indicator	Potential source
		Development – fossil fuel subsides tracker
	Climate-related official development assistance	OECD Climate Finance database
6. Governance	Transport climate targets	GIZ-SLOCAT NDC Transport Tracker ClimateWatch NDC Explorer ATO – POL database
	Clean fuels regulatory policy strength	UNEP Partnership for Clean Fuels and Vehicles (PCFV) TransportPolicy.net
	Vehicle pollutant emissions standards	UNEP
7. Energy	Share of renewables in electricity generation	Our World In Data
	Share of zero-emission fuels in transport	IEA World Energy Balances
	Carbon intensity of electricity	Our World in Data EMBER – Electricity Data Explorer
	Road transport fuel prices (diesel)	IMF – 2023 update
	Road transport fuel prices (petrol)	IEA – Energy Statistics Data Browser
8. Context	Share of paved road infrastructure	IRF World Road Statistics
	Deaths attributed to ambient air pollution	Global Burden of Disease-Major Air Pollution Sources
	Road traffic fatalities	IRF World Road Statistics
	Awareness and support for climate policies	Our World in Data

Overcoming data gaps

Data gaps in the application of the TDI can arise for various reasons, including limited data availability, insufficient coverage, outdated information and a lack of granularity. Identifying these gaps is essential for implementing effective solutions. The overview of data sources in the previous section highlights the availability of transport-related data across different topics, regions and countries.

Despite efforts to prioritise indicators with broad coverage, users may encounter missing indicators for their specific country. In such cases, the simplest approach for tracking progress or making cross-country comparisons is to treat the indicator as missing. However, if estimating the value of a missing indicator is necessary, the use of proxies can be considered.

The first step in using proxies is to identify countries with available data for the relevant indicator. Proxies should come from countries that are comparable in key dimensions such as economic development (e.g., GDP per capita), geographic proximity or vehicle trade patterns (e.g., second-hand vehicle imports). Ultimately, the selection of proxy countries involves careful judgment. The use of proxy data should be limited, and any assumptions or caveats related to the derived score must be clearly communicated.

The TDI was designed to generate dimension scores, even if some indicator values are missing. The scoring reflects the available data and adjusts the equal weights accordingly. While this is not the ideal solution, it ensures that the TDI can still provide meaningful results despite data gaps. However, it must be acknowledged that such scores may not fully capture all aspects of the respective dimension.

Data gaps should be seen as a call to action to improve data collection and sharing. Addressing these gaps will enhance the robustness and reliability of future assessments, ensuring that the TDI reflects a more comprehensive picture of transport decarbonisation efforts.

Denomination, scoring and normalisation

Following data preparation, the indicators need to be normalised to make them usable for aggregation. The first step is to make the indicators comparable across countries, or “denominated”, by dividing extensive variables by the total or urban population, the GDP or GDP per capita (as a proxy for the level of economic development).

The next step is to “score” the variables – placing them on a continuous scale (e.g., from 0 to 1) or binning them into discrete values based on their distribution or for variables that are inherently ordinal (such as fuel economy standards), rather than continuous. Scoring ensures that indicators can be comparable, even if they originally have different units of measurement, distributions and/or variances, and measurement scales.

The scoring approach for the indicators in the updated TDI is based mostly either on min-max methods (i.e., a value is scored within a specific scale from a lower to maximum value) or on separating values into discrete bins based on the distribution of values (i.e., the first quartile, mean and third quartile among other approaches). The research team adopted min-max scoring for continuous variables where the minimum and maximum values could be readily identified and where the distribution of values was not highly skewed (e.g., as a lognormal or exponential distribution). The team adopted bins (mostly either from 0 to 5 or from 1 to 5) based on the minimum, quantiles (including the median and first and third quantiles), mean and maximum values for each indicator.

Weighting

The weighting of indicators within dimensions plays a crucial role in generating aggregated dimension scores for the TDI. The dimension level serves as the key assessment level for the TDI results and directly links to policy guidance. The TDI uses an equal weighting system, meaning that all indicators within a dimension are treated as equally important for the final score.

The advantage of equal weighting is that it automatically adjusts based on the number of available indicators within a dimension. Assigning weights to different indicators can be challenging, and it is difficult to justify why certain indicators should carry more weight than others. This approach helps minimise the risk of bias towards specific aspects, ensuring a more balanced representation across the indicators.

The approach of equal weighting allows the spreadsheet toolkit to adjust easily based on the provided data, offering greater flexibility in cases where some indicators are missing. Other weighting methods do not offer the same level of adaptability and robustness, making equal weighting the most practical solution for the TDI.

Aggregation

In the final calculation step, the treated, denominated, normalised and weighted indicators are aggregated into a final index. The aggregation is conducted within the dimensions using simple linear aggregation. In this approach, the results are presented as cumulative scores, with each higher-level score being the sum of its weighted lower-level components. Specifically, the TDI provides results for each dimension, which are derived from the sum of the normalised and weighted indicator scores for the indicators in each respective dimension.

As a result, the aggregation indicates scores from 0 to 1 for the respective dimensions. A score of “1” is seen as the best performance possible for a country, whereas a score of “0” would indicate severe issues and challenges. A high score does not automatically mean that the country has high values for a specific indicator or dimension. The score of 1 can, in some cases (such as for transport CO_2 emissions), reflect a low value. The aggregated scores are the main elements that the TDI communicates.

Policy guidance

The TDI scoring results are linked to illustrative, non-prescriptive advice on policy actions that are sourced from recent knowledge products on sustainable, low carbon transport (IPCC 2022; SLOCAT 2022, 2023). It is also linked to previous HVT projects on “Quick Wins” for low carbon transport, which identified ten policy interventions considered to be most relevant for low-income countries (SLOCAT 2019). The function of this policy guide is to assist LMICs to gain better insight into which measures may be most effective given their circumstances and to provide informed policy decisions. The policy guidance outlines how a country can improve and decarbonise its transport system. The recommendations depend on the scores – that is, a list of policy actions will be connected to the identified low scores of a dimension. Policy actions are shown for the two lowest-scoring dimensions. For example, if governance and emissions have the lowest score among the categories, then illustrative policy actions are shown for these two categories.

The policies introduced require an enabling environment to thrive. In many cases, the policies require certain financial, political, institutional and technical needs to be implemented. The HVT project on “Improving access to climate finance for transport projects in LMICs” provides a policy guide on how to better access climate finance (SLOCAT and WRI 2024), with very detailed recommendations and actions. Securing finance enables the implementation of policies and projects for sustainable, low carbon transport.

The number of potential illustrative policy actions on sustainable transport is infinite. To limit the scope, actions that are closely linked to the indicators and that are perceived as having significant emission reduction potential are included. For every dimension, between 8 and 10 policy actions have been identified and included in the assessment.

The following options are illustrative, non-prescriptive activities that will need to be operationalised with more detail and specific measures, while involving the relevant stakeholders. The policy guidance should be taken with caution and assessed against the country context and its needs. Recent research by Stechemesser *et al*. (2024) shows that, especially in transport, the highest emission reductions can be achieved through a combination of several policies.

Similar policy guiding tools are the ITF’s Transport Climate Action Directory (ITF n.d.) and Sustainable Mobility for All’s Policy Decision-Making Tool for Sustainable Mobility 3.0 (SuM4All n.d.).

1. Passenger transport and mobility system

The policy options in this first category focus on improving public transport infrastructure and systems, walking and cycling, and rural transport.

- Prioritisation of public transport (through infrastructure expansion, new services and fare programmes, service improvements, prioritisation)
- Cycling improvements (infrastructure, policies, parking, financial incentives)
- Walking improvements (infrastructure, policies, financial incentives)
- Prioritising collective transport, walking, and cycling in investments, planning and infrastructure
- Rural transport development by providing access to all-weather roads
- Integrating informal transport in public transport
- Road tolls and parking fees for private vehicles on major roads and specific areas
- Transit-oriented development and land-use improvements (mixed-use and compact city approaches)
- Supporting policy frameworks (e.g., National Urban Mobility Plans, Sustainable Urban Mobility Plans)

2. Passenger vehicles

This category focuses on options that reduce the carbon intensity of passenger vehicles. The activities can support the transition to zero-emission vehicles.

- Light-duty vehicle taxes (based on pollution, size, usage)
- Light-duty vehicle import regulations (including bans)
- Electric charging infrastructure (focusing on cars, buses, two-/three-wheelers)
- Electric vehicle procurement (focusing on cars, buses, two-/three-wheelers)
- Electric vehicle import levies (focusing on cars, buses, two-/three-wheelers)
- Domestic production of electric vehicles
- Encouraging the gradual replacement of the fleet with newer vehicles

3. Freight system and vehicles

The category aims to improve freight transport services and promote improvements through regulations and policies.

- Medium- and heavy-duty vehicle taxes (based on pollution, size, usage)
- Medium- and heavy-duty vehicle import regulations (including bans)
- Medium- and heavy-duty vehicle air pollution emission standards
- Electric charging infrastructure for medium- and heavy-duty vehicles
- Electric vehicle procurement (focusing on freight vehicles)
- Electric vehicle import levies (focusing on freight vehicles)
- Domestic production of electric vehicles
- Shifting freight movement to more sustainable modes (rail, shipping)

4. Emissions

This category aims at tackling transport emissions directly. The suggested policies are based on decarbonisation pathways.

- Carbon tax and pricing mechanism
- Emission trading scheme covering transport
- Integrated approach, such as the Avoid-Shift-Improve framework for sustainable transport
- Zero-emission zones in urban areas

5. Finance and economics

Financial and economic policy actions target transport policies as well as overarching investment frameworks. The actions are collected from recent knowledge and advocacy products on this topic (TUMI *et al.* 2022).

- Prioritising sustainable transport in planning and investment frameworks
- Investing in sustainable transport
- Removing inefficient fossil fuel subsidies
- Shifting finance from polluting modes towards zero-emission vehicles
- Introducing policies and incentives to support clean transport
- Enabling private financing to the transport sector
- Providing financial support on transport for low-income households (e.g., transport subsidies, mobility passes, purchase subsidies)

6. Governance

This category aims to strengthen governance-related aspects. The focus is on NDCs, Long-Term Low Emission Development Strategies (LT-LEDS), vehicle regulations and fuel regulations.

- Transport greenhouse gas mitigation targets in NDCs and LT-LEDS, ideally aligned to the low carbon transport pathways of the Intergovernmental Panel on Climate Change
- Transport actions in NDCs and LT-LEDS, both on mitigation and adaptation in a comprehensive manner across Avoid-Shift-Improve
- Aligning targets in NDCs, LT-LEDS and national strategies
- Phasing out sales of vehicles with internal combustion engines by a certain year
- Taxes to incentivise (advanced) biofuels and clean energy sources
- Vehicle emission regulatory policies (such as Euro III to VI)
- CO_2 performance standards for new light- and heavy-duty vehicles (Euro VII+)
- Clean fuel regulatory policies

7. Energy

The policy actions on energy look at areas that indirectly influence decarbonisation of the transport sector by pointing to cleaner energy systems.

- Advanced biofuels
- Renewable energy-sourced electricity for transport
- Renewable energy increases in the power mix
- Carbon pricing to encourage the use of green/clean energy
- Energy efficiency mandates
- Fossil fuel taxes

8. Context

The category on context grasps additional aspects that are relevant to sustainability in transport for a country. Thus, the policies look directly at improving these identified sustainability aspects.

- Road safety improvements focusing on the safety of people walking, cycling, using motorcycles and using public transport
- Speed limits on roads
- Connectivity improvements to other countries (e.g., international, cross-border rail linkages)
- Campaigns to promote use of public transport, walking and cycling, and electric mobility
- Campaigns for “ecodriving” and more awareness about climate impacts of travel choices
- Road transport network development with climate-proof design standards

- Peer exchange and capacity building with countries facing similar challenges

Spreadsheet toolkit

The TDI is supported by a spreadsheet toolkit that enables users to conduct a self-assessment of a country's transport system. This diagnostic toolkit aims to indicate through the assessment the status and readiness of a country towards transport decarbonisation. The toolkit takes the form of an Excel file, as this is perceived to be the most accessible platform for practitioners and policy makers in LMICs. The toolkit is embedded on the HVT website, together with a user guide and all other relevant deliverables of the project.

The spreadsheet toolkit can be downloaded and used as a local file. Once downloaded, it will not require an internet connection. The Excel spreadsheet toolkit is not resource-heavy and runs on most computers. Users can input transport data on a specific sheet and receive scores for the dimensions. Explanations about what the score means are provided alongside the results.

Long-term benchmarking through the TDI can be conducted by applying the toolkit to several data years and repeating the assessment with newer data in the future.

4 Benchmarking scope

4.1 Piloting phases

The application of the TDI was carried out in two piloting phases, each with specific functions. The first piloting phase focused on process, with close engagement of country stakeholders and extensive data exploration. It also aimed at socialising the TDI among the community of practitioners working on sustainable, low carbon transport. A stakeholder review workshop was held to collect feedback from policy makers in the pilot countries and to bring the concept of the TDI closer to their work.

The second piloting phase focused on results, to finalise the TDI, including the indicators and scoring methods. In this phase, the TDI was tested in a larger number of countries, through simulation of how target users might use the index to conduct a self-assessment for a specific country. The data from the identified global datasets were prioritised and put to the assessment.

First piloting phase

The first piloting phase took place after the initial TDI methodology was developed, with the aim of revising the methodology and ensuring the identification of a robust set of indicators. Therefore, the main criterion for country selection in the target regions was the perceived availability of transport data. On this basis, the following six piloting countries were selected:

- in Africa: Kenya, Nigeria, South Africa; and
- in South Asia: India, Pakistan, Sri Lanka.

The first piloting phase consisted of three key activities: 1) outreach to stakeholders in the countries to obtain additional data, 2) a stakeholder review workshop to share the initial results (see Box **1**) and 3) peer review of the TDI Methodology Report.

For the first activity, the project consortium engaged with practitioners working in the selected countries to raise awareness about the TDI and to collect any additional country-specific data. Outreach efforts targeted 30 key contacts representing 19 organisations operating across 6 countries. The country-specific data collection had limited success, as very few practitioners were able to share any data. They pointed mainly to modelling exercises, such as the India Energy Security Scenarios 2047, or to specific annual reports, such as the Kenya Roads Board Strategic Plan 2023-2027 and South Africa's Green Transport Strategy 2018-2050. The reports did not provide major significant new information compared to the already identified datasets.

The stakeholder review workshop was held in July 2024, and key insights are summarised in Box **1**). A total of 102 invitations were sent out, with around 8 to 15 people invited from each country; in total, 44 stakeholders registered for the workshop and 23 participated in the event, including a mix of government officials and practitioners.

For the peer review, the further refinement of the TDI methodology occurred in parallel with the first piloting phase. The methodology was developed in an iterative process, with the lessons learned from the first piloting helping to fine-tune the approach.

Box 1: Key insights from the stakeholder review workshop

The intended outcomes of the TDI stakeholder review workshop were as follows:

- Refine the understanding on how the TDI can add value to the policy decision-making process.

- Build capacity towards using the TDI.
- Present findings from the first pilot phase and collect feedback to further refine the methodology.
- Identify and discuss remaining issues (e.g., methodology, data availability, regional context).

The TDI stakeholder review workshop engaged a diverse group of government representatives and practitioners from the six pilot countries. Nearly all participants were exposed to the TDI for the first time, showing them the envisioned approach and benefits. The workshop successfully achieved its intended outcomes and gathered valuable feedback on how to further refine the TDI. This stakeholder engagement increased understanding of the project. Participants also raised concerns about the complexity and data gaps within the TDI.

Participants' feedback on indicators, scoring and weighting focused on the following matters:

- Many transport policies are implemented at the local level, whereas the TDI and its indicators focus primarily on the national level. It was suggested that the TDI could better represent the local level, with the indicator of "access to public transport" cited as an example.
    - ⇨ To implement this feedback, more indicators were embedded that focus on urban mobility, especially on passenger transport and mobility systems.
- Many different stakeholders and government entities are involved in transport policies. Therefore, the TDI and its tools need to be accessible and usable by a wide range of stakeholders, with varying levels of technical knowledge. It was recommended that the TDI explicitly state how it can function as a tool within the process of the UN Framework Convention on Climate Change and support the development of NDCs.
    - ⇨ To implement this feedback, the TDI was expanded with the policy guidance as a new feature.
- It was questioned whether having 50 indicators is valuable, noting that this could complicate data collection and scoring. It was suggested that the TDI might become overly complex and difficult for users to interpret. A down-selection process to create an aggregate composite indicator could be a viable solution.
    - ⇨ Through the piloting phases, the number of indicators was reduced and adjusted to focus more on key aspects valuable for the objectives of the TDI.
- It was suggested that a weighting system would be beneficial, given that the TDI is intended as a decision-making tool. Some indicators may be viewed as more critical than others, and users should have the ability to adjust weights based on priorities or regional context.
    - ⇨ The project team explored options for applying different weighting systems and allowing users to adjust weighting. Ultimately, equal weighting was retained as the more balanced solution.
- Guidance on overcoming data gaps would be highly valuable. There was consensus that using global datasets is useful as an initial step. Once the tool and global databases are identified, countries can benefit from such datasets to address gaps.
    - ⇨ The TDI outlines approaches to overcome data gaps, while being functional in scenarios of lower coverage of data.

Second piloting phase

The list of assessed countries was expanded in this phase. Primary activities involved applying the revised TDI approach to the initial six countries and extending it to six additional countries. Based on the focus countries of the HVT Applied Research Programme, the following six countries were added:

- in Africa: Ethiopia, Ghana, Rwanda, Zimbabwe; and
- in South Asia: Bangladesh and Nepal.

The data situation for these additional countries is generally more challenging compared to the countries in the first piloting phase, with far fewer appearances in the global datasets used by this project. Applying the TDI to countries with bigger data gaps was an attempt to test the robustness and flexibility of the indicator set.

4.2 Country overviews

The 12 countries from the two target regions present a very diverse set of characteristics. All except for South Africa are either low income or lower-middle income countries.

Ethiopia, Nepal, Rwanda and Zimbabwe are landlocked countries, and as such they rely heavily on neighbouring countries for access to international freight corridors and seaports, as well as on surface transport and regional cross-border connectivity.

Bangladesh, India and Nigeria are characterised by large populations and rapid urbanisation, which creates significant challenges in managing road traffic congestion, pollution and public transport demand. At the national level, these countries show low levels of private motorisation. However, their cities face severe road traffic congestion, air pollution and frequent road crashes. Major cities in these countries also grapple with high demand for transport infrastructure development.

The overviews in this section provide more information on each country's national context and national circumstances and its climate-related transport ambitions, as outlined in the NDCs and LT-LEDS. The information is based on the most recent NDCs; however, if no recent data were available, the first-generation NDCs from 2015/16 were used.

Bangladesh

General information			
Population size (2023):	170.4 million		
Urban population share (2023):	41.5%	**Human Development Index (2022):**	0.67
Income group:	Lower-middle income	**GDP per capita (2022):**	1,815 USD
Transport greenhouse gas (GHG) emissions			
Transport GHG emissions (2023):	12.4 million tonnes	**Per capita transport GHG emissions (2023):**	0.072
Share of transport GHG emissions in total national GHG emissions:		4.4%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions by 27.56 million tonnes of CO_2 equivalent (Mt CO_2e) (6.73%) below business as usual (BAU) in 2030 (unconditional) • Reduce GHG emissions by 89.47 Mt CO_2e (21.85%) below BAU in 2030 (conditional)
NDC transport targets:	• Reduce transport GHG emissions by 3.39 Mt CO_2e compared to BAU of 36.28 Mt CO_2e (unconditional) • Reduce transport GHG emissions by 6.33 Mt CO_2e compared to BAU (conditional)
LT-LEDS economy-wide target:	• No submission

Bangladesh's NDC sets ambitious targets for economy-wide emission reductions, aiming for a 6.73% reduction below business-as-usual (BAU) by 2030 unconditionally and 21.85% conditionally. In the transport sector, the NDC outlines a reduction of 3.39 Mt CO_2e unconditionally and 6.33 Mt CO_2e conditionally, supported by a range of mitigation actions. These mitigation measures include the implementation of mass rapid transit and bus rapid transit systems in Dhaka, railway expansion with electrification and withdrawal of unfit vehicles from service. Efforts to improve road infrastructure are also outlined, such as widening roads, developing lanes for active mobility and introducing congestion pricing mechanisms. Bangladesh further plans to encourage the use of hybrid and electric vehicles, enhance inland water transport and promote a modal shift from road to rail to reduce transport emissions.

Transport adaptation actions focus on developing climate-resilient infrastructure, particularly through projects led by the Inland Water Transport Authority and the Ministry of Road Transport and Bridges. Bangladesh's strategy also includes improving fuel quality, integrating intelligent transport systems and completing all highways with four lanes.

The country has not yet submitted a Long-Term Strategy (LT-LEDS).

Ethiopia

General information			
Population size (2023):	127.0 million		
Urban population share (2023):	22%	**Human Development Index (2022):**	0.492
Income group:	Low income	**GDP per capita (2022):**	854 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	6.8 million tonnes	**Per capita transport GHG emissions (2023):**	0.053
Share of transport GHG emissions in total national GHG emissions:		4%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions 14% below 2030 BAU (unconditional) • In total, reduce GHG emissions 68.8% below 2030 BAU (conditional)
NDC transport targets:	• Reduce transport GHG emissions 25% below BAU in 2030 (10 Mt CO_2e) (First NDC)
LT-LEDS economy-wide target:	• Not available
LT-LEDS transport targets:	• Extend railway network by 3,297 kilometres by 2030 (+366%) • Increase rural transport service coverage from 67% to 100% • Increase urban mass transport services from 34% to 70% • Expand bus routes and increase the number of buses by 89,680 • Increase electric vehicle infrastructure by 10% • Ban imports of used vehicles by 2030

Ethiopia's NDC commits to reducing economy-wide emissions 14% below BAU by 2030 unconditionally and 68.8% conditionally. While the second-generation NDC does not feature a transport greenhouse gas mitigation target, the first NDC aimed for a 25% reduction in transport emissions, equal to 10 Mt CO_2e. The second-generation NDC features transport emissions mitigation actions on electrification and a shift from fossil fuels to electric energy sources. Ethiopia plans to expand public transport services, including railways, to further reduce emissions. Adaptation efforts focus on building sustainable transport systems with non-motorised transport infrastructure and enhancing climate resilience through improved mobility and safety standards.

Ethiopia's LT-LEDS focuses mainly on targets to be achieved by 2030. The country aims to expand its railway network by 3,297 kilometres, increase rural transport service coverage to 100% and raise urban mass transport services from 34% to 70%. Additional plans include increasing electric vehicle infrastructure by 10%, banning the import of used vehicles and expanding bus networks with nearly 90,000 new buses. Mitigation actions under the LT-LEDS include shifting freight transport to rail, and adaptation strategies emphasise the development of climate-resilient infrastructure and transport systems to support sustainable mobility and long-term resilience.

Ghana

General information			
Population size (2023):	33.5 million		
Urban population share (2023):	57%	**Human Development Index (2022):**	0.602
Income group:	Lower-middle income	**GDP per capita (2022):**	2,086 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	9.2 million tonnes	**Per capita transport GHG emissions (2023):**	0.26
Share of transport GHG emissions in total national GHG emissions:		19.1%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions by 8.5 Mt CO_2e by 2025 and a further 24.6 Mt CO_2e by 2030 (unconditional) • Reduce GHG emissions by 16.7 MtCO_2e by 2025 and 39.4 Mt CO_2e by 2030 (conditional)
NDC transport targets:	Not available
LT-LEDS economy-wide target:	No submission

Ghana's second-generation NDC targets reducing greenhouse gas emissions by 8.5 Mt CO_2e until 2025 and 24.6 Mt CO_2e by 2030 as economy-wide unconditional goals. Under conditional targets, the reductions increase to 16.7 Mt CO_2e by 2025 and 39.4 Mt CO_2e by 2030. Although specific transport sector targets are not included in the NDC, mitigation efforts focus on expanding both inter-city and intra-city transport modes.

Transport adaptation actions centre on developing resilient infrastructure through comprehensive city-wide planning, aiming to enhance urban transport systems and address climate vulnerabilities. Ghana has not yet submitted an LT-LEDS.

India

General information			
Population size (2023):	1,431.7 million		
Urban population share (2023):	36.2%	**Human Development Index (2022):**	0.644
Income group:	Lower-middle income	**GDP per capita (2022):**	2,095 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	349.3 million tonnes	**Per capita transport GHG emissions (2023):**	0.24
Share of transport GHG emissions in total national GHG emissions:		8.5%	

Climate strategies	
NDC economy-wide target:	• Reduce the emission intensity of GDP 45% by 2030 compared to 2005 level
NDC transport targets:	• Increase the share of railways in total land transport from 36% to 45% (First NDC)
LT-LEDS transport targets:	• Indicative 2025 target: 20% ethanol blending in petrol, with a savings potential of around INR 30,000 crore per year (USD XX per year). • Indian Railways to become net zero by 2030, leading to annual mitigation of 60 Mt CO_2. • National Logistic Policy aspires to reduce cost of logistics in India to be comparable to global benchmarks by 2030

India's second-generation NDC commits to reducing the emission intensity of the country's GDP 45% by 2030 from 2005 levels. In the transport sector, India's first-generation NDC aimed to increase the share of railways in total land transport from 36% to 45%. The second-generation NDC does not refer to any sectoral targets nor actions. Key transport emission mitigation actions in the first-generation NDC include setting passenger vehicle fuel-efficiency standards, expanding metro lines, promoting electric and hybrid vehicles, and reducing subsidies on fossil fuels. Further measures focus on enhancing coastal shipping and inland water transport, building solar-powered toll plazas and constructing dedicated freight corridors. India also plans to develop a national biofuel policy and implement the Green Highways Policy to improve sustainability in the sector.

The long-term ambitions outlined through India's LT-LEDS feature a target for Indian Railways to become net zero by 2030, which would result in mitigating 60 million tonnes of CO_2 annually. Another target is 20% ethanol blending in petrol for 2025. The National Logistics Policy aspires to reduce logistics costs to align with global standards. India's LT-LEDS emphasises cleaner fuels, electrification and hydrogen as an energy carrier, positioning the country as a future hub for green hydrogen-powered maritime transport. Other plans include fuel-efficient aircraft designs, biofuel-powered planes, and hydrogen-powered aircraft, underscoring India's focus on innovation and sustainability across multiple transport modes.

Kenya

General information			
Population size (2023):	54.8 million		
Urban population share (2023):	30.9%	**Human Development Index (2022):**	0.601
Income group:	Lower-middle income	**GDP per capita (2022):**	1,764 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	10.8 million tonnes	**Per capita transport GHG emissions (2023):**	0.20
Share of transport GHG emissions in total national GHG emissions:		10%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions 32% by 2030 relative to the BAU scenario of 143 Mt CO_2e
NDC transport targets:	• Promote the use of appropriate designs and building materials to enhance the resilience of at least 4,500 kilometres of roads to climate risk.

Kenya's NDC aims to reduce greenhouse gas emissions 32% below the BAU scenario of 143 Mt CO_2e by 2030. In the transport sector, mitigation efforts focus on promoting low carbon and efficient transport systems to support sustainable mobility and emission reduction. For transport adaptation and resilience, Kenya plans to enhance the design and construction of at least 4,500 kilometres of roads using climate-resilient materials and techniques, while also promoting water harvesting to mitigate flooding risks. The country intends to improve institutional capacities through vulnerability assessments and climate-proofing infrastructure, ensuring that transport networks remain functional and sustainable in the face of climate challenges.

Kenya has not yet submitted an LT-LEDS.

Nepal

General information			
Population size (2023):	29.7 million		
Urban population share (2023):	22.8%	**Human Development Index (2022):**	0.601
Income group:	Lower-middle income	**GDP per capita (2022):**	1,113 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	4.9 million tonnes	**Per capita transport GHG emissions (2023):**	0.16
Share of transport GHG emissions in total national GHG emissions:		8.6%	

Climate strategies	
NDC economy-wide target:	Not available
NDC transport targets:	• Electric vehicle sales in 2025 to comprise 25% of all private passenger vehicle sales, including two-wheelers, and 20% of all four-wheeled public passenger vehicle sales • By 2030, increase electric vehicle sales to comprise 90% of all private passenger vehicle sales, including two-wheelers, and 60% of all four-wheeled public passenger vehicle sales • By 2030, develop 200 kilometres of the electric rail network to support public commuting and mass transport of goods
LT-LEDS economy-wide target:	• Minimise emissions and sustainably achieve net zero emissions by 2045. • Reduce CO_2 emissions by 30 Mt CO_2 in 2030 and 50 Mt CO_2 in 2050. • In the additional measures (WAM) scenario, reduce net CO_2 emissions to below zero in the period 2020-2030, then to around zero during 2035-2045. Increase sequestration from 2045 onwards, to reach -5.7 Mt in 2050.
LT-LEDS transport targets:	• LT-LEDS repeats the transport targets set in the NDC

Nepal's NDC and LT-LEDS echo similar ambitions for the transport sector. There is a strong focus on increasing the adoption of electric vehicles. By 2025, the aim is for 25% of all private passenger vehicle sales (including two-wheelers) and 20% of all public four-wheeler sales to be electric, contributing to a 9% reduction in fossil fuel demand. Nepal aims to expand these targets by 2030, with the aim of 90% of private passenger vehicle sales and 60% of public passenger vehicle sales to be electric. The country plans to develop a 200 kilometre electric rail network by 2030 to facilitate public commuting and goods transport. Initiatives also include establishing vehicle fitness test centres in three provinces and ensuring that metropolitan cities have cycling and pedestrian lanes to promote sustainable mobility.

Nepal's LT-LEDS aspires to achieve net zero emissions by 2045. Emission reduction efforts in transport include expanding electric vehicle infrastructure, promoting electric mass transport and shifting to cleaner fuels such as hydrogen and biofuels. In freight transport, electrification is a key goal, supported by installing charging stations. Nepal's NDC and LT-LEDS do not feature transport-related adaptation and resilience content.

Nigeria

General information			
Population size (2023):	225.5 million		
Urban population share (2023):	53.5%	**Human Development Index (2022):**	0.548
Income group:	Lower-middle income	**GDP per capita (2022):**	2,424 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	59.0 million tonnes	**Per capita transport GHG emissions (2023):**	0.26
Share of transport GHG emissions in total national GHG emissions:		15.3%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions to 453 Mt CO_2e by 2030; limit growth to 31% between 2018 and 2030 (2.6% per year) • Reduce GHG emissions 20% below BAU by 2030 (unconditional) • Reduce GHG emissions 47% below BAU by 2030 (conditional)
NDC transport targets:	• 100,000 extra buses by 2030 • Bus rapid transport to account for 22.1% of passenger-kilometres by 2035 • 25% of trucks and buses to use compressed natural gas by 2030
LT-LEDS economy-wide target:	Echoing the updated NDC targets: • Reduce GHG emissions 20% below BAU by 2030 (unconditional) • Reduce GHG emissions 45-47% below BAU by 2030 (conditional)
LT-LEDS transport targets:	• Reduce GHG emissions by around 4Mt CO_2e by 2030 • Move the country towards carbon neutrality by 2050 through a national transport system that provides access to a range of affordable transport choices, in which not more than 50% of all

	journeys are by car, at least 40% are by public transport (including train and bus rapid transit) and at least 10% are by active travel (e.g., cycling and walking), to generate little to no GHG, keep the air clean, and reduce vehicle distance travelled while increasing access and growing the economy

Nigeria's NDC sets a goal to limit emissions to 453 Mt CO_2e by 2030, aiming for a 20% reduction below BAU under an unconditional scenario and up to 47% reduction with international support. In the transport sector, key mitigation targets include deploying 100,000 additional buses by 2030, ensuring that 25% of trucks and buses use compressed natural gas, and expanding bus rapid transit systems to account for 22.1% of passenger-kilometres travelled by 2035. Nigeria also aims to enforce EURO III emission standards by 2023 and to upgrade to EURO IV by 2030.

The LT-LEDS aligns with the NDC targets and envisions reducing greenhouse gas emissions by around 4 Mt CO_2e annually by 2030. The long-term vision aims for a national transport system that promotes sustainable mobility, where by 2050 at least 40% of all journeys are by public transport, 10% are by active travel and less than 50% are by private cars. Key actions include expanding rail infrastructure, integrating land use and encouraging electric vehicles. The strategy also emphasises behaviour change and building technological capacity in clean transport technologies.

Pakistan

General information			
Population size (2023):	245.7 million		
Urban population share (2023):	33%	**Human Development Index (2022):**	0.54
Income group:	Lower-middle income	**GDP per capita (2022):**	1,655 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	44.9 million tonnes	**Per capita transport GHG emissions (2023):**	0.18
Share of transport GHG emissions in total national GHG emissions:		8.4%	

Climate strategies	
NDC economy-wide target:	• Reduce projected GHG emissions 50% by 2030, with a 15% drop below BAU from the country's own resources (conditional and voluntary intention) • Reduce GHG emissions an additional 35% below BAU subject to international financial support
NDC transport targets:	• By 2030, electric vehicles to comprise 30% of all new vehicles sold, in various categories • 30% shift to electric passenger vehicles and 50% shift to electric two-/three-wheelers and buses by 2030; 90% shift to electric passenger vehicles and 90% shift to electric two-/three-wheelers and buses by 2040
LT-LEDS economy-wide target:	No submission

Pakistan's NDC sets the goal to reduce emissions 50% from projected BAU levels by 2030, with a 15% unconditional target and an additional 35% conditional target. The country targets a 30% shift to electric vehicle purchases by 2030 across all vehicle categories, increasing to 90% by 2040 for passenger vehicles and two-/three-wheelers. To support the uptake of electric vehicles, Pakistan is implementing incentives such as tax exemptions, establishing recharging infrastructure and exploring carbon pricing instruments.

Other key transport emissions mitigation efforts include bus rapid transit systems in major cities, the development of the 40-kilometre Karachi Circular Railway to reduce urban emissions and adherence to EURO 5 emission standards to improve air quality. Karachi's bus rapid transit system aims to incorporate methane fuel sourced from cow dung to achieve zero emissions.

Pakistan has not yet submitted an LT-LEDS, and the latest NDC does not feature transport adaptation measures.

Rwanda

General information			
Population size (2023):	13.8 million		
Urban population share (2023):	18.1%	**Human Development Index (2022):**	0.548
Income group:	Low income	**GDP per capita (2022):**	959 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	0.61 million tonnes	**Per capita transport GHG emissions (2023):**	0.044
Share of transport GHG emissions in total national GHG emissions:		8.1%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions 16% below BAU by 2030 (1.9 Mt CO_2e mitigated by 2030) (unconditional) • Reduce GHG emissions an additional 22% below BAU by 2030 (2.7 Mt CO_2e mitigated by 2030) (conditional)
NDC transport targets:	Not available
LT-LEDS economy-wide target:	No submission

Rwanda's NDC aims to reduce emissions 16% below the BAU scenario by 2030, mitigating 1.9 Mt CO_2e through domestic efforts, with an additional 22% reduction (2.7 Mt CO_2e) dependent on international support. Mitigation actions in transport include electrifying buses, cars, and motorcycles, improving the vehicle fleet's emission performance through incentives, and promoting modal shifts through projects such as bus rapid transit and non-motorised transport lanes. Rwanda also plans to phase out older vehicles to reduce emissions from petrol and diesel use.

For transport adaptation and resilience, Rwanda is focused on climate-resilient transport infrastructure by incorporating environmental and engineering guidelines to reduce road vulnerability to floods and landslides. Other measures include disaster risk monitoring, response planning and institutional capacity building to support NDC implementation across sectors. The country is working on an integrated early warning system to manage climate-related risks and to enhance the resilience of its transport services and infrastructure.

Rwanda has not yet submitted an LT-LEDS.

South Africa

General information			
Population size (2023):	62.8 million		
Urban population share (2023):	66.4%	**Human Development Index (2022):**	0.717
Income group:	Upper-middle income	**GDP per capita (2022):**	5,821 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	50.4 million tonnes	**Per capita transport GHG emissions (2023):**	0.80
Share of transport GHG emissions in total national GHG emissions:		9.6%	

Climate strategies	
NDC economy-wide target:	• Keep annual GHG emissions in the range of 398-510 Mt CO_2e during 2021-2025 and in the range of 350-420 Mt CO_2e during 2026-2030
NDC transport targets:	Not available
LT-LEDS economy-wide target:	Not available

South Africa's NDC sets annual greenhouse gas emission targets of 398-510 Mt CO_2e for 2021-2025, dropping to 350-420 Mt CO_2e for 2026-2030. Although the NDC does not specify transport targets, it promotes electric and hybrid vehicles, public transport expansion and modal shifts. On adaptation, the focus lies on climate-proofing infrastructure by integrating climate considerations into planning, ensuring water and energy security, and retrofitting older infrastructure to enhance resilience.

The LT-LEDS outlines plans the improve the average vehicle energy intensity of road vehicles 20% by 2030. Mitigation actions include fuel efficiency standards, rolling out solar-powered public electric vehicle charging stations, and promoting local electric vehicle and battery production. South Africa also aims to shift freight transport from road to rail to reduce emissions and improve efficiency. Other actions include expanding the bus rapid transit system, leveraging CO_2 taxes on high-emission vehicles and advancing the hydrogen programme to position the country as a leader in fuel cell technology.

Sri Lanka

General information			
Population size (2023):	22.9 million		
Urban population share (2023):	17.8%	**Human Development Index (2022):**	0.78
Income group:	Lower-middle income	**GDP per capita (2022):**	3,932 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	9.6 million tonnes	**Per capita transport GHG emissions (2023):**	0.42
Share of transport GHG emissions in total national GHG emissions:		25.1%	

Climate strategies	
NDC economy-wide target:	• Reduce GHG emissions 4.0% below BAU for the period 2021-2030 in power, transport, industry, waste, agriculture and livestock, and forestry • Reduce GHG emissions an additional 10.5% below BAU for the period 2021-2030
NDC transport targets:	• By implementing the updated NDCs, reduce transport GHG emissions 4.0% below BAU (1.0% unconditionally and 3.0% conditionally), equivalent to reductions of an estimated 1.3 Mt CO_2e unconditionally and 4 Mt CO_2e conditionally (total of 5.3 Mt CO_2e) during 2021-2030
LT-LEDS economy-wide target:	• In the prosperity scenario, keep annual GHG emissions to 35.5 Mt CO_2e (2022), 21.9 Mt CO_2e (2030), 10.2 Mt CO_2e (2040) and -1.4 Mt CO_2e (2050). This allows for reductions of -48.7% (2030), -79.4% (2040) and -102.4% (2050) compared to the baseline, or an average annual reduction in CO_2e emissions of -26.4% during 2022-2030 and of -65.5% during 2022-2050.

Sri Lanka's NDC targets a 4% reduction in greenhouse gas emissions relative to the BAU scenario for 2021-2030, with an additional 10.5% conditional reduction. It aims to cut transport emissions 4% during this period (1% unconditionally and 3% conditionally), reducing them by 5.3 million Mt CO_2e. Key actions include avoiding unnecessary travel, improving public transport, expanding rail and freight networks, and integrating transport modes for better connectivity. New rail-based systems and park-and-ride schemes will help ease congestion, while a levy will restrict private vehicle use in sensitive urban areas during peak times.

The NDC also emphasises the electrification of railways and vehicles, with incentives such as tax breaks for electric and hybrid vehicles and investments in supporting infrastructure such as charging stations. Other NDC measures include the developing bike lanes and encouraging non-motorised transport, with 20-30% of road trips expected to shift to involve cycling or walking by 2035. Improvements in road architecture, intelligent transport systems and driver behaviour programmes aim to enhance efficiency and safety while reducing emissions. Maritime emissions are addressed through policies to promote sea transport and energy-efficient shipping practices.

Sri Lanka's LT-LEDS sets long-term goals, including for 50% of new road vehicles to be electric or hybrid-electric by 2030 and 90-100% by 2035, as well as converting half of public transport to electric by 2030 through retrofitting. It also aims to integrate bike lanes into key roads and to increase non-motorised trips. Adaptation actions focus on developing a renewable energy-based transport system that ensures resilience and sustainability. The LT-LEDS also includes measures supporting green lifestyles, transitioning to low carbon fuels, and enhancing infrastructure to withstand climate impacts, contributing to significant emissions reductions through 2050.

Zimbabwe

General information			
Population size (2023):	16.2 million		
Urban population share (2023):	37.7%	**Human Development Index (2022):**	0.55
Income group:	Lower-middle income	**GDP per capita (2022):**	1,378 USD
Transport greenhouse gas emissions			
Transport GHG emissions (2023):	1.5 million tonnes	**Per capita transport GHG emissions (2023):**	0.094
Share of transport GHG emissions in total national GHG emissions:		4.9%	

Climate strategies	
NDC economy-wide target:	• Reduce per capita GHG emissions 40% below BAU by 2030, conditional on international support
NDC transport targets:	• Through transport fuel economy policy, improve annual fuel efficiency during 2025-2030 by 2.2% for motorcycles, 2.9% for light-duty vehicles, 2.6% for buses and 2.5% for heavy-duty vehicles • Shift 5% of private car trips to public transport by 2030
LT-LEDS economy-wide target:	• Reduce GHG emissions 57% below BAU by 2050 (to reach 16.2 MT CO_2e total in 2050)
LT-LEDS transport targets:	Not available

Zimbabwe's NDC aims to achieve a 40% reduction in per capita greenhouse gas emissions by 2030 (conditional target). In transport, the focus is on improving fuel economy, with annual efficiency targets for motorcycles (2.2%), light-duty vehicles (2.9%), buses (2.6%) and heavy-duty vehicles (2.5%) between 2025 and 2030. Zimbabwe aims to shift 5% of private car use to public transport by 2030 and to introduce 2% biodiesel blending in fuels to lower emissions.

Transport adaptation efforts focus on enhancing infrastructure resilience to future climate risks, ensuring that new and retrofitted roads are designed to withstand extreme weather events. In the long term, Zimbabwe's strategy includes reducing emissions 57% below BAU by 2050, driven by a shift from fossil fuels to low carbon alternatives. These include local biofuel production, the introduction of electric and hydrogen vehicles, and policies to reduce petrol and diesel consumption.

Key mitigation actions under the LT-LEDS involve modernising public transport, promoting non-motorised transport, and refurbishing and electrifying rail networks to replace diesel use with grid-based electricity.

5 TDI results

This section presents the results of the piloting phases. Although the TDI does not aim to serve as a comparison tool as its primary objective, assessing multiple countries together offers an opportunity to showcase the application of the index. Specific indicators are detailed, along with the rationale for their inclusion and the approach used for scoring.

The second part of this section reflects on the TDI approach, critically discussing its challenges and shortcomings. The last part of the section focuses on common limitations and issues that are faced by any indicator assessment exercise. This evaluation aims to provide insights into areas where the methodology could be improved and to highlight challenges encountered during the piloting process.

5.1 Overview of results

The TDI uses the most recent data available for the selected indicators. Efforts were made to collect time-series data for the 12 pilot countries, drawing from globally recognised databases that have harmonised collection processes and annual updates. For scoring purposes, the latest available data year was used, which, in most cases, falls within the 2018-2022 time frame.

Because data issues may arise for individual indicators, the results should be interpreted with caution. In the context of the Benchmarking Report, the TDI results are intended to facilitate discussions and to prompt further investigation into how the scores were established and what insights they offer regarding each country's context and governance.

Given the 12 pilot countries, as well as the chosen dimensions and indicators, this section highlights the results for indicators with a good coverage across countries.

Results for Dimension 1: Passenger transport and mobility system

Among the potential eight indicators for this dimension (see Table 2), it was possible to retrieve data for seven of the indicators. Data for the indicator "walkability" were collected across all pilot countries. The concept of walkability relates both to urban design (with infrastructure such as footpaths and crosswalks) and to the proximity of residences to desired services and destinations. The mostly widely available indicator in this regard is from ITDP's Atlas of Sustainable City Transportation (ITDP 2024), which provides values for a large number of countries that focus on the time required to walk from residences to destinations such as schools and hospitals. This is converted into the share of the population living within a walkable distance to such destinations.

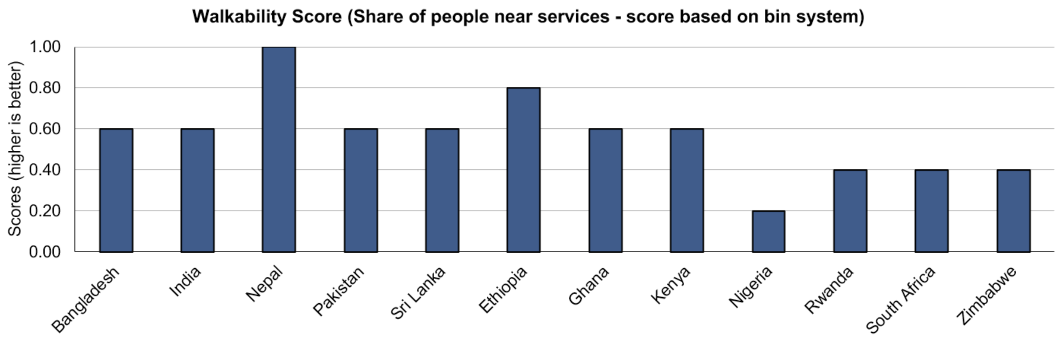
For the TDI, the project consortium created "bins" of scores ranging from low to high percentages, with similar numbers of countries in each bin, as shown in Table 4. With this approach, even reaching 10% of trips scores a 2, and 25-50% scores a 3, etc. Note that the highest-scoring countries in the database, among all countries, are The Vatican, with a score of 93% walkable trips, and Greece, with 92% walkability for urban areas.

Table 4: Scoring approach for walkability indicator

Percentage of trips walkable	Bin category (higher is better)	Converted to 0-1 score
>75%	5	1
50-75%	4	0.8
25-50%	3	0.6
10-25%	2	0.4
0.1-10%	1	0.2

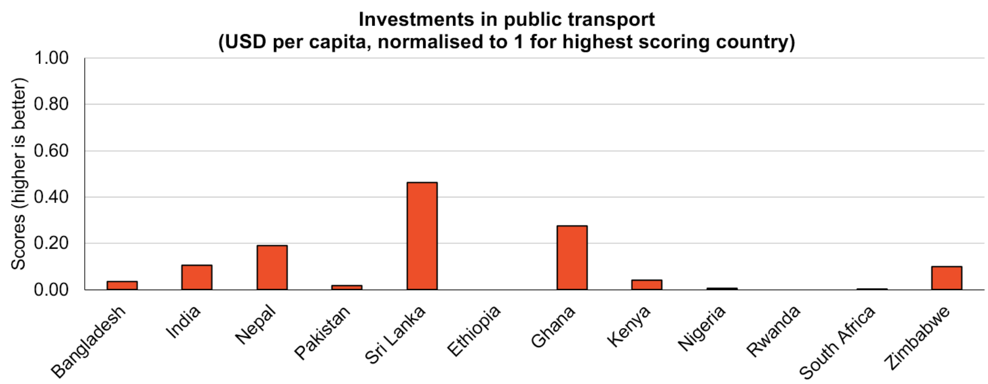
The resulting scores for the piloted countries are shown in Figure 9, after converting from a 0-5 score to a 0-1 system so that the range matches all other indicators. In Nigeria, just 6% of trips are regarded as being walkable, thus falling in the first bin category. The dataset indicated a walkability share of 77% for Nepal, resulting in the highest score.

Figure 9: Walkability indicator scores for the 12 piloting countries



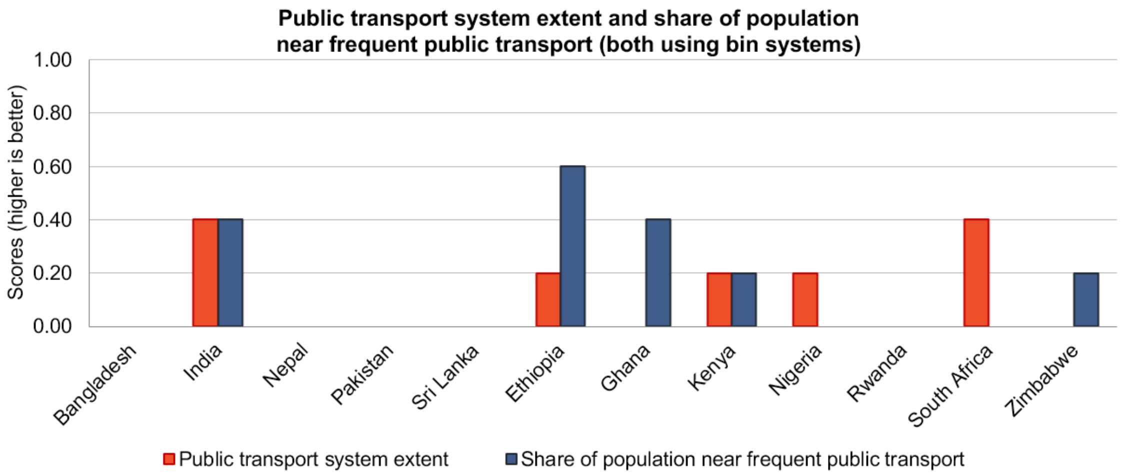
Another indicator in the first dimension is investment in public transport. The World Bank tracks total public transport investment, which is presented here on a per capita basis to allow for more meaningful comparisons, as it is assumed to scale logically with population. Among all countries covered by the World Bank, Uruguay ranks highest, with USD 139 spent per capita. However, as Uruguay was considered a major outlier, Senegal (with the second-highest value of USD 64.7 per capita) was used as the best-in-class target benchmark. Among the pilot countries, Sri Lanka leads with USD 30 per capita. Scores are calculated by dividing each country's per capita spending by that of Senegal (see Figure 10).

Figure 10: Public transport investment indicator scores for the 12 pilot countries



Two indicators of public transport access and quality are shown in Figure 11. Both indicators are developed and tracked by ITDP at a city level but aggregated to a national total. For scoring purposes, these indicators were converted to a "bin" system ranging from 0 to 5. Approximately the top 10% of countries globally, with the highest access and longest systems, receive a score of 5. The scoring is skewed so that countries with low but measurable access and system length receive at least a 1. The scores were further adjusted to a 0-1 scale to align with the TDI's general scoring approach. Several pilot countries achieved a minimum score of 1 (equivalent to 0.2 in these figures), while some scored 2 (0.4) and Ethiopia stood out with a score of 3 (0.6), reflecting its high population percentage with proximity to frequent public transport.

Figure 11: Public transport scores for the 12 pilot countries



Results for Dimension 2: Passenger vehicles

Data were identified for two of the four envisioned indicators in this dimension.

In earlier iterations of the TDI, the number of total light-duty vehicles (LDVs) in use was included as an indicator. The idea was that the ownership of light-duty vehicles (i.e., passenger cars) was assumed to offer significant mobility benefits at the individual level, but it also poses sustainability challenges, including emissions, traffic congestion and safety concerns. It was not possible to design a target ownership level that appears "best" or "most sustainable", since it could be argued that any number of LDVs takes road space away from public transport and other modes that offer a broader mobility benefit. Therefore, while acknowledging the importance of LDVs in mobility, this indicator was removed during the revision of the TDI.

The benchmarking exercise included data for two indicators on zero-emission vehicle (ZEV) adoption: the ZEV share of LDV sales and the ZEV share of bus sales. While ZEV adoption is widely recognised as a key strategy to reduce CO_2 emissions from vehicles, its impact depends on the decarbonisation of the power grid. It remains a critical lever for reducing the transport sector's dependency on fossil fuels. The sales shares were evaluated against the global targets for 2030, aligned with the 1.5-degree Celsius target of the Paris Agreement, which are set at 75% for LDVs and 60% for buses (WRI 2024 and Table 5).

In addition to LDVs and buses, the TDI includes the ZEV share of two/three-wheeler sales as an indicator, but no data were available for the pilot countries. For LDVs and buses, some countries also did not report data. It was assumed that countries not reporting data have ZEV sales shares low enough to round to zero for this assessment.

As of 2023, the 12 pilot countries record very low ZEV sales shares. In contrast, many European and high-income countries have reached a 20% or higher ZEV sales share, with Norway achieving as high as 75% for LDVs. Nevertheless, even these countries, like most globally, have substantial progress to make in transitioning to electric vehicles.

Table 5: ZEV sales targets aligned to low-carbon transport pathways

Transport mode	Required ZEV sales share target by 2030 (WRI 2024)
Light-duty vehicles	75%
Two/three-wheelers	85%
Buses	60%
Trucks *(covered under Dimension 3: Freight system and vehicles)*	30%

Results for Dimension 3: Freight system and vehicles

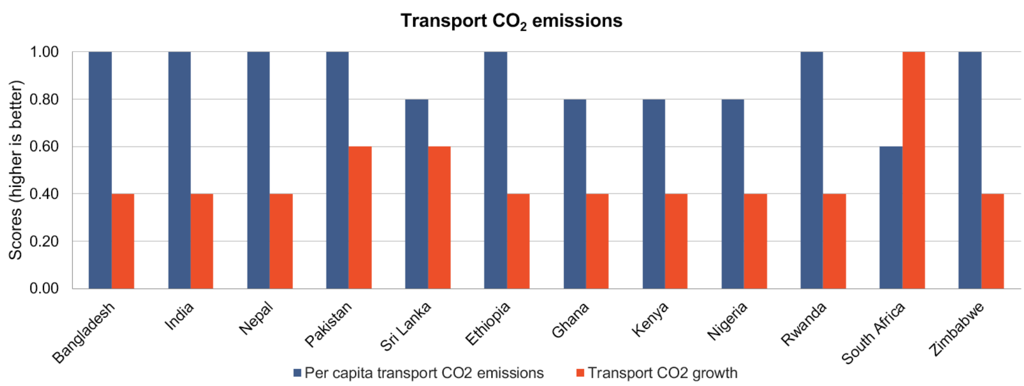
The biggest challenge for this dimension was obtaining information on freight transport. Reliable data on freight activity and vehicle fleets and freight activity were unavailable across all countries in global large-scale databases. Moreover, desk research on the pilot countries as well as country outreach did not lead to any reliable information. For India and Pakistan, data on the share of rail in total freight activity were retrieved and included. The scoring approach ranks countries based on the share of rail in total freight activity, with the highest score set at 30%, reflecting targets set by the EU and other countries for rail's share in freight transport.

Consideration was given to including additional indicators, such as the Logistics Performance Index. However, integrating an index with different objectives and conceptual frameworks into the TDI would introduce several challenges.

Results for Dimension 4: Emissions

Data on transport emissions are readily available through the Emissions Database for Global Atmospheric Research (European Commission et al. 2024). Most of the 12 LMICs examined through the TDI have relatively low baseline transport CO_2 emissions, with average per capita emissions of around 0.24 tonnes of CO_2 in 2022. Emission levels vary widely, ranging from 0.05 tonnes per person in Rwanda to 0.8 tonnes per person in South Africa. This variation is reflected in the scoring. Combining this with emission growth data from 2010 to 2019 offers valuable insights into trends in transport emissions across countries. Scoring for both indicators uses bins where the highest scores are assigned to countries with emissions below the first quartile. So, the lower the per capita transport CO_2 emissions or the lower their historic growth, the higher the score. The bin categories are based on values across all 197 countries in the dataset.

Figure 12: Transport emissions indicator scores for the 12 pilot countries



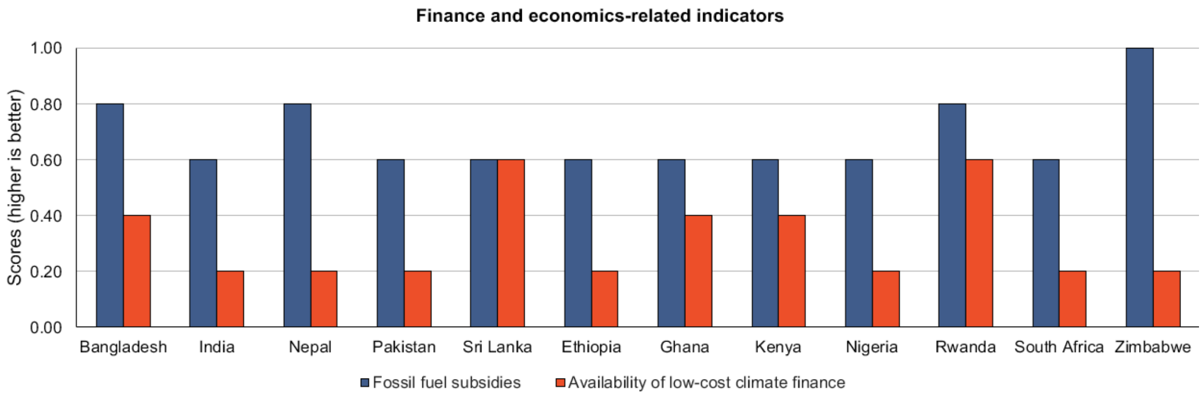
Results for Dimension 5: Finance and economics

The piloting phase successfully gathered data on both of the two envisioned indicators: fossil fuel subsidies and the availability of low-cost climate finance.

The 12 pilot countries provide lower per capita fossil fuel subsidies for petrol and diesel than the global averages, resulting in higher TDI scores. In 2022, these countries spent between USD 17 and USD 180 per capita on fossil fuel subsidies. Subsidies near zero received a score of 5 (1.0), with the 1st quartile scoring 4 (0.8), the 3rd quartile scoring 3 (0.6), and so on. Notably, all these countries scored no worse than the 2nd quartile, placing them above the global median.

In contrast, the pilot countries scored lower on the availability of low-cost climate finance, an indicator that tracks climate-related official development assistance. Although these data are not strictly limited to the transport sector, they offer an indication of potential financial support for transport initiatives.

Figure 13: Finance and economics indicator scores for the 12 pilot countries



Results for Dimension 6: Governance

Under the governance dimension, the TDI assesses transport-related climate targets in NDCs, as well as the strength of regulatory policies on vehicles and clean fuels. Reliable datasets were available for the pilot countries for each of these three indicators.

The indicator for the strength of clean fuel policies reveals that the 12 pilot countries are at various stages of policy development. Only India achieved a high score, due to its advanced fuel quality standards. Scoring for this indicator is based on sulphur concentration levels in road fuels, with bin categories defined as outlined in Table 6.

Table 6: Scoring approach for policy strength of clean fuels

Sulphur level	Bin category (higher is better)
<15 ppm	5
15-50 ppm	4
50-500 ppm	3
500-2000 ppm	2

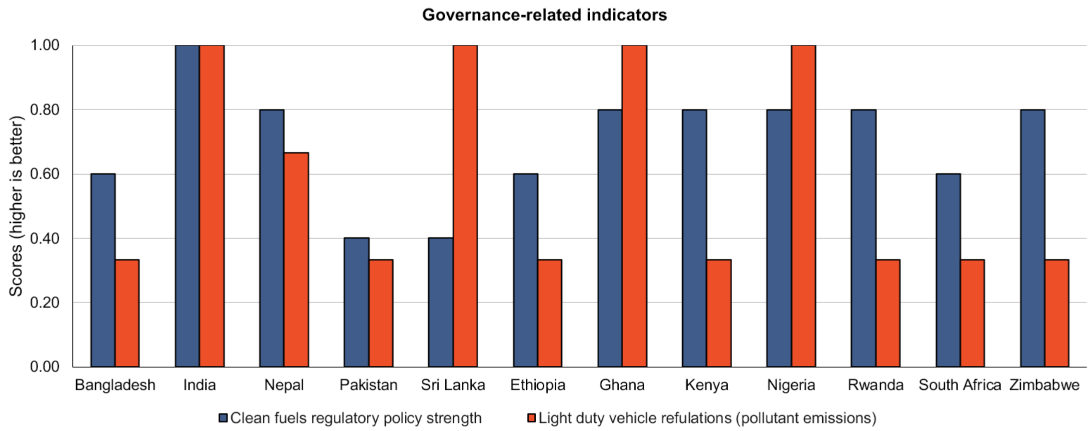
2000-5000 ppm	1

Examining regulations on local pollutants, the pilot countries were scored according to their light-duty vehicle regulations. Four categories were applied, as outlined in Table 7.

Table 7: Scoring approach for vehicle emission standards in the 12 pilot countries

EURO standards	Countries	Bin category (higher is better)
No standard	-	1
Below Euro 3	Bangladesh, Ethiopia, Kenya, Rwanda, Pakistan, South Africa and Zimbabwe	2
Euro 3	Nepal	3
Euro 4 and above	Ghana, India, Nigeria and Sri Lanka.	4

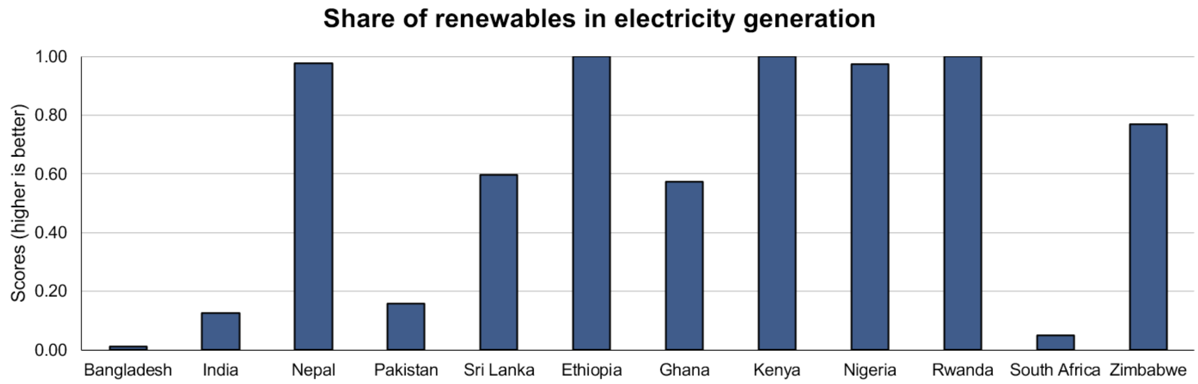
Figure 14: Governance indicator scores for the 12 pilot countries



Results for Dimension 7: Energy

A clean power grid, characterised by low carbon intensity and a high share of renewable energy, is crucial for maximising the emission reduction benefits of transport electrification. Among the 12 pilot countries, several achieved high scores for their renewable energy share (min-max score with a target score of 77%, aligned to IEA's Net Zero Roadmap, IEA 2023) (see Figure 15). In countries such as Kenya, Nepal, and Nigeria, renewables account for more than 70% of total energy consumption.

Figure 15: Energy indicator scores for the 12 pilot countries

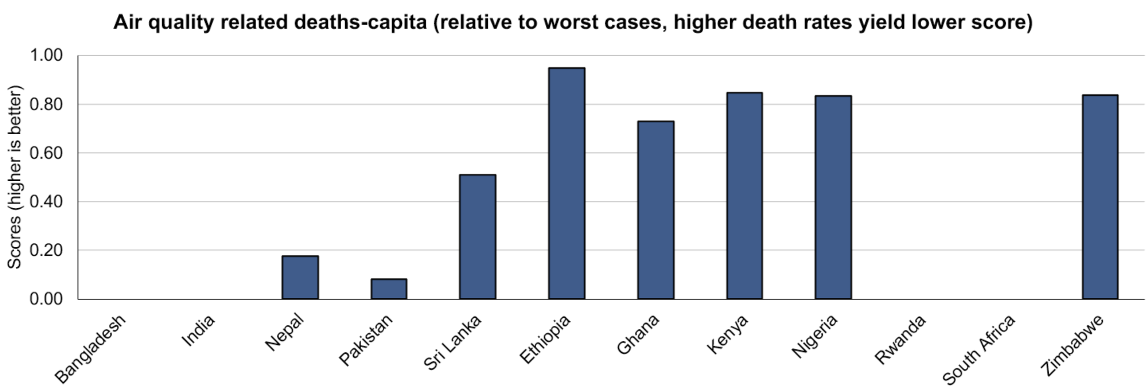


Results for Dimension 8: Context

Context-related aspects are captured through the four indicators on share of paved roads, air pollution, road traffic fatalities and awareness of climate policies. Data for the first three indicators were identified for the 12 piloting countries.

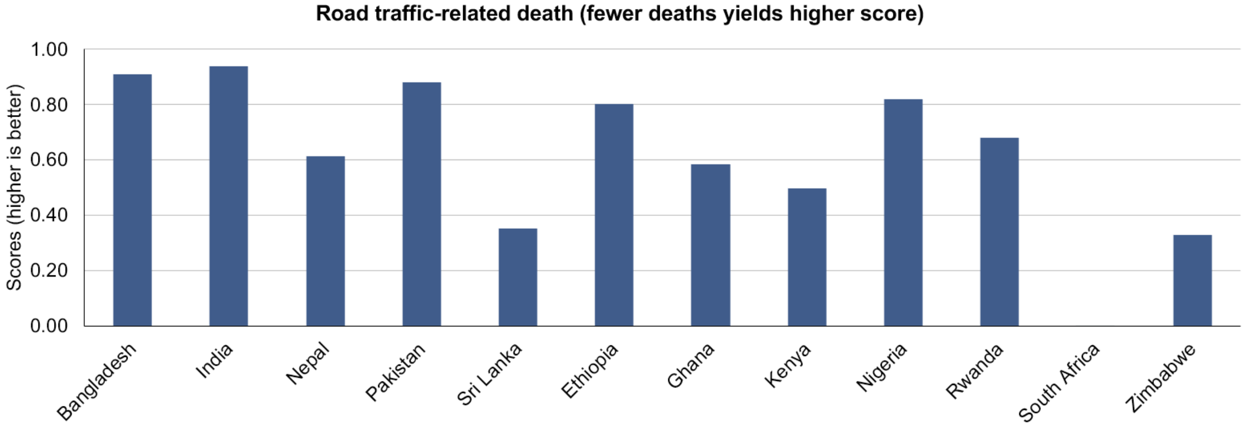
Although many aspects of a country's context may affect its performance and policies around sustainable transport, probably none are more important than air quality and its effects on human health. Here, scores were estimated based on the incidence of mortality per capita as related to impacts of transport on ambient air quality. The measures illustrated in Figure 16 are based on a country's position relative to the worst-case countries, with a higher mortality rate leading to a lower score. No data were available for Bangladesh, Rwanda and South Africa. India received a score of 0.

Figure 16: Air quality mortality indicator scores for the 12 pilot countries



Another very important context-setting indicator is the rate of road traffic fatalities. The fewer deaths occur, the higher the score for the countries. The score is relative to the worst case of 182 fatalities per 1 million people, which is the value of South Africa. It is by a far margin the highest value among the 12 pilot countries, and thus the score for South Africa is 0 (see Figure 17).

Figure 17: Road traffic-related death indicator scores for the 12 pilot countries



Overall TDI results

The piloting of the TDI succeeded in operationalising 23 indicators out of the 30 indicators envisioned (see Table 2). Each dimension was represented through at least one indicator (in the case of passenger vehicles and freight system and vehicles), but often there are two or more indicators per dimension. Further, data for these 23 indicators could not be gathered for all countries. Table 8 indicates the number of indicators used and the number of pilot countries with data.

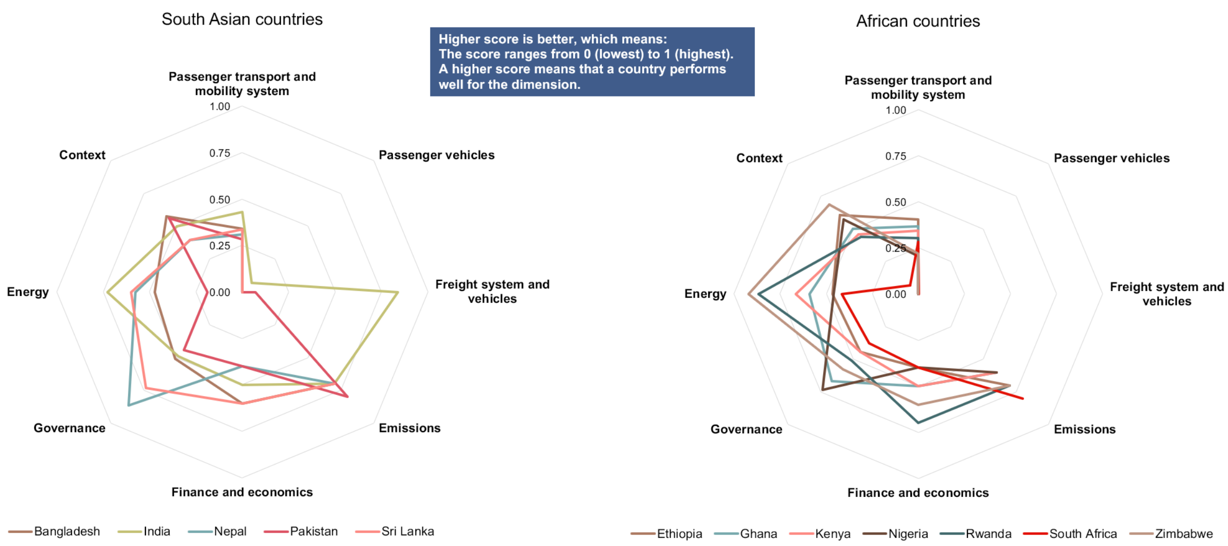
Table 8: Overview of covered indicators

Dimensions	Indicators	Number of pilot countries with data
Passenger transport and mobility system	Share of rail in passenger activity	4
	Public transport (bus, rail) system extent	12
	Share of population near frequent public transport	12
	Share of population near protected bikeways	12
	Walkability score	12
	Investment in public transport	10
	Rural transport access	12
Passenger vehicles	Light-duty zero-emission vehicle sales	12
	Bus zero-emission vehicle sales	12
Freight system and vehicles	Share of rail in freight activity	2
Emissions	Transport CO_2 per capita	12
	Transport CO_2 growth	12
Finance and economics	Fossil fuel subsidies	12
	Low-cost climate finance	12
Governance	Climate targets on transport	11
	Clean fuels policy	12
	Light-duty vehicle emissions regulations	12
Energy	Renewable energy share	12
	Road transport fuel prices (diesel)	12
	Road transport fuel prices (petrol)	12
Context	Share of paved road infrastructure	7
	Deaths attributed to ambient air pollution	9
	Road-related deaths	12

The summary figures that follow (Figures 18 to 20), which combine multiple countries, are not the standard format for displaying TDI scores. The standard approach is to visualise results for a single country through a spider chart and a bar chart (see Figures 21 to 24 for examples). Figures 18-20 are attempts to visualise the piloting results to identify similarities among the countries. These figures are intended for comparative purposes within the context of this report. Visualising multiple countries in a spider chart should generally be avoided, as it makes identifying individual country scores challenging.

Figure 18 summarises TDI results for the 12 pilot countries in the two focus regions. Scores range from 0 (lowest) to 1 (highest), with higher scores indicating stronger performance for the respective dimension. The closer a country's lines are to the outer edges of the spider chart, the higher its score for those dimensions. Missing values, such as for freight systems and vehicles, are represented by an interrupted line. Only the lines for India and Pakistan have values for all dimensions, and thus a continuous line in the spider chart.

Figure 18: TDI dimension scores for pilot countries

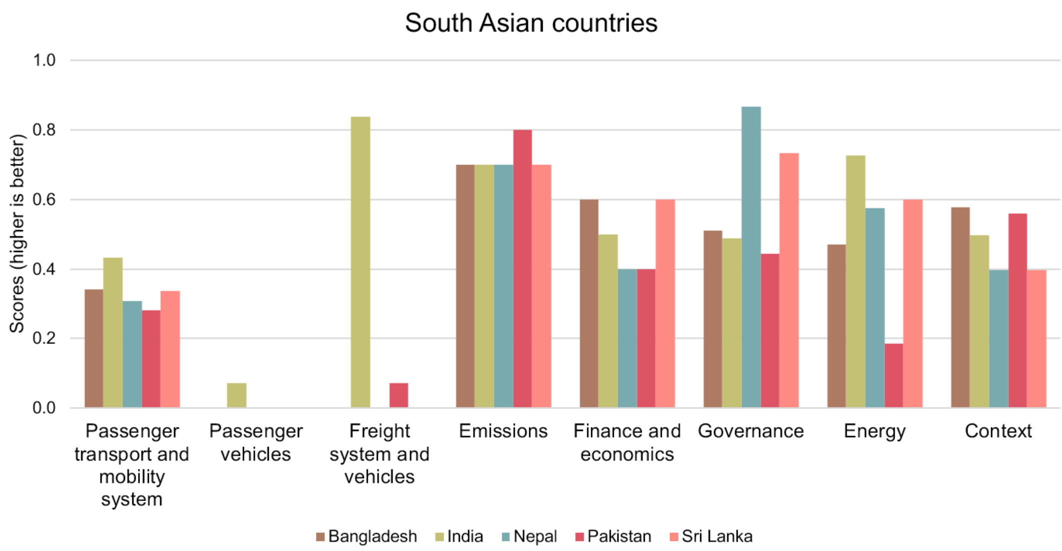


The figure shows that South Asian countries have similar results across the dimensions of passenger transport and mobility systems, emissions, and finance and economics. In contrast, African countries display greater diversity in their results. Notably, South Africa stands out in the context dimension, with road traffic fatalities significantly higher than those in the other pilot countries.

An alternative comparison method uses bar charts (Figure 19 and Figure 20). Among the five South Asian countries, all score low in the passenger vehicles dimension. Scores are similarly low in the emissions dimension, indicating comparable levels of growth and per capita emissions. A notable issue with the bar chart visualisation is the lack of clarity regarding whether a score of zero reflects missing data (as in the case of freight systems and vehicles) or an actual score of zero (as for passenger vehicles).

Sri Lanka performs well compared to other pilot countries across most dimensions. As noted in section 4.2, the country's ambitious transport decarbonisation goals in its NDC are reflected in the scores, particularly in the governance dimension, where it ranks second, with NDC transport targets integrated as an indicator. Sri Lanka's NDC adopts a comprehensive approach to transport measures, reflected in its high scores in the share of renewable energy in the electricity mix and other energy-related indicators.

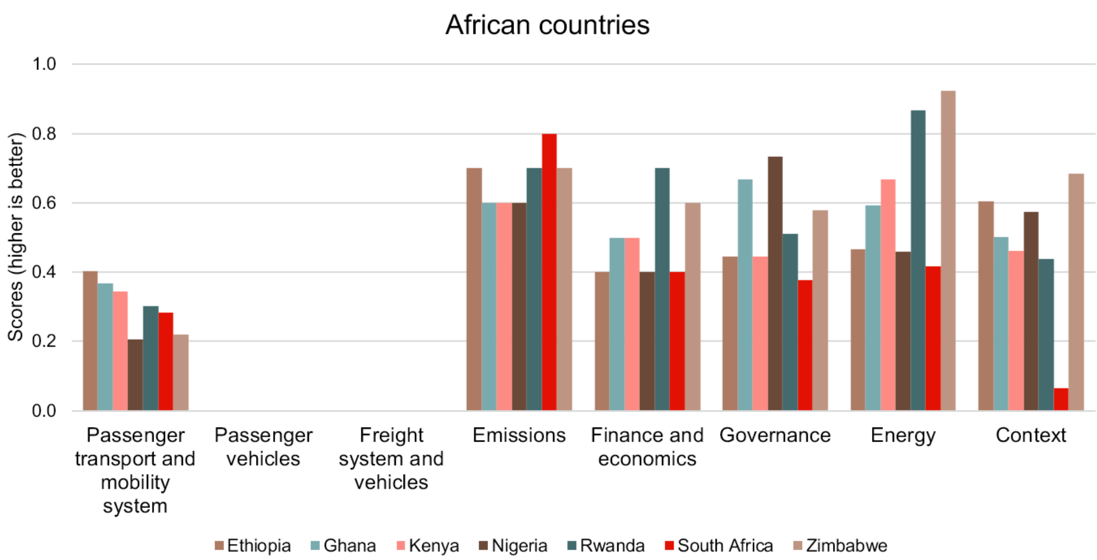
Figure 19: TDI dimension scores for South Asian countries



When interpreting the scores for countries in the region, priority should be placed on improving data collection for freight transport and on enhancing policies and performance related to passenger vehicles and context.

For African countries, Figure 20 shows missing information in the “freight system and vehicles” dimension, as well as the very low scores for passenger vehicles dimension. South Africa is falling behind in the context dimension because of road safety issues. Rwanda ranks highest in three of the eight categories; however, it also highlights a comparison challenge: Rwanda has data for only two indicators in the passenger transport and mobility system dimension, which is not apparent from the figure alone. This suggests that TDI scores should indicate the number of indicators on which each dimension score is based for a clearer interpretation.

Figure 20: TDI dimension scores for African countries



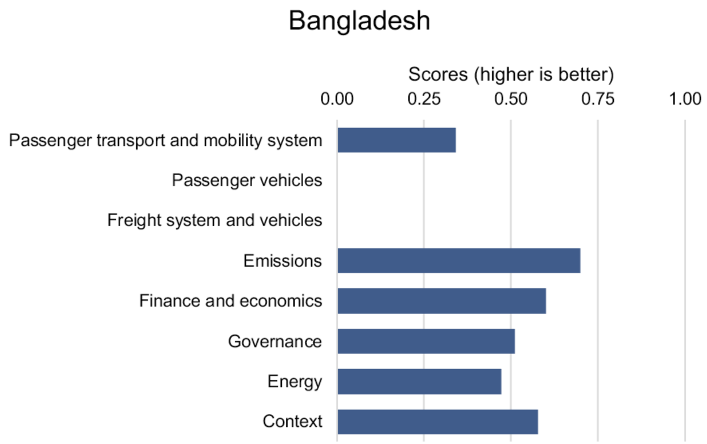
Assessing the scores for African countries highlights the need for improved data on freight transport. Additionally, according to the TDI, policies that enhance light-duty vehicle-related aspects and prioritise passenger transport and mobility systems would be most beneficial.

Example of Bangladesh

An examination of the TDI results for Bangladesh (see Figure 21) reveals that the passenger vehicles dimension scores the lowest by a significant margin. The second-lowest dimension is passenger transport and mobility system.

Bangladesh has near-zero reported light-duty zero-emission vehicle sales, similar to all the pilot countries with one or two exceptions. In the passenger transport and mobility system dimension, Bangladesh shows low scores due to lack of public transport services relative to the urban population. The country has also a relatively low share of renewables in its electricity mix, leading to a low score for the energy dimension. Transport fuel prices, however, fall within the average range for the 12 pilot countries.

Figure 21: TDI scores for Bangladesh



Given that the TDI identifies passenger vehicles and passenger transport and mobility system as the lowest-scoring dimensions for Bangladesh, the methodology suggests prioritising policy actions in these areas. This entails supporting the transition to zero-emission vehicles by expanding efforts to track the current electric vehicle stock and establishing policy frameworks for charging infrastructure, vehicle procurement and import regulations for zero-emission vehicles.

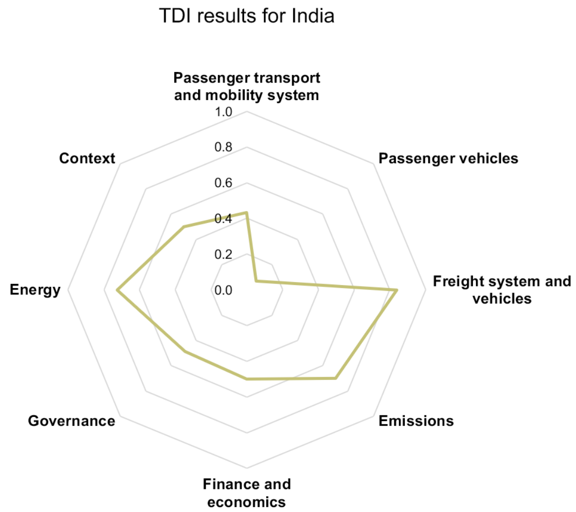
For passenger transport and mobility system-related improvements, policies prioritising public transport, expanding public transport systems, and promoting walking and cycling are recommended. The TDI does not currently assess informal transport, which is a critical component of the transport system in countries like Bangladesh. Integrating informal transport more effectively into public transport services and recognising its role within policy frameworks such as NUMPs and SUMPs could significantly enhance mobility solutions.

Example of India

In the case of India, complete data for all 23 indicators were used in this TDI assessment. The country performed best in the freight systems dimension (see Figure 22), with a significant share of freight movement already conducted via railways. India also scored highly in the emissions dimension, reflecting relatively low per capita transport CO_2 emissions and relatively modest growth of transport CO_2 emissions.

The lowest score was in the passenger vehicles dimension. Although India is a leader among the pilot countries in the electric vehicle transition, the percentage sales are still just a few percent for LDVs and buses. This is likely to change rapidly and on-going tracking of this variable should see India (and other pilot countries) registering double digit percentages within a few years. Additionally, India received a low score in the context dimension, due primarily to issues related to air pollution and road safety.

Figure 22: TDI results for India

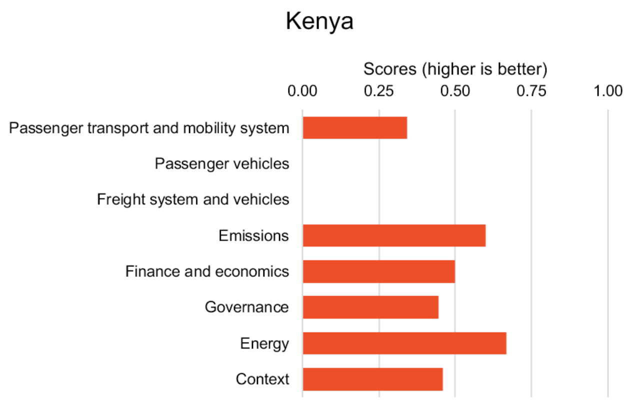


India's LT-LEDS features several transport targets that could be benchmarked against the TDI. The available data, supplemented by the targets, can be inputted to the TDI, and a comparison to the results above can be undertaken.

Example of Kenya

Kenya, representing the African pilot countries, shows high scores in the energy and emissions dimensions (see Figure 23). Although the growth in transport CO_2 emissions is above the global average, the overall baseline remains very low. The assessment identifies passenger vehicles and passenger transport and mobility system as Kenya's lowest-scoring dimensions.

Figure 23: TDI scores for Kenya

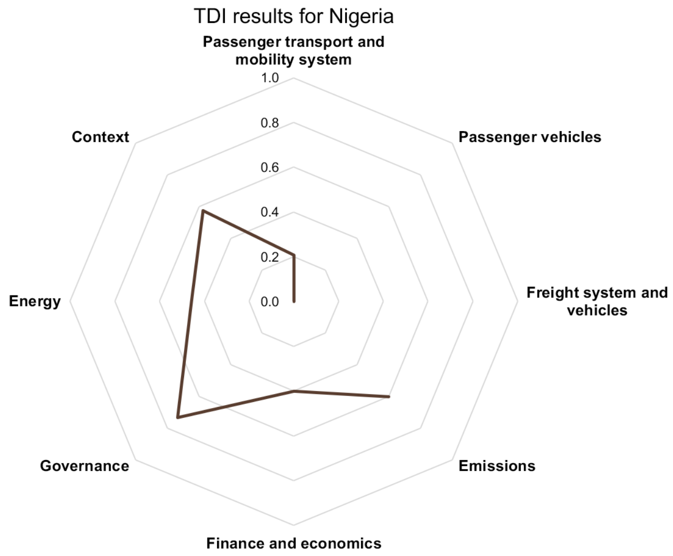


Kenya has the lowest share of paved road infrastructure among the pilot countries, which impacts its scoring in the context dimension.

Example of Nigeria

The TDI assessment for Nigeria indicates as well that improvements in the areas of passenger vehicles and passenger transport and mobility system seem to be valuable. Governance is relatively strong thanks to clean fuel policies and strong vehicle emission standards. All other dimensions received modest scores (Figure 24). Nigeria had the best data availability among the African pilot countries, despite a lack of information on passenger and freight transport activity.

Figure 24: TDI results for Nigeria



The TDI policy guidance recommends for Nigeria to pursue LDV electrification and put more efforts into public transport, walking and cycling.

Results for policy guidance

After using the TDI, together with the TDI scores, the user receives a list of non-prescriptive policy actions. The spreadsheet toolkit will point to the policy areas, as outlined in section 3.2. These are closely structured around the dimensions. For the pilot countries, an approach highlighting policies for the two lowest-scoring dimensions would lead to the results indicated in Table 9.

Table 9: Lowest-scoring dimensions among the pilot countries

Dimensions and their related policy guidance	Countries scoring the lowest dimension scores	Countries scoring the second-lowest dimension scores
1. Passenger transport and mobility system	-	Bangladesh, Ethiopia (two dimensions with same score), Ghana, India, Kenya, Nepal, Nigeria, Rwanda, Sri Lanka, Zimbabwe
2. Passenger vehicles	Bangladesh, Ethiopia, Ghana, India, Kenya, Nepal, Nigeria, Pakistan, Rwanda, South Africa Zimbabwe	-
3. Freight system and vehicles	-	Pakistan
4. Emissions	-	-
5. Finance and economics	-	Ethiopia (two dimensions with same score)
6. Governance	-	-
7. Energy	-	-
8. Context	-	South Africa

Table 9 shows that all 12 pilot countries could focus their policies and activities on passenger vehicles. It reflects the very low level of ZEV sales throughout all countries. Most of countries could also focus on improving passenger transport and mobility systems by expanding public transport, walkability, cycling and investments in collective transport.

Through these results, policy makers can recognise several areas that require attention and improvement in their countries. This focus is not limited to the two lowest-scoring dimensions; foremost, the TDI highlights the significant data gaps that are prevalent.

Overall, the results indicate that the pilot countries face significant challenges related transport sustainability and decarbonisation. Most have a relatively low carbon intensity in the energy sector. Despite rapid growth, emissions-related indicators scored relatively well across most countries. However, emissions are often a consequence rather than a root cause of unsustainable, inefficient transport systems. Maintaining low baselines will require co-ordinated efforts across all dimensions covered by the TDI.

5.2 Discussion of TDI approach

The following section discusses challenges and issues around the piloting phase as well as the overall approach of the TDI.

Assessment issues

Applying the TDI to the pilot countries provides valuable insights into the **processes of obtaining, processing and evaluating indicators** as well as transport data availability. In terms of results, the pilot countries generally scored well in the emissions dimension due to their low baseline per capita transport emissions. However, they exhibited significant growth in transport emissions between 2010 and 2019, ranging from 15% in South Africa to 165% in Ethiopia. Both emission levels and growth rates are captured within the emissions dimension.

The passenger vehicles dimension recorded low scores across the pilot countries, highlighting **challenges in setting optimal thresholds** for sustainable, low carbon transport. Further fine-tuning is needed of the thresholds and the way this aspect is being assessed.

Additionally, the TDI's **limited geographic scope**, focusing on LMICs in Africa and South Asia, as explained in sections 1 and 2, means that the selected countries share many similarities, such as low emission baselines and comparable vehicle emission regulations. While focusing on underrepresented regions is valuable, incorporating a broader set of countries with diverse profiles could enhance the TDI's ability to address a wider range of transport decarbonisation and sustainability challenges and provide deeper insights into varying contexts and conditions for countries across regions.

Challenges in data coverage

A major challenge is that, although a wide range of indicators was identified and collected, **very few datasets included data for all 12 pilot countries**. In general, the data coverage was weak for African countries, such as Ethiopia, Rwanda, and Zimbabwe, while it was better for larger countries, such as India, Nigeria, Pakistan and South Africa (see Table 10). Establishing a broad TDI system for major economies may therefore be easier.

Overall, the **data coverage** was better in the pilot countries in Asia than those in Africa. Data coverage issues show that despite the TDI being a concept-driven approach, the applicability of indicators was still determined by data availability. Nevertheless, the piloting phase also showed that, with the TDI, it is possible to obtain scores for most dimensions, even in scenarios of limited data.

As highlighted in the previous section, in the TDI pilot phase, sufficient data were available for 23 of the 30 intended indicators. Even among these, data gaps persisted for one or more countries.

A key challenge was the lack of data on **freight transport**. While many freight-related indicators are available for a wide range of countries, data were often missing for the pilot countries, indicating the need for more targeted efforts, potentially through collaboration with national governments, to improve data collection.

Data on **sales and stocks of zero-emission vehicles** is another area with limited development. For many pilot countries, low sales and stock levels likely mean that data are not systematically collected. Available databases on zero-emission vehicles across all transport modes (passenger cars, buses, trucks, two-/three-wheelers) held limited information for the pilot countries, resulting in low data coverage for the dimensions of passenger vehicles and freight system and vehicles.

Table 10: Data coverage for each country and dimension

Dimensions	Bangladesh	India	Nepal	Pakistan	Sri Lanka	Ethiopia	Ghana	Kenya	Nigeria	Rwanda	South Africa	Zimbabwe
1. Passenger transport and mobility system (out of 7)	100%	100%	100%	100%	86%	71%	86%	86%	86%	71%	86%	86%
2. Passenger vehicles (out of 4)	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
3. Freight system and vehicles (out of 3)	0%	33%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%
4. Emissions (out of 2)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5. Finance and economics (out of 2)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6. Governance (out of 3)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7. Energy (out of 5)	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
8. Context (out of 4)	50%	75%	75%	75%	75%	75%	75%	75%	75%	50%	50%	75%

Overall, the project findings confirmed **significant data limitations across the piloted LMICs** in Africa and South Asia, which make comprehensive transport assessments challenging. Each of these countries has its own statistical institutes, reporting mechanisms and data availability, marked by a varying degree of detail. Obtaining detailed data from national sources is often burdensome, with differences in vehicle typologies and classifications across countries further complicating the direct comparison of data.

The data limitations were accentuated during the second piloting phase of the project, where the revised TDI approach was extended to six additional countries (Ethiopia, Ghana, Rwanda and Zimbabwe in Africa; and Bangladesh and Nepal in South Asia). Compared to the countries assessed during the first piloting phase, the countries added during the second phase featured significantly less within the global and regional datasets on which the project relied.

The lack of data results in no scores for certain dimensions and results in these dimensions being excluded from the **TDI's policy guidance** step. However, this does not imply that the country should refrain from implementing measures in those areas. On the contrary, these areas might represent the most critical priorities for action. The toolkit and associated materials will clarify that the policy guidance is limited by data coverage, which may not fully reflect the country's needs.

The TDI project confirms what has been widely known for decades: improvements in data collection and availability are highly needed in LMICs. Regional efforts on data analysis can contribute immensely to better assessment and policy making. The TDI provides valuable insights on the type of data that needs to be captured. The example of the *Asia Transport Outlook* is a success model for the Asia region, and such data observatories should be replicated in more regions.

Issues with using proxies

Earlier in the report, the methodology outlined the potential use of proxies to address severe data gaps. In cases where the value of an indicator needs to be estimated without available data, proxies can be resorted to. Ultimately, however, the choice of proxy country or countries will depend on individual judgment, whereby a country is being deemed as "similar" in terms of the level of economic development (GDP per capita), geographic proximity, or other identified aspects. In other words, applying proxies means borrowing data from countries that have similar characteristics and transport situations and that have data for the relevant indicator.

The project team decided **not to apply proxies during the pilot testing**, for several reasons. A key reason was that the pilot aimed to stress-test the TDI under challenging conditions, such as missing data, to evaluate how well it functions without proxies. Since not all users may rely on proxies, it was important to use the TDI with incomplete indicators. Additionally, using proxies could compromise the comparability of results, which was one of the intentions of the piloting phase, since proxy data might influence the results.

By refraining from using proxies, the pilot testing provided an opportunity to examine the sustainability and robustness of the TDI, ensuring that the methodology remains reliable even when faced with data limitations.

Limitations of scoring and thresholds

An important consideration for indicator assessment is how the **thresholds and evaluation for the scoring** should be structured. In both cases – the min-max approach and the bin categories – certain classes and values must be set. The individual country values are then benchmarked against these values, and the scores are produced. In many cases, the **"best-in-class"** concept is helpful, where the best performing country within a dataset is used as the target value for others. However, this is often a country belonging to another income group or other region or having specific characteristics that enabled this development. It may not be realistic for LMICs to perform anywhere near the level of these top performers, at least not in the foreseeable future. So, while pursuing alternative concepts, some indicators looked at regional averages to advance ambitious policy targets.

However, an argument against using a lower target, such as comparing countries only to others in their own region or at their own level of economic or social development, is that this may distract from the need to improve performance. An example is public transport availability, which scores relatively low in many LMICs. Having this benchmark allows countries around the world to draw lessons and inspiration from the best-performing countries in that domain.

Shortcomings of the TDI

The TDI can serve as a valuable tool for the identification of policy priorities and the tracking of progress towards surface transport decarbonisation; however, it is not without its limitations. As a **data-driven approach**, it was evident from the outset of the project that data gaps in the form of inadequate data availability, insufficient data coverage, outdated data, and lack of data granularity could pose significant challenges to the TDI's application and the results it produces.

The TDI has mostly relied on **transport and climate datasets at the regional and international levels** due to their more recent and more regularly updated nature. Whereas international databases (e.g., the ITF Transport Outlook and the UNEP *Emissions Gap Report*) offer insightful global trends and allow for comparisons among countries based on common methodologies, their country-level estimates might be less accurate and less useful in benchmarking applications. What is more, limiting data collection, validation and scoring efforts to international databases may result in the unintentional exclusion of highly relevant and valid indicators, which, however, are not systematically reported on and collected at the global level.

Despite the TDI's initial intention of covering aspects pertaining to **equity and informal transport**, obtaining reliable datasets for the associated aspects in the target regions has proven to be particularly challenging. For example, transport-related household expenditures could offer valuable insights into the burden of current transport systems, with a higher dependency on private motorisation typically leading to higher household expenditures, whereas greater availability of public transport and active mobility options lower expenditures.

To address identified data shortcomings, **dimensions and indicators** were chosen based on fairly adequate data coverage across the 12 pilot countries. Despite efforts to prioritise indicators with broad coverage across all countries, certain indicators remain unavailable in some countries. Out of the 30 indicators identified, only around 10 were backed with sufficient data. Even then, most were missing data for one or more countries.

Moreover, given that composite indicators, including the TDI, typically rely on **generalised metrics and indicators**, it may be challenging to fully capture the diversity of national contexts, especially where unique geographic, economic or social factors heavily influence transport systems. The initial ambition of the TDI was to include climatic or geographic features (i.e., a country's landlocked or mountainous nature), which can shape mobility behaviour. Eventually, however, the indicator was not incorporated due its arbitrary nature and to an insufficient correlation between the above-mentioned features and transport policies.

Consequently, users of the TDI may find that the index fails to adequately reflect certain **local characteristics**, including urbanisation levels, public transport accessibility and regulatory environments. Bearing in mind these data limitations, the scoring results need to be approached with great caution and interpreted in conjunction with the country-specific context.

Another limitation is the potential for unintentional bias towards **measures that are more easily quantifiable**, such as vehicle electrification rates or public transport expansion, possibly overlooking more qualitative or innovative approaches that are less standardised but equally impactful. To illustrate, whereas indicators on awareness and support for climate policies were initially included in the TDI, the impossibility of retrieving any reliable, quantifiable data for these aspects resulted in their eventual removal from the scope.

Finally, many of the TDI scores are affected by **comparisons to the "best-in-class"**, which is often a country from outside Africa or Asia that shows a global best. Such comparison often sets the pilot countries back in terms of their relevant scores. For the index to drive constructive action, it is essential for users to interpret the results as a mere baseline for improvement rather than as a definitive ranking of successes or failures. Emphasising the TDI as a guiding tool rather than as a final assessment will support countries in viewing their scores as part of a collaborative journey towards sustainable, low carbon transport systems (see more on the narrative of the TDI results below).

Issues related to recommending policy actions

A key takeaway from the stakeholder engagement was the advice to **connect the indicator assessment to transport policies**. For the priority group of policy makers, a guidance on policies adds significant value to any toolkit. Implementing an approach that provides informed policy making faces several challenges.

It is challenging to generalise policy measures while remaining relevant and valuable for a given context of policy making. Whereas in theory, the list of policies is infinite, in practice it can be difficult to find the right level of detail without being too general or too detailed. The recommended policies also ignore the governance structure that may be found in specific countries, because it is impossible to account for all the different approaches. It needs to be acknowledged that policies are nested within the bigger context of regulations and governance structures.

Therefore, the featured policy recommendations only cover topics that were measured through the indicators. They are closely related to the assessment, but they might not be the only policies worth implementing.

The current approach has the function of providing illustrative examples of potential policies. It depends on the users to then further explore the options and to tailor policies towards their country context and frameworks. The transport-related policies need to be adjusted to the country's governance system and consulted with the relevant stakeholders.

Most importantly, the TDI cannot be regarded as the sole tool for policy making in transport. It is a support tool to identify potential weaknesses; however, setting priorities and the design of policies requires additional analysis, stakeholder engagement and careful planning.

Interpretation of results and narrative by policy makers

Building meaningful, robust and reliable composite indicators for sustainable transport is a complex endeavour that poses a multitude of challenges. These are related to: identifying the most appropriate dimensions; selecting indicators that create value while guaranteeing a reasonable degree of data availability, reliability and ease of interpretation; weighting and aggregating these indicators; and ultimately communicating the results. Many indexes involve techniques related to categorisation and subsequent scoring. Such approaches, even if supported by established concepts and common practices, are always arbitrary. Because, in practical terms, their use entails attributing specific descriptions to abstract numbers, this underscores the paramount importance of building consensus around how to communicate the messages stemming from the scoring results.

The TDI strives to assist LMICs in decarbonising their surface transport systems by providing them with a clear, data-driven overview of where they stand in their transition towards a sustainable, low carbon transport sector. In particular, the index seeks to empower policy makers in LMICs to identify their strengths and areas needing improvement, to benchmark long-term progress towards greenhouse gas emission reduction targets, to compare performance against other countries and to support the development of NDCs. However, unleashing the full potential of the TDI and realising the full range of its benefits will strongly depend on the **correct understanding by users** of the index's scoring results and, ultimately, how they act upon these results.

Once a user has inputted data about a country into the TDI spreadsheet toolkit, scores for each of the eight dimensions will be shown. Simply put, the scoring mechanism is based on an evaluation of the data for the indicators. Depending on the indicator, it might be based on categories or on a range defined by global values. A higher score (1 being the highest score) means that the indicators of this dimension are performing well in relation to the set boundaries.

In addition, each country is provided with illustrative and non-prescriptive advice in relation to its two lowest-scoring dimensions. This policy guidance seeks to enable LMICs to gain better insight into the most effective measures for their specific circumstances while informing policy decisions to decarbonise transport systems.

Importantly, the TDI is designed not as a tool for casting blame or shaming countries with lower scores, but as a platform for mutual learning, collaboration and inspiration. In view of this, the dissemination of the index's scoring results is to be approached with caution and tailored to the needs, knowledge and data literacy of the target audience while involving all relevant stakeholders. This, in turn, will be crucial to ensuring that the information is not only accessible but also actionable for each interest group, from decision makers to scientists, media and citizens.

The TDI can serve as a strategic tool for participating countries to accelerate the decarbonisation of their transport sectors while advancing a wider spectrum of sustainable development goals – including integration, access, economic development and road safety. A low score indicates significant untapped decarbonisation potential, thereby signalling where policy and financing efforts should be prioritised. By approaching a low score as a starting point for targeted interventions, rather than as a negative label, countries can use the index to build partnerships with financial and development institutions, mobilise financial and technical resources, improve public awareness and engagement, and devise impactful policies for sustainable, low carbon transport systems. This would enable fostering alignment with global agendas, including the Paris Agreement and the 2030 Agenda for Sustainable Development with its SDGs.

Countries using the index can leverage their scores to attract partnerships with multilateral development banks, climate finance institutions and private sector investors. The lack of sufficient understanding and technical capacity to develop bankable projects is one of the main obstacles hindering LMICs from attracting international climate investments. By equipping countries with detailed knowledge of the specific gaps in their transport systems, the TDI results can support them in preparing targeted proposals that align with the funding criteria and overall priorities of financial institutions (e.g., deploying electric mobility, expanding public transport networks, or shifting freight transport to more sustainable modes, such as railways and inland water transport).

Subsequently, the possibility of using the TDI to assess long-term progress in reducing transport-related emissions can support countries' reporting obligations vis-à-vis financing entities, while also demonstrating their commitment to global climate and sustainability objectives. Such transparency, in turn, can enhance trust and credibility among current and prospective investors, rendering them an attractive candidate for accessing scarce flows of climate financing. Not least, countries capable of demonstrating significant progress through the index may receive priority when it comes to technical assistance and capacity building programmes, which, in turn, stand to further strengthen their ability to achieve global climate and sustainability goals.

The TDI's function of serving as a benchmark of national progress against global standards can enable countries to learn from the policies and practices of higher-scoring countries. Low-scoring countries can use this as an opportunity to adopt solutions already proven in similar contexts, thereby accelerating their efforts towards net zero emissions by mid-century. Moreover, the index can serve as a foundation for dialogue among policy makers, industry, academics, and civil society, fostering a more collaborative approach to developing innovative and impactful sustainable mobility solutions. Greater public awareness and engagement can drive political momentum for stronger climate and transport policies, with the index results providing a clear mandate for action.

Placing transport on a low carbon pathway in line with the 1.5 degree Celsius target of the Paris Agreement will necessitate regular measurement and transparent reporting of countries' performance in emission reductions. This is where indexes, such as the TDI, have an instrumental role to play in enabling such tracking of progress over time, while ensuring that scarce financial resources are channelled towards transport initiatives with the highest mitigation potential.

5.3 Limitations

This section connects to the **bigger picture** of limitations and challenges that transport indicator assessments face in general. All the points mentioned are relevant for the TDI as well but are embedded in the bigger context of composite indicators, their methodologies and applicability.

Issue of global versus national databases

The TDI is focused mainly on sourcing data from global, large-scale databases. The most obvious advantage is accessibility. Global datasets are easier and more efficient to retrieve than individual national ones. They are often in the public domain and are accessible to everyone. Most of the practitioners with technical expertise and stakeholders with transport knowledge are aware of such datasets. As shown in section 2.3 and Appendix 1, a large variety of data sources and information are available for use.

A key advantage is that such global databases enable reliable comparisons. This approach minimises concerns related to differences in data collection methods or definitions, which can arise when relying on individual national databases. For instance, national databases may use varying vehicle typologies and classifications, making cross-country comparisons difficult. Global datasets usually follow common practices on measurement and units. They reflect global standards or, at least, globally well recognised classification systems, such as the EURO vehicle emission standards.

Another advantage of using these databases is their sustainability and future-proof nature. Most of the covered databases are updated annually, with their services expected to remain available in the future. The assessment can be repeated over time, allowing long-term benchmarking through the TDI. This ensures the longevity of the TDI by enabling users to rely on the same data sources for future assessments.

Large-scale databases provide a solid foundation for comparing country performance both over time and across countries. Their data quality is generally high, and their methodologies are built on robust principles. Moreover, the quality and availability of data through these platforms continue to improve, further enhancing the value of such databases for ongoing assessments.

National databases, which are defined as any information produced and collected and hosted by an individual country, have several strengths and weaknesses. Usually, national databases are perceived to better capture the national context. It can be assumed that national authorities have a better potential to estimate or calculate specific values. Global datasets are often based on certain scenarios or assumptions that might not be correct for every country.

National databases provide a higher level of detail for parameters. For example, global datasets on vehicles might only feature high-level categories of vehicles (passenger cars, commercial vehicles, buses, trucks), whereas an individual country can reflect any specific vehicles that operate on its roads. Examples are jeepneys in the Philippines and boda-bodas in Sub-Saharan African countries.

National databases are likely to provide more recent data. The curation of global databases takes more time and effort, so by the time of their release, the data points might date a few years back. This is not true throughout all national and global databases and depends on the country's capacity for such activities.

However, the availability, format and quality of national datasets differs widely. A major issue limiting data access is that in some cases, national datasets might not be available in a digital format. The data might be owned by a specific authority and may not be openly shared. The methodology of national datasets is also more likely to be overhauled over time and certain data aspects discontinued. This, in turn, increases the risk of sustainability and longevity for the TDI.

Each national stakeholder might develop and follow its own methodology for data. In other words, the specific units or measurement systems might not follow common international practices. Consequently, it may not be possible to directly incorporate national data into the TDI. This calls for strong technical knowledge to transform the data into the correct units and approaches.

Notably, the piloting of the TDI led to the favouring of global datasets because of their global coverage and the possibility to compare countries. Even so, the main objective of the TDI is not to compare countries, but to conduct an individual country assessment. The comparison in the piloting phase makes it possible to understand how the TDI's application varies among a subset of countries. Nevertheless, the orientation of the TDI around global datasets provides several advantages and enables greater uptake of the TDI. Moreover, the thresholds and scales, under which the indicators are scored, are set by values across all countries or "best-in-class" values. Such values can be identified only by examining global datasets.

In the conceptualisation phase, it was emphasised that developing the TDI should be a concept-inclusive exercise, rather than just a data-driven exercise. However, it is difficult to ignore data gaps and the lack of information. The TDI was developed by considering practical approaches for the target regions among which the use of widely available, open-access datasets is a key advantage. The associated toolkit and guidelines will feature an overview of potential data sources.

One of the aims of relying primarily on international, harmonised data is to make national authorities and policy makers aware of indicators that are missing in their country and to encourage efforts to address these gaps.

Potential for misinterpretation

From the outset, it was clear that the TDI should not merely focus on enabling benchmarking and comparison among countries, but it should ideally also provide insights towards the advancement of decarbonisation policies and measures. The element of providing policy recommendations connected to the results caters to this desired function. However, the results and recommended policies in the TDI need to be always taken with caution to avoid misinterpretation.

The TDI captures potentially nuanced and varying concepts related to surface transport (e.g., modes and vehicles) into a structured, rigid assessment framework that might fail to reflect the complexity and local context of a country. Therefore, strictly approaching the index as a complete representation of transport decarbonisation progress could lead to an incomplete understanding of the complexities involved and the need for targeted interventions across multiple areas.

Similarly, there is a risk of users approaching the TDI's policy guidance as prescriptive, while expecting that certain high-scoring strategies deliver similar results without accounting for the local context. Here it is important to recall that the TDI's guidance is illustrative and non-prescriptive, intended to inspire tailored approaches rather than universal solutions. Policy makers should interpret their scores in the context of their specific national circumstances, adapting interventions to align with local priorities and resources to achieve meaningful climate mitigation progress in transport. The TDI should, therefore, not be used in isolation but considered in combination with a range of other policy instruments to effectively steer the transport sector on a low carbon pathway while advancing broader sustainable development objectives.

As highlighted previously, another risk of misinterpretation is associated with viewing the TDI as a competitive ranking tool rather than as a collaborative, diagnostic tool. While the index scores are designed to highlight existing gaps and strengths, they should not be seen as an absolute measure of success or failure. Such an interpretation risks creating unintended “naming and shaming”, especially for countries with lower scores, thus undermining the TDI’s primary objective of fostering knowledge sharing and capacity building.

Lastly, it is crucial to recall that the TDI relies on data availability, which, as we have seen, has encountered significant limitations in the assessed LMICs. Inconsistencies in data quality and availability can distort scores and result in sub-optimal representations of transport decarbonisation realities. Accounting for these data gaps is crucial to avoid the inadequate setting of policy priorities and unfair comparisons among countries at different stages of development or with different financial and institutional capacities.

Overarching issues with transport indicator assessments

Transport indicator assessments such as the TDI are a useful and effective way of turning complex phenomena into actionable insights. However, indices are prone to limitations, and there is no perfectly holistic, all-encompassing index, nor can an actionable index be created without making compromises. The quality and usefulness of any index ultimately depends on how the various components (i.e., data, indicators, dimensions) are selected, processed, combined, applied and used. Translating theoretical concepts and real-world phenomena into an operational index often requires balancing the ideal and the feasible, which inevitably leads to trade-offs (Nardo *et al.* 2008).

Establishing a clear objective and conceptual framework is crucial but challenging, especially with complex, multi-dimensional phenomena such as transport. Consensus on these foundational elements can be difficult to achieve, as defining the phenomenon and the core underlying concepts involves choosing what to include or exclude. Without this consensus, there is a risk that the chosen framework may be incomplete or biased, failing to represent key dimensions and undermining the index’s overall validity. Ensuring alignment of objectives from the outset is critical in providing a solid foundation for the index and guiding its development (Nardo *et al.* 2008; Gudmundsson *et al.* 2016; Saisana *et al.* 2019).

Developing an index without adhering to known, reproducible and well-tested methods is a fundamental limitation that can undermine its credibility and validity. Established methods in index development, such as transparent selection criteria, normalisation, weighting, and adequate aggregation techniques, are critical to ensure that an index is reliable, robust, transparent and representative of the phenomenon it attempts to measure.

A further major challenge lies in meeting key quality criteria for both the overall index and the data used. Data, which among others should be relevant, timely, accurate, and comparable, are a cornerstone of any composite indicator system. If the data sources are inconsistent, outdated or lack comparability across different units (e.g., countries or regions), the index may misrepresent trends and distort the intended message. Furthermore, if the quality of the index framework itself is compromised – whether through the omission of important dimensions, the use of overly simple methods or the inclusion of poorly chosen indicators – the index results run the risk of providing an incomplete or distorted overall picture.

Furthermore, an index must be actionable, useful and user-friendly; otherwise, it risks becoming a tool from which nobody benefits. The most robust index will be ineffective if it lacks clarity, accessibility or practical application for the target audience. A user-centred approach to development – considering ease of use, interpretability and relevance to real-world challenges – ensures that the index provides insights that can be easily understood and acted upon by stakeholders. Without this focus, an index may be underutilised or overlooked altogether and lose its potential value as a support tool for decision making.

Finally, composite indicators should not be seen as definitive and ultimate decision-making tools. Although an index can provide valuable high-level insights, it should not be considered exhaustive.

Rather, its true value lies in highlighting key areas of interest and drawing attention to where more detailed, focused analysis is required. Composite indicator assessments provide a starting point – a summarised overview that highlights trends or potential challenges. Viewing an indicator assessment as the ultimate decision-making tool can lead to an oversimplification that may overlook complex relationships or context-specific nuances. Instead, indices should be seen as guides that help stakeholders prioritise further analysis and identify areas that require more comprehensive, context-specific investigation. In this way, indices are one aspect of a broader toolkit that supports informed, multi-layered decision making.

6 Conclusion

Low- and middle-income countries in Sub-Saharan Africa and South Asia are facing mounting pressures to transform their transport and mobility systems in response to rapidly growing populations, rising private motorisation, rapid urbanisation and an underperforming transport sector. The region's growth in emissions from surface transport is expected to outpace the global average in the coming decades, underscoring the need for urgent action. Adding to the challenge, the pursuit of transport decarbonisation policies will have to go hand-in-hand with measures to safeguard the region's need for enhanced transport and connectivity in support of socio-economic development.

The TDI provides a critical framework for assessing and supporting LMICs in their efforts to achieve sustainable transport and to reduce emissions from this sector, while supporting the advancement of broader sustainable development objectives. The piloting process across 12 countries has demonstrated the importance of tailored transport assessments, revealing both the potential and challenges in aligning national transport strategies with global decarbonisation and sustainability agendas. The TDI offers a nuanced understanding of key transport dimensions such as emissions, governance, infrastructure, and finance, helping countries identify priority areas for policy action.

The results reveal substantial variability across dimensions such as public transport investment, freight efficiency, emissions and clean energy. Even so, some interesting observations can be made. With spending between USD 17 and USD 180 per person in 2022, the assessed countries provide fewer per capita fossil fuel subsidies for petrol and diesel compared to global averages, thereby resulting in higher TDI scores under the dimension of "finance and economics". The piloted countries, however, received lower scores for the availability of low-cost finance, which, in turn, refers to climate-related official development assistance. Sri Lanka emerged as a national best practice in public transport investment relative to other pilot countries, whereas India stood out with higher scores on the indicator of "policy strength of clean fuels", thanks to its high fuel-quality standards.

The majority of the 12 LMICs examined through the TDI are marked by low baseline transport CO_2 emissions, and nearly all the examined countries display extremely low levels of zero-emission vehicle sales, reflecting room for further development of these transport systems. In countries such as Kenya, Nepal, and Nigeria, renewables account for over 70% of total energy consumption, representing some of the highest values in the dataset examined and pointing to important opportunities to amplify emission benefits of transport electrification.

Realising the full potential of the TDI will depend strongly on correct interpretation by the users of the scoring results and, ultimately, on how they act upon these results. Importantly, the TDI should not be approached as a tool for casting blame or shaming countries with lower scores, but as a platform for mutual learning, collaboration and inspiration. By approaching a low score as an indicator of significant untapped decarbonisation potential, policy makers can make informed decisions regarding the policy and financing efforts needing prioritisation. Countries can, furthermore, use the index to build partnerships with financial and development institutions, mobilise financial and technical resources, improve public awareness and engagement, and devise impactful policies for sustainable, low carbon transport systems.

The TDI's function of serving as a benchmark of national progress against global standards can enable countries to learn from the policies and practices of higher-scoring countries. Low-scoring countries can use this as an opportunity to adopt solutions already proven in similar contexts, thereby accelerating their own efforts towards net zero emissions by mid-century. For these benefits to materialise, however, the index's scoring results would have to be disseminated with great caution and in consideration of the needs, knowledge and data literacy of its target audience and its local context. Here the engagement of all relevant stakeholders from the outset will be key to ensure relevance and increase the sense of ownership among end-users.

The results show that there are a wide range of indicators, across important sustainability dimensions, that can help to measure transport sustainability; however, the data for these indicators must be widely and systematically collected. The fact that only one-third of the identified indicators had sufficient representation for the 12 pilot countries suggests that significant data gaps and capacity limitations remain in LMICs in Africa and South Asia. This is reinforced as an issue specific to LMICs, given that for many of the indicators, good coverage exists for other regions such as Europe, as well as many of the larger economies in the Global South. Data limitations are particularly pronounced in the freight transport sector, where India and Pakistan were the only countries for which data could be secured on the share of rail in total freight activity. Without reliable data, designing and implementing effective policies becomes even more challenging.

These data challenges underscore the need for further efforts to improve data availability and the practical application of the TDI. For example, a TDI comparison incorporating a significantly broader coverage of countries with adequate data availability can provide more accurate insights into countries' performance. Moreover, this can incentivise countries to gauge their own efforts to collect the needed data and put in place ongoing tracking efforts.

Future iterations of the TDI could aim to further enhance the assessment with more indicators and to expand the features of the index. With more data available, the TDI could be expanded to include more indicators on themes that could not be tackled at this point, such as equity, informal transport and other topics. The dimensions can be expanded with more indicators so that the overall structure stays the same. A more sophisticated approach on weighting can be introduced if a robust set of base indicators is ensured. Features for future development could include an increased level of interactive visualisations and dashboards. The project team identified numerous alternatives to using Excel for the spreadsheet toolkit. With more resources, an interactive online dashboard based on R, Python or other coding languages could be developed and implemented.

Despite these data difficulties, the TDI has proven it can be a valuable tool for tracking progress, benchmarking performance and informing policy decisions. The methodology developed through this project provides a foundation for future assessments, enabling countries to refine their strategies and take decisive steps towards sustainable and low carbon transport systems. By fostering policy alignment and guiding investments, the TDI supports LMICs in achieving both climate goals and socio-economic development.

Appendix 1. Data sources

Table 11: Global and regional data sources

Database	Update frequency	Covered scale	Data categories covered	URL
BNEF New Energy Outlook	Annually	Global, National	E-mobility, battery prices	https://about.bnef.com/new-energy-outlook
EEA Transport and Environment Report (TERM)	Annually	Regional	Sustainable transport development in Europe	https://www.eea.europa.eu/themes/transport/publications
Global Supply Chian Pressure Index (GSCPI)	Continuously	Global	Supply chain pressures, important for freight	https://www.newyorkfed.org/research/policy/gscpi#/interactive
IEA Energy Efficiency	Annually	Global, Regional	Progress on energy efficiency for major sectors, including transport	https://www.iea.org/reports/energy-efficiency-2021
IEA Global EV Outlook	Annually	Global, National	Electric vehicle stock, sales, chargers	https://www.iea.org/articles/global-ev-data-explorer
IEA World Energy Outlook	Annually	Global, National	Energy trajectories and climate action	https://www.iea.org/reports/world-energy-outlook-2021
IATA Air Passenger/Freight Analysis	Monthly	Regional	Passengers and freight activity by air	https://www.iata.org/en/publications/economics
Innovative Mobility: Carsharing Outlook	Biennially	Regional	Car-sharing members and cars by region	http://innovativemobility.org/?page_id=378
IRENA Renewable Energy Statistics	Annually	Global	Renewable energy	https://www.irena.org/publications/Collections
ITF Transport Outlook 2023	Biennially	Global	Trends and future forecasts for transport	https://www.oecd-ilibrary.org/transport/itf-transport-outlook_25202367
ITF Transport Statistics	Annually	Regional, National	OECD transport data on goods, passengers, infrastructure, investments	https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=trsprt-data-en&doi=g2g5557d-en

REN21 Renewables GSR	Annually	Global, National, Local	Renewable energy	https://www.ren21.net/reports/global-status-report
Transport Energy Data Book	Annually	Global, National	Various data, vehicle trends, efficiency indicators	https://tedb.ornl.gov
UNCTAD Review of Maritime Transport	Annually	Regional	Trade, maritime transport, global freight transport	https://unctad.org/topic/transport-and-trade-logistics/review-of-maritime-transport
UNEP Emissions Gap Report	Annually	Global	Report on emission development and climate action	https://www.unep.org/resources/emissions-gap-report
WMO United in Science	Annually	Global	Compilation of major climate change insights	https://public.wmo.int/en/resources/united_in_science
UN-Habitat Urban Indicators Database	n/a	Local	Various data relevant to urban issues	https://data.unhabitat.org

Table 12: National data sources

Database	Update frequency	Covered scale	Data categories covered	URL
ADB Asian Transport Outlook	Continuously	National, Local	Major data for Asian countries and cities	https://data.adb.org/dataset/asian-transport-outlook-database
Apple Mobility Trends Reports	Discontinued	National, Local	Impact of COVID-19 on walking, transit and driving requests	https://covid19.apple.com/mobility
bp Statistical Review of World Energy	Annually	National	Energy use by fuel type	https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
CBI Green Bonds	Continuously	National	Climate/green bonds	https://www.climatebonds.net/cbi/pub/data/bonds
CCG Energy & Transport Starter Data Kits	n/a	National	Vehicle fleets, passenger and freight activity	https://climatecompatiblegrowth.com/starter-kits
DHL Global Connectedness Index	Annually	National	Index reflecting the global “connectedness” for freight	https://www.dhl.com/global-en/spotlight/globalization/

				global-connectedness-index.html
EDGAR – Emissions Database for Global Atmospheric Research	Annually	National	CO_2 emissions	https://edgar.jrc.ec.europa.eu
EU Transport in Figures – Statistical Pocketbook	Annually	National	Transport activities in Europe	https://transport.ec.europa.eu/facts-funding/studies-data/eu-transport-figures-statistical-pocketbook_en
GIZ Fossil Fuel Prices	Annually	National	Diesel and petrol prices	https://www.transformative-mobility.org/news/international-fuel-prices
Global Fuel Economy Initiative	n/a	National	Vehicle fuel economy in major markets	https://www.globalfueleconomy.org/data-and-research/publications/gfei-working-paper-22
Google COVID-19 Community Mobility Reports	Discontinued	National, Local	Impact of COVID-19 on mobility to major destinations	https://www.google.com/covid19/mobility
ICCT Passenger Vehicle Fuel Economy	Annually	National	Fuel economy and progress by major economies	https://theicct.org/pv-fuel-economy
ICCT Transportpolicy.net	Continuously	National	Fuel economy data and major efficiency policies	https://www.transportpolicy.net
IGES Grid Emission Factors	Annually	National	CO_2 emissions per million watt hour	https://www.iges.or.jp/en/pub/list-grid-emission-factor/en
IMF Fossil Fuel Subsidies		National	Database on fossil fuel subsidies, released in 2017 and 2021	https://www.imf.org/en/Topics/climate-change/energy-subsidies
IRF World Road Statistics	Annually	National	Road infrastructure, etc.	https://worldroadstatistics.org
ITDP Rapid Transit Database	n/a	National, Local	Data on bus rapid transit, light rail and metro for major cities	https://docs.google.com/spreadsheets/d/1uMuNG9rTGO52Vuuq6skyqmkH9U5yv1iSJDJYjH64MJM
KAPSARC Data Portal	Continuously	National	Various datasets for the Middle East and North	https://datasource.kapsarc.org/explore/?sort=modified&refine.theme=Transp

			Africa region as well as global datasets	ort&disjunctive.theme&disjunctive.country&disjunctive.iso-region&disjunctive.publisher&disjunctive.keyword
Meddin Bike-Sharing World Map	Continuously	National	Bike-sharing services	https://bikesharingworldmap.com/#/all/3/0/51.5
NACTO Shared Micromobility Snapshot	Annually	National	US data for bike-sharing and shared e-scooters; 2021 report not released	https://nacto.org/publications/#policy-reports-practitioners-papers
ND-GAIN Country Index	Annually	National	Countries' vulnerability	https://gain.nd.edu/our-work/country-index
OICA Motor Vehicles	Annually	National	Vehicle production statistics (sales statistics also exist for a single year)	https://www.oica.net/production-statistics
The Street-network Sprawl Map	n/a	National	Index about sprawl	https://sprawlmap.org/#globe
Subway Preprocessor	Continuously	National, Local	Initially an overview of subway systems in Openstreetmaps, but also covers subway systems, lines and stations	https://maps.mail.ru/osm/tools/subways/latest
UIC Railway Statistics	Annually	National	Railway length, passenger and freight activity	https://uic.org/support-activities/statistics
UNCTAD Liner Shipping Connectivity Index	Quarterly	National	Freight shipping efficiency	https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=92
UNDP Human Development Report	Annually	National	Human development	http://hdr.undp.org
UNECE	Continuously	National	Safety, vehicle and traffic data for road and rail, focusing on European countries	https://w3.unece.org/PXWeb/en
UN Energy Statistics	Annually	National	Energy demand by country	http://data.un.org/Data.aspx?d=EDATA&f=cmID%3AEL

Walk21 Pathways to Walkable Cities	Continuously	National	Walking policies, activities and other indicators	https://pathways.walk21.com/dashboard
WEF Global Competitiveness Report	Annually	National	Infrastructure quality	https://www.weforum.org/reports/the-global-competitiveness-report-2020
WHO GSR on Road Safety	n/a	National	Road safety data (injuries, fatalities and policies)	https://www.who.int/health-topics/road-safety
World Bank Data	Continuously	National	Database covering topics such as air transport, rail infrastructure, etc., updated at different times of the year	https://data.worldbank.org
World Development Indicators	Continuously	National	Data on rail passenger and freight activity, aviation freight, CO_2 emissions	https://datacatalog.worldbank.org/search/dataset/0037712

Table 13: Local data sources

Database	Update frequency	Covered scale	Data categories covered	URL
CDP-ICLEI Cities Dataset	Annually	Local	Mode share, emission and other data submitted by cities	https://data.cdp.net/Governance/2020-Full-Cities-Dataset/eja6-zden
Global BRT Data	Quarterly	Local	Bus rapid transit services, network size, passengers	https://brtdata.org
NUMO New Mobility Atlas	n/a	Local	E-scooter, bike-sharing	https://www.numo.global/new-mobility-atlas
UN-Habitat SDG 11: Access to Public Transport	Biannually	Local	Access to public transport	https://data.unhabitat.org/datasets/GUO-UN-Habitat::11-2-1-percentage-access-to-public-transport/about

Urban Access Regulations in Europe	Continuously	Local	Low emission zones, access regulations for European cities	https://urbanaccessregulations.eu
UrbanRail.net	Continuously	Local	Overview of urban rail systems	https://www.urbanrail.net

Appendix 2. Data of pilot countries

The data and scoring of the 12 pilot countries is shared as an Excel spreadsheet and is available on the project website.

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