Towards the Development of a Surface Transport Decarbonisation Index for Low- and Middle-Income Countries in South Asia and Sub-Saharan Africa

State of Knowledge Report

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Surface Transport Decarbonisation Index/HVT057

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Abstract	
This State-of-Knowledge Report, titled "Towards the Development of a Surface Transport Decarbonisation Index for Low- and Middle-Income Countries in South Asia and Sub-Saharan Africa provides the basis for the development of a methodology for a surface transport decarbonisation index (TDI) which is envisioned to be a diagnostic tool designed to assist policymakers in Low and Middle Income Countries (LMICs) – particularly in South Asia and Sub-Saharan Africa – towards formulating targeted emission reduction strategies. This report investigates the following: the importance of surface transport in achieving decarbonisation in the transport sector; commitments and actions towards decarbonising surface transport; review of methods and elements that are important in developing such indexes; review of similar indexes as well as related indicator initiatives, databases and portals.	
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LIST OF ACRONYMS

$M	Million dollar
ADL	Arthur D Little
AHP	Analytical hierarchy process
ASIF	Activity -structure- intensity- factor of emissions
ATO	Asian Transport Outlook
BC	Black carbon
BEV	Battery electric vehicle
CA	Concave aggregation
CAGR	Compound annual growth rate
CAT	Concordance analysis technique
CC-COIN	Competence Centre on Composite Indicators and Scoreboards
CCS	Carbon capture and storage
CO_2	Carbon dioxide
CSV	Comma separated value
DEA	Data Envelopment Analysis
DM	Delphi method
ED	Euclidean distance

EO	Expert opinion
EST	Environmentally sustainable transport
EU	European Union
EV	Electric vehicle
EW	Equal weights
FA	Factor analysis
FCDO	Foreign, Commonwealth & Development Office
GA	Geometric aggregation
GDP	Gross domestic product
GHG	Greenhouse Gas
GSMI	Global Sustainable Mobility Index
GTF	Global Tracking Framework
HVT	High Volume Transport
ICCT	International Council on Climate Change
ICT	Information and communications technology
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRAP	International Road Assessment Programme
ITF	International Transport Forum
JRC	Joint Research Centre
LA	Linear aggregation
LDV	Light duty vehicle
LMICs	Low- and Middle-Income Countries
LPI	Logistics Performance Index
LTS	Long-term Strategies
MCA	Multi-criteria analysis
MSCI	Morgan Stanley Capital International

NDC	Nationally Determined Contributions
NGO	Non-government organisation
NOx	Nitrogen oxide
NZEI	Net Zero Economy Index
NZRI	Net Zero Readiness Index
PCA	Principal component analysis
PHEV	Plug-in hybrid electric vehicle
PM	Particulate matter
PT	Public Transport
PwC	Price Waterhouse Cooper
RMS	Root mean square
RTR	Rapid transit ratio
SAR	Simple additive rule
SAW	Simple additive weighting
SDG	Sustainable development goal
SMP	Sustainable Mobility Project
SUMI	Sustainable urban mobility index
SUTI	Sustainable Urban Transport Index
TDI	Transport decarbonisation index
TOR	Terms of Reference
UNCRD	United Nations Commission on Regional Development
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
WLC	Weighted linear combination
WoS	Web of Science

EXECUTIVE SUMMARY

This State-of-Knowledge Report - Towards the Development of a Surface Transport Decarbonisation Index for Low- and Middle-Income Countries in South Asia and Sub-Saharan Africa" addresses the development of a Transport Decarbonisation Index (TDI). This diagnostic toolkit aims to assess progress and barriers, enabling evidence-based decisions on emissions reduction in surface transport for low- and middle-income countries (LMICs) in Sub-Saharan Africa and South Asia. The TDI will be instrumental for policymakers in developing targeted emission reduction actions and supporting LMICs in fulfilling their climate pledges, with an ultimate goal of achieving net zero by 2050 to limit global warming to 1.5 degrees.

The report highlights the importance of decarbonising surface transport, given the sector's substantial contribution to greenhouse gas (GHG) emissions. The transport sector accounted for approximately 15% of global GHG emissions in 2019. Road transport is the largest contributor within this sector, followed by water-borne navigation and railways. The report notes significant emission growth in developing regions, highlighting the urgency for targeted decarbonisation efforts.

The report provides an extensive overview of existing literature (scientific, and grey), indexes, and initiatives relevant to the TDI. It includes a thorough literature review, assessment of selected indexes, and evaluation of data sources and indicators. This review extends beyond transport to other sectors, offering insights into potential approaches and elements useful for developing the TDI. The following are the key insights from the review:

Bibliometric Analysis of Scientific Literature

- The bibliometric analysis of the scientific literature shows that there had been a significant increase in terms of the enthusiasm of the scientific community to look into indexes in surface transport.
- However, such increase in scientific literature had been observed mostly for East Asia, and Europe.

Review of Methodological Approaches

- The in-depth review of the literature on processes for the development of such indexes shows the core phases: (1) Setting objectives & defining the phenomenon, (2) Iterative composite indicator construction, (3) Assessment of the composite indicator and (4) Application, presentation & dissemination.
- It is important to highlight the importance of the adequacy of time and resources to be allotted to the first step which is the setting of the objectives within the context of the phenomenon.
- The development or choice of a theoretical framework for the TDI should capture the main substance, intention, and procedures.
- It will be crucial to engage stakeholders from the very beginning to ensure relevance of the TDI and increase a sense of ownership among end-users.
- Developing the TDI should be a concept-inclusive rather than just a data-driven exercise. The development team needs to clarify what, why and how, engage with stakeholders, understand the complexities and interrelationship of the surface transport system and the progress towards decarbonisation.
- We note that the selection of the variables is a key step towards the construction of the index, and that the selection of variables and indicators should be based on an assessment of soundness, timeliness, accessibility and comparability.
- Developing the TDI will be an iterative process that allows improvements and going back and forth between different options such as dimensions, indicators, or index construction methods.

Review of Indexes, Tracking Platforms, and Databases

- The TDI needs to be responsive to the needs and availability of information in the target regions. While there are a variety of potential data sources that could be used for calculating indicators, we expect that data and information in the target regions would be scarcer than in more developed ones.

- The dimensions of the TDI should be able to capture the state (of relevant GHGs), action (and commitment) towards decarbonising surface transport; and readiness (capacities to further drive change towards decarbonisation).
- The TDI should ideally provide insights towards the advancements of decarbonisation policies and measures.
- Discussions focusing on how modelling-based future projections would be treated in the TDI. It could also be a possibility that such models could interact with the TDI and provide complementary information (e.g. for the national stakeholders) which may not necessarily be used as input data for the TDI.
- Techniques related to categorisation and subsequent scoring can be evidenced in many of the indexes. While they represent practical approaches towards attributing specific descriptions to abstract numbers, it is critical to be aware of the importance of building consensus as to how they are developed and utilised.
- While the usage of tiered approaches and supporting indicators may result in providing valuable information to the target users, the TDI should be developed with the aim of utilizing available and comparable core indicators.
- The indexes reviewed that are related to transport reminds us of the ideal situation wherein the TDI would be able to consider decarbonisation as part of a wider sustainability frameworks and need to be cognizant of elements that are not necessarily limited in the realm of surface transport.
- Data imputation and processing methods should be clearly documented and presented as part of the toolkit. Reproducibility is critical towards adoption.
- The results of the TDI shall be made openly accessible, to provide insights and input for further analysis.
- In addition to providing a comprehensive bird-eye view perspective where LMICs in South Asia and Africa are heading in terms of decarbonising surface transport. Insight into the underlying data, interrelationships, possible bottlenecks, or low hanging fruits on where to improve in could provide valuable insights for countries and shall not be neglected.

The review emphasizes the importance of clearly defining objectives and goals at the outset, ideally with participation from relevant stakeholders. The TDI should incorporate comprehensive theoretical frameworks, reflecting stakeholders' perspectives, capabilities, constraints, and adaptability to changing contexts. Stakeholder engagement is crucial from the beginning to ensure the TDI's relevance and end-user ownership. The development process should be inclusive of various concepts in surface transport, not just data driven. Selecting variables for the TDI involves considerations of soundness, timeliness, accessibility, and comparability. The process will be iterative, allowing for adjustments and improvements. Decisions about data normalization, weighting, aggregation, and processing are vital for the TDI's effectiveness and robustness.

The review also suggests potential dimensions for the TDI, which should ideally encompass assessments relating to the status, action, and readiness of countries in decarbonising surface transport. The report underlines the importance of capturing various aspects, like spatial layers and temporal coverage. The analysis also recommends testing various combinations of index dimensions, indicators, and statistical methods. Aside from benchmarking, the TDI should be directed towards providing insights and impetus toward accelerating decarbonisation policies and measures. The review also suggests potential dimensions for the TDI, which should ideally encompass assessments relating to the status, action, and readiness of countries in decarbonising surface transport. The report underlines the importance of capturing various aspects, like spatial layers and temporal coverage. In addition, the analysis recommends testing various combinations of index dimensions, indicators, and statistical methods. Aside from benchmarking, the TDI should be directed towards providing insights and impetus toward accelerating decarbonisation policies and measures.

While the stocktaking of relevant data sources reveals the diversity of available data sources, the study team expects that data relevant to the target regions would not be at par with what is available in more advanced regions, which are mostly reflected in a lot of the data portals and open databases. Collaboration with existing initiatives would enhance the TDI's relevance, adoption, and sustainability.

The lessons learnt from the process of developing this report will feed into the upcoming practitioner workshop which is planned to be an online event wherein insights from key stakeholders (e.g. the project advisory group, representatives from relevant government agencies, NGOs, research institutions, experts, and practitioners) would be gathered to feed into the further development of the TDI methodology. Subsequent interactions with the participants through dedicated consultations are to be designed in order to ensure that the process of TDI development is participatory and iterative.

The lessons and insights from this report will also form the building blocks for the drafting of the methodology for the TDI. A data source report that would complement the methodology, and will expound on the sources, availability, and quality of relevant data that could potentially feed into the TDI will be delivered mid-March 2024.

1. Introduction

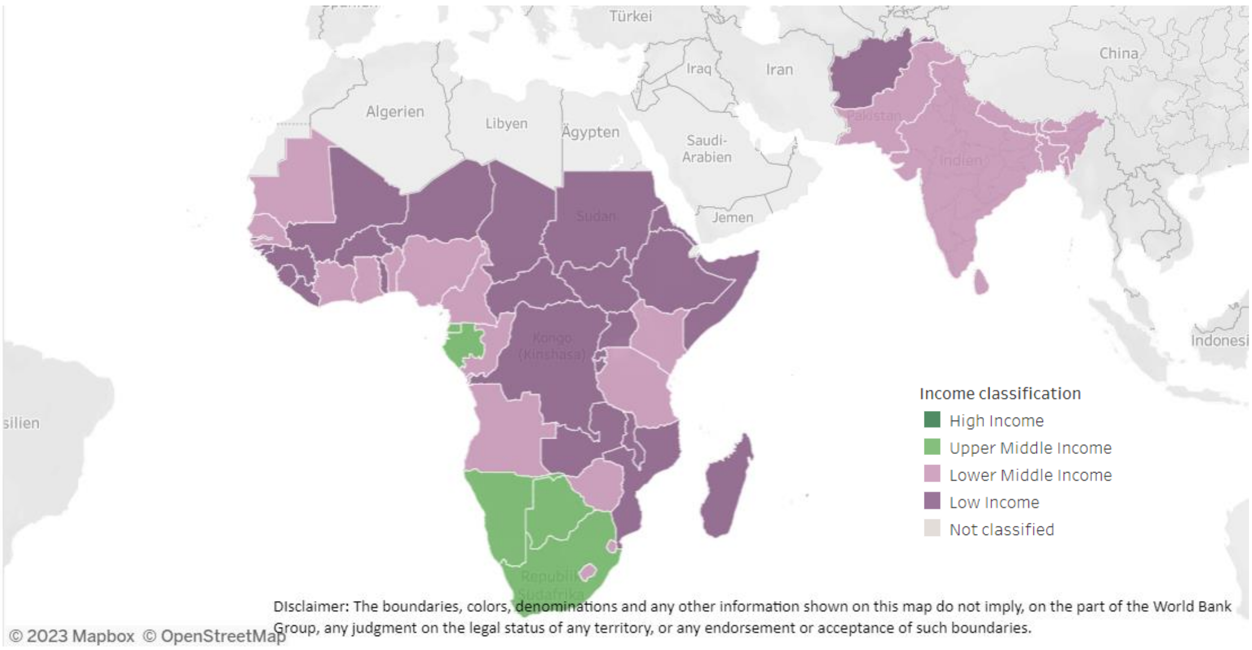
1.1 Background of the Project

With the Transport Decarbonisation Index (TDI) the project 'HVT057: Surface Transport Decarbonisation Index' is going to produce a diagnostic toolkit assessing progress and barriers and enable evidence-based, time-sensitive, and targeted decisions on emissions reduction towards surface transport decarbonisation in low- and middle-income countries (LMICs) in Sub-Saharan Africa and South Asia.

The TDI will provide evidence for policymakers to develop targeted emission reduction actions on transport. It will support LMICs in developing their NDCs and long-term monitoring of climate pledges. The tool will compare and benchmark the progress of LMICs in reducing GHG emissions from surface transport and assess their preparedness and ability to achieve net zero by 2050 to limit global warming to 1.5 degrees Celsius above pre-industrial levels.

In addition, the TDI application will cover selected countries in the target regions – split between Sub-Saharan Africa and South Asia. According to the World Bank classification of countries by income level and region, the overall group of relevant countries includes eight South Asian countries, namely Afghanistan, which is categorised as a low-income country, six lower-middle-income countries (Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka), and the Maldives as the only upper middle-income country. Out of the 48 countries in Sub-Saharan Africa, 47 countries fall within the scope of the TDI, including 22 low-income countries, 19 lower-middle-income countries and six upper-middle-income countries (Hamadeh et al., 2022) (see Figure 1).

Figure 1. World Bank Country Classification by Income Level



(Source: Hamadeh et al., 2022)

The methodology will be produced so that it can be applied to other LMICs as well. The index will be developed to consider all relevant surface transport types – e.g., road, rail, inland waterways – and the relevant modes (e.g., private, public, informal). The project team is specifically aware of the nuances and complexities of capturing various forms of surface transport – particularly informal transport widely used in LMICs[1] – which need to be reflected in the index development and application. In addition to capturing the state and pathways of surface transport decarbonisation, the research project shall also consider relevant key areas such as: policy, capacity, gender, equity, and inclusion, and just transition.

[1] For the purposes of this paper, we refer to informal transport as paratransit-type services without official sanction (Cervero & Golub, 2007).

1.2 Purpose of the Report

This state of knowledge report provides a comprehensive overview of the existing literature, indexes, and initiatives to serve as a basis for the development of a relevant, robust, and practicable TDI. As part of this, a literature review of index development approaches, frameworks, and methodological guidelines for developing high-quality indexes, as well as an assessment of relevant selected indexes to understand their advantages and disadvantages, are provided. In addition, the data sources and the individual indicators used in the existing indexes are examined, their relevance for the Surface TDI is assessed, and a summarised overview of other relevant databases and key data sources that could potentially be useful for developing the TDI is provided.

Moreover, this report identifies key developments, targets, and pathways towards a global sustainable net zero surface transport, with a particular focus on countries in South Asia and Sub-Saharan Africa. In this context, relevant core concepts are defined. This also includes the delineation and definition of the surface transport sector, which is at the centre of the TDI. In addition, the importance of climate change mitigation is emphasised. Finally, an overview is given of global and regional commitments that have a strong influence on the development of the TDI framework to make it relevant, effective, and valuable to core user groups.

To this end, the report will make a valuable contribution to developing a unique indicator framework that adequately captures the complex phenomenon of decarbonising surface transport. It will further inform stakeholder consultations and the online practitioner workshop beginning in January 2024 and form the basis for the initial TDI methodology.

1.3 Structure of the Report

This report is structured as follows:

- Section 1: Introduction – This section provides a basic overview of the report and situates it within the overall project design and objectives.
- Section 2: Methodological Framework – This section provides a description of the methodological framework used for gathering and analysing the information related to existing indexes, indicators, and data.
- Section 3: Overview of surface transport decarbonisation – This section establishes the importance of decarbonising surface transport, and provides insights regarding the current state of commitments towards mitigating surface transport emissions, particularly in the target regions (South Asia, Sub-Saharan Africa)
- Section 4: Review of existing indexes and frameworks – This section presents the methodology and the results of the review process for the existing indexes and frameworks conducted by the study team. This includes a holistic literature review of the process employed in developing such indexes, a bibliometric analysis of scientific literature, the analysis of relevant indexes, and an overview of selected relevant initiatives that tracks transport (surface transport-relevant) and stocktake of relevant data sources for developing a surface TDI. Finally, the section discusses the results of the review, and provides an overview of the main lessons, and elements that are proposed to be considered for developing the methodology for the TDI index.
- Section 6: Conclusions which summarises the main findings of this report and next steps.

2. Methodology

This paper focuses on establishing the basis for the development of a methodology for a surface transport decarbonisation index which is meant to systematically assess the decarbonisation actions in surface transport. For the purposes of this project, the transport modes that are included are: road, rail, metro, bus, informal transport (e.g. minibus, motorcycle taxi, tuk-tuk, etc.), bus rapid transit, walking and cycling, and inland water transport.

2.1 Data Collection

Data for this research was gathered through a combination of credible sources including academic journals, publications, as well as established relevant efforts that are being done by internationally recognised institutions. The initial list of indexes and sources were identified based on the original terms of reference (ToR) issued for the call for proposals for the surface transport decarbonisation index. This was then complemented by the other relevant indexes and sources based on the knowledge of the members of the study team. Moreover, a comprehensive online search for literature was conducted.

A bibliometric analysis of scientific literature (within the Web of Science (WoS) platform) was conducted. The bibliometric analysis was conducted using the "Bibliometrix" package in R (Aria & Cuccurullo, 2017). The search terms were categorized into three groups related to 1) indices and composite indicators, 2) surface transport and 3) sustainability and decarbonisation. The search terms used are as follows:

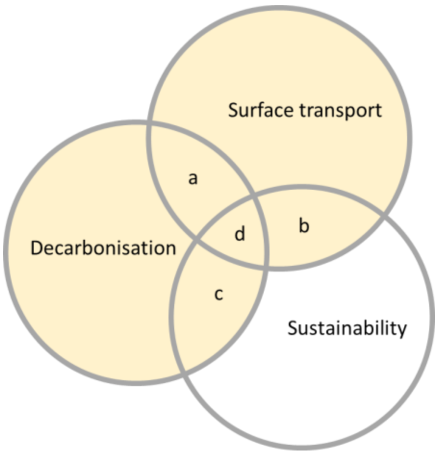
> *"(TS=(Index) OR TS=(Indices) OR TS=("Composite Indicator*"))*
>
> ***AND** ((TS=("Transport* System*") OR TS=("Surface Transport*") OR TS=("Land Transport*") OR TS=("Road Transport*") OR TS=("Rail Transport*") OR TS=("Inland Waterway*") OR TS=("Public Transport*") OR TS=("Public Transit*") OR TS=("Passenger Transport*") OR TS=("Rail Freight") OR TS=("Road Freight") OR TS=("Freight") OR TS=("*Urban Transport*") OR TS=("Active Mobility") OR TS=("*Urban Mobility") OR TS=("Human Mobility") OR TS=("Micro Mobility") OR TS=("Non Motori*ed Transport"))*
>
> ***AND** (TS=(Sustainab*) OR TS=("Decarboni*ation") OR TS=("Net Zero") OR TS=("Low Carbon") OR TS=("Just Transition"))".*

The terms "informal transport" and "popular transport" were excluded from the search criteria as they did not provide additional results. In addition, terms such as "climate" were excluded from the search to avoid distorting the results, as their wide-ranging scope extends far beyond the specific focus of this study. The WoS search was confined to the Topic ("TS") variable, i.e. the title, abstract and keywords of the scientific publications. After screening and cleaning the data, the bibliometric analysis of 497 articles was carried out in R. The results are provided in Section 4.1.1.

Aside from the review of scientific literature, relevant indexes from grey literature were analysed based on an objective to find relevant approaches, elements, and insights on data sources which might be useful in developing the TDI. Given this, the study team did not limit the review within the realm of transport, but also looked into other sectors. The search for such relevant indexes was conducted using Google search as the primary tool. Specific keyword combinations were used to ensure focused yet comprehensive explortation of the topic such as: "surface transport" AND " decarbonisation", "transport" AND "decarbonisation", "mobility" AND "decarbonsation", "decarbonisation index."

Also, the collection of information regarding indexes inherently included those that are related to sustainability in general. Figure 2 below visualises the general thematic coverage of the search for relevant indexes in grey literature. We had prioritized 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) may (section a) 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. We had also looked into the sustainability dimensions of such indexes (sections c, b, and d) but we did not prioritize their inclusion of broader sustainability indexes that partially had elements that touched upon surface transport and/or decarbonisation in order to focus on the ones that are best related to our objective of developing a TDI considering the limited resources.

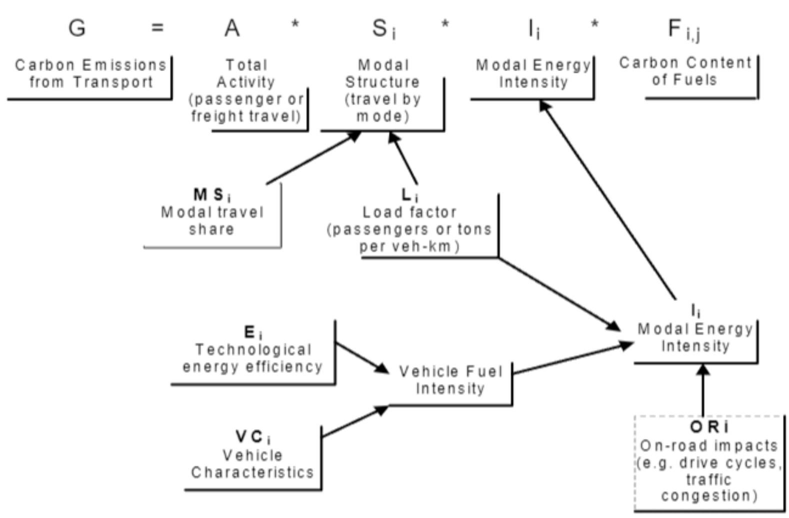
Figure 2. General Thematic Coverage used in the Review of Relevant Indexes



It is understood that the surface TDI is meant to be implemented at the country level. However, the study team also included indexes which are focused on other levels such as urban, and even companies. This was done as it is recognized that valuable elements related to procedures might be useful for the development of a TDI methodology.

We also investigated specific indexes and indicator frameworks that focus primarily on surface transport but may not necessarily focus on surface transport decarbonisation – to be specific) as these may provide specific insights to the determinants of GHG emissions e.g. factors that relate to the A-S-I-F framework (Schipper et al., 2007).

Figure 3. ASIF Framework



Source: Schipper et al., (2007)

2.2 Analysis

The analysis conducted by the study includes those relevant to the methodological approaches (Section 4.2) towards the development of such relevant indexes, as well as an assessment of selected indexes (Section 3), indicator sets (Section 4.4), and other potential sources of data (Section 4).

In this exercise, we mainly pertain to an index as a composite measure that aggregates multiple indicators to provide an overall score or ranking for specific themes. In analysing the existing indexes, various elements were identified and analysed as presented in Section 4.3 (analysis of existing indexes):

Table 1. Key Characteristics of Relevant Indexes that were Analysed

Section	Description
Introduction	This provides a basic description of the origins, objectives, coverage and focus of the index.
Methodology	This section provides description of the framework used, as well as the structure of the index, and indicators that are relevant to transport and decarbonisation. This section also provides insights on procedural elements such as data imputation, normalisation, weighting, and aggregation.
Dissemination and Availability	The analysis also provides insights related to the availability of relevant inputs and outputs, as well as strategies used for the dissemination of information.
Key Take-aways	This summarizes the main key points that are deemed to be useful in the development of the surface TDI methodology.

Aside from the relevant indexes, the team also looked into sources that involve the provision of relevant indicators that are relevant to surface transport and/or decarbonisation. These sources do not necessarily go towards the calculation of indices but provide useful information towards characterizing the state or trends related to specific areas (Section 4.4). These are analysed using a modified version of the template used for the existing indexes (see Appendix B).

A comprehensive stocktaking of potentially useful sources of data and information was also conducted. These will feed into the analysis of the availability (and quality) of data as the process of the development of the TDI is conducted.

3. Overview of Surface Transport Decarbonisation

3.1 Surface transport: Coverage in Relation to the Project

The surface TDI project focuses on all relevant types of surface transport - i.e. road, rail, and inland waterways - that enable the transport of people and goods. The following pages provide an overview of the most important concepts, vehicle types and developments. To define the concept of surface transport and put it into the context of sustainable development and the net-zero transition, this report can build on a multifaceted repository of relevant academic and grey literature.

Other layers, categories and service typologies can be used to further organise information on such surface transport groupings, particularly as new transport concepts emerge (see Table 2 below). Transport task types (freight and passenger transport), service and ownership types, and modes and vehicles are some of the primary layers that the study team shall consider. It is also noted that there are specific nuances, and lack of disaggregation which may lead to specific challenges in terms of developing a TDI for surface transport. In some instances, references to more general terms would be made (e.g. water-borne transport that encompasses maritime and inland waterways) as existing materials may not necessarily provide information at ideal granularity.

The study team also anticipates that some level of standardisation of definitions (especially those related to vehicle and service categories) need to be done in order to accommodate the variations in the target regions but still come up with a useful tool that can be used for constructive benchmarking.

Table 2. Surface Transport Spectrum

Surface Type	Transport Task Type	Service and Ownership Type	Modes and Vehicles

• Road
• Railways
• Inland Waterways
	• Passenger
	• Freight
	• Combined
		• Collective transport
		  □ Formal
		  □ Informal
		• Ride services
		  □ Taxi services
		  □ Ride sourcing
		  □ Micro transit
		  □ Ride pooling
		• Fleet sharing
		  □ Micro mobility
		  □ Moped sharing
		  □ Car sharing
		• Private
		• Other
			• Motorized
			  □ Intercity train
			  □ Regional train
			  □ Metro
			  □ Tramway
			  □ Bus
			  □ Mini bus/van
			  □ Ferry
			  □ Cable car
			  □ Minibus, microbus, taxi-bus, jitney
			  □ (Electric) Auto-rickshaw
			  □ Motorcycle taxi
			  □ Pedicabs/ cycles taxi / cycle rickshaw
			  □ Private hire vehicle
			  □ Car
			  □ Van
			  □ Moto taxi
			  □ Ride-hail vehicle
			  □ Automated vehicle
			  □ Micro transit vehicle
			  □ Pooled vehicle ride
			  □ (Electric) bicycle
			  □ Cargo bike
			  □ Electric scooter
			  □ (Electric) Moped
			  □ (Electric) Car
			• Non-motorized
			  □ Walking
			  □ Cycling

Source: Adopted from ITF (2023) ; Note: The table is more illustrative rather than exhaustive.

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 also due to the goal of the TDI to assist the governments in LMICs in the target regions (South Asia and Sub-Saharan Africa) to identify key barriers to surface transport decarbonisation and provide evidence for policymakers to develop targeted emission reduction actions. In some cases, references to international transport would be made, primarily due to the relevance of the specific concepts, or due to the lack of more disaggregated information to isolate domestic transport.

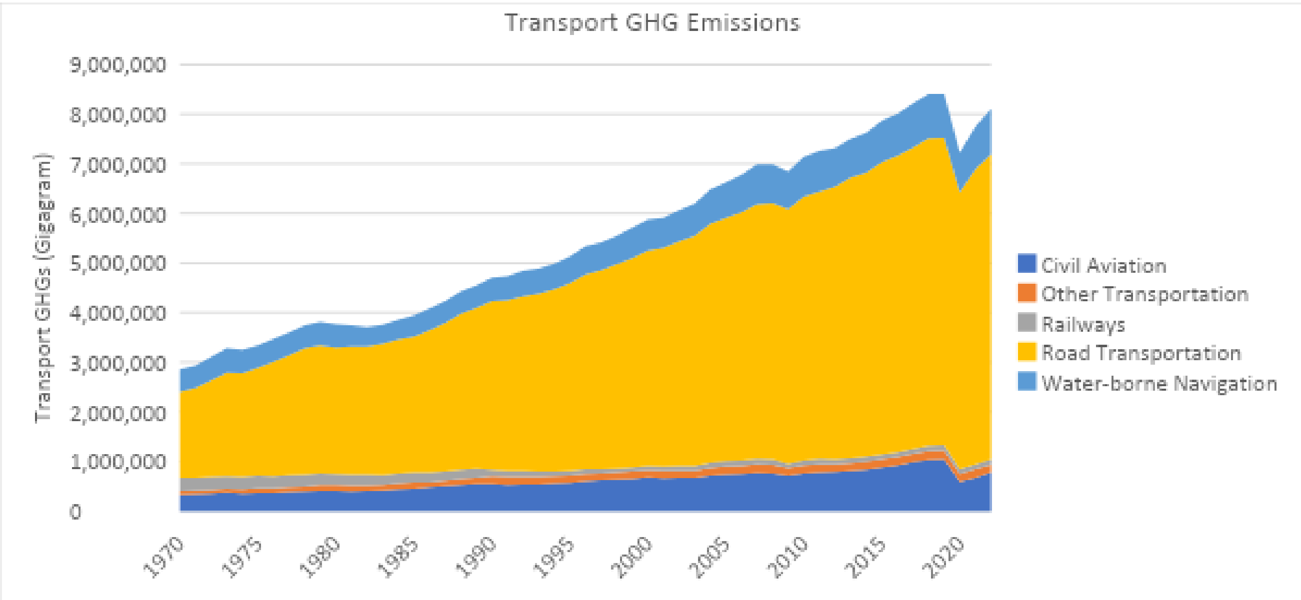
3.2 Importance of Surface Transport: GHG Emissions

In the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC), it estimates that the transport sector contributes around 15% of the total global greenhouse gas (GHG) emissions in 2019.

The graphs below are based on the analysis of the latest sectoral GHG estimates from (JRC, 2023). Please note that the data does not provide disaggregated data for domestic and international transport by mode.

The transport sector has been growing at an annual average of 1.9%, from the turn of the century up to 2019. The overall GHG emissions during the same period grew at similar rates at 1.87% per annum. The COVID-19 pandemic resulted in -1.68% reduction in non-transport sectors in terms of GHG emissions between 2019-2020. The transport sector was significantly impacted, as the GHG emissions dropped by 14% during that period (see Figure 4).

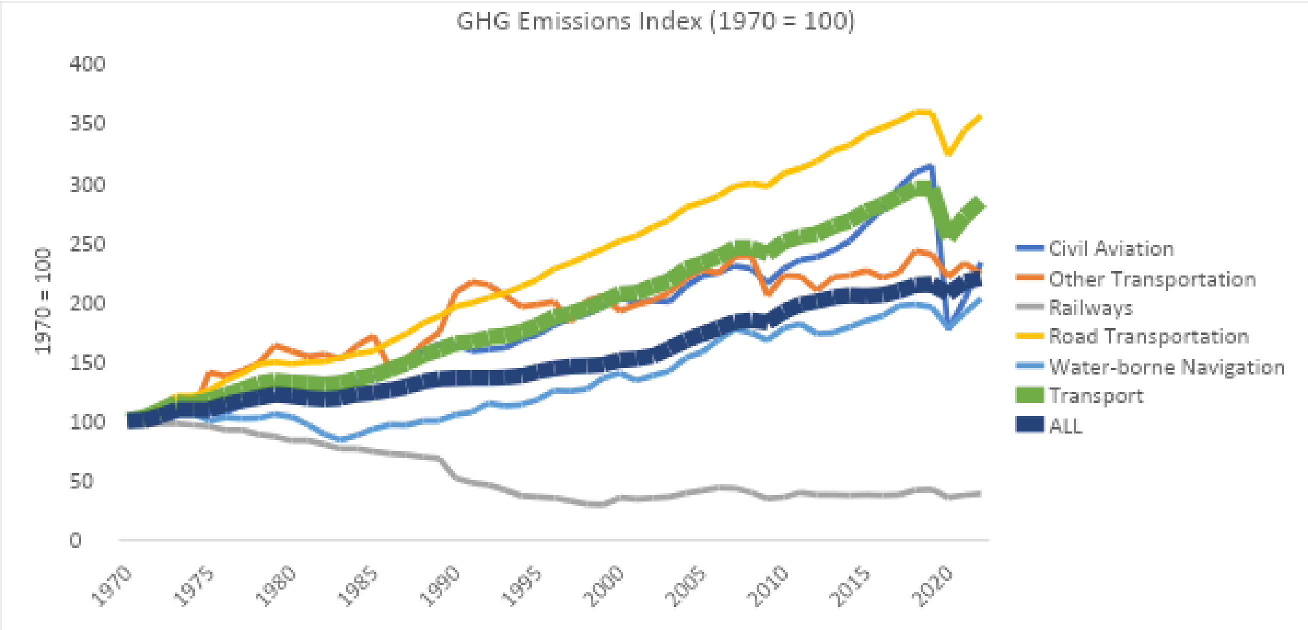
Figure 4.Historical GHG Emissions from the Transport Sector



Source: Own visualisation based on data from JRC (2023)

As we can see from Figure 5 below, road transport has been dominant in terms of long-term growth in emissions from the 1970s. Note that the GHG emissions from railways have declined since the 1970s, primarily due to improvements brought about by the change in technology in the sector. From the turn of the century, though, GHG emissions from water-borne navigation have been growing fastest at 1.70% per annum, while road transport GHG emissions have been growing at 1.60%.

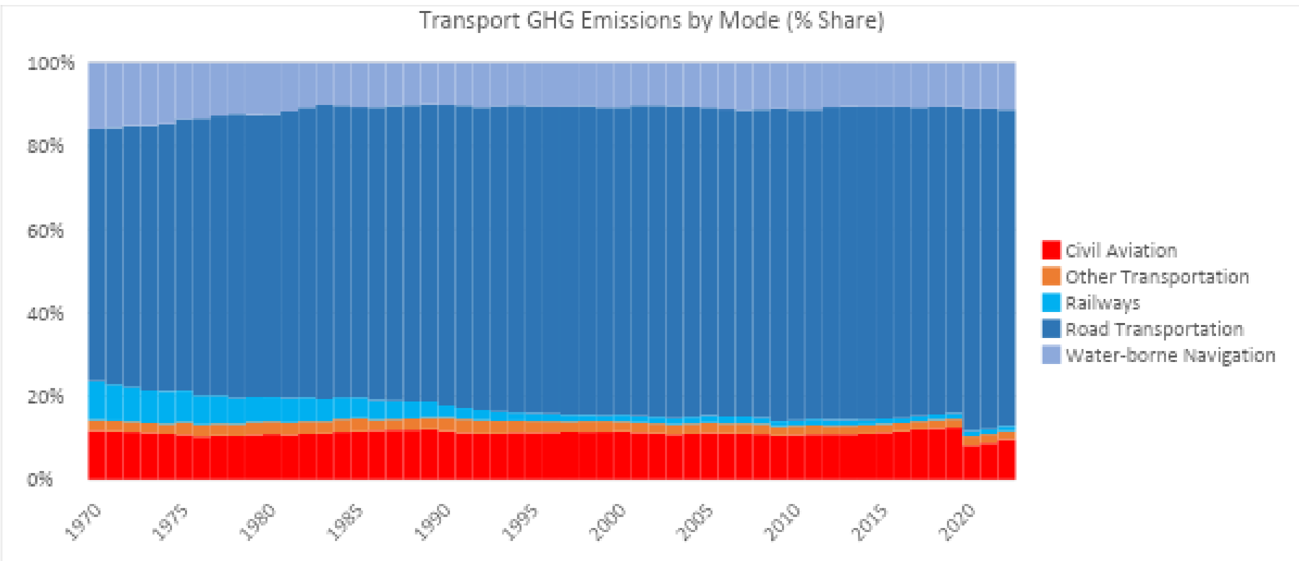
Figure 5.GHG Emissions Indexes (1970 =100)



Source: Own visualisation based on data from JRC (2023)

In 2022, it is estimated that the transport sector emitted 8.1 billion tons of GHG, with 88% of the emissions coming from surface transport modes. Road transport modes are estimated to contribute 76%, water-borne transport is estimated to contribute around 11%, and railways contribute 1% of the transport GHG emissions (See Figure 6 below). It is also important to note that international shipping accounts for 55% of the total GHG emissions attributable to water-borne navigation (Figure 6).

Figure 6.Percentage Share of Modes in the Transport GHGs



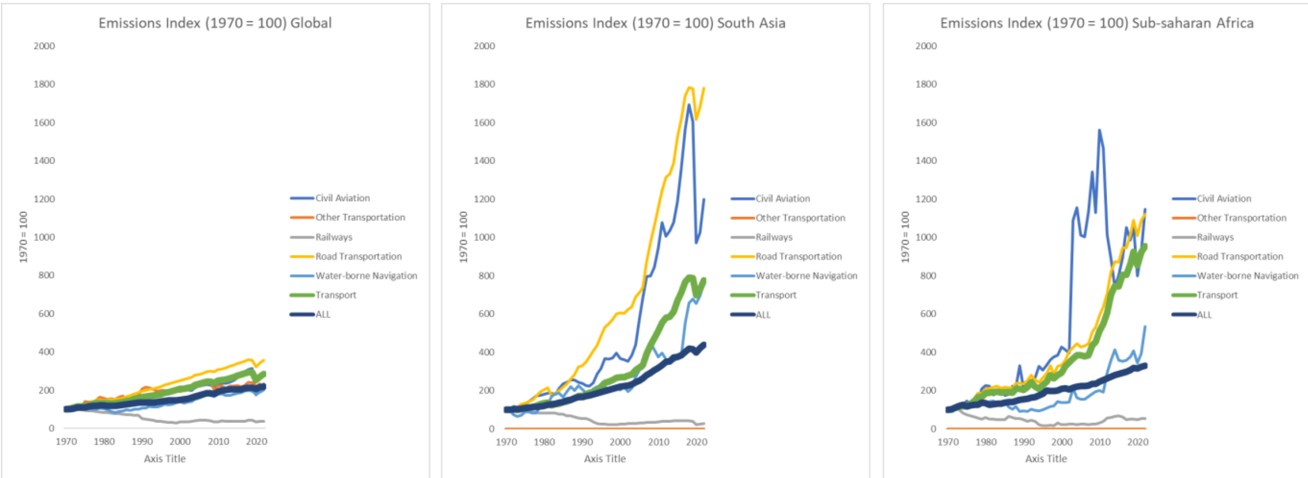
Source: Own visualisation based on data from JRC (2023)

Freight transport is a major cause of growing transport emissions. Freight accounted for 42% of global transport CO_2 emissions in 2019, while passenger transport accounted for 58%. Surface freight transport is estimated to account for a third of freight activity but causing almost three quarters of global freight transport emission in 2019. The opposite is the case for passenger transport, where passenger surface transport accounts for 92% of passenger activity in 2020 but just 83% of passenger transport CO_2 emissions in 2019 (ITF, 2021).

In developing regions such as South Asia and Sub-Saharan Africa, the percentage contribution of surface modes of transport in the GHG emissions is slightly lower than the global average of 13.47%. In South Asia, the surface transport modes contribute 7.93% of the total GHG emissions, while 9.14% of the total emissions in Sub-Saharan Africa are from surface transport modes.

While the percentage contributions are relatively lower, the growth in emissions in such developing regions has been at a different pace as compared to the global averages. For example, transport emissions in general have increased more than 7 times in South Asia (with road transport emissions growing almost 18 times against 1970), and more than 9 times in Sub-Saharan Africa (Figure 7).

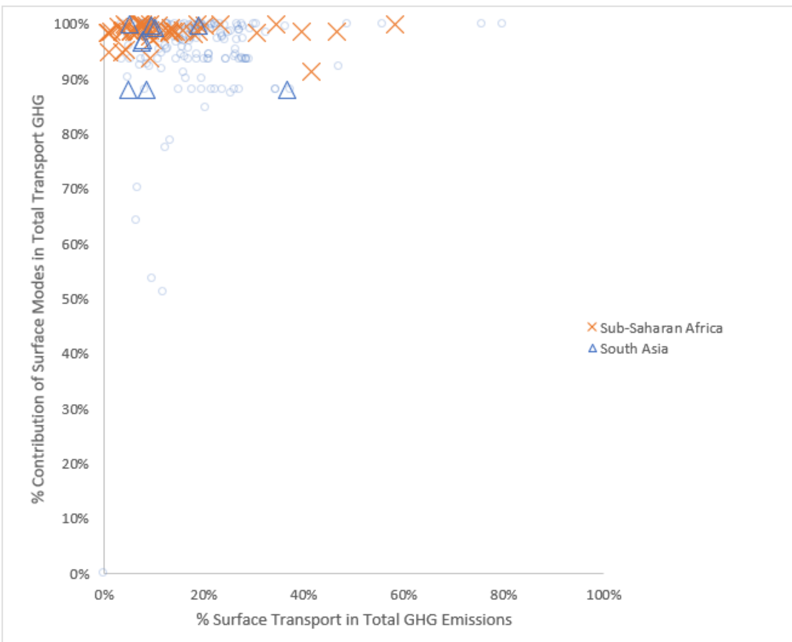
Figure 7. Emissions Indexes Comparison



Source: Own visualisation based on data from JRC (2023)

Figure 8 below depicts the importance of surface transport modes in terms of their relative contributions to the total transport GHG emissions, as well as the contribution of surface transport modes in total GHGs. Essentially, surface transport modes contribute 97% and 98% of the total transport GHGs in Sub-Saharan Africa and South Asian regions, respectively (global average is at 88%). Surface transport as a whole contributes 9% and 8% of the total GHGs for Sub-Saharan Africa and South Asia, respectively (13% globally).

Figure 8. Importance of Surface Transport Modes in terms of GHG Emissions



Source: Own visualisation based on data from JRC (2023)

3.3 Pathways towards Decarbonising Surface Transport

This section discusses some of the key studies relating to the decarbonisation of surface transport. Decarbonisation (and GHG mitigation) policy measures, in general, is often framed within the Avoid-Shift-Improve framework (Dalkmann & Brannigan, 2007). In essence, there are policies that: result in the avoidance of the need for transport; shift transport to more efficient modes; improve the efficiency of vehicles, fuels, and transport performance.

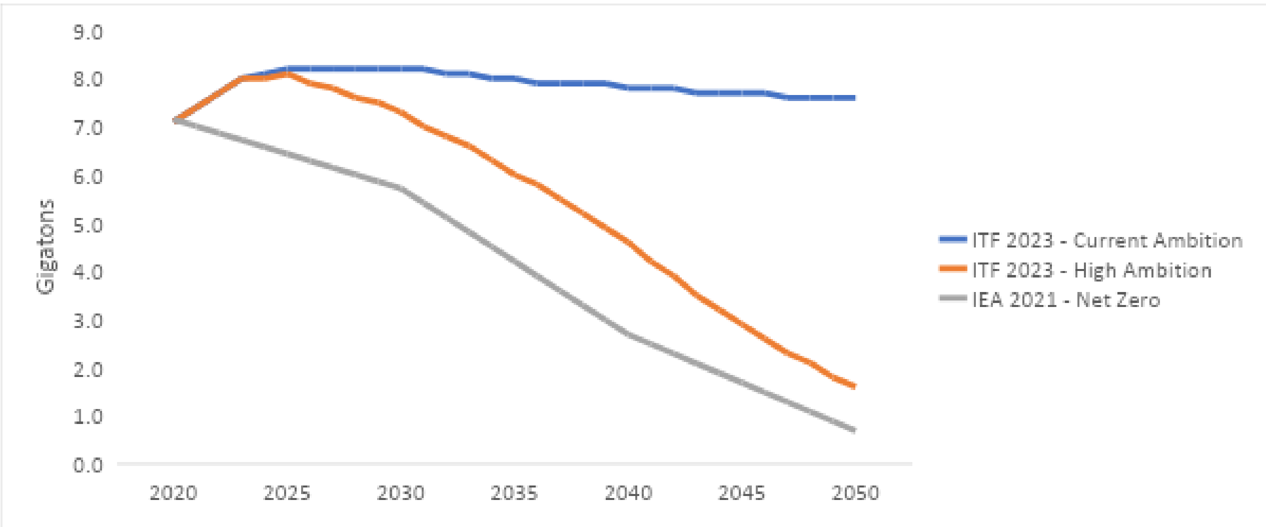
UNEP reports that global GHG emissions reached a record of 57.4 gigatons of CO_2 equivalent in 2022 (UNEP, 2023). Transport accounted for 8.1 gigatons (14%) of the total direct GHG emissions but remains to be the only sector that has yet to rebound from the impacts of the COVID-19 pandemic. Accelerated measures towards mitigating the emissions from the transport sector are needed to realise optimal scenarios towards reaching the goal of limiting the global temperature increase to 1.5 degrees Celsius.

The International Transport Forum (ITF) postulates that current transport decarbonisation policies would be insufficient to pivot passenger and freight transport into sustainable pathways, as CO_2 emissions from transport are expected to increase by 16% by 2050. Increasing transport demand would still offset the emission reduction from existing policies.

The ITF (2023) reiterates the importance of developing nations in Asia and Africa in driving the transport demand. These regions will constitute about 90% of the increase in urban population leading up to 2050, and as economic growth continues in such regions, so would the demand for transport.

The International Energy Agency (IEA) postulates that under a net zero emissions scenario, transport sector emissions would go slightly over 5.5 gigatons by 2030 (from 7 gigatons in 2020). By 2050, such a net zero scenario would require that the transport sector emit only 0.7 gigatons, or 90% reduction as compared to 2020 levels (IEA, 2021a). The IPCC on the other hand (IPCC Working Group III, 2022) estimates that a 1.5-degree scenario would require reducing total transport emissions to 2 to 3 gigatons by 2050. In contrast, ITF (2023) proposes that a high ambition scenario - where current mitigation commitments are accelerated – would lead to reducing the overall transport emissions to 1.6 gigatons by 2050 (see Figure 9).

Figure 9. GHG Projections for the Transport Sector



Sources: IEA (2021b); ITF (2023b)

The decarbonisation of the transport sector in the net zero emissions scenario relies on a combination of policies that promote modal shifts, improvements in energy efficiency, and more efficient operations. IEA suggests that decarbonisation is dependent on two major technological transitions: electrification, and low carbon fuels.

IEA's Net Zero scenario outlines the need for a 90% drop in transport CO_2 emissions below 2020 levels by 2050. Surface transport modes will have to contribute the most to the emission reductions (IEA, 2021a). Light-duty vehicles will have to reduce their CO_2 emissions by 97% from 2020 to 2050, heavy-duty vehicles by 89% and other road vehicles by 93%. It emphasizes the importance of the following overarching strategies toward mitigating emissions from the transport sector:

- Reduce transport demand and distance
- Shift to more environmentally friendly and lower carbon modes of transport
- Resilient transport systems, infrastructure, and vehicles
- Substitute fuels with electricity and improve vehicle, fuel, and operational efficiencies to decrease emissions of unavoidable travel.

UNEP emphasizes the importance of shifting investments from road infrastructure towards shared and mass transit e.g. buses, rail, car- sharing) to minimize emissions while reaping numerous social and environmental benefits (UNEP, 2023). UNESCAP (2021) concludes that “improve” policies (i.e. energy efficiency improvements and EV adoption) offers the most significant emission reduction potential in its analysis of decarbonisation pathways for Asia. However, the wider (and in some cases, longer term) impacts of avoid and shift policy measures must also be taken into consideration (e.g. other developmental co-benefits).

According to the International Council on Clean Transportation (ICCT), 85% of the CO_2 reductions needed from land transport to meet the 1.5-degree target can be achieved through existing and emerging policies and technologies such as electrification and improvements in efficiencies. Its ambitious scenario relies on the combination (ICCT, 2020):

- Automobile manufacturer-focused efficiency standards (CO_2 or fuel efficiency targets)
- Zero emission vehicle mandates mandating specific percentages of ZEV constituting sales volumes.
- Emission standards for specific pollutants such as particulate matter, nitrogen oxides for new vehicles
- Renewable fuels standards require fuel suppliers to include targets (content) of renewable fuels in the fuel mix.

UNFCCC (2021) states that by 2030, leading markets (e.g., Europe, USA, China, Japan) should aim to have zero emissions for at least 75% of the new light-duty vehicles (LDVs). While a combination of technology solutions can enable decarbonisation of long-haul road transport (e.g. battery, overhead wire, or hydrogen).

The UNFCCC estimates that emissions from shipping could grow by 84% under a business-as-usual scenario due to lack of regulation, continued growth in demand, widely fragmented industry, and short investment horizons. Operational efficiency measures can potentially reduce emissions by 30% to 50%. Zero-carbon fuels, though, are needed to achieve full decarbonisation (UNFCCC, 2021). The UNFCCC states that by 2030, the shipping industry should achieve 5% of propulsion energy coming from zero carbon fuels for international shipping. For domestic shipping, the target should be 15%. Please note that the UNFCCC (2021) specifically mentions that such a 15% target can be reached by 32 developed countries which accounts for 50% of the domestic emissions. Zero carbon ship demonstration projects implemented by 2025 is said to be a critical step towards the decarbonisation path.

In terms of rail, the IEA (2021a) suggests that passenger rail almost doubles its share of total transport activity to 20% by 2050 in the net zero emissions scenario. This scenario states that all new tracks on high-throughput corridors would be electrified. Battery electric and hydrogen trains are also assumed to be adopted, contributing towards the drop in oil use in the rail sector to almost zero, from 55% in 2020.

The following tables (Table 3 and Table 4) summarize the main targets related to surface transport that had been proposed by the expert organisations as necessary towards achieving the 1.5 degree Celsius scenario. We note that such studies and roadmaps focus primarily on the leading markets and developed economies as prioritized by the source institutions. However, these targets are still useful in providing insights as to the kinds of interventions that could also be adopted in LMICs. Noting that these are geared towards the leading markets/economies is also important to take into account, as the adoption of the associated measures in the context of LMICs would need to take into account context specific circumstances and nuances.

Table 3. Targets for the Transport Sector towards a 1.5 Degree Consistent Scenario

	2030	2035	2050
Road in general	20% of road transport energy consumption from alternative fuels (biofuels, electricity, and hydrogen)	22% of road transport energy is sourced from electricity	Electricity represents 75% of energy consumption in road transport
Two/Three-wheelers	54% of stock are electric		100% of stock are electric
LDV	78% of global car sales are battery-electric, plug-in hybrid or fuel cell electric (20% of car stock are electric)	No new internal combustion engine cars, vans and two-/ three-wheelers are sold after 2035	86% of car stock are electric
Bus	56% of buses sold are plug-in hybrid, battery, and fuel cell electric (23% of total stock are electric)		All buses sold are battery-electric, plug-in hybrid or fuel cell electric 79% of the bus stock are electric
Truck	8% of heavy-duty vehicle stock are electric	65% of heavy truck sales are battery-electric, plug-in hybrid or fuel cell electric	All heavy trucks sold are battery-electric, plug-in hybrid or fuel cell electric
Rail	65% of rail is electric		Passenger rail nearly doubles its share of total transport activity, to 20% 90% of rail energy is provided by electricity ; 5% by hydrogen
Shipping			Sustainable biofuels provide up to 20% of total shipping energy

Source: IEA (2021) and (IEA, 2023)

The UNFCCC (2021), in a document that summarizes priority actions towards mitigating emissions from the transport sector proposes the following breakthrough goals for surface transport:

Table 4. Breakthrough Goals for Decarbonising Transport

	2030	2035	2040	2050
ICE buses	100% of bus sales in leading markets are zero emission vehicles (ZEV)			

ICE Heavy goods vehicles			100% of sales in leading markets are ZEVs	
ICE passenger vehicles		100% of passenger and van sales in leading markets are ZEVs		
Shipping				Zero emission fuels make up 100% of shipping fuels

Source: UNFCCC (2021)

It must be noted that these pathways heavily focus on improve measures, but the roles of avoid and shift strategies should also not be undermined.

3.4 Overview of Mitigation Commitments and Measures in the Target Regions

Prior to providing an overview of the surface transport commitments and measures in the target regions of this exercise, it is also important to note where the countries are in terms of wider commitments towards achieving net zero emissions status in the future. Five countries in South Asia, and 15 countries in Sub-Saharan Africa have put forth such commitments as shown in Figure 10.[2]

Figure 10. Net Zero Commitments

Region	Country	Type		2030	2035	2040	2045	2050	2055	2060	2065	2070
South Asia	Bhutan	2nd NDC	Already achieved and commit to maintain									
	India	Updated NDC	2070									
	Maldives	In law	2030									
	Nepal	2nd NDC; LTS	2045									
	Sri Lanka	Updated NDC	2050									
Sub-Saharan Africa	Cape Verde	Updated NDC	2050									
	Comoros	Updated NDC	Already achieved and commit to maintain									
	Ethiopia	Long-term Emission and Cliamte Resilient Development	2050									
	Gabon	2nd NDC	Already achieved and commit to maintain									
	Gambia	Climate Neutral Development Strategy	2050									
	Ghana	In political pledge	2070									
	Liberia	1st NDC	2050									
	Malawi	In political pledge	2050									
	Mauritania	In political pledge	2030									
	Mauritius	In political pledge	2070									
	Namibia	Updated NDC	2050									
	Nigeria	In law	2050									
	Rwanda	In political pledge	2050									
	Seychelles	Updated NDC	2050									
	South Africa	Just Transition Framework for SA	2050									

Source: Climate Watch (n.d.)

This section examines the Nationally Determined Contributions (NDCs), and the Long-term Strategies (LTS) of countries in the target regions. NDCs embody the efforts and plans of countries towards reducing national emissions, as well as those that relate to climate adaptation (UNFCCC, n.d.). LTS, on the other hand, represent long-term GHG strategies that are to be taken in light of national

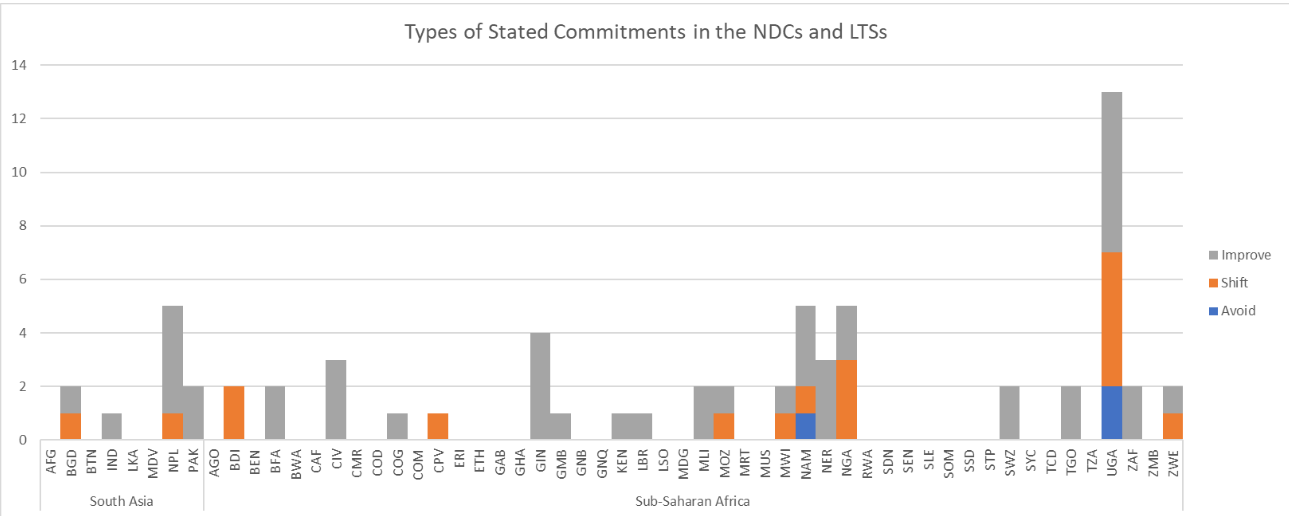
[2] The data from Climate Watch categorizes commitment into those in the form of : pledges (e.g. commitments from heads of state); in policy document (mentioned in the

circumstances and capabilities, and accounting for common but differentiated responsibilities (UNFCCC, 2023).[3] Detailed information on the relevant targets are contained in Appendix A.

According to the ITF (2023), transport has been acknowledged in 82% of the NDCs globally, but only 18% of the NDCs include specific emission reduction targets for transport. Investigating specific measures that are present in the NDCs and LTSs is quite interesting for the development of a surface TDI as it provides and overview of the types and prevalence of measures towards reducing emissions from surface transport. The following graphs are based on the NDC Transport Tracker data that keeps track of the national level climate policies and targets in transport (GIZ & SLOCAT, 2023).

Figure 11 below reveals that majority of the LMICs in South Asia and Sub-Saharan Africa (57%; 32 out of the 56 countries) do not have specific targets (GHG-specific or relevant targets contained in the NDCs and LTSs) pertaining to surface transport in their NDCs and LTSs. For those which have committed specific targets related to surface transport modes, most of these are categorized under the "improve" pillar.

Figure 11. Types of Stated Commitments (Surface Transport-related) in the NDCs and LTs

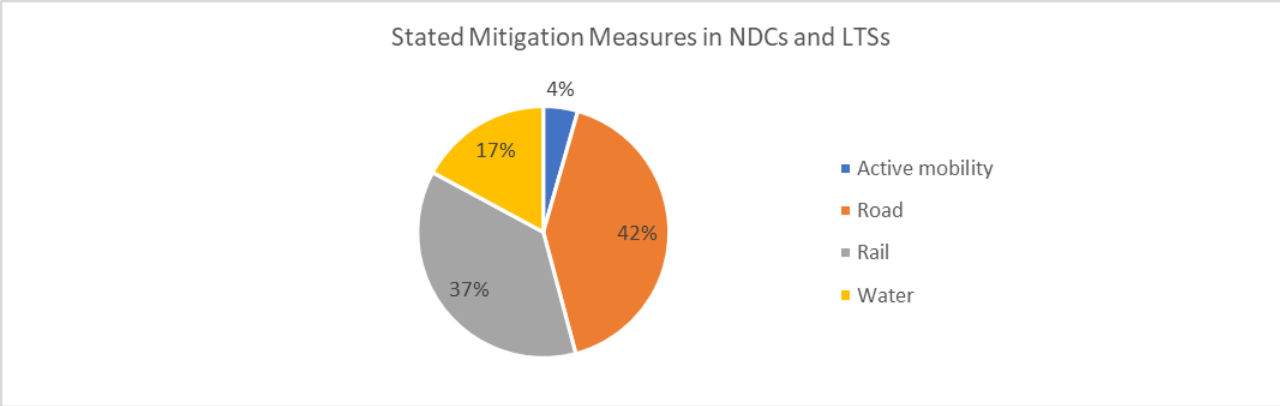


Source: Own visualisation based on data from GIZ & SLOCAT (2023)

Figure 12 shows the overall distribution of mitigation measures contained in NDCs and LTSs in the LMICs in South Asia and Sub-Saharan Africa. Forty-one percent (41%) pertain to measures towards mitigating emissions from road vehicles, followed by rail-related measures.

Figure 12. Surface Transport Mitigation Measures by Mode

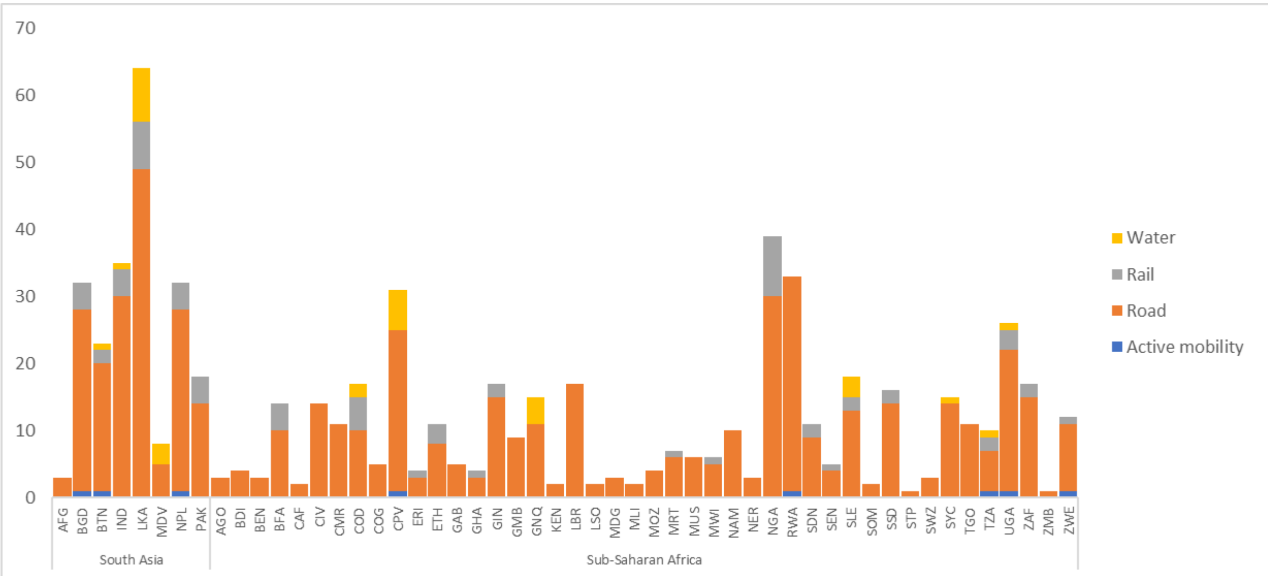
[3] Only 10 of the 55 countries in South Asia and Sub-Saharan Africa have submitted their Long-term Strategies based on the LTS portal.



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

Figure 13 provides further breakdown of the mitigation measures relevant to surface transport at the country level. On average, the LMICs in South Asia have been more vocal regarding mitigation measures in surface transport, and that there are many countries in Sub-Saharan Africa which have not mentioned any mitigation measures related to surface transport in their NDCs/ LTSs.

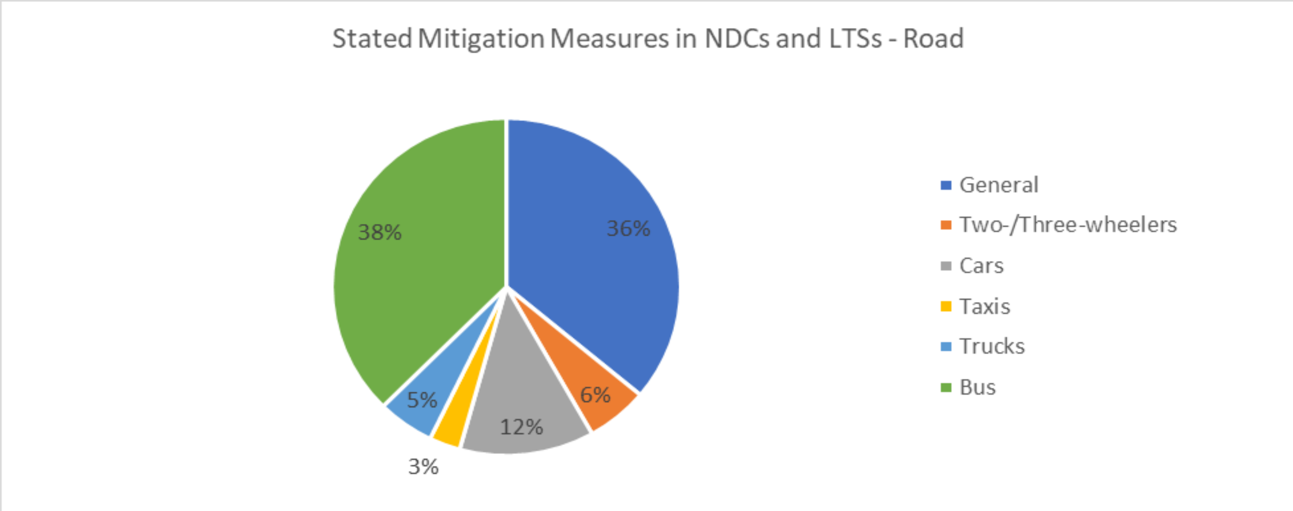
Figure 13.Surface Transport Mitigation Measures by Mode and Country



Source: Own visualisation based on adjusted data from GIZ & SLOCAT (2023). The count of the "road" measures were adjusted based on the observed counts of measures related to different road vehicles.

It is also interesting to have a closer look at mitigation measures mentioning road transport modes. Figure shows that 36% of the measures are general and do not mention specific modes. There is a strong preference towards bus-related measures in the countries in the target regions, as 38% of the measures pertain to buses (Figure 14).

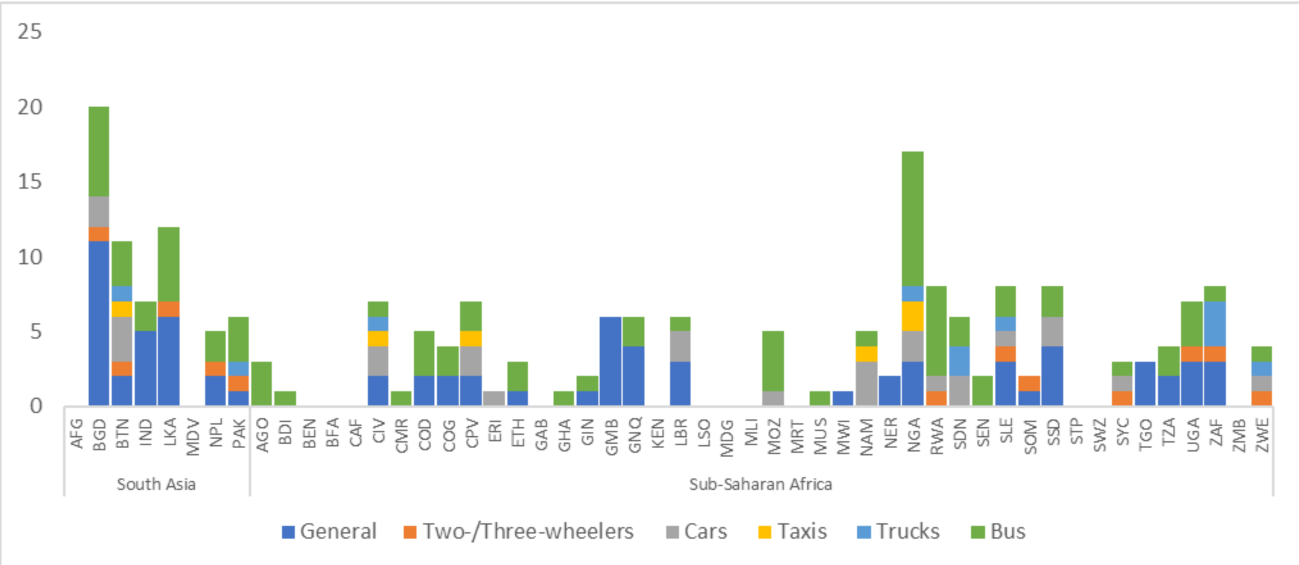
Figure 14. Road Transport Mitigation Measures – by Vehicle Type



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

Figure 15 below shows the breakdown of the measures mentioned in the NDCs and LTSs in the LMICs in South Asia and Sub-Saharan Africa. Twenty-nine (out of 55 countries) had mentioned such measures in their NDCs and LTSs.

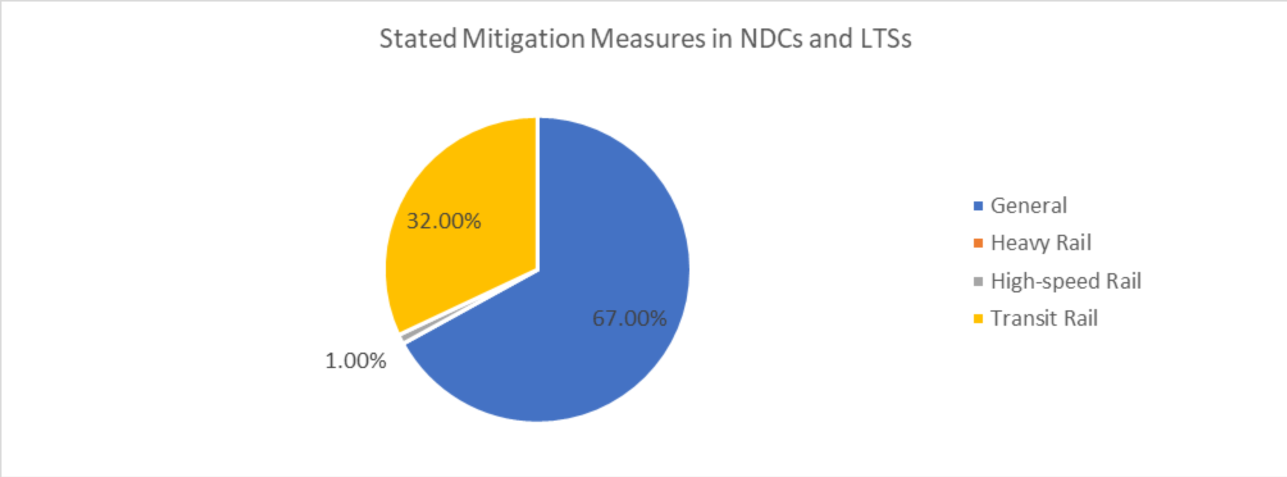
Figure 15. Road Transport Mitigation Measures – by Vehicle Type and by Country



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

Figure 16 and Figure 17 provide the distribution of mitigation measures for rail types. Sixty-seven percent (67%) are general, while 32% pertain to transit rail.

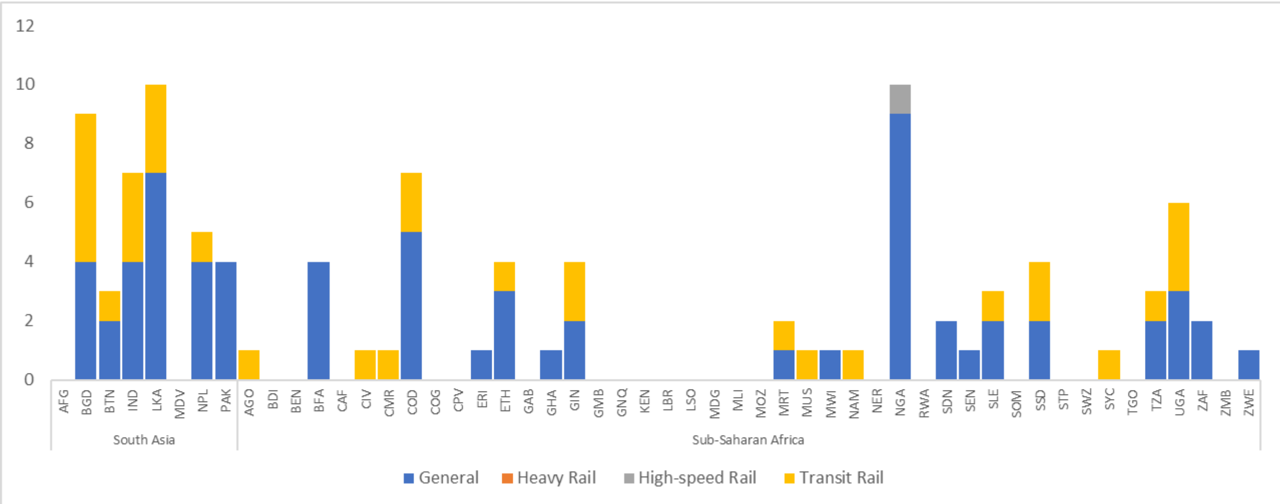
Figure 16. Rail Transport Mitigation Measures – by Type



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

It is also worthwhile noting that less than half (23) of the countries had mentioned mitigation measures that pertain to railways (see Figure 17).

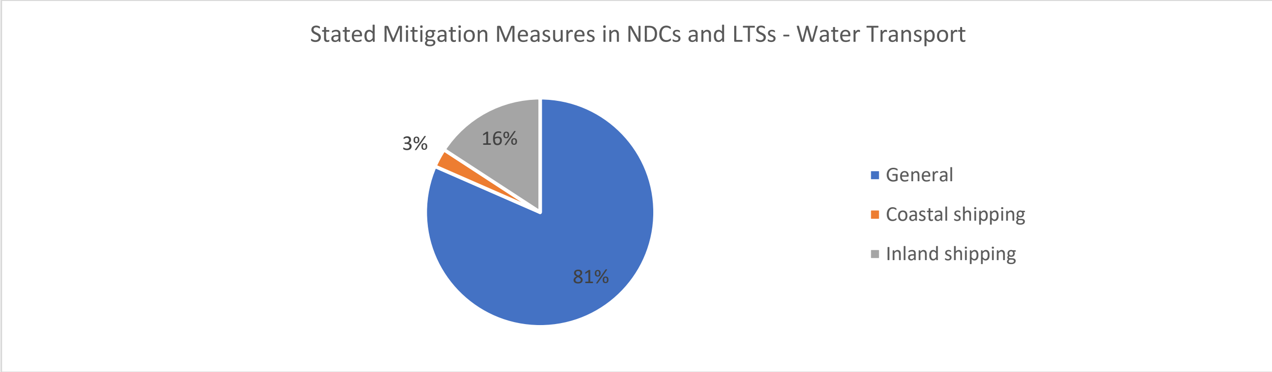
Figure 17.Rail Transport Mitigation Measures – by Type and by Country



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

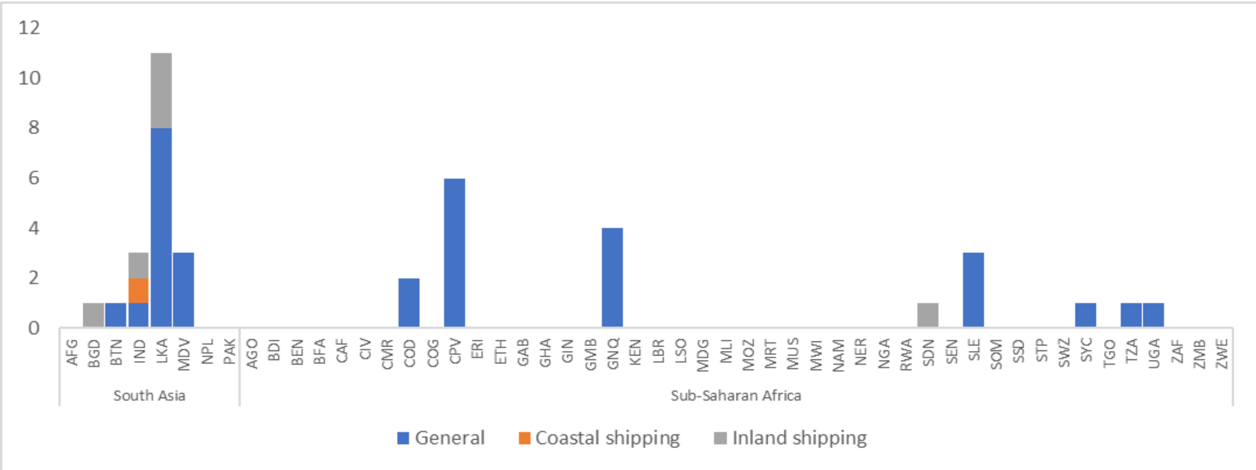
In terms of water transport, 81% of the measures mentioned are general in nature (see Figure). Figure shows that only a handful of countries are prioritizing mitigation measures relating to water transport (13 countries only).

Figure 18. Water Transport Mitigation Measures – by Type



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

Figure 19.Water Transport Mitigation Measures- by Type and by Country



Source: Own visualisation based on data from GIZ & SLOCAT (2023)

3.5 Discussions and Conclusions

Surface transport is at the core of the decarbonisation of the transport sector, as 88% of the GHG emissions from the transport emanate from surface transport. The GHG emissions from surface transport in the developing LMICs in South Asia and Sub-Saharan Africa have been growing at different scales as opposed to the global average, and such growth is expected to be sustained moving into the future.

The achievement of the global goal to limit the average global temperatures to 1.5-degrees Celsius requires deep cuts in emissions, including surface transport. While there are differences in the estimated ideal levels of emissions load from the transport sector by 2050 by expert organisations, the general recommendation of achieving as many reductions, as early as possible, is consistent. Such would require a combination of various policy measures and should be appropriate to national circumstances and capacities. While the various transport-related decarbonisation studies and roadmaps focus on developed economies and leading markets, specific ones focusing on consolidated recommendations for LMICs are not yet available. It must also be noted that decarbonisation of transport needs to be tackled within a wider sustainable framework, particularly in the context of LMICs whose emissions are lower than in developed countries, and require growth in transport activity as they thread through economic development.

We had documented the ambition of the LMICs to move towards net zero status in the future, with twenty countries in South Asia and Sub-Saharan Africa expressing such commitments. The surface-transport related targets embedded in the NDCs and LTSs of the LMICs in South Asia and Sub-Saharan Africa are mainly related to “improve” measures that deal with technological solutions. We also note that road related mitigation measures are most prevalent in the said documents in the target regions, which is reasonable as the emissions contribution by road transport is more than three-fourths. Specific opportunities towards shifting travel towards highly efficient modes (e.g. water-borne) could be quite impactful in certain use cases in specific areas.

The exercise points to anticipated challenges towards defining standardized categories that would characterize surface transport (and the associated elements such as modes, vehicles, tasks) in the development of a surface TDI. Such will be critical in enabling a surface TDI that would enable robust benchmarking and be useful for identifying national priority gaps and opportunities for accelerating the decarbonisation of surface transport. It is also critical to note how the TDI should capture commitments and actions towards decarbonisation, and how to assess the country’s progress towards such in a manner that also considers the wider context of sustainability goals.

4. Review of Existing Indexes and Frameworks

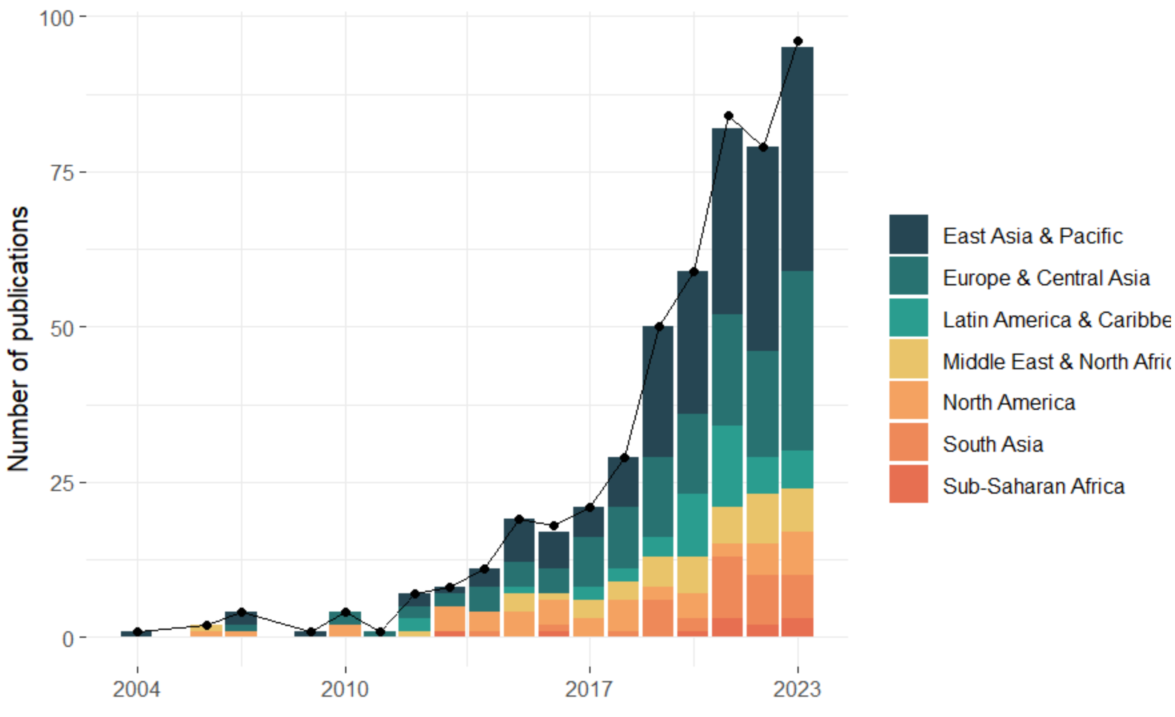
This chapter provides the details of the review of the relevant literature focusing on relevant indexes, indicator sets, and databases to understand what exists in terms approaches, methods, data, and tools which can be useful in the development of a surface TDI.

4.1 Bibliometric Analysis of Scientific Literature

This section discusses the results of a bibliometric analysis informed by the research conducted by Andrieu et al. (2024, unpublished manuscript). To obtain a preliminary overview of the scientific landscape around indexes in sustainable surface transport, the authors conducted a bibliometric analysis on the Web of Science (WoS) platform using a pre-defined search strategy and the software package "Bibliometrix" in R (Aria & Cuccurullo, 2017). The WoS search was confined to the Topic ("TS") variable, i.e. the title, abstract and keywords of the scientific publications. After an in-depth screening to remove articles not directly related to surface transport and eliminating duplicates, the articles accounted to 497 (see Figure 20).

The analysis indicates a growing trend in scientific production per year, starting with one publication in 2004 and peaking at 95 publications in 2023. Regional productivity as shown in Figure 20 is assessed based on the location of the first author. From a regional perspective, the majority of these publications come from countries in East Asia and the Pacific, with 179 publications. In contrast, publications from South Asia and sub-Saharan Africa are comparatively modest, with 36 and 11 publications, respectively.

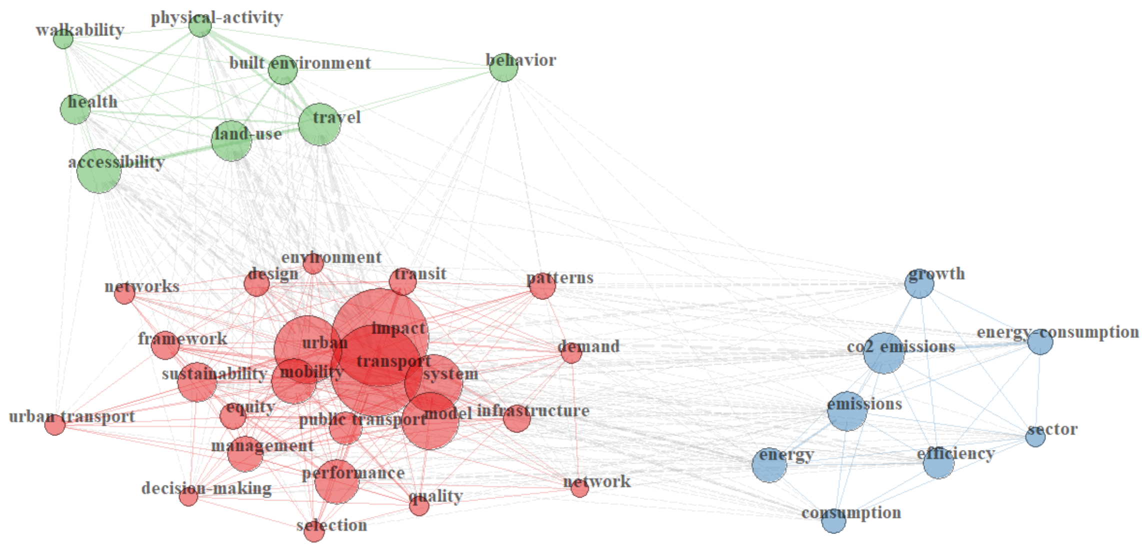
Figure 20.Scientific Production Literature on Sustainability Indexes



Source: Andrieu et al. (2024, unpublished manuscript)

The network visualisation shown in Figure 21 reveals three distinct thematic clusters in the literature based on the frequency of co-occurrence of keywords. 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 21).

Figure 21. Keyword Co-Occurrences



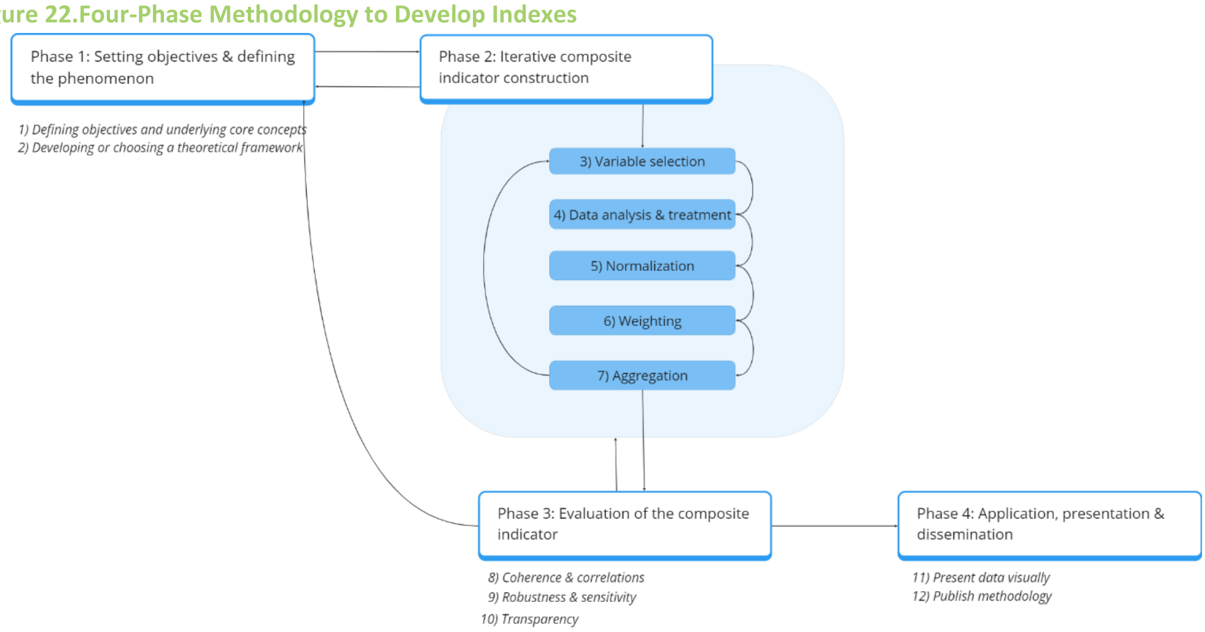
Source: Andrieu et al. (2024, unpublished manuscript)

4.2 In-depth Review: Methodological Approaches for Index Development

Comprehensive guidelines, such as those developed by UNECE (2019) and Nardo et al. (2008), provide concise instructions for index development. Amongst others, these highlight the importance of ensuring that indexes are not only relevant, reliable, and methodologically sound, but are also comparable and easily accessible to relevant stakeholders. Building meaningful, robust, and reliable composite indicators for sustainable transport poses challenges, ranging from identifying and delineating the most appropriate sub-dimensions to select indicators that create value, are strong in terms of data availability and reliability and are easy to interpret, to choosing an effective method for weighting and aggregating these indicators.

Through an in-depth literature review, several handbooks, guidelines and other references have been studied. Based on these insights, the development of indexes is categorized into four core phases namely (1) Setting objectives & defining the phenomenon, (2) Iterative composite indicator construction, (3) Assessment of the composite indicator and (4) Application, presentation & dissemination of the composite indicator comprising 12 steps. The details for each phase and methodological steps are outlined in the following subsections.

Figure 22.Four-Phase Methodology to Develop Indexes



Source: Own visualization.

4.2.1 Phase 1: Setting Objectives & Defining the Phenomenon

Saisana et al. (2019) state that in the first step of index development it is crucial to build an understanding and define the concept to be measured, which includes clearly defining objectives and end-users of the index and structuring the concept into a framework of dimensions. Mapping existing references, assessing the value proposition of the new to be developed index and stakeholder engagement, e.g. via workshops are recommended. As a rule of thumb, it is stated that 2/3 of the development time is typically attributed with defining the conceptual framework and its indicators. According to Nardo et al. (2008) at the end of step 1 the multi-dimensional phenomenon to be measured needs to be clearly defined and understood, the nested structure of various sub-groups defined, selection criteria for the variables identified and all interim steps clearly and transparently documented.

4.2.1.1 Defining Objectives and Underlying Core Concepts

In this initial phase, it is important to establish a clear definition of the overarching purpose and goals of the composite indicator. This step serves as an important guidance that informs and steers decisions in subsequent phases of development. These are important when choosing the framework, defining subdimensions and selecting indicators, but also during methodological phases such as the normalisation phase, objectives should not be neglected. The European Commission's Competence Centre on Composite Indicators and Scoreboards (CC-COIN) recommends engaging with end-users and the commissioners of the index from early on in the development process, amongst other this includes validating key definitions, research questions and the purpose of the index. To identify key stakeholders that should be included with different levels of intensity tools such as stakeholder mapping exercise are recommended. In addition, engaging relevant experts, reviewing existing literature, indicators, indexes and existing initiatives is part of this step (Di Bella, 2023).

4.2.1.2 Developing or Choosing a Theoretical Framework

Terzi et al. (2021) refer to this step as the definition of the phenomenon and point to the fact that a fundamental issue, often overlooked when developing indexes, is the identification of a suitable measurement model. These models specify the relationship between the phenomenon to be measured and individual indicators. It can be differentiated between reflective and formative models. In formative models, the individual indicators are influencing or causing the underlying phenomenon, while in a reflective model, the phenomenon affects the individual indicators. The formative model is typically used for constructing composite indicators based on objective and subjective indicators, while the reflective model is used as a scaling model for subjective measurements, such as satisfaction scale construction (Terzi et al., 2021).

In the context of sustainable transport, Gudmundsson et al. (2016) outline that the key questions in selecting or developing an appropriate framework revolve around the purpose for which the information is needed, the specific information requirements, and how the information is to be delivered. Overarching frameworks can be classified into the following four groups: (1) transport appraisal frameworks, (2) environmental policy review and reporting, (3) sustainability assessment frameworks, and (4) performance management frameworks (Gudmundsson et al., 2016; Illahi & Mir, 2020). While a universally applicable sustainable transport framework does not exist, a "framework of frameworks" developed by Gudmundsson et al., provides a starting point, particularly with its emphasis on performance management, which helps to deconstruct and understand how different frameworks can be adapted to different circumstances. The authors brought together the evidence from existing frameworks and research into three basic dimensions that should be defined to create an effective indicator framework:

1. **Substance** refers to elements that need to be measured by describing the core goals the index aims to capture *Sustainability concept, Transport system boundary, Causal linkages.*
2. **Intention** addresses the reasoning and purpose of the index, including the level of activity addressed and its application: *Time orientation, Level of activity, Stage in decision making, Indicator applications.*
3. **Procedure** covers the process involved in identifying, creating, and reporting the dimensions and individual indicators: *Types of indicators, Aggregation, Indicator connectivity to tools, Institutionalisation of indicator production.*

To establish a robust framework that effectively promotes sustainability in transport, Pei et al. (2010), as cited by Gudmundsson et al. (2016), describe six essential criteria that any framework, regardless of its type, should meet. Frameworks need to be 1) comprehensive, 2) connected to overall objectives and goals, 3) internally integrated, 4) able to capture effects of variable interactions, 5) ensuring stakeholder's perspectives are reflected, 6) capabilities and constraints are considered, and 7) be flexible and foster self-learning to enable suitability in rapidly changing contexts.

As Di Bella (2023) summarises, this phase is meant to clarify the what, why and how, engage with stakeholders, understand the domain, be concept-driven instead of data-driven and structure the concept, while being patient with the process and allowing multiple iterations if needed.

4.2.2 Phase 2: Iterative Index Construction

According to Terzi et al. (2021), a composite indicator is not always valid even if the phenomenon is well defined in phase 1 and it consists of good-quality individual indicators. Instead, it depends on the statistical methodology used, which must be well aligned with the theoretical framework on which the phenomenon to be measured is based. An overview of selected and relevant statistical methods is given below.

4.2.2.1 Variable Selection

As Terzi et al. (2021) argue, selecting appropriate variables is crucial when measuring a complex, multidimensional phenomenon. A misstep at this stage can render the whole development process of the composite indicator invalid. Selecting appropriate variables for the composite indicator involves iterative steps such as reviewing literature, establishing a validation method, and maintaining quality criteria. At the end of the variable selection step the quality of the indicators shall be assessed, the strengths and weaknesses of each selected indicator discussed and a summary table on data characteristics developed Nardo et al. (2008). Saisana et al. (2019) recommend using at least three indicators per dimension as a rule of thumb to achieve optimal results, with the ideal range being between five and seven.

Panella & Caperna (2023) list relevance, soundness, timeliness, accessibility, and comparability as the core criteria for the selection of indicators. As an example, when it comes to comparability over space the question to be answered is whether the variables are comparable across observations. According to Panella & Caperna, it would be ideal if the data came from a single source. If this is not possible, the comparability of the chosen indicator must be guaranteed. In addition, data from different environments, e.g., from a large city or a small village, must be placed in an appropriate context. Adjustments such as scaling and denomination (e.g., number of cars per population) can improve comparability and give a more realistic picture. External events can affect the reliability and consistency of the data. For an effective validation methodology it is recommended to determine if the methodology is available in the data source, assess the completeness of the attributes, and consult literature on validation methodologies (Panella & Caperna, 2023).

In addition to traditional data sources, from official statistical institutions, non-conventional data sources, such as secondary resources available online or open street map data, can also be utilised for composite indicator development and offer advantages, such as high availability, cost-effectiveness, and ease of access. While phase one was concept driven, looking at what should be done, during the construction phase this shifts to a data driven approach, looking at what can be done given the available data. This may lead to the need to exclude previously identified indicators as they are simply not available, even though they would be of core benefit to the index. (Domínguez-Torreiro, 2023) points out that in such cases it is advisable to include a section on data gaps to the method description as this information can be crucial for the future development and advancement of the index.

Nardo et al. (2008) emphasise that minimising the number of variables in the index may be desirable for increased transparency and parsimony. Furthermore, composite indicators often mix input and output indicators related to the same phenomenon (e.g. R&D expenditures (inputs) and the number of new products and services (outputs), which is not ideal. Instead, it is recommended to only include output indicators. Although the use of another composite indicator as a data source may be contemplated, Panella & Caperna (2023) advise caution. Using another composite indicator may compromise transparency of the index. Hence, indicators from another index should instead be integrated individually, possibly with adjusted weights.

Joumard & Gudmundsson (2010) provide comprehensive guidelines for selecting indicators for sustainable transport analysis. They identify transport infrastructure, energy and vehicles, each comprising activities that impact environmental sustainability, as the core components of transport systems. The activities associated with these components highly rely on the interplay of different sectors as they include the building, existence, maintenance and destruction of infrastructure, final electricity generation and distribution, fuel production and distribution, and the production of vehicles, their existence, maintenance and destruction (Joumard & Gudmundsson, 2010).

4.2.2.2 Data Analysis & Treatment

Often, data required for each observed unit (e.g. each country) is not uniformly available or formatted for direct use for composite indicator construction. The essence of this step is to understand the data and prepare it for the subsequent construction steps.

Data exploration & preparation

Depending on the indicator, its data sources, data type and other factors, different methods are available to analyse and treat data when necessary. In their 10-Step Pocket Guide for Composite Indicator Construction, Saisana et al. (2019) emphasise the importance of visualising individual indicators' distributions, like histograms or scatter plots, for an initial data understanding. They advise ensuring at least 65% data availability for each indicator and country before its inclusion. Once an indicator has been included, missing data can be dealt with in different ways and a decision needs to be made on whether to impute the data and which method to use. Often, 'proxy' or 'default' values are used. In addition, outliers need to be discussed and addressed, and it is essential to ensure that such outliers do not become unintended benchmarks. Completion of these steps results in a complete populated dataset with no missing values, as indicated by Nardo et al. (2008). In addition, the reliability of each imputed value is assessed to determine its impact on the composite indicator. The documentation includes the imputation procedures for missing data and outliers, as well as an explanation of the choice of imputation procedure and its results.

Multivariate analysis

In addition, Nardo et al. (2008) point out the importance of assessing the interrelationships between indicators to support the assessment of the appropriateness of the dataset and provide an understanding for the methodological choices in the following construction steps. Multivariate statistical analysis is concerned with analysing and understanding data in high dimensions (Härdle & Simar, 2019). Consequently, the steps aim to shed light on the underlying structure of the data by grouping the data into the individual indicator dimensions and relating them to the individual indicators. On the one hand, this can help to identify subgroups of the indicators or groups of countries that are statistically similar. On the other hand, it helps to structure the data set and compare it with the theoretical framework developed in Phase 1 to assess its suitability. It can contribute to assessing whether the dimensions of the framework are conceptually balanced and can stimulate discussions on the need to revise the individual indicators.

As with the above steps, detailed documentation of the results of the multivariate analysis as well as the interpretation of the components and factors is required. Possible measures to consider include principal component analysis, factor analysis, Cronbach's coefficient alpha and cluster analysis. Härdle and Simar (2019) offer a comprehensive explanation of applied multivariate statistics methods that may be considered in this context.

4.2.2.3 Normalisation

Once the data set is complete, the next step in the construction process is to normalise the data. This step is necessary to prepare the indicators in the dataset, which frequently have different units of measurement, for the aggregation step. As Nardo et al. (2008) simply puts it, this step ensures that the units of measurement are on a common scale or dimensionless to ensure that apples and oranges are not added together. Normalisation methods come into play when different units of measurements are represented by the chosen indicators, but also if indicators have a different distribution and/or variance or the measurement scale of the indicators showcase polarity (Domínguez-Torreiro, 2023). As such, this step requires the constructor to make directional adjustments so that higher indicator values correspond to better performance, and to select appropriate normalisation methods that take into account the conceptual framework and data properties (Saisana et al., 2019).

(Domínguez-Torreiro, 2023) differentiates between linear transformations, which do not modify the shape of the original distribution, such as Min-Max, Distance to target/reference and Z-scores, and non-linear transformations. Non-linear transformations include (percentile) ranking, categorical scale, and quantity normalisation. In addition to these methods Nardo et al. (2008) outline scale transformation before normalisation, Indicators above or below the mean, Methods for cyclical indicators, Balance of options and percentage of annual difference over consecutive years, as possible techniques for normalisation when constructing composite indicators.

Illahi & Mir (2020) identified seven normalisation methods commonly used in the development for composite indicators for sustainable transport across 24 analysed indexes, noting that choosing the right normalisation method is critical to the robustness of the index developed. The methods identified include: 1) Min-Max, 2) Z-score, 3) Likert Scale, 4) Lookup tables, 5) Distance from leader, 6) Distance from average and 7) Borda Count. The following table outlines the advantages and disadvantages of these methods based on the analysis of Illahi & Mir (2020).

Table 5. Advantages & Disadvantages of Normalisation Methods for Sustainable Transport Indexes

Method	Advantages	Disadvantages
Min-Max	Ensures uniform scaling across all features.	Vulnerable to outliers, which can distort the normalised outcome.
Z-score	Efficiently manages outliers.	Does not ensure the same scale for normalised data.
Likert scale	Transparent choices; intuitive; speeds up feedback collection.	Potential for biased or skewed results; sometimes challenging to pick between close scale options (e.g., 'agree' vs 'strongly agree').
Lookup table	Straightforward to implement and maintain.	Concerns with data integrity; may not scale well; lacks flexibility; generally less efficient.
Distance from leader	Useful for setting time-bound goals.	Relies on potential extreme values, which might be untrustworthy outliers.
Distance from average	Simple to apply; resilient against outliers.	The threshold level can be arbitrary; absolute value information might get lost.
Borda count	Considers all preferences; ideal for surveys with multiple options; rare instances of violating fairness criteria.	Can breach the absolute majority criterion; might be less dependable in certain contexts.

Source: Illahi & Mir (2020)

4.2.2.4 Weighting

In the preparatory discussions for the State-of-Knowledge report, weighting was often described as the most difficult and delicate step in index development, where opinions on the method to be chosen often diverge. This experience is also reflected by Kovacic (2023), who points out that, firstly, there is no standardized approach and, secondly, the weights chosen have a significant impact on the final score and rank. As with the previous steps, it is crucial to choose weighting methods that are consistent with the framework and overall objective of the index and that the selection process remains transparent.

Broadly speaking, weighting methods can be divided into three categories: Equal weighting, weighting based on statistical methods such as PCA, Data Envelop Analysis (DEA) or regression, and weighting based on public opinion/expert opinion such as Analytic Hierarchy Process (AHP), budget allocation or conjoint analysis. In addition, it is recommended to conduct expert interviews to understand the relative importance of indicators and dimensions and whether correlations between indicators should be considered in weighting (Saisana et al., 2019).

Illahi & Mir (2020) identified five weighting methods commonly used in the development for sustainable transport indexes: 1) Equal Weights (EW), 2) Principal Component Analysis/ Factor Analysis (PCA/FA), 3) Expert Opinion/ Delphi Method (EO/DM), 4) Analytic Hierarchy Process (AHP) and 5) Data Envelopment Analysis (DEA). The following table outlines the advantages and disadvantages of these methods based on the analysis of Illahi & Mir.

Table 6. Advantages & Disadvantages of Weighting Methods For Sustainable Transport Indexes

Method	Advantages	Disadvantages
Equal Weights (EW)	Simple and reproducible application; uncomplicated approach.	Does not allow differentiated understanding of indicator relationships; risk of double weighting of indicators.
Principal Component Analysis/ Factor Analysis (PCA/FA)	Mitigates risk of double weighting of indicators; allows non-grouped categorisation of indicators.	Dimensions of tenability are not predictable, actual weighting may vary.
Expert Opinion/ Delphi Method (EO/DM)	Transparent; enriched by the involvement of experienced professionals.	Potentially biased, risk of valuing concerns over actual importance; tends to be area or country specific.
Analytic Hierarchy Process (AHP)	Adaptable; supports hierarchical structures consistent with sustainability; handles both quantitative and qualitative data; facilitates structured verification.	Requires numerous pairwise comparisons; can lead to inconsistencies due to too many indicators within clusters.
Data Envelopment Analysis (DEA)	Facilitates efficient integration into index development; optimises weighting selection to maximise the index for each unit.	Results lack transparency and comparability; different possible solutions exist.

Source: Illahi & Mir (2020)

4.2.2.5 Aggregation

Saisana et al., (2019) explain that the aggregation process involves decisions such as determining the level of aggregation, selecting the most appropriate methods consistent with the index objectives, and ensuring the transparency and communicability of the chosen techniques. In addition, deciding whether to allow compensability between indicators is crucial.

Caperna (2023) categorises aggregation methods into those based on averages, rankings and pairwise comparisons. Furthermore, aggregation methods can be divided into two groups: compensatory and non-compensatory. Compensatory methods, such as linear and geometric aggregation, allow the underperformance of one indicator to be offset by the over-performance of another within the index or sub-index. Non-compensatory methods, including multi-criteria approaches (MCA), do not allow such a balancing (Nardo et al., 2008; Saisana et al., 2019; Caperna, 2023). Whereas the arithmetic mean, for instance, allows perfect and constant substitutability between indicators, the geometric mean offers only partial substitutability and penalises unbalanced performance more severely than the arithmetic approach. Caperna (2023) argues that, despite normalisation and weighting being rather subjective, aggregation can be based on scientific principles to ensure the consistency and meaningfulness of a composite indicator. They argue that regardless of how the different scales and dimensions are adjusted (i.e. through normalisation and weighting) to combine them into a single index, it is crucial that the end result reflects the same reality.

In their study, Illahi & Mir (2020) examined eight aggregation methods commonly used in the development of composite sustainable transport indicators. Their analysis found that 43% of the indexes used linear aggregation or weighted linear combination methods. About 19% used a simple additive rule or simple additive weighting and around 10% each used geometric aggregation, Euclidean distance, or the root-mean-square method for aggregation. The following table summarises these methods and outlines their respective advantages and disadvantages, as described in detail by Illahi & Mir.

Table 7. Advantages & Disadvantages of Aggregation Methods for Sustainable Transport Indexes

Method	Advantages	Disadvantages
Linear Aggregation / Weighted Linear Combination (LA/WLC)	Straightforward, transparent, allows easy sensitivity analysis and uncertainty assessment	Requires strict prerequisites such as the condition of mutual preferential independence
Geometric Aggregation (GA)	Transparent methodology, applicable to all ratio-scale indicators, discourages imbalanced performance profiles	Requires strict prerequisites such as the condition of mutual preferential independence
Concave Aggregation (CA)	Balances the features of LA and GA	Less reliable than GA; constant dependency
Simple Additive Rule / Simple Additive Weighting (SAR/SAW)	Simple transparent, permits straightforward sensitivity analysis and uncertainty assessment	Requires strict prerequisites such as the condition of mutual preferential independence
Root Mean Square (RMS)	Simplifies index development, does not require weighting, heavily penalizes large errors which is beneficial when such errors are especially problematic	Ambiguous as variability varies within the distribution
Euclidean distance (ED)	Treats economic, social, and environmental dimensions equally, simple calculation	Potential for unclear indicator interrelations; possibility of double counting an indicator
Concordance Analysis Technique (CAT)	Determines the relative preference of options based on a specific weighting scheme	Complex to comprehend for non-specialists and the general public

Source: Illahi & Mir (2020)

To conclude this section, it has been shown that rigorous and detailed documentation of procedures and construction decisions is crucial for the fulfilment of quality criteria in the development of a transparent index. A review of academic and grey literature and other resources has shown that testing multiple methods and selecting those that are best suited to achieve the main objective of the indicator and support the framework developed in phase 1 is required. The next phase will focus on validating the constructed index and provide feedback for phase 2 to iteratively adapt the selected methods where necessary.

4.2.3 Phase 3: Evaluation of the Index

4.2.3.1 Ensuring Quality and Transparency

Following Nardo et al. (2008) a composite indicator needs to be relevant, accurate, credible, timeless, accessible, interpretable and coherent. Furthermore, they point out the fitness-for-purpose principle to ensure the aggregate index, its individual dimensions and indicators adhere to the user needs.

In his presentation at the CC-Coin "2023 - JRC Week on Composite Indicators and Scoreboards", Becker (2023) discussed the importance of composite indicators meeting the TRACE criteria, which stands for transparency, robustness, accuracy, credibility and the engagement of stakeholders. Essentially, he talks about ensuring robustness by assessing the uncertainties of the index, automating, and avoiding errors to get accurate results, following established guidelines, continuously examining, visualising and paying attention to statistics throughout the development process to ensure the credibility of the final product. Furthermore, this includes involving stakeholders and experts from the outset to ensure that the index is tailored to the needs of its user groups, engaging end users to support the validation of the framework, the methods chosen and the end results that the composite indicator captures and ensuring that these results are communicated in a useful and effective way.

4.2.3.2 Statistical Coherence of the Indicator Framework and Data

The assessment of the static and conceptual coherence of the overall index, its dimensions and indicators include analysing the correlation to assess their balance, the over- or under-representation of indicators and whether the level of aggregation is appropriate. This involves examining whether the indicators are assigned to the right dimension, whether indicators are over- or under-represented and up to which level the index should be aggregated.

Among other things, this is a way to reflect on the quality of the index and determine whether changes such as splitting or merging dimensions are necessary, and to recognise possible biases and inconsistencies (Saisana et al., 2019). According to Papadimitriou (2023), there are three common methods that are often used to assess the coherence of the indicator framework and the underlying data. These include correlation analysis, PCA analysis and reliability analysis (Cronbach's alpha).

These analyses are intended to help the constructor of the index to reflect on the results of the index and to examine where these results come from. They can trigger a discussion about possible shortcomings of the composite indicator and help to clarify whether the phenomenon being measured is captured by the dimensions, indicators, and data. As a result, consideration can then be placed on adjusting the overall framework and methodology and examining the data in more detail to assess whether the data quality, availability and proxy data could be steering the composite indicator in the wrong direction.

4.2.3.3 Robustness and Sensitivity

When assessing the robustness and sensitivity of an index, the inherent uncertainties associated with the chosen methodology to accurately reflect the intended phenomenon must be closely examined. This assessment includes examining the impact of these uncertainties on the final index scores and rankings, as well as conducting sensitivity analyses to determine the degree of uncertainty introduced by the underlying assumptions. Such analyses provide a clearer understanding of the impact of changing assumptions and enable index developers to make these variations transparent.

To improve the understanding of how the rankings and scores withstand changes in the modelling approach, Saisana et al. (2019) suggest providing the full rankings and scores along with confidence intervals. Borgonovo (2017) emphasises the need to provide more than just a single value for responsible decision-making. This includes recognising uncertainties surrounding that single value when uncertain inputs are involved and showing which input parameters most influence the output and the associated uncertainties. Becker (2023) notes that while each step in the development of a composite indicator involves some degree of uncertainty, it is critical to assess the uncertainty inherent in the index itself, its components, and the methods and assumptions chosen. This assessment determines how consistently the index performs amidst these uncertainties. A low level of uncertainty correlates with high robustness, while high sensitivity indicates lower robustness. Although essential for validation, uncertainty and sensitivity testing can be labour intensive as it essentially requires multiple reconstructions of the index to test different alternatives in terms of data, weights, selected variables, normalisation, and aggregation methods according to an experimental design. Common methods include "what-if" analyses to assess the impact of different alternatives, "dominance pairs" derived from an outranking matrix to identify pairs with a higher percentage of dominance - indicating greater robustness to changes in weighting and methodology - as well as examining correlations between indicators to thoroughly understand the data from collection to derivation of final results.

4.2.4 Phase 4: Application, Presentation & Dissemination

The final phase in the development of a composite indicator involves the application and transparent dissemination of the composite indicators results and methodology. This phase is not only about interpreting the results generated, but also about presenting it in an accessible and effective manner. Phase 4 has two core aspects: 1) Telling the story of the composite indicator and 2) communicating the appropriate knowledge products and supporting documents to end users in a way tailored to the different end-user types (Alberti, 2023; Moura, 2023; Neves, 2023).

Telling the story of a composite indicator in essence, means developing a narrative that not only informs but also captivates, creating visuals that are insightful, and providing data-driven insights that both educate and inspire users of the index. This step is about answering the fundamental questions raised by the index and uncovering the stories in the data. It includes pinpointing the strengths and weaknesses of the assessed entities e.g., countries, not only overall, but also across the various dimensions and sub-dimensions. Furthermore, analysing correlations within the indicator framework, between entities or in comparison with other indexes can provide valuable insights. Visualisations can also stimulate further reflection and discussion, potentially revealing inaccuracies in the data or encouraging exploration of data relationships and calling for further stakeholder exchanges (Neves, 2023).

Moreover, it is important to adapt the communication of the results to the different needs of the various end users. Alberti (2023) provides an overview of the typical users of indexes and their different requirements for the communication material for a composite indicator. The dissemination of a composite indicator needs to be tailored to the interests, knowledge, and data literacy of the target audience to ensure that the information is not only accessible but also actionable for each group. While scientists or experts may focus on increasing their knowledge and have a high level of data literacy, decision makers use the composite indicator to support evidence-based decisions and need a synthesis of information that is both concise and actionable. Media and multipliers, on the other hand, are interested in disseminating insights to a wider audience, and citizens may be rather interested in exploring the results to raise awareness. The level of technical detail required from end users varies. While throughout the development process it is important to be transparent about assumptions and weaknesses, effective communication of limitations depends on the target audience. Policy makers, for example, may require a simplified explanation of the relevant constraints, while researchers may seek a thorough understanding of the methodological underpinnings. In contrast, other users, such as citizens may not require detailed information about constraints if they are not relevant to their use case (Alberti, 2023).

Knowledge products can be broadly divided into two categories: "detailed and technical" and "generalist and short messages". Detailed and technical knowledge products include reports and policy briefs, which are available both online and in print, as well as country/region/city profiles and online tools, the latter requiring specific knowledge of coding and data visualisation. Generalist and short message products include infographics and newspaper articles, available both online and in print, with infographics requiring graphic design skills, videos and social media posts (Alberti, 2023).

4.2.5 Practical implications for the development of the TDI

The development of the TDI will be carefully guided by the framework described above, which adheres to the key phases of index development: 1) setting the objectives and defining the phenomenon, 2) iterative construction of a composite indicator, 3) validation of the composite indicator, and 4) application, presentation and dissemination.

In the initial phase, the development of the TDI will centre on clearly defining its overall purpose and objectives and identifying its key end users. This phase will be particularly important to ensure that the TDI captures the multiple aspects of land transport in a way that is both standardised and localised, addressing the specific challenges of LMICs. The identification and involvement of stakeholders from the outset is critical to aligning the TDI with the needs and expectations of its target audience.

The development of the TDI should go beyond a purely data-driven approach and pursue a concept-driven methodology. This requires a clear understanding of the "what", "why" and "how" aspects of the index. It includes the selection of variables and indicators based on criteria such as robustness, timeliness, accessibility and comparability, while also taking into account practicability for the target regions. To ensure the credibility and value of the index, the index developers shall ensure transparency throughout the construction process. In addition, the TDI will be developed in an iterative process that facilitates continuous refinement and allows for flexible adaptation of the various dimensions, indicators and construction methods. This iterative approach is designed to ensure the statistical soundness and robustness of the TDI and will be underpinned by the testing of various statistical methods throughout the index construction.

Recognising that transport decisions are not solely based on decarbonisation, the TDI project will follow the methodological procedures described above, taking into account the wider co-benefits of transport, such as integration, access, economic development and road safety. It is essential to place decarbonisation in the context of these additional benefits so that the TDI can provide a holistic and comprehensive view of transport progress.

4.3 Review of Selected Indexes relating to Surface Transport and/or Decarbonisation

To develop a novel TDI and underlying indicator framework assessing existing indexes and initiatives monitoring the state and progress towards sustainable and/or low emission transport is vital. This section will provide an overview of indexes and present them in a structured format. The indexes identified and selected include:

- Net Zero Readiness Index (NZRI)
- Net Zero Economy Index (NZEI)
- Janus Henderson Decarbonisation in Emerging Market Index
- MSCI Index carbon footprint metrics
- Global Sustainable Mobility Index (GSMI)
- Sustainable Urban Transport Index (SUTI)
- Sustainable Cities Index
- Global Electric Mobility Readiness Index
- Utility Decarbonisation Index
- GlobalABC Climate Tracker
- Urban Mobility Readiness Index

These had been applied to specific countries in the target regions, at varying degrees (Table 8). As mentioned in the methodology section, the review is meant to highlight various approaches, methods, and not just data sources.

Table 8. Selected Indexes and their Applications in the Target Regions

Country	Region	NZRI	NZEI	Decarbonisation in EM Index	GSMI	SUTI	Sustainable Cities Index	Global Electric Mobility Readiness Index	Urban Mobility Readiness Index
Bangladesh	South Asia		X		X	X	X		
Bhutan	South Asia			X	X	X			
India	South Asia	X	X	X	X	X	X	X	X
Pakistan	South Asia		X	X	X	X	X		
Nepal	South Asia				X	X			
Sri Lanka	South Asia				X	X			
South Africa	SSH Africa	X	X		X		X	X	X
Cameroon	SSH Africa				X		X		
Cote d´Ivoire	SSH Africa				X		X		
Ghana	SSH Africa				X		X		
Kenya	SSH Africa				X		X		X
Nigeria	SSH Africa				X		X		X

Senegal	SSH Africa				X		X		
Tanzania	SSH Africa				X		X		

4.3.1 Net Zero Readiness Index (NZRI)

The KPMG Net Zero Readiness Index (NZRI) is an indicator that compares the progress of 32 countries in reducing greenhouse gas emissions and assesses their readiness and ability to achieve net zero emission by 2050. The index focus is on country comparisons, but also allows comparisons between sectors consisting of two dimensions: 1) national preparedness score, 2) sectoral readiness.

Figure 23. Illustrative Example of the NZRI and Selected Subdimensions

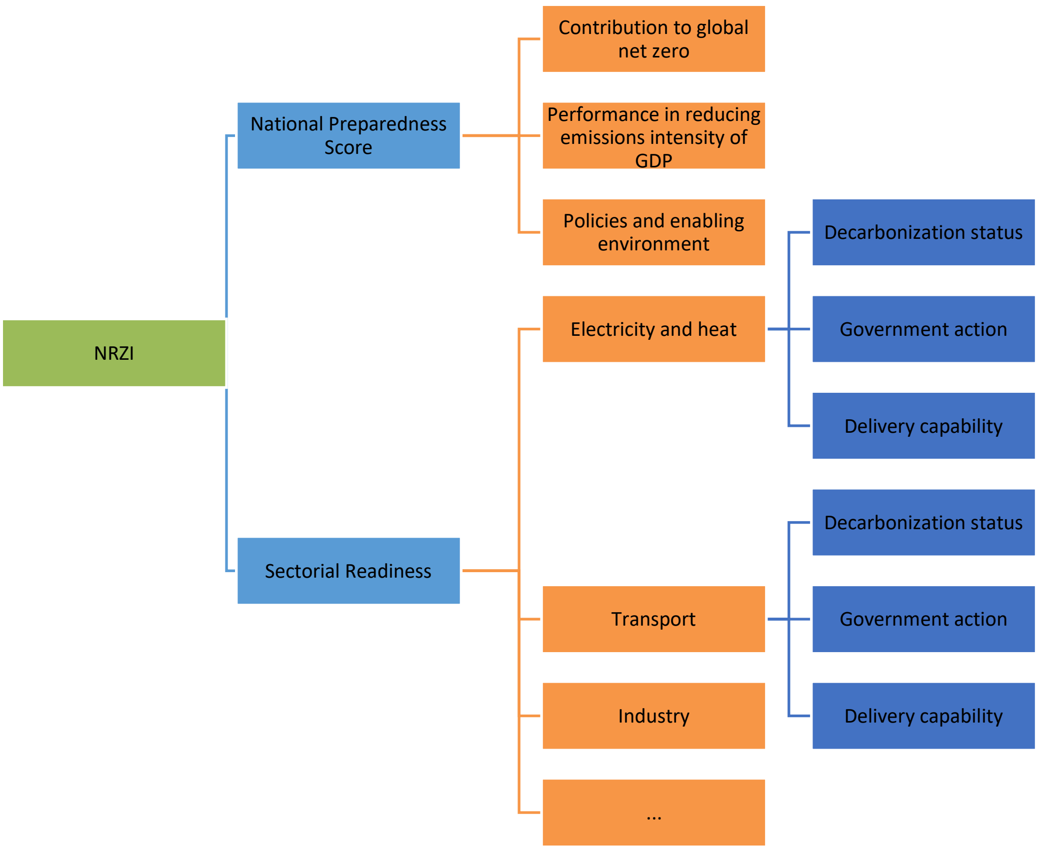


Table 9 outlines the key characteristics of the NZRI, its methodology and key-takeaways for the development of a surface TDI.

Table 9. Overview and Assessment NZRI

Introduction	
Organisation	KMPG
Est. Year	2021
Update frequency	Not Available
Target group	The index is targeted in particular at governments and the public sector, multilateral organisations, investors and financial institutions, the private sector,

	and the general public. However, as stated in the index description, it is aimed fundamentally at any organisation, department, company or individual with an interest in or responsibility for driving the Net Zero agenda.
Coverage	National & Sectoral
Regional focus	Global
# Countries	32
# of LMICs	12
LMICs in South Asia & SSH Africa	India, Nigeria, South Africa
Methodology	
Description of the framework	The NZRI consists of two dimensions: 1) national preparedness score, 2) sectoral readiness. National readiness comprises the sub-dimensions “contribution to global net zero”, “performance in reducing the emissions intensity of GDP” and the sub-dimension “policy and enabling environment”. Sectoral readiness comprises the five sub-dimensions “electricity and heat”, “transport”, “buildings”, “industry” and “agriculture, land use and forestry”. Each sector is assessed based on the 2nd subdimension “decarbonization status”, “government action” and “delivery capability”. In total 103 indicators are aggregated to retrieve the final NRZI score. The overall NZRI score for each country is calculated by multiplying the national readiness score by the overall sectoral score and dividing by 100.
Benchmark	Country to country
# dimensions	2
# subdimensions	8
# indicators	103
Indicators directly focused on surface transport / decarbonisation	● **Dimension Sectorial Readiness – Subdimension Transport** □ Inland transport activity □ Emissions per capita □ Adoption of electric vehicles □ Availability of public transport □ Prevalence of vehicle sharing □ Availability of electric vehicle charging infrastructure □ Average age of passenger cars □ Ban on sale of internal combustion engines □ Incentives for electric vehicles □ Electric vehicle charging legislation □ Low-carbon fuel mandates □ Biofuel blending obligations □ Planned investment in public transit □ Electric vehicle charging infrastructure market size □ Clean transport patents □ Clean transport companies

	• **National Preparedness:** □ **Contribution to global net zero:** Emission to decarbonise after meeting nationally-determined contributions (NDC) targets, Emission reduction progress, Presence of a Net Zero target □ **Performance in reducing emissions intensity**: Emissions intensity of GDP (present), Emissions intensity of GDP (growth) □ **Policies and enabling environment:** Presence of agency, Transparency on emissions, Enabling environment for climate finance, Availability of climate finance (market size), Availability of climate finance (growth), Fossil fuel subsidies, Carbon capture and storage (CCS) policy, Planned carbon capture and storage (CCS) capacity, Transformation readiness, public belief in climate change, public support for climate action • The selection of indicators used in the NZRI is subject to availability of comparable data across the countries
Data imputation	Methods for data imputation vary across different indicators. Methods mentioned in the KMPG NZRI Report include: • Using the measure from the country with the closest GDP per capita • Average score of a country's income group • Average percentage for the region the country is located • Average percentage for the country's income group
Normalisation	Min-Max
Weighting	Equal Weighting, Analytic Hierarch Process
Aggregation	Arithmetic mean, Weighted mean
Dissemination & Availability	
Communication channels	Interactive website, Online Country profiles, Report, Interactive PDF
Accessibility of input data	The Annex of the NZRI provides a comprehensive overview of the included indicators and methods used for the construction of the index. Furthermore, it details the data sources consulted for each of the indicators. The concrete input values in the form of a dataset are not available.
Accessibility of output database	The results of the NZRI are available in different formats e.g. in the final report or online overall and as country profiles. A dataset of the output values is not available. The calculations are described in an easily understandable way and the data sources are transparent. The data sets are not made directly accessible.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• The NZRI uses a range of data sources amongst other from the OECD, IEA, European Alternative Fuel Observatory, World Bank, CIA World Factbook, Our World in Data, BP Statistical Review of World Energy and Ember, World Resource Institute (WRI), Climate Watch, Climate Bond Initiative, International Monetary Fund (IMF) and the UN Sustainable Development Goals indicators database. • Furthermore, several indicators are based or supplemented with data originating from research conducted by KPMG.

	• While it is expected that the above-mentioned sources may also provide key data for countries in LMICs in South Asia and Sub-Saharan Africa, the developers of the TDI are expecting that their own data collection efforts will be crucial for the development and application of the TDI.
Core benefits & learnings	• The indicators excluded by the NZRI and their underlying considerations to be considered for developing the Surface TDI include: □ **Population and population growth**, as NZRI countries are at different stages of their demographic transition, as well as **GDP per capita and GPD per capita** growth since higher incomes and growth rates can function as important enablers of decarbonisation. □ **Emissions intensity of imports and exports:** To avoid penalizing any country for existing import dependency and economic structures. □ Presence of **carbon markets, carbon pricing and carbon taxes:** Due to the complexity of varying sector and commodity coverage across countries. □ **Emissions from road and rail freight:** As these emissions are not tracked in a comparable manner across countries. • The NZRI aims to consider some of these indicators in subsequent iterations as data availability and comparability across countries improves; as part of the TDI construction the availability, comparability and relevance of these indicators shall be assessed

Source: (KMPG, 2021)

4.3.2 Net Zero Economy Index (NZEI)

The Net Zero Economy Index (NZEI) is an annual index used by PWC to measure progress in reducing energy-related CO_2 emissions and decarbonising economies. Its principal purpose is to calculate national and global carbon intensity (CO_2/GDP) and the rate of change in carbon intensity required by 2050 to limit warming to 1.5°C above pre-industrial levels.

Figure 24. Illustrative Example of the NZEI

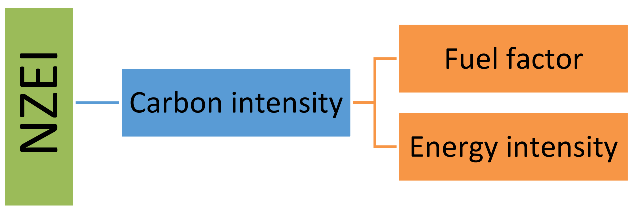


Table 10 outlines the key characteristics of the NZEI, its methodology and key-takeaways for the development of a surface TDI.

Table 10. Overview and Assessment NZEI

Introduction	
Organisation	PwC
Est. Year	2009
Update frequency	Annual

Target group	The index is aimed at everyone, from communities and local authorities to political decision-makers and companies.
Coverage	National and global, E7, G7 and G20 aggregation
Regional focus	Global
# Countries	67
# of LMICs	30
LMICs in South Asia & SSH Africa	India, Bangladesh, Pakistan, South Africa
Methodology	
Description of the framework	The NZEI consists of a single dimension, namely: carbon intensity. It is measured as the product of two factors that are analysed as separate sub-dimensions: 1) fuel factor and 2) energy intensity. As a comparative variable, the NZEI calculates the necessary global carbon intensity reduction, using the IPCC carbon divided by the projected increase in global GDP, to estimate the required reduction in carbon intensity needed to limit warming to 1.5°C.
Benchmark	Year to year, Country to global
# dimensions	1
# subdimensions	2
# indicators	3
Indicators directly focused on surface transport / decarbonisation	• This index does not have a dedicated focus on surface transport. However, it has a clear focus on decarbonisation. The three output indicators include: □ Fuel factor: as an indicator of a country's transition to renewable energy sources □ Energy intensity: as an indicator of the energy required to produce a given amount of GDP □ Carbon intensity: as the product of fuel factor and energy intensity
Data imputation	• Not available
Normalisation	-
Weighting	Equal weight
Aggregation	Geometric aggregation
Dissemination & Availability	
Communication channels	Report, Interactive Website
Accessibility of input data	• The annual NZEI report outlines data sources consulted for the construction of the index. These include the IPCC carbon budget and emission factors, GDP

	values by the World Bank and predictions by the OECD and PwC's internal data, the IEA, and Energy Institute's Statistical Review of World Energy. No data set of input variables is available.
Accessibility of output data	• PwC makes the final results of the NZEI with the output data from 2000 to 2022 available for download on the PwC website (Spreadsheet). In addition, the interactive web dashboard allows exploration of different display formats and filter options. The output variables include the fuel factor, energy intensity and carbon intensity as absolute values as well as annual percentages.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• While the TDI team is optimistic about the availability of country-level data for some countries such as India, Pakistan, Bangladesh, and Sri Lanka, it expects data gaps for other counties in the target regions. For example, the Statistical Review of World Energy does not include country-level data for many countries on the African continent. Therefore, other open data sources and approaches to ensure data quality need to be explored.
Core benefits & learnings	• Although the NZEI is not primarily concerned with surface transport, its methods and indicators nevertheless provide valuable insights for the development of the TDI. As one of the core drivers in the transition to more sustainable surface transport are electric and alternative fuelled vehicles, environmentally friendly energy systems are key. Considering such aspects and examining how best to integrate them into the TDI will therefore be an important task.

Source: (PwC, 2023)

4.3.3 Janus Henderson Decarbonisation in Emerging Market (EM) Index

The Janus Henderson Decarbonisation in EM Index shows a combination of successful initiatives, policy frameworks and financing for decarbonisation in emerging markets.

Figure 25. Illustrative Example of the Decarbonisation in EM Index

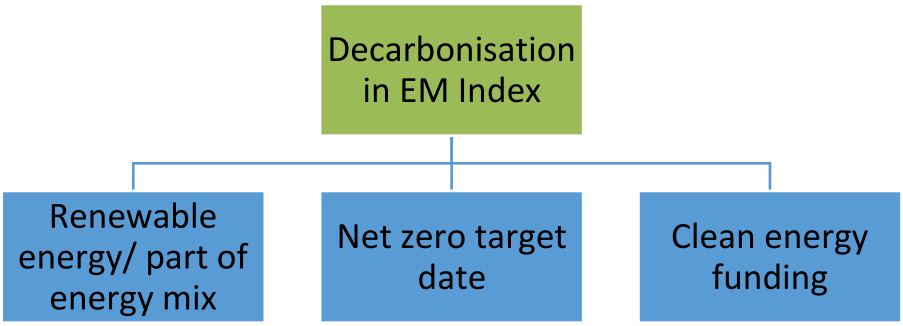


Table 11 outlines the key characteristics of the Janus Henderson Decarbonisation in EM Index, its methodology and key-takeaways for the development of a surface TDI..

Table 11. Overview and Assessment Decarbonisation in EM Index

Introduction	
Organisation	Janus Henderson
Est. Year	2022
Update frequency	NA
Target group	The target group includes anyone from academic experts, to NGOs, national policy makers, industry executives, and more.
Coverage	National and regional
Regional focus	Latin America and Asia
# Countries	38 (26 in Asia, 12 in Latin America)
# of LMICs	Min. 20 (overview not easily accessible)
LMICs in South Asia & SSH Africa	India, Bhutan, Pakistan
Methodology	
Description of the framework	The Janus Henderson Decarbonisation in EM Index is constructed as an equally weighted index that evaluates three trends that can be effectively tracked over time. Each trend is tracked via a proxy indicator, which is assumed to help track the degree and speed of progress in decarbonisation trends now and in the future. The index is constructed based on an equal weighted index of scores for three trends: □ Renewable energy as part of total energy final consumption □ Net zero target dates □ Climate bond issuance to date

Benchmark	Country to country
# dimensions	3
# subdimensions	None
# indicators	3
Indicators directly focused on surface transport / decarbonisation	While the indicators are not directly focused on surface transport, these are also relevant for the decarbonisation of the sector: • Renewable energy % (>30%, 15-30%, <15%) • Commitments towards net zero (Before 2040, 2040-2050, Beyond 2050) • Levels of clean energy funding (>$50bn, $1-50bn, <$1bn)
Data imputation	• Scores are defined for each of the dimensions, for example • Renewable energy mix (>30% = 2 points; 15%-30% = 1 point; <15% = 0)
Normalisation	None
Weighting	Equal between the dimensions
Aggregation	The country level composite scores are then aggregated at the regional level using weights based on real GDP per capita in PPP dollars
Dissemination & Availability	
Communication channels	Report disseminated through the website
Accessibility of input data	• Sources are mentioned for the three dimensions and individual data points are integrated in the report. No downloadable data set available.
Accessibility of output data	• The index results are provided in comprehensive, individual summary reports for each region. The output data in these report is aggregated. For leading countries, more in-depth information is available. However, there are no options for downloading the data set or accessing open data tables.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• Renewable energy data available for 224 countries through the IRENAstat • NDC commitments available • Data from climate bonds initiative also seem have limited data for African countries (South Africa, Egypt, Morocco, Mauritius, Nigeria, Namibia, Seychelles, Kenya, Ghana)
Core benefits	• Points towards databases with relevant information • Simple scoring mechanism might be useful, but assigning scores should be conducted with care

Source: (Janus Henderson Investors, 2022b, 2022a)

4.3.4 MSCI Index Carbon Footprint Metrics

The MSCI Carbon Footprint metric measures the carbon footprint of MSCI's global flagship indexes with the aim of helping asset owners and asset managers understand, measure, and manage the carbon risk in their portfolios. This metric is independent of ownership and therefore allows comparison with asset classes other than equities. It shows the exposure of a portfolio to potential risks related to climate change compared to other portfolios or a benchmark.

Table 12. Overview and Assessment MSCI Carbon Footprint Metrics

Introduction	
Organisation	MSCI
Est. Year	2015
Update frequency	Not available, last updated: 2021
Target group	Investors, asset owners and asset managers
Coverage	Financial indexes
Regional focus	Global
# Countries	-
# of LMICs	-
LMICs in South Asia & SSH Africa	Potential relevance: • MSCI All Country World (ACW) Index • MSCI Emerging Markets Index • MSCI Pacific Index
Methodology	
Description of the framework	The MSCI carbon footprint metric provides the weighted average carbon intensity of flagship MSCI Indexes. It considers the scope 1 and scope 2 emissions of companies in a portfolio. The carbon footprint metric comprises two core input variables, which are the total carbon emissions in tons CO_2 equivalent based on the ownership share and the carbon emissions per company and the carbon emissions in tons CO_2 equivalent/$M invested. The two output variables are the carbon intensity of a portfolio (Total emissions/total sales) based on company sales and the weighted average carbon intensity based on the portfolio weight of each company. The required data is usually reported by the companies.
Benchmark	• Financial indexes to financial indexes • Portfolios to portfolios
# dimensions	1
# subdimensions	None
# indicators	4

Indicators directly focused on surface transport / decarbonisation	None
Data imputation	• <u>If data is not reported:</u> Scope 1 & 2 carbon emissions are estimated using MSCI's proprietary carbon estimation mode. Even though Scope 3 emissions are reported where available, MSCI does not estimate Scope 3 since the definitions of which emissions should or should not be included in Scope 3 are not well defined or consistently calculated by companies. • Methods for estimation: □ Use of the company-specific intensity model based either on the emissions data previously reported by the respective company or, in the case of electricity suppliers, on the fuel mix used by the company for electricity generation. □ If the company does not provide data, the Global Industry Classification Standard (GICS®) Sub-Industry Model is used. □ For companies that have not reported data and MSCI does not have access to the GICS sub-industry data, the Economic Input-Output Life-Cycle Assessment Model is used.
Normalisation	Scaling: □ carbon emission by $M invested □ carbon intensity by $M sales
Weighting	Portfolio weight
Aggregation	Linear Aggregation
Dissemination & Availability	
Communication channels	Report
Accessibility of input data	Not available. Data used for the calculation is reported directly to MSCI by the respective companies.
Accessibility of output data	Aggregated scores are published publicly in a report for an entire index.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	□ Accessibility of open company level data very unlikely for the development of the TDI. □ Relevance questionable.
Core benefits & learnings	• Frankel et al. (2015) provides not only a comprehensive overview of the methodology used for carbon footprinting, but also insights into how to ensure carbon data quality. • TDI can aim to publish aggregated as well as disaggregate results. Publishing input data open access can be a leverage to increase data availability and accessibility.

Source: (Frankel et al., 2015; MSCI, 2021a)

Box 1. MSCI Net-Zero Tracker

While not a dedicated composite indicator, the MSCI Net-Zero Tracker provides quarterly insights into the world's public companies in mitigating climate risk since July 2021. Building upon the MSCI carbon footprint metrics outlined in section it aims to provide investors, companies, financial intermediaries and policymakers with the collective progress towards net-zero and the alignment of listed companies with the Paris Agreement (MSCI, 2021b). Based on the most recent report from November 2023 indicators included to track the companies' progress global climate goals are outlined in Table 13.

Table 13. Indicators Tracking the Progress towards Climate Targets in the MSCI Net-Zero Tracker

Category	Indicators

Emissions	• Scope 1 emissions in developed markets from 2016 to 2021 (listed companies' emissions vs. governments)
	• Annual changing in Scope 1 emissions from 2016 to 2021 (listed companies' emissions vs. governments)
	• Prediction of Scope 1 emissions in developed markets in the next decade (listed companies' emissions vs. governments)
	• Projected change in absolution Scope 1 emissions 2022-2030 (listed companies' emissions vs. governments)
	• Historical GHG emissions: Global vs. MSCI ACWI Investable Market Index Scope 1
	• Disclosure of GHG emissions in number of companies:
	  □ Scope 1 and/or Scope 2
	  □ Any aspect of Scope 3
	  □ Any aspect of Scope 3 Upstream,
	  □ Any aspect of Scope 3 Downstream

Commitments	• Percentage of companies with self-declared net-zero targets by GICS sector • Number of companies with self-declared net-zero targets by GICS sector • Percentage of companies with science-based targets • Percentage of companies with climate targets for 2023 and beyond
Projected warming	• Share of companies aligned with 1.5°C, 2°C, misaligned or strongly misalign with temperature rise by GICS industry group • Projected warming from the worlds listed companies if they deliver on their commitments • Countries' projected warming based on choice of remaining emissions budget and modelling of future emissions trajectory
Top 20 companies with largest carbon footprint	• Total carbon emissions over the past 12 months • Scope 1 emissions over the past 12 months • Scope 2 emissions over the past 12 months • Estimated Scope 3 emissions over the past 12 months

	• Availability of self-declared net-zero target • Availability of science-based target

Source: (MSCI, 2021b)

4.3.5 Global Sustainable Mobility Index (GSMI)

The Global Sustainable Mobility Index (GSMI) measures the extent by which the mobility system of a country is sustainable.

Figure 26.Overview of the Structure of the GSMI

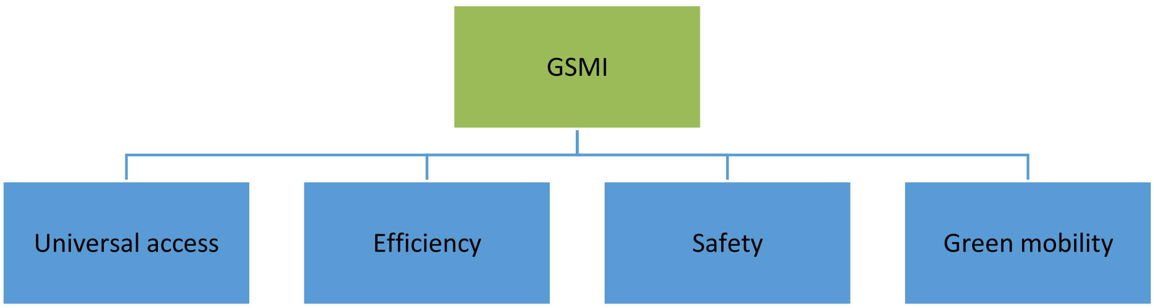


Table 14. Overview and assessment GSMI outlines the key characteristics of the GSMI, its methodology and key-takeaways for the development of a surface TDI.

Table 14. Overview and Assessment GSMI

Introduction	
Organisation	SuM4All
Est. Year	2017
Update frequency	Carried out once (to date)
Target group	Policymakers
Coverage	National
Regional focus	Global
# Countries	183
# of LMICs	Covers most (if not all) LMICs globally
LMICs in South Asia & SSH Africa	Covers most (if not all) of the countries in the target regions
Methodology	
Description of the framework	The framework is based on the following goals: ● Universal access ● Efficiency ● Safety ● Green mobility Sum4all also refers to this framework as the Global Tracking Framework (GTF) for Transport which was introduced in SuM4All (2017). The GTF essentially sets principal and supporting indicators to measure the performance of the transport systems against the aforementioned goals. The GSMI allows for the comparison and

	ranking of the countries based on the scores for their transport system performances.
Benchmark	
# dimensions	4
# subdimensions	
# indicators	Universal access – 2 principal ; 10 supporting Efficiency - 1 principal; 8 supporting Safety - 2 principal; 5 supporting Green mobility – 4 principal; 4 supporting
Indicators directly focused on surface transport / decarbonisation	Universal Access ● Rural access index (%) ● Rapid transit to resident ratio (km/million) ● Female workers in transport (%) Efficiency ● Logistics performance index Safety ● Mortality caused by road traffic injury (per 100,000 people) Green Mobility ● Transport-related GHG emissions per capita (tCO2/person) ● PM2.5 air pollution, mean annual exposure (microgram/m^3) ● Number of urban dwellers exposed to excessive noise levels The most relevant ones for the TDI are the ones related to efficiency and green mobility.
Data imputation	For each principal indicator, the baseline year for the calculation of the index scores (0-100) is identical for all countries. Baseline year may vary by indicator. Extrapolation based on the last available data from the preceding year is done to minimize the impact of missing data on the index score. In cases where no data is available at any point in time, no value is added to the calculation of its SM index.
Normalisation	The score for each goal is computed by taking the country's value for the principal indicator which is expressed as a percentage relative to the best and least performing countries in the world on that goal.
Weighting	Equal weights are provided for the four goals.
Aggregation	Arithmetic mean
Dissemination & Availability	
Communication channels	Website, dashboards, reports (pdf) are available
Accessibility of input data	SuM4All provides the list of sources where the input data come from.

Accessibility of output data	Outputs are provided in pdf form (no direct download of csv).
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	
Core benefits & learnings	• The complete set of input sources is provided and may be useful in the collection of data for the decarbonisation index • The country dashboards contain country specific data which could be useful for the TDI • Under the global tracking framework, there is also a catalogue of measures which could be useful for establishing a basis for assessing action in decarbonisation

Source: (Sustainable Mobility for All, 2023)

4.3.6 Sustainable Urban Transport Index (SUTI)

The Sustainable Urban Transport Index (SUTI) was developed by UNESCAP as an Excel-based tool that can help summarise, track, and compare the performance of sustainable urban transport systems in cities. It is a framework of indicators to assess urban transport systems and services with a focus on the Asia-Pacific region. The SUTI's ten indicators reflect the state of urban transport performance and encompass the transport system, social, economic, and environmental dimensions of sustainable urban transport.

Figure 27. Overview of the Structure of SUTI

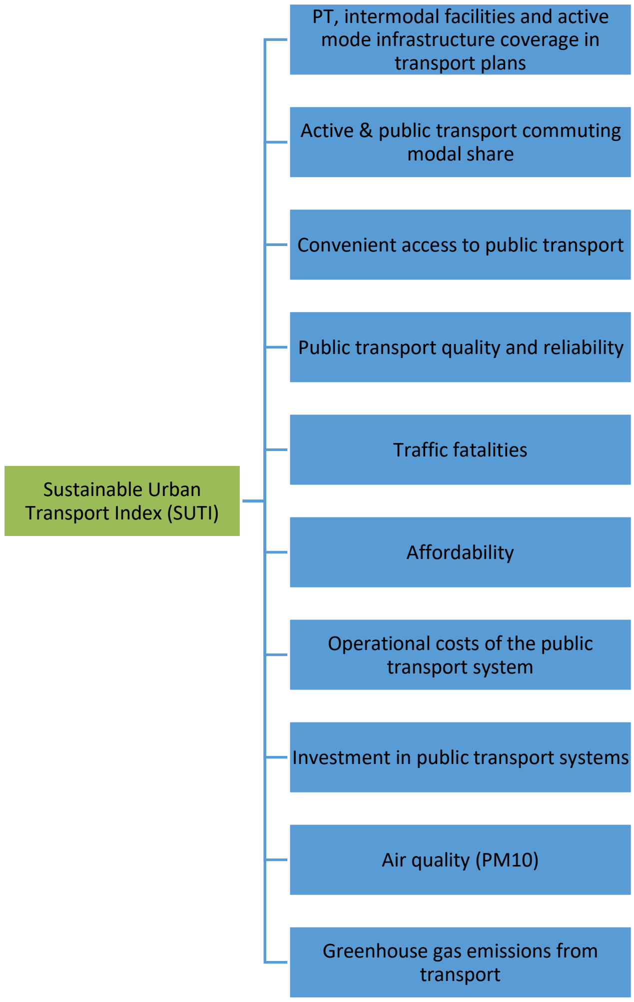


Table 15 outlines the key characteristics of the SUTI, its methodology and key-takeaways for the development of a surface TDI.

Table 15. Overview and Assessment SUTI

Introduction	
Organisation	United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
Est. Year	2018
Update frequency	Recommended frequency is every two years, four cities updates available in 2022 publication. Cities are doing self-assessments (e.g., Dhaka is now being updated)
Target group	Cities

Coverage	Urban
Regional focus	Asia-Pacific
# Countries	15 (between 2018 and 2021) ; 25 cities
# of LMICs	15
LMICs in South Asia & SSH Africa	India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan
Methodology	
Description of the framework	The SUTI consists of ten individual indicators which cover the elements of planning, access, safety, quality and reliability, affordability, and emissions. It does not have dimension or subdimensions. The individual indicators are equally weighted, and the aggregation method used to combine the individual indicators is geometric aggregation. For comparability, the indicators are normalised on different scales and the performance of each indicator is compared on a scale of 1-100 and presented in a spider diagram.
Benchmark	City to city
# dimensions	None
# subdimensions	None
# indicators	10
Indicators directly focused on surface transport / decarbonisation	All indicators of the SUTI are linked to surface transport: □ Extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes □ Modal share of active and public transport in commuting □ Convenient access to public transport service □ Public transport quality and reliability □ Traffic fatalities per 100,000 inhabitants □ Affordability – travel costs as part of income □ Operational costs of the public transport system □ Investment in public transport systems □ Air quality (PM10) □ Greenhouse gas emissions from transport
Data imputation	• The SUTI methodology comprises a handbook on how to collect the data required in a respective city (UNESCAP, 2019b)
Normalisation	Min-Max
Weighting	Equal Weighting
Aggregation	Geometric Aggregation
Dissemination & Availability	

Communication channels	Reports, Workshops
Accessibility of input data	For each city a comprehensive report is developed which outlines the input data used to calculate the SUTI for the respective city. The availability of a dedicated database or complementary excel files has not been identified during the assessment.
Accessibility of output data	The results for each indicator and the overall SUTI are published for each city in a comprehensive report. A dedicated database or complementary excel files have not been identified during the assessment. Comprehensive methodology and explanation of results in dedicated reports.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	While the expected availability of the data source for the SUTI indicator can vary greatly from city to city in the TDI target region, the data collection methodology developed as part of the SUTI provides guidance for the collection of missing data. According to the data collection guide, it is estimated that the proposed data collection process can be completed in one to two months. However, this is subject to the existence/availability of useful data and allocated human resources. As SUTI has already been calculated for 25 cities, including cities in six South Asian countries, it is anticipated that the indicator and data collection method can also be a useful resource for the TDI, increasing the likelihood that the data identified will be available for the TDI target regions.
Core benefits & learnings	• SUTI methodology has been published in a transparent manner • Data collection guide has been made available The TDI needs to ensure results are communicated to end-users effectively. Communication channels and knowledge products must be tailored to the needs of end-user groups.

Sources: (Regmi, 2019, 2021; UNESCAP, 2019b, 2019a; United Nations Economic and Social Commission for Asia and the Pacific, 2022)

4.3.7 Sustainable Cities Index

Launched in 2021, the Sustainable Cities Index assesses global cities in terms of air quality, emissions, renewable energy, and other sustainability measures. The index is available in an interactive format and is based on a crowd-sourcing approach. It allows local governments to register with a user-friendly data hub and provide 15 data points to assess the sustainability of their cities. Following its release in 2021, the Index developers started with an initial group of 50 cities using public data; this group is planned to grow as cities visit the interactive data hub and enter their data into the database. In 2023, the Index included 70 cities worldwide.

Figure 28.Sustainable Cities Index (% refer to the indicators weights in the overall score)

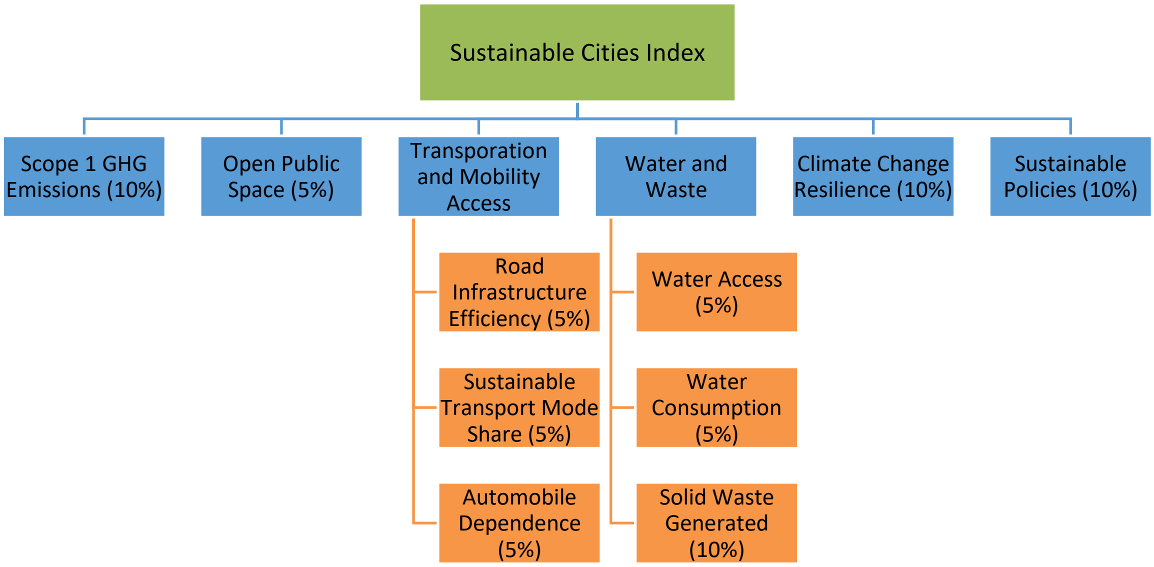


Table 16 outlines the key characteristics of the Sustainable Cities Index, its methodology and key-takeaways for the development of a surface TDI.

Table 16. Overview and Assessment Sustainable Cities Index

Introduction	
Organisation	Corporate Knights
Est. Year	2022
Update frequency	Annual
Target group	While the main end-user group are cities and cities officials, the index aims to attract everybody across end-user groups.
Coverage	Urban
Regional focus	Global
# Countries	38
# of LMICs	19
LMICs in South Asia & SSH Africa	Bangladesh, India, Pakistan Cameroon, Cote d'Ivoire, Ghana, Kenya, Nigeria, Senegal, South Africa, Tanzania

Methodology	
Description of the framework	The Sustainable Cities Index measures the progress of cities on 12 key indicators of urban sustainability in the areas of climate change, air quality, land use, transport, water, waste, policy, and resilience to give them A, B, C and D grades. One of the indicators is policy-driven related to a city's commitments to renewable energy, reduced greenhouse gas emissions and clean transport. The other 11 indicators include, particulate air pollution, access to and consumption of drinking water, waste generation, car dependency and road density, modal share and active transport, open space, local and consumption-related greenhouse gas emissions, and resilience to the impacts of climate change. The 2023 Sustainable Cities Index report indicates that the index consists of seven dimensions: 1) Greenhouse gas emissions, 2) Particulate air pollution, 3) Public open space, 4) Transport and mobility access, 5) Water and waste, 6) Sustainable policies and 7) Resilience to climate change. On the interactive dashboard for each city, the dimensions 1) Consumption-based climate emissions, 2) Air quality, 3) Climate change resilience, 4) Transport (Public Transit, Walking, Cycling) and 5) Renewable Energy Policy are presented as separate categories with a score from A to F. The final results published in the 2023 report and the full dataset show the final scores, which are based on the weighted aggregation of all individual indicators into a single score.
Benchmark	City to City
# dimensions	7
# subdimensions	None
# indicators	12
Indicators directly focused on surface transport / decarbonisation	• Transport and mobility access ◦ Road Infrastructure Efficiency ◦ Sustainable Transport ◦ Vehicle Dependence • Particulate Air Pollution ◦ Consumption-Based GHG Emissions ◦ Particulate Air Pollution
Data imputation	• Where public data was not available, city officials were asked to provide data from their internal databases.
Normalisation	• Min-Max • Each environmental indicator is further adjusted with the Corporate Knights Socio-Economic Adjustment Factor (CKSEAF) which has been developed to discount the extent they coincide with unsustainable social and economic conditions. (All indicators expect for Sustainable Policies and Climate Change Resilience)
Weighting	Weights have been selected; the method to retrieve weights is not stated in the report
Aggregation	Linear Aggregation

Dissemination & Availability	
Communication channels	Interactive Website, Report, Dataset
Accessibility of input data	Input data to the Sustainable Cities Index is not published. However, according to the 2023 report the index relies primarily on data points that are in the public domain and mostly accessible from free databases.
Accessibility of output data	Output data and results are published in a report, made available in an interactive dashboard and the complete result dataset can be downloaded. This includes the results for the overall Sustainable Cities Index Score. Results for the individual dimensions are available in an aggregated form (Score A to F) in the interactive dashboard.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• Public data used stems from CDP Cities, the World Bank, and the UN-Habitat Urban Indicators Database. • While not only attributed with surface transport or decarbonisation other relevant indicators include: □ Climate Change Resilience □ Sustainable Policies
Core benefits & learnings	• Interactive and collaborative format which enables and encourages the participation of key audiences i.e., city officials are highly positive. • In all 70 cities included in the 2023 ranking city official were contacted to review any data collected from these databases and where needed revise data with internal data. • The methodological document accompanying Sustainable Cities Index, essential for ensuring transparency and replicability in index construction, is commendably detailed, catering to a broad audience including media, policymakers, and the general public. To further enhance its utility, particularly for stakeholder’s keen on a comprehensive understanding of the index's construction method, it could be beneficial to expand on certain aspects. For instance, providing more explicit descriptions of the weighting applied to the subdimensions could significantly enrich the document's informativeness. • The methodological guideline which will be provided as a supporting document to the TDI must be detailed and transparent, hence making index construction replicable.

Source: (Corporate Knights Inc., 2023; Iveson, 2023; Torrie & Morson, 2023)

4.3.8 Global Electric Mobility Readiness Index

Arthur D. Little (ADL) has developed a methodology to support leaders – specifically targeting automotive organizations - that focuses on assessing market readiness for electric mobility. This standardized method involves a comprehensive analysis of the principal factors driving electric vehicle (EV) adoption.

Figure 29.Overview of the Global Electric Mobility Readiness Index

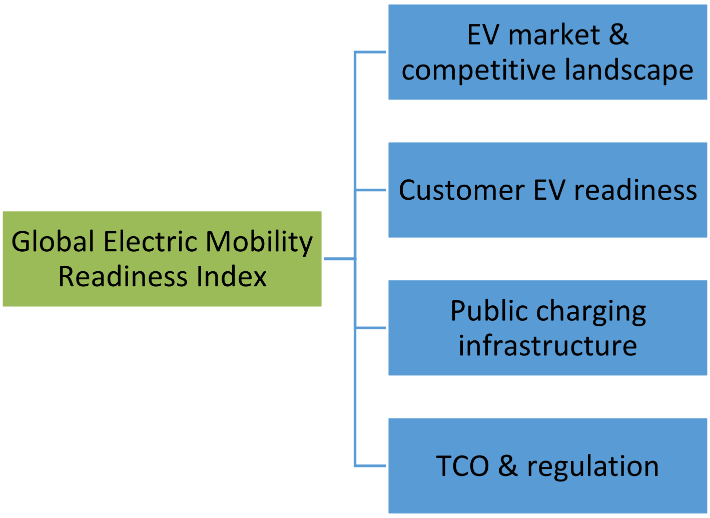


Table 17 outlines the key characteristics of the Global Electric Mobility Readiness Index, its methodology and key-takeaways for the development of a surface TDI.

Table 17. Overview and Assessment Global Electric Mobility Readiness Index

Introduction	
Organisation	Arthur D Little
Est. Year	2018
Update frequency	Annual
Target group	Automotive organisations
Coverage	Country level
Regional focus	Global
# Countries	15
# of LMICs	7
LMICs in South Asia & SSH Africa	South Africa, India
Methodology	
Description of the framework	The framework that is utilized for analysing EV readiness and adoption is based on the following factors: macro factors; market readiness; infrastructure readiness; customer readiness; government readiness

<table>
<tr><td>Benchmark</td><td>Country to country</td></tr>
<tr><td># dimensions</td><td>5</td></tr>
<tr><td># subdimensions</td><td>None</td></tr>
<tr><td># indicators</td><td>12</td></tr>
<tr><td>Indicators directly focused on surface transport / decarbonisation</td><td>

Macro factors
Quality of electricity infrastructure
Motorization rate
EV market & competitive landscape
BEV/PHEV market share expectations, 2021–2026
Number of BEVs offered in market (OEM, model line)
Number of BEVs offered in the market
Customer EV readiness
Home ownership rate in market (country)
Customers likely to buy PHEV/BEV as next vehicle
Public charging infrastructure
Third-party highway HPC network density
DC public/destination charging points CAGR
TCO & regulation
Tax & tariff benefits for BEV (general)
Direct financial subsidies for BEV (general)

</td></tr>
<tr><td>Data imputation</td><td>n/a</td></tr>
<tr><td>Normalisation</td><td>The index is benchmarked against a hypothetical baseline value of 100. A score equal to 100 indicates that the market's readiness for electric mobility matches that of internal combustion engines (ICEs) in key purchasing factors like cost, utility, and availability. Therefore, a score above 100 suggests that electric vehicles (EVs) offer more advantages compared to ICEs.</td></tr>
<tr><td>Weighting</td><td>The five categories were weighted according to their relevance for EV adoption. Markets can score a different number of points in each category, with each category varying depending on the weight and depending on market data.

The individual point score is calculated based on analysis that considers relative and absolute performance measures. The final index score is the sum of performance indicators from the five subcategories, allowing for a detailed evaluation of a market’s e-mobility readiness.</td></tr>
<tr><td>Aggregation</td><td></td></tr>
<tr><td colspan="2">Dissemination & Availability</td></tr>
<tr><td>Communication channels</td><td>Website</td></tr>
</table>

Accessibility of input data	The basic data (snapshots) for some of the indicators are provided in the report.
Accessibility of output data	The results for some of the stated indicators are provided in the report.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• Limited official information on the share of electric vehicles in the vehicle stock in the TDI target regions. • Very limited information on the number of charging infrastructure (open-source data may not be up to date; unofficial sources are available but not in a consistent manner)
Core benefits & learnings	• The methodology is inclusive in a way that it recognizes the importance of regulations/policies

Source: (Schlosser et al., 2023)

4.3.9 Utility Decarbonisation Index

The Utility Decarbonisation Index provides insights on the state of decarbonisation across the top investor-owned power utilities in the United States.

Figure 30.Overview of the Utility Decarbonisation Index

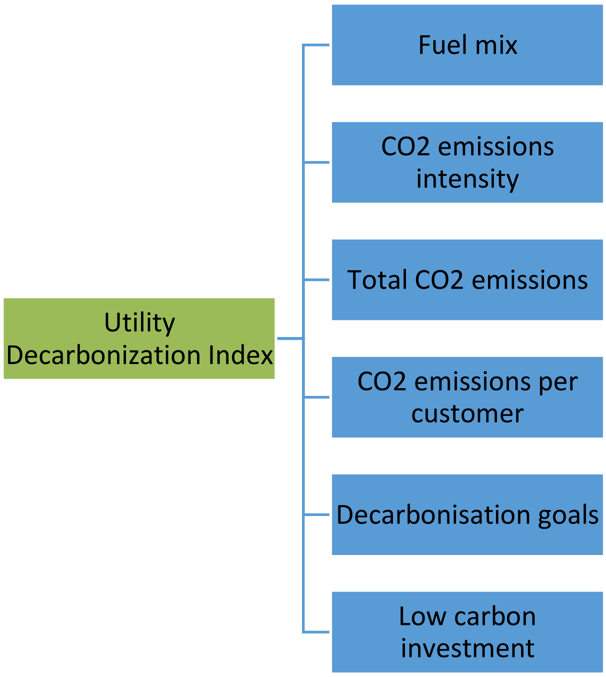


Table 18 outlines the key characteristics of the Utility Decarbonization Index, its methodology and key-takeaways for the development of a surface TDI.

Table 18. Overview and Assessment Utility Decarbonization Index

Introduction	
Organisation	National Public Utilities Council
Est. Year	Based on 2021 data (or company reports)
Update frequency	Annual
Target group	Electric utility companies and stakeholders
Coverage	Company-level
Regional focus	North America
# Countries	1 (United States)
# of LMICs	n/a
LMICs in South Asia & SSH Africa	n/a
Methodology	

Description of the framework	The framework includes two groups of indicators that reflect the current (fuel mix and CO_2 emissions), as well as those that reflect future direction based on reported goals and investments being made to support the transition. The main dimensions are: • Fuel mix • CO_2 emissions intensity • Total CO_2 emissions • CO_2 emissions per customer • Decarbonisation goals • Low carbon investment
Benchmark	Company-level
# dimensions	6
# subdimensions	None
# indicators	6 (one for each theme/dimension)
Indicators directly focused on surface transport / decarbonisation	The indicators employed in the index are not directly usable in the exercise of developing a decarbonisation index for surface transport as these are hinged on company-level or power generation based indicators (e.g. for fuel mix : owned net generation from low-carbon sources / total owned net generation).
Data imputation	The companies are scored on a scale for each metric based on their latest report.
Normalisation	Scores (1-5) are assigned based on the min-max values for each of the metrics. In cases where such utilization of min-max values is not possible, it is not so clear how the companies were scored (e.g. in terms of decarbonisation goals – wherein baseline targets of 50% reduction by 2030 and net zero by 2050 are given a score of 2.5).
Weighting	Equal weights are assigned for each of the metrics.
Aggregation	Arithmetic mean
Dissemination & Availability	
Communication channels	Website
Accessibility of input data	Not relevant to this exercise (due to the geographical and thematic coverage)
Accessibility of output data	
Key take-aways for the development of the Surface TDI	

Expected availability of data in the TDI target region	Not relevant to this exercise (due to the geographical and thematic coverage)
Core benefits & learnings	The development of the decarbonisation index for surface transport can benefit from the integration of metrics that capture the current state (e.g. emissions; emissions intensities, among others), but also future direction as what has been included in the utility decarbonisation index.

Source: (NPUC, 2023)

4.3.10 GlobalABC Buildings Climate Tracker

To track decarbonisation in the buildings and construction sector globally using suitable and reliable data that is aggregated in a transparent, consistent, and continuous way. It focuses on climate change mitigation in the building sector, but also contains information on adaptation and resilience. In the context of the tracker, the term "decarbonisation" and its measurement go beyond GHG emissions, and reflect efforts made by relevant organisations (policymakers, regulators, industries, among others) towards the decarbonisation of the buildings and construction sector.

Figure 31. Overview of the GlobalABC Buildings Climate Tacker

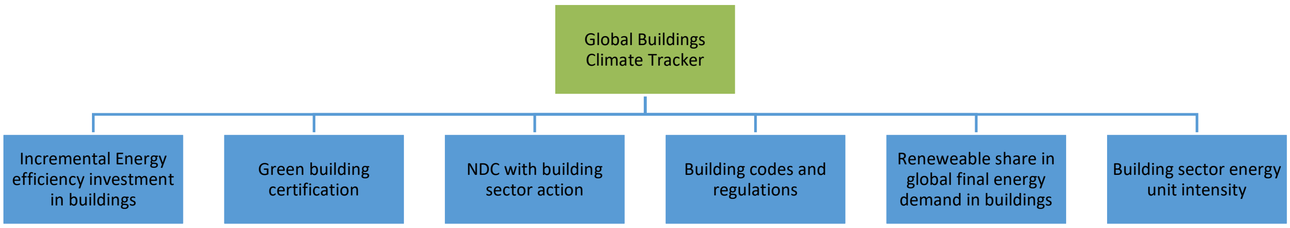


Table 19 outlines the key characteristics of the Global Buildings Climate Tracker, its methodology and key-takeaways for the development of a surface TDI.

Table 19. Overview and Assessment GlobalABC Buildings Climate Tracker

Introduction	
Organisation	Global Alliance for Buildings and Construction
Est. Year	2020
Update frequency	Annually (Global Status Report for Buildings and Construction)
Target group	Buildings sector
Coverage	Sectoral
Regional focus	Global
# Countries	n/a
# of LMICs	n/a
LMICs in South Asia & SSH Africa	n/a
Methodology	
Description of the framework	The "Buildings Climate Tracker" or "decarbonisation index" was developed through 5 key steps: data collection, analysis, selection, normalisation and aggregation of the indicators into a composite index. Forty-seven (47) possible indicators were identified from annual reports (global building status reports). These indicators were then subjected to an assessment of

	the suitability of these indicators towards the development of the buildings climate tracker based on the following: □ Measurability □ Availability and quality of data □ Detail of data □ Geographical coverage The selected indicators reflect the following themes: □ Energy related emissions □ Energy intensity □ Renewable energy share in final energy □ Building energy codes and standards □ Incremental energy efficiency investments in buildings □ NDCs with building sector action □ Green building certifications Please note that the tracker is applied to the global buildings sector as a whole. Essentially, it recognises that the indicators characterize two key aspects: decarbonisation impact; and decarbonisation action.
Benchmark	The buildings/construction sector; against time.
# dimensions	6
# subdimensions	None
# indicators	47
Indicators directly focused on surface transport / decarbonisation	The main indicators may prove to be useful in providing insights for the development of a surface transport decarbonisation index, in particular: □ Gt CO_2/year □ % share renewable energy in final energy consumption □ $ billion incremental investments in the sector/year □ kWh/m2/year energy intensity Some other indicators are more applicable to the buildings sector itself, or when doing a sector wide assessment □ % adoption of codes and standards □ % NDCs with sector action □ Cumulative growth in voluntary green building certification.
Data imputation	n/a
Normalisation	Compositional data were transformed to real space using isometric log ratio transformation. Normalisation, including rescaling, is essential before combining different-scale indicators to represent the current decarbonisation index as a fraction of the 100% decarbonisation target by 2050. This process necessitates establishing a baseline and an end goal. The exercise assumes 2015 as the base year. For instance, with the indicator "building energy codes (number of countries which have adopted such)", it is presumed that all countries will have such codes. For simplicity, the methodology assumes that every indicator follows a uniform trajectory from its start to its end value.

Weighting	The weighting is done through expert judgement and was reviewed by an appointed task force. Essentially, the decarbonisation impact indicators are weighted cumulatively at 37%, while efforts are weighted cumulatively as at 63%.
Aggregation	Ultimately one composite index is calculated (decarbonisation index)
Dissemination & Availability	
Communication channels	Website / videos are available
Accessibility of input data	Not relevant to the transport sector
Accessibility of output data	Not relevant to the transport sector
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	Not relevant to this exercise (due to the geographical and thematic coverage)
Core benefits & learnings	Some useful elements for developing the TDI are: • Methodology in selecting the indicators • Grouping of the indicators based on key aspects (decarbonisation “impacts” and decarbonisation “actions”) • Process for weighting combines practicality (i.e. expert judgement) and validation (i.e. involvement of experts through a task force) • Process used for the normalisation is also interesting, wherein ideal states representing objectives related to “decarbonisation” are defined and used as a basis for calculating the scores. • The use of one final composite index is powerful in communicating the status, but it works specifically for this application as the sector is assessed as a whole (as opposed to indexes that are used at the national level).

Source: (Kockat et al., 2020; United Nations Environment Programme, 2022)

4.3.11 Urban Mobility Readiness Index

The Urban Mobility Readiness Index captures what consumers, businesses, and policymakers consider indispensable for urban mobility. It is focused on assessing five dimensions: social impact, infrastructure, market attractiveness, system efficiency, innovation. It is also cognizant of the importance of disruptive innovations towards determining the future of transport in cities.

Figure 32.Overview of the Urban Mobility Readiness Index

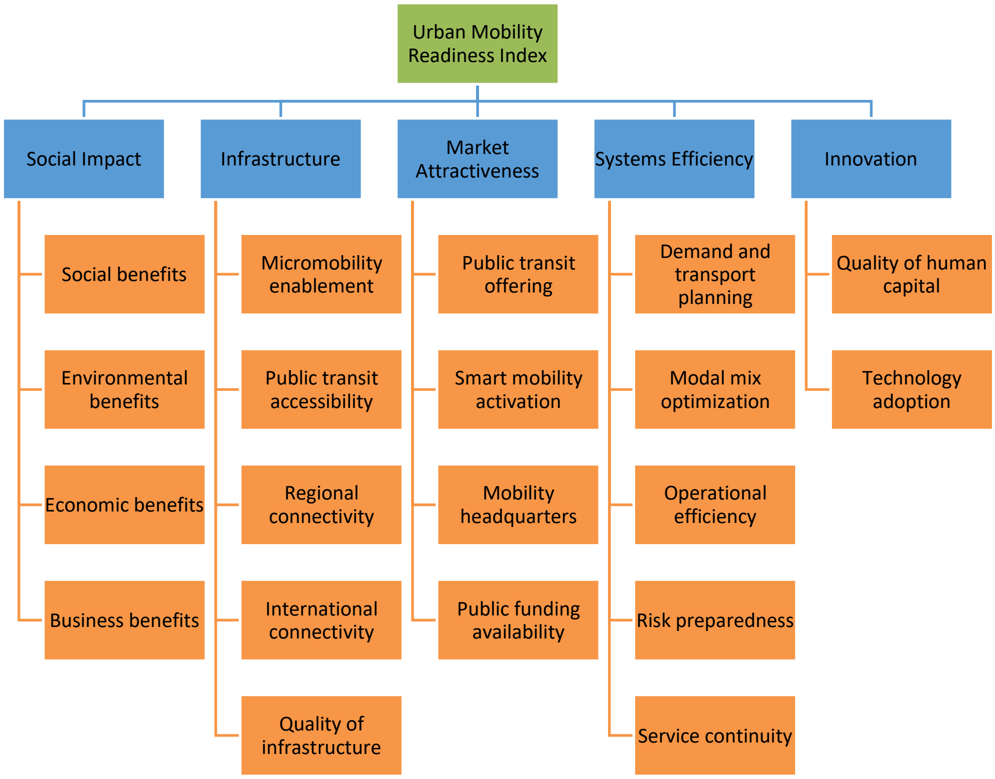


Table 20 outlines the key characteristics of the Urban Mobility Readiness Index, its methodology and key-takeaways for the development of a surface TDI.

Table 20. Overview and Assessment Urban Mobility Readiness Index

Introduction	
Organisation	Oliver Wynam Forum and the University of Berkeley
Est. Year	2022
Update frequency	Annual
Target group	Policymakers, businesses, consumers
Coverage	Urban
Regional focus	Regional analyses are provided for Asia Pacific, Europe, Latin America, Middle East and Africa, and North America
# Countries	60 cities in 42 countries

# of LMICs	19
LMICs in South Asia & SSH Africa	Delhi and Mumbai (India); Nairobi (Kenya); Lagos (Nigeria); Johannesburg and Cape Town (South Africa)
Methodology	
Description of the framework	Cities are ranked based on the five dimensions that are characterized by 57 key performance indicators. The five dimensions include: infrastructure, social impact, market attractiveness, system efficiency, and innovation. Furthermore, each dimension is calculated by aggregating subdimension, e.g. for the infrastructure dimension these include micro mobility enablement, public transit accessibility, regional connectivity, international connectivity and quality of infrastructure. Aside from the "Urban Mobility Readiness Index" the results are also shown for the following sub-indexes: sustainable mobility sub-index, and the public transit sub index.
Benchmark	City to city
# dimensions	5
# subdimensions	20
# indicators	57
Indicators directly focused on surface transport / decarbonisation	• Dimension: Social Impact ◦ Social benefits: Road safety, Enforcement of transport safety ◦ Environmental benefits: Air quality, Noise and light pollution restraint ◦ Economic benefits: Transit commute speed, Public transit affordability ◦ Business benefits: Mobility employment, Mobility-related spend • Dimension: Infrastructure ◦ Micro mobility enablement: Walkability, Pedestrian friendliness, Cycling Infrastructure ◦ Public transit accessibility: Rail network, Public transit station density, Length of walk to Public transit ◦ Regional connectivity: Road connectivity, Strength of multimodal network International connectivity ◦ Quality of infrastructure: Road quality, Supply chain infrastructure • Dimension: Market Attractiveness ◦ Public transit offering: Diversity of public transit modes, Public transit operating hours, Transit estimated time of arrival ◦ Smart mobility activation: Mobility sharing economy competitiveness and penetration, Multimodal app maturity ◦ Mobility headquarters: Market capitalization of mobility companies headquartered in city ◦ Public funding availability: Government investment in the mobility sharing economy, charging stations, and connected and autonomous vehicles technologies • Dimension: Systems Efficiency

	◻ Demand and transport planning: Existence of master plan, Information and communication technology preparedness, Innovation grade, Direct electric vehicle incentivization, Electric charging station availability ◻ Modal mix optimization: Public transit utilization, Car ownership moderation, Cycling adoption, Share of time in public transit ◻ Operational efficiency: Traffic management grade, Traffic fluidity, Supply chain efficiency • Further indicator potentially interesting: ◻ Risk preparedness: Disaster-risk informed development, Natural hazard preparedness, Catastrophe insurance, Institutional capacity and access to resources ◻ Quality of human capital: Top university/lab presence, University quality, Information and communication technology patents ◻ Technology adoption: Connected and autonomous vehicles adoption grade, Autonomous transit in operation, Electric market share in sales
Data imputation	n/a
Normalisation	n/a
Weighting	The indicators are assigned weights based on their relative importance as determined by discussions of an internal team with a range of experts (e.g. urban planners, traffic managers, transport finance specialists, mobility technology executives) in combination with data. Convex optimization techniques were used to understand the weight structure needed for benchmarking. The testing resulted in similar weights chosen by the team.
Aggregation	n/a
Dissemination & Availability	
Communication channels	Interactive website, report
Accessibility of input data	Only a list of sources is provided.
Accessibility of output data	The only outputs provided in the report are the final score for the three main indexes.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	Not too optimistic, as the data is not necessarily made open or made available in an easily usable manner.
Core benefits & learnings	• The formulation of headliner questions that are attached to the main dimensions might be useful for the development of the surface transport decarbonisation index. • It provides a comprehensive list of sources which might be useful in our exercise.

Source: (Thibault et al., 2022)

4.4 Overview of Selected Indicator Tracking Platforms and Initiatives

While this report foremost focuses on the assessment of existing indexes and methods for developing indexes, this section sheds light on other relevant initiatives. Particular focus lies on an initial mapping of existing data sources potentially relevant for the TDI. In addition, it aims to provide an overview of relevant indicators not covered by indexes described in Section 3. The references described in this section lie outside "indexes" but still provide a variety of indicator sets which might be useful for the development of such indexes.

- Sustainable Development Goals (SDG) indicators and database
- Asian Transport Outlook
- Aichi Declaration on Environmentally Sustainable Transport (EST)
- Urban Mobility Indicators for Walking and Public Transport (UITP and Walk 21)
- Sustainable Urban Mobility Indicators (SUMI) of the European Commission
- Indicators for Sustainable Mobility
- Accessing Asia
- State of Climate Action

4.4.1 Sustainable Development Goals (SDG) Indicators and Database

The SDG indicators are based on the framework adopted by the UN General Assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (United Nations General Assembly, 2017). It is meant to enable the monitoring of the state of the achievement of the SDGs. There are no indicators that have been included specifically for the transport sector.

Table 21. Overview and Assessment SDG Indicators and Database

Introduction	
Organisation	United Nations
Est. Year	2017
Coverage	Global
Regional focus	n/a
# Countries	193
LMICs in South Asia & SSH Africa	50 in Sub-Saharan Africa; 9 in South Asia
Indicators	
# dimensions	The indicators are organised based on the 17 SDGs
# subdimensions	Each goal has varying numbers of sub goals.
# indicators	The global SDG indicator framework consists of 231 unique indicators.
Indicators directly focused on surface	The following set of goals (and the associated indicators) are those that are relevant to transport (as well as transport decarbonisation), and is primarily based on a recent

transport / decarbonisation	study focusing on the performance of countries vis-à-vis relevant transport-related SDG indicators (Gota et al., 2023). *Economy* ● SDG 8.1 "Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries" □ Indicator 8.1.1 annual growth rate of real GDP per capita ● SDG 8.5 By 2030 achieve full and productive employment and decent work for all women and men, including young people and people with disabilities, and equal pay for work of equal value; □ Indicator 8.5.1 average hourly earnings of employees, by sex, age, occupation and persons with disabilities ● SDG 17.17 Encourage and promote effective public, public-private, and civil society partnerships, building on the experience and resourcing strategies of partnerships. □ Indicator 17.17.1 amount in United States dollars committed to public-private partnerships for infrastructure *Infrastructure and Activity* ● SDG 9.1 Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all □ Indicator 9.1.1 proportion of the rural population who live within 2 km of an all-season road □ Indicator 9.1.2 passenger and freight volumes, by mode of transport ● SDG 9.c Significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in the least developed countries by 2020 □ Indicator 9.c.1 proportion of population covered by a mobile network, by technology *Urban Transport* ● SDG11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons □ Indicator 11.2.1 proportion of population that has convenient access to public transport, by sex, age and persons with disabilities *Energy* ● SDG 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix □ Indicator 7.2.1 renewable energy share in the total final energy consumption ● SDG 7.3 Double the global rate of improvement in energy efficiency by 2030 □ Indicator 7.3.1 energy intensity measured in terms of primary energy and GDP

- SDG 12.c Rationalise inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimising the possible adverse impacts on their development in a manner that protects the poor and the affected communities.
    - Indicator 12.C.1 Amount of fossil-fuel subsidies (production and consumption) per unit of GDP.

Climate Change

- SDG 9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
    - Indicator 9.4.1 CO_2 emissions per unit of value added.
- SDG 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
    - Indicator 13.1.1 number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.
- SDG 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.
    - Indicator 1.5.1 number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.
- SDG 13.2 Integrate climate change measures into national policies, strategies and planning Transport and Climate Change Indicators
    - Indicator 13.2.1 Number of countries with nationally determined contributions, long-term strategies, national adaptation plans and adaption communications, as reported to the secretariat of the UNFCCC

Air Pollution

- SDG 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
    - Indicator 3.9.1 mortality rate attributed to household and ambient air pollution
- SDG 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
    - Indicator 11.6.2 annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

Road Safety

- SDG 3.6 By 2020 (2030), halve the number of global deaths and injuries from road traffic accidents (adjusted to 2030)
    - Indicator 3.6.1 death rate due to road traffic injuries

Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	Based on the most recent data for the aforementioned indicators, there are those indicators whose input data are readily available for many (of not most of the countries in the target regions such as: 8.1.1, 7.2.1, 7.3.1, 12.c.1, 13.2. 3.9.1, 9.4.1, 11.6.2, 3.6.1. However, there are also those indicators whose input data are not available for many of the countries in the target region such as indicators 8.5.1, 17.17.1,9.1.1, 9.1.2, 9.c.1, 11.2, 13.1.1,1.5.1.
Core benefits	The SDG database itself can be a good source of data for indicators which might be relevant for the surface TDI. In particular, data for energy, basic economic data, fossil fuel subsidies. There is also evidence, though, that for those indicators that directly relate to transport (e.g., passenger and freight kms), may not necessarily have available input data for many of the countries within the target regions (i.e., official values).

Source: (United Nations, 2023; UNStats, n.d.)

4.4.2 Asian Transport Outlook (ATO)

The Asian Transport Outlook (ATO) also plays a core role as a reference source for the Aichi Declaration on Environmentally Sustainable Transport, which is presented in the next subsection.

Table 22. Overview and Assessment Aichi Declaration on EST

Introduction	
Organisation	United Nations Commission on Regional Development (UNCRD)
Est. Year	2021
Coverage	National / Regional
Regional focus	Asia
# Countries	19
# of LMICs	19
LMICs in South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Indicators	
# dimensions	9 dimensions (national level)
# subdimensions	Various, depending on the dimensions
# indicators	In total, there are 486 indicators • Infrastructure -88 • Transport Activity and services – 93 • Access and connectivity – 13 • Road safety – 41 • Air pollution and health – 41 • Climate change – 47

	• Socio-economic – 92 • Transport policy- 42 • Others - 28
Indicators directly focused on surface transport / decarbonisation	Indicators pertaining to the following might be useful in the development of the surface TDI: infrastructure; transport activity and services; air pollution; climate change; transport policy; socio-economic.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	It is perhaps the most comprehensive single source of organised data for relevant indicators in Asia. However, as the title suggests, the coverage is only for the Asian countries.
Core benefits	The ATO might essentially be one of the key sources of data and information that can be used in the further development of the TDI. It provides a good overview of the data availability in LMICs (albeit, only for Asia). It documents various sources of data (official; secondary) and provides these for the users to choose The indicators and data can be downloaded through an interface, or users can also directly download the full data set in spreadsheet form.

Source: (Asian Transport Outlook, 2023)

4.4.3 Aichi Declaration on Environmentally Sustainable Transport (EST)

The Aichi Declaration of 2021 is an agreement between representatives of Asian countries, international organizations, bilateral and multilateral agencies, non-governmental organizations (NGOs), research organizations, and expert sustainable transport professionals to foster sustainable transport in Asia by 2030. It provides an overview of an initial list of indicators linked to the SDGs. The agreement has been initiated by the United Nations Commission on Regional Development (UNCRD) and comprises 19 Asian countries.

While the declaration does not propose an index to measure the progress towards reaching the six core goals agreed upon, it does provide a total of 27 indicators, which are well aligned with SDG 3, 7, 9, 11, 12, 13 and 17. Looking at these indicators from an index development perspective one can attempt to divide them into separate pillars based on the goals of the declaration. There are two dimensions, namely "sustainability goals" and "access and connectivity goals", as well as six sub-dimensions that relate to the six goals of the Aichi Declaration. The sustainability goals can be divided into environmental sustainability, road safety and economic sustainability, while access and connectivity can be divided into rural access, urban access and national access and connectivity. The environmental sustainability sub-dimension can be further subdivided into low carbon (climate change mitigation), resilience and air pollution.

Table 23. Overview and Assessment Aichi Declaration on EST

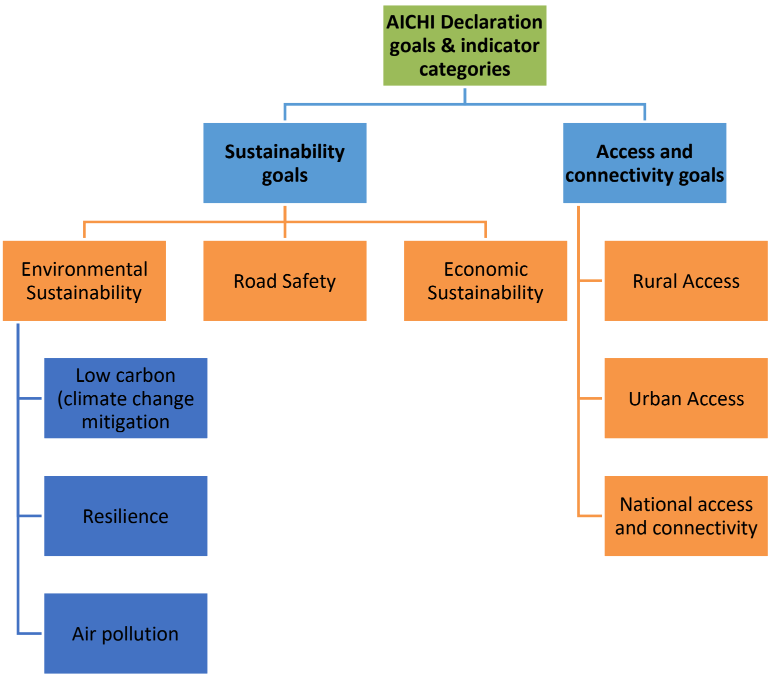
Introduction	
Organisation	Asian Transport Outlook (project); supported by the Asian Development Bank and the Asian Infrastructure Investment Bank
Est. Year	Updated 2023
Coverage	Country; city; regional

Regional focus	Asia
# Countries	51
# of LMICs	All of the relevant LMICs in Asia
LMICs in South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka
Indicators	
# dimensions	2
# subdimensions	6
# indicators	27
Indicators directly focused on surface transport / decarbonisation	**Sustainability goals** • Environmental Sustainability □ Transport CO_2 emissions (Fossil) and GDP □ Modal share transport CO_2 emissions □ Fuel subsidies in the transport sector □ Renewable energy in the transport sector □ Global climate risk for infrastructure □ Notre Dame - GAIN infrastructure vulnerability score □ Multi hazard expected annual damages to transport infrastructure/GDP □ Transport related air pollutant emissions (NOx, PM^{10}, BC), transport related CO_2 emissions, and GDP □ NOx and PM emissions by transport mode □ Transport air pollution health impact • Road Safety □ Road traffic crash fatalities □ Road traffic crash fatalities and GDP □ Traffic deaths by road user category □ IRAP safety rating of road infrastructure • Economic Sustainability □ Transport share in GDP □ Multilateral Development Bank funding for transport □ PPP investments in transport □ Transport employment □ Logistics Performance Index (LPI) **Access and connectivity goals** • Rural Access □ Rural population who lives within 2 km of an all-season road • Urban Access □ Share of population with convenient access to public transport □ Rapid Transit to Resident ratio (RTR)

	• National access and connectivity □ Transport infrastructure growth □ Transport infrastructure score □ Transport connectivity □ Passenger and freight transport activity □ ICT broadband coverage and internet use
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	• Increasing data availability anticipated through the Aichi Declaration and related actions taken by the countries and stakeholders involved
Core benefits	• Potential for strong partnership between TDI and Aichi Initiative The TDI could act as a core tool supporting the Aichi Initiative in measuring the goals agreed upon, hence ensuring the TDI's relevance and importance for end-users and contributing to a long-term institutionalisation of the TDI. The TDI can be used in conjunction with the ATO data.

Source: (UNCRD, 2021)

Figure 33. Overview of the Structure of the Aichi Declaration Goals



4.4.4 Urban Mobility Indicators for Walking and Public Transport

The International Association of Public Transport (UITP) and the Walk21 Foundation has published a common set of urban mobility indicators to allow cities to benchmark themselves against other cities of a similar size and learn from each other. The indicators are a mix of objective, satisfaction and quality measures. The objective measures relate to the data that is already collected by operators and government agencies or can be calculated from available datasets. The satisfaction measures result from surveys of the population and the quality measures reflect the quality of walking and public transport (PT) infrastructure that are typically measured at a neighbourhood scale.

Figure 34.Overview Urban Mobility Indicators for Walking and Public Transport

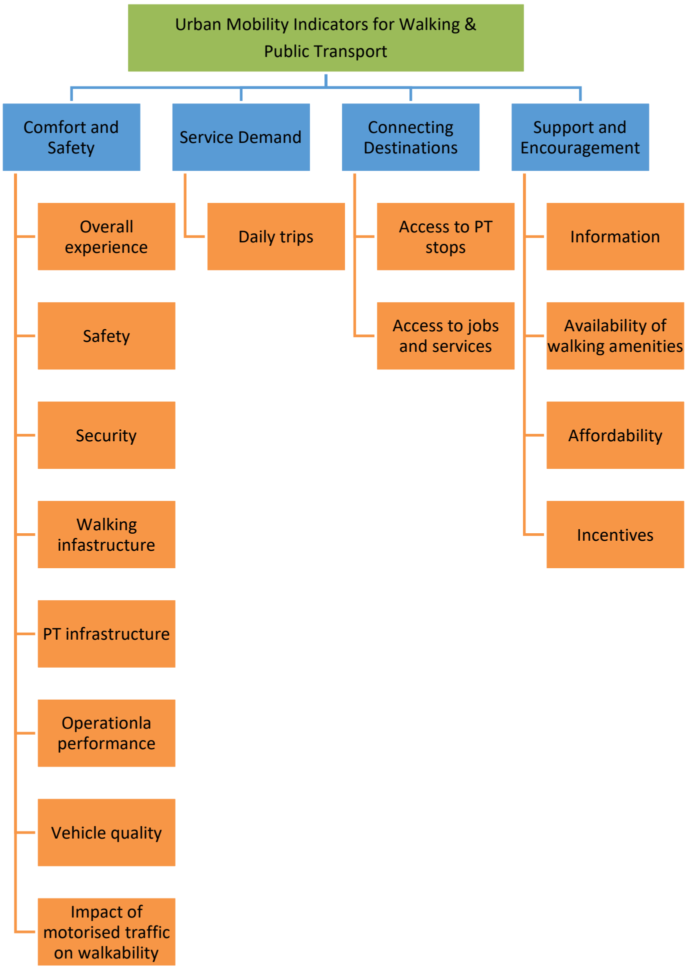


Table 24. Overview and Assessment Urban Mobility Indicators for Walking and Public Transport

Introduction	
Organisation	UITP and Walk 21
Est. Year	2019
Coverage	Urban
Regional focus	Europe
Indicators	
Description of the framework	The indicator framework covers four main dimensions: • Comfort and safety • Service demand • Connecting destinations • Support and encouragement. A tiered approach is utilized with tier 1 measures providing high-level framework for consistent international benchmarking

	A common set of indicators focusing on walkability and access to public transport were consolidated by UITP and Walk21 to support the Urban Agenda for the EU (released in 2019). It covers 52 indicators on comfort and safety (34), service demand (8 indicators), connecting destinations (4 indicators) and support and encouragement (5 indicators).
# dimensions	4
# subdimensions	15
# indicators	52
Indicators directly focused on surface transport / decarbonisation	The indicators directly relate to surface transport as these are all indicators that focus on active modes of transport. Most of the indicators, though, either rely on survey data that have been generated for EU cities; are not within the main scope of a decarbonisation index (e.g. safety); or are too granular to be considered.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	Mostly non-existent as the data requirements are either based on available data within the EU or are at urban levels which may not be useful for the development of a decarbonisation index.
Core benefits	The idea of utilizing a tiered approach to maximize the utility of available detailed data while providing alternatives in cases where such detailed data is not available might be useful in the development of a decarbonisation index for developing countries.

Source: (UITP & Walk21, 2019)

4.4.5 Sustainable Urban Mobility Indicators (SUMI) of the European Commission

The SUMI project was supported by the European Commission DG MOVE initiative which adapted the 2nd phase of the Sustainable Mobility Project's (SMP2) sustainable mobility indicators into the European Context. SUMI's indicator set is composed of 13 core indicators and 5 non-core indicators (released in 2020).

Table 25. Overview and Assessment SUMI

Introduction	
Organisation	Rupprecht Consult on behalf of European Commission
Est. Year	2020
Coverage	Urban (Small, Medium-sized and large cities, metropolitan regions)
Regional focus	Europe
Indicators	
# dimensions	There are no specific dimensions, but there are core and non-core indicators that represent specific themes.
# indicators	There are 13 indicators on: affordability; accessibility; air pollutant emissions; noise; road deaths; access to mobility services; emissions of greenhouse gases; congestion

	and delays; energy efficiency; opportunity for active mobility; multimodal integration; satisfaction with public transport; traffic safety. There are also non-core indicators for the following: quality of public spaces; urban functional diversity; commuting travel time; mobility space usage; security.
Indicators directly focused on surface transport / decarbonisation/ decarbonisation	The indicators on GHGs, energy efficiency, and those that characterize the modes might be useful for the development of the decarbonisation index. However, the SUMI is primarily focusing on the urban level.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	The detailed guidelines for the calculation of the indicators (e.g. GHG) requires data which might not necessarily be available in many of the countries in the target regions. For example, the GHG emissions are ideally to be calculated even for specific mode-fuel-vehicle class- vehicle sub class segments.
Core benefits	SUMI provides useful definitions and categorisations which might be useful in structuring the decarbonisation index (e.g. modes; travel types; fuel types, among others)

Source: (SUMI Project, 2021)

4.4.6 Indicators for Sustainable Mobility (ITDP)

The indicators are designed to offer valuable insights that assist in decision-making processes, with the goal of promoting sustainable transport. They are primarily targeted at city officials and community advocates and encompass elements related to sustainable transit in three dimensions: proximity, access, city characteristics.

Table 26. Overview and Assessment Indicators for Sustainable Mobility

Introduction	
Organisation	Institute for Transport and Development Policy (ITDP)
Est. Year	2019
Coverage	Urban (city and metropolitan scale)
Regional focus	North America, Latin America
# Countries	3 (25 cities)
# of LMICs	1
LMICs in South Asia & SSH Africa	None
Indicators	
# dimensions	3
# subdimensions	None

# indicators	7
Indicators directly focused on surface transport / decarbonisation	• Proximity (to transit) ◦ People/Jobs/Low-Income Households Near Rapid Transit ◦ People/Jobs/Low-Income Households Near Frequent Transit • Access (to opportunity) ◦ Access to Jobs by Sustainable Transit (60 and 30 minutes) ◦ Access to Low-Skill Jobs by Sustainable Transit (60 and 30 minutes) ◦ Access to People by Sustainable Transit (60 minutes) • City Characteristics ◦ Block Density ◦ Weighted Population Density
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	According to ITDP, the indicators can be collected using open source data. • The primary tools used for the calculation include ArcGIS and ArcGIS Network Analyst, which utilise data from OpenStreetMap and General Transit Feed Specification (GTFS) data. • Other data sources include census data, which provides demographic and population insights. • City boundaries are also considered to define the scope and applicability of indicators within specific urban areas.
Core benefits	• The methodology emphasises the use of accessible data and transparent methods to facilitate the understanding and application of the indicators. • The report is well structured and comprehensive and provides clear visualisations for insight.

Source: (Chestnut & Mason, 2019)

4.4.7 Accessing Asia

"Accessing Asia" is a product of the Knowledge Partnership for Measuring Air Pollution and GHG Emissions in Asia which is convened by the Clean Air Initiative for Asian Cities Center. The report presents the results of a benchmarking exercise focusing on air pollution and GHGs focusing on road transport and electricity sectors.

Table 27. Overview of Accessing Asia

Introduction	
Organisation	Clean Air Initiative for Asian Cities Center
Est. Year	2000-2009
Coverage	National level
Regional focus	Asia
# Countries	13

# of LMICs	13
LMICs in South Asia & SSH Africa	Pakistan, India, Nepal, Bangladesh, Sri Lanka
Indicators	
# dimensions	The indicators are organised based on the main sectors in focus : road transport and electricity
# subdimensions	While there are no specific subdimensions, indicators focus on CO_2, PM, SO2, NOx, as well as activity and consumption.
# indicators	Road transport – 24 Electricity -21
Indicators directly focused on surface transport / decarbonisation	The iterations for the road transport indicators might be useful, however the data are already dated.
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	CO_2 estimates at the modal level would more or less be available, as well as fuel consumption figures.
Core benefits	• The report illustrates how a benchmarking exercise focusing on relevant metrics (e.g. CO_2 from road transport) in developing countries can be done. The main steps in coming up with such a benchmarking exercise are also notable: □ Selection of (long list) indicators and identification of input requirements □ Data mapping exercise □ Selection of a short list of indicators □ Development of guidelines □ Data collection □ Derivation of indicators □ Review of results □ Benchmarking and publication • The report also maps out the sources of the input data for deriving the indicators, as well as the availability of such in the different countries (albeit, now outdated).

Source: (Clean Air Asia, 2012)

4.4.8 State of Climate Action

The annual "State of Climate Action" reports by the Systems Change Lab measure the progress in current efforts towards 2030 targets. It assesses progress using 42 indicators across eight dimensions/sectors: Power, Buildings, Industry, Transport, Forests and Land, Food and Agriculture, Technological Carbon Removal, and Finance.

Table 28. Overview Indicator Selection State of Climate Action Report

Introduction

Organisation	Systems Change Lab
Est. Year	2021 (Annual update)
Coverage	Sectoral
Regional focus	Global
Indicators	
# dimensions	8
# indicators	42
Indicators directly focused on surface transport / decarbonisation	☐ Transport ☐ Share of electric vehicles in light-duty vehicle sales (%) ☐ Share of electric vehicles in the light-duty vehicle fleet (%) ☐ Share of electric vehicles in two- and three-wheeler sales (%) ☐ Number of kilometres of rapid transit per 1 million inhabitants (km/1M inhabitants) ☐ Number of kilometres of high-quality bike lanes per 1,000 inhabitants (km/1,000 inhabitants) ☐ Share of battery electric vehicles and fuel cell electric vehicles in medium- and heavy-duty commercial vehicle sales (%) ☐ Share of sustainable aviation fuels in global aviation fuel supply (%) ☐ Share of zero-emissions fuels in maritime shipping fuel supply (%) ☐ Share of kilometres travelled by passenger cars (% of passenger-km) ☐ Share of battery electric vehicles and fuel cell electric vehicles in bus sales (%) • Power ☐ Share of zero-carbon sources in electricity generation (%) ☐ Share of coal in electricity generation (%) ☐ Share of unabated fossil gas in electricity generation (%) ☐ Carbon intensity of electricity generation (g CO_2/kWh) • Further potentially relevant indicators: ☐ Share of electricity in the industry sector's final energy demand (%) ☐ Carbon intensity of global cement production (kg CO_2 /t cement) ☐ Green hydrogen production (Mt) ☐ Carbon intensity of global steel production (kgCO_2 /t crude steel) ☐ Technological carbon removal (Mt CO_2 /yr) ☐ Global total/public/private climate finance (trillion $/yr) ☐ Ratio of investment in low-carbon to fossil fuel energy supply ☐ Weighted average carbon price in jurisdictions with emissions pricing systems (2015$/t CO_2 equivalent) ☐ Total public financing for fossil fuels (billion $/yr)
Key take-aways for the development of the Surface TDI	

Core benefits & learnings	• Provides an assessment for each indicator: Right direction on track, right direction off track, right direction well off track, wrong direction u-turn needed, insufficient data.

Source: (Boehm et al., 2023)

4.5 Stocktaking of Other Major Data Sources

This section conducts a high-level review of existing databases and major data sources to better understand the global landscape of transport data. The review is structured along the geographic scale of the featured databases, which stretches from global (i.e., global values and national values for all countries, regional (i.e., data by Africa, Asia and so on), national (i.e., country data) and local (i.e., subnational, city or urban level data). Each table indicates the covered scale as there might be multiple scales covered. In addition, the review indicated the frequency of updates and the major data points covered in each database.

The review is limited to major databases that cover several jurisdictions (several countries or several cities throughout countries). The scope is focused on databases accessible to the public. Most of the databases allow the reproduction and usage of their data which might make it valuable for the TDI and allow any user of the TDI to conduct their own research. It does not feature a review of individual national databases, which is an activity that can be conducted in the pilot testing of the TDI with specific countries.

4.5.1 Global and Regional Level

Transport and climate data on the global and regional level features data points on global energy demand, electric vehicles, renewables, supply chains and transport activity (passenger and freight). All datasets are being updated frequently. In some cases, the global and regional data featured in these reports or databases can be further distinguished by country. Some of the databases, such as the ITF Transport Outlook and the UNEP Gap Emissions report, are based on their institutions models and while they show very insightful global trends, the estimates broken down for each country might be less accurate and less useful in benchmarking applications.[4]

Table 29. Global and Regional Data Sources

Database	Update frequency	Covered scale	Data points covered	Hyperlinks
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 incl. transport	https://www.iea.org/reports/energy-efficiency-2021

[4] Please note that these are not assessments of the relevance of the data sets to the target regions/countries, but mainly a listing of potential sources of data. The detailing of the relevance of these datasets will be done subsequently.

IEA Global EV Outlook	Annually	Global National	EV 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 good, passenger, infrastructure, investments	https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=trsprt-data-en&doi=g2g5557d-en
REN21 Renewables GSR	Annually	Global Local National	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-2021
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	Urban	Various data that are relevant to urban issues	https://data.unhabitat.org/

4.5.2 National Level

National data related to transport decarbonisation covers a larger diversity of topics than the global, regional or local databases. Regional efforts, such as the Asian Transport Outlook and the EU transport in figures, are resourceful databases for major transport-related data points. The World Bank provides a collection of data-sets on the national level. During the COVID-19 pandemic in 2020 and 2021, the large technology companies Apple and Google have released mobility-focused indications for the national and city level. These datasets were very useful to capture the mobility changes compared to the pre-COVID-19 pandemic situation in 2019, however, these data efforts have been discontinued.

Table 30. National Data Sources

Database	Update frequency	Covered scale	Data points covered	Hyperlinks
ADB Asian Transport Outlook	Continuously	Local National	Major data for Asian countries and cities	https://data.adb.org/dataset/asian-transport-outlook-database
Apple Mobility Trends Reports	Discontinued	Local National	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://op.europa.eu/en/search-by-theme?p_p_id=eu_europa_publications_portlet_search_executor_SearchExecutorPortlet_INSTANCE_JSGqfvP2APNP&p_p_lifecycle=1&p_p_state=normal&facet.theme=N07&facet.collection=EUPub&language=en&startRow

				=1&resultsPerPage=10&SEARCH_TYPE=SIMPLE
GIZ Fossil Fuel Prices	Annually	National	Diesel and gasoline 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	Local National	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, it was 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	Local National	Data on BRT, LRT and Metro for major cities	https://docs.google.com/spreadsheets/d/1uMuNG9rTGO52Vuuq6skyqmkH9U5yv1iSJDJYjH64MJM/
KAPSARC Data Portal	Continuously	National	Various data-sets for MENA region but also global data-sets	https://datasource.kapsarc.org/explore/?sort=modified&refine.theme=Transport&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	Country's 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	Local National	Initially a page to provide an overview of subway systems in Openstreetmaps, but very useful to get an overview of 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 countries	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#tab=tab_1
World Bank Data	Continuously	National	Database covering several 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

4.5.3 *Sub-national/ Local Level*

There are a few city-level datasets that cover several cities across countries. Much of the covered datapoints focus on public transport and mode share. The CDP-ICLEI Cities dataset is based on cities directly reporting their information to CDP. For transport, the database covers mode share and transport emissions among several other data points.

Table 31. Local Databases

Database	Update frequency	Covered scale	Data points covered	Hyperlinks
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	BRT 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#2/22.9/19.5
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/

This high-level review of databases gives us an idea on what kind of transport data is readily available. The advantage of such major databases is that the underlying methodology for the data points have been equally applied to all countries. Using individual national databases might have different vehicle typologies, which make it challenging to directly compare several countries.

During the development of the initial TDI methodology, data sources will be further examined. This high-level review will help to kickstart the data source report for the TDI. The suitability of the listed databases for the TDI will be investigated once there is more clarity about the assessment approach and indicators. The current high-level review does not examine the quality of specific data points. While the priority of the TDI will be to explore national databases for the benchmarked countries, the databases from above might be useful as an alternative solution where major data gaps exist. The data sources report will set specific quality criteria connected to the TDI because data quality goes beyond update frequency and regional coverage.

4.6 Discussions and Conclusions

Bibliometric Analysis

The bibliometric analysis of the scientific literature shows that there had been a significant increase in terms of the enthusiasm of the scientific community to look into indexes in surface transport. However, the regional focus has primarily been in other regions such as East Asia and Europe. The exercise also reveals important clusters which might also be useful in formulating the surface TDI later on: performance, impacts, and goals.

Methodological Approaches

The in-depth review of the methodological approaches towards index development reveals the core phases by which such indexes should ideally be developed: 1) Setting objectives & defining the phenomenon, (2) Iterative composite indicator construction, (3) Assessment of the composite indicator and (4) Application, presentation & dissemination of the composite indicator.

It is important to highlight the importance of the adequacy of time and resources to be allotted to the first step which is the setting of the objectives within the context of the phenomenon. Defining the overarching purpose and goals, and end users, is a key step. In the case of the surface TDI, the purpose is to assist LMICs in decarbonising their (implying domestic level) surface transport through the provision of a diagnostic toolkit. This implies that to provide such assistance, the TDI should be able to capture potentially nuanced and varying concepts related to surface transport (e.g. modes and vehicles) into standardized concept, and more importantly, the localisation of the index to capture issues relevant to LMICs.

The development or choice of a theoretical framework for the TDI should capture the main substance, intention, and procedures. We emphasize the importance of recognising the criteria mentioned by Gudmundsson et al. (2016) in defining such frameworks: comprehensive; connected to the objectives; able to capture variable interactions; reflective of stakeholders' perspectives; considers capabilities and constraints; enables flexibility towards adapting to changing contexts.

The study team recognises the importance of embedding discussions focusing on these elements in opportunities wherein we can have conversations with the target stakeholders – in particular, relevant decision makers in LMICs in the target regions of the TDI. It will be crucial to engage stakeholders from the very beginning to ensure relevance of the TDI and increase a sense of ownership among end-users. Making sure target end-users have an interest in the final results is important. Furthermore, the risk of stakeholders not feeling comfortable of being measured in such a competitive comparison was raised. Hence, mitigation strategies shall be explored during stakeholder engagement workshops. In addition to benchmarking countries against each other possible pathways shall be explored.

Developing the TDI should be a concept-inclusive rather than just a data-driven exercise. The development team needs to clarify what, why and how, engage with stakeholders, understand the complexities and interrelationship of the surface transport system and the progress towards decarbonisation.

We note that the selection of the variables is a key step towards the construction of the index, and that the selection of variables and indicators should be based on an assessment of soundness, timeliness, accessibility and comparability. The TDI should be based on data that would be available in the target regions, and thus need to be developed with practicality in mind. We also note that transparency is key towards realising the value of any index.

Developing the TDI will be an iterative process that allows improvements and going back and forth between different options such as dimensions, indicators, or index construction methods. Understanding the data and ensuring statistical soundness and robustness is critical and shall be assessed using suitable statistical methods.

There are also specific decisions that need to be taken in relation to the data, and the processing of the data into information for such a TDI – normalisation, weighting, aggregation – and the development of the TDI needs to select approaches that would ideally achieve the intent of the TDI, ensure practicality, while maintaining robustness. It is also important to emphasize that indexes and composite indicators need to tell narratives in an effective manner, particularly in terms of tracking progress over time. Understanding the requirements towards communicating the messages of the numbers is also important.

Review of the Indexes, Relevant Tracking Platforms and Databases

The structured review of the existing indexes – as well as the indicator tracking initiatives and platforms; and the relevant databases - related to evaluating surface transport and/or decarbonisation points to various insights that can feed into the development of the surface TDI such as the following:

Structure and Elements

- The dimensions relating to assessing the decarbonisation of surface transport can potentially include:
  - Status – This dimension provides insights as to where the county is in relation to decarbonising surface transport. This could be composed of metrics on overall surface transport GHGs, or normalized GHG values, as well as rates of change. This may also cover other key impacts and externalities.
  - Action – This captures the level of commitment and action by the government towards decarbonising surface transport.
  - Readiness – Perhaps could reflect overall capacities to further drive change and absorb the impacts of transition towards decarbonised surface transport. This may also consider pillars such as institutions, markets, infrastructure, etc.
- Integrating the other "layers" such as those described in Section 3.1 is important for the TDI. For example, how it treats the different modes and transport tasks in its structure, would be important in determining its efficacy in surfacing gaps and opportunities that could lead to actionable items. The reflection of various spatial layers (e.g. national, sub-national, urban) is also something that needs to be discussed.
- The TDI should not merely focus on enabling benchmarking and comparison (e.g. country vs country). The TDI should ideally provide insights towards the advancements of decarbonisation policies and measures.
- Considering the dimensions presented above, a temporal coverage capturing historical development, as well as "outlooks" moving forward (i.e. represented by readiness and planned action) should ideally be employed by the TDI.
- Discussions focusing on whether to and how modelling-based future projections should be (or not be) treated in the TDI. It could also be a possibility that such models could interact with the TDI and provide complementary information (e.g. for the national stakeholders) which may not necessarily be used as input data for the TDI.

Approaches

- Techniques related to categorisation and subsequent scoring can be evidenced in many of the indexes. While they represent practical approaches towards attributing specific descriptions to abstract numbers, it is critical to be aware of the importance of building consensus as to how they are developed and utilised.
- Based on learnings from above it is advisable to test different combinations of index dimensions, subdimension, indicators and statistical methods for normalization, weighting, and aggregation.
- While the usage of tiered approaches and supporting indicators may result in providing valuable information to the target users, the TDI should be developed with the aim of utilizing available and comparable core indicators.
- The indexes reviewed that are related to transport reminds us of the ideal situation wherein the TDI would be able to consider decarbonisation as part of a wider sustainability framework.
- There might be cases wherein the TDI needs to consider sectors outside surface transport – metrics relating to the electricity grids (in relation to surface transport electrification), and potentially those that relate to scales (e.g. urban, non-urban, etc.), and pillars (e.g. finance and governance) might be needed to be included.
- Data imputation and processing methods should be clearly documented and presented as part of the toolkit. Reproducibility is critical towards adoption. It is also important to consider the future updating and maintenance of the TDI and its database, and favouring simple yet robust approaches that utilize readily available data would be beneficial.

Data and Results

- The TDI needs to be responsive to the needs and availability of data and information in the target regions. While there are a variety of potential data sources that could be used for calculating indicators, we expect that data and information in the target regions would be scarcer than in more developed ones.
- The indicators would have to be selected based on a combination of priority criteria which would include: relevance to the objectives of the TDI; and the availability of, and accessibility to comparable data across the target region
- There are certain elements targeted for inclusion in the HVT STDI concept, which are not necessarily reflected many of the relevant indexes, such as informal transport, as well gender, equity, and inclusion.
- We note that the availability of organised data in South Asia is better as opposed to Sub-Saharan Africa.
- The results of the TDI shall be made openly accessible, to provide insights and input for further analysis.
- In addition to providing a comprehensive bird-eye view perspective where LMICs in South Asia and Africa are heading in terms of decarbonising surface transport. Insight into the underlying data, interrelationships, possible bottlenecks, or low hanging fruits on where to improve in could provide valuable insights for countries and shall not be neglected.
- Possible collaboration between the TDI development team and existing initiatives, indices and database can be explored to build on synergies, increase collaborative efforts and ensure the relevance of the TDI beyond the lifetime of this project.

5. Report Summary and Next Steps

The Surface Transport Decarbonisation Index research project aims to produce a diagnostic toolkit to assist respective governments in LMICs in South Asia and Sub-Saharan Africa towards identifying key barriers to surface transport decarbonisation, and to provide evidence for policymakers to develop targeted emission reduction actions. It will support the LMICs in developing and pursuing their NDCs and assist in the monitoring of its climate pledges.

To aid the development of the TDI, this report was developed to provide a sound evidence base in terms of underlining the importance of addressing emissions from surface transport as an integral pillar in the pursuit of a 1.5-degree scenario in the future, and to investigate existing literature which could be helpful in crafting an effective TDI for surface transport. This process has uncovered various lessons and insights from scientific and grey literature which focus on the provision of indexes, and relevant indicators whose objectives are tangential, or directly consistent with the objective of the surface TDI.

This report establishes the existing, and projected importance of addressing emissions from surface transport towards achieving 1.5-degree future scenarios. More importantly, there is a need to situate decarbonisation efforts within a wider spectrum of sustainable development objectives in LMICs in the target regions. Highlighting the co-benefits of emissions mitigation may prove to be key in communicating the need to transition into more sustainable pathways for surface transport.

The review of the relevant indexes, indicator platforms, and databases unpacks the various options, and highlights important decisions to make in order to ensure the efficacy and usefulness of the TDI to be developed. The exercise also points the study team towards potential useful sources of data that could be used in the calculating indicators. Moreover, the review surfaced significant insights and lessons that need to be taken into consideration as the TDI is developed.

The lessons learnt from the process of developing this report will feed into the practitioner workshop which is planned to be an online event wherein insights from key stakeholders (e.g. the project advisory group, representatives from relevant government agencies, NGOs, research institutions, experts, and practitioners) would be gathered to feed into the further development of the TDI methodology. This workshop is intended to be conducted in January 2024. Subsequent interactions with the participants through dedicated consultations are to be designed in order to ensure that the process of TDI development is participatory and iterative.

The lessons and insights from this report will also form the building blocks for the drafting of the methodology for the TDI. The initial methodology will be developed up to February 2024, while the full methodology will be delivered at the end of April 2024. Some of priority insights (and questions) garnered through this review will be utilized in going through the different phases as discussed in Section 4.2.

In terms of setting the objective and defining the phenomenon, the next steps would focus on pinning down the final objectives, and thus, guiding the scope definition of the TDI, particularly in terms of what dimensions would ultimately be included. As per the review, ideally, the index could incorporate reflecting the "state" of surface transport emissions, as well as the "actions" being taken to decarbonise surface transport. The inclusion of an assessment of the actions may prove to be difficult and needs careful consideration. The review also points towards the need to define how capacities and limitations could be included in the index results, to provide more detailed guidance to decision makers.

The review also provided valuable insights to how the iterative index construction can be conducted. The next step is to consolidate a list of potentially useful indicators based on the indexes and databases that had been reviewed (roughly guided by the assumption that the index would include assessing the state of surface transport emissions, and could include components related to assessing actions).These would then need to be subjected to criteria that aim at prioritizing relevant indicators which would have reliable, comparable, and accessible data across the target regions. Discussions (with the advisory group), and or surveys with representatives from the target regions, should ideally feed into enlightening decisions related to issues such as the disaggregation/inclusion of various modes into the index, and how the index should reflect nuanced context factors such as transport informality, as well as insights on normalisation, weighting, and aggregation. Such can also feed into defining future interaction mechanisms for the evaluation of the index, as well as in the application, presentation & dissemination of the index.

A data source report that would complement the methodology, and will expound on the sources, availability, and quality of relevant data that could potentially feed into the TDI will be delivered mid-March 2024. The insights gained in terms of the commitments and actions relevant to mitigating GHGs from surface transport will also be useful in defining the set of pilot countries, as well as the full list of countries in the target regions wherein the TDI methodology will be applied. The lessons garnered in relation to the communication, and narration of messages related to the TDI would also be useful in the communications and dissemination phase of the project.

The development of the TDI will be carefully guided by the framework described above, which adheres to the key phases of index development: 1) setting the objectives and defining the phenomenon, 2) iterative construction of a composite indicator, 3) validation of the composite indicator, and 4) application, presentation and dissemination.

In the initial phase, the development of the TDI will centre on clearly defining its overall purpose and objectives and identifying its key end users. This phase will be particularly important to ensure that the TDI captures the multiple aspects of land transport in a way that is both standardised and localised, addressing the specific challenges of LMICs. The identification and involvement of stakeholders from the outset is critical to aligning the TDI with the needs and expectations of its target audience.

The development of the TDI should go beyond a purely data-driven approach and pursue a concept-driven methodology. This requires a clear understanding of the "what", "why" and "how" aspects of the index. It includes the selection of variables and indicators based on criteria such as robustness, timeliness, accessibility and comparability, while also taking into account practicability for the target regions. To ensure the credibility and value of the index, the index developers shall ensure transparency throughout the construction process. In addition, the TDI will be developed in an iterative process that facilitates continuous refinement and allows for flexible adaptation of the various dimensions, indicators and construction methods. This iterative approach is designed to ensure the statistical soundness and robustness of the TDI and will be underpinned by the testing of various statistical methods throughout the index construction.

Recognising that transport decisions are not solely based on decarbonisation, the TDI project will follow the methodological procedures described above, taking into account the wider co-benefits of transport, such as integration, access, economic development and road safety. It is essential to place decarbonisation in the context of these additional benefits so that the TDI can provide a holistic and comprehensive view of transport progress.

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Appendix A: Summary of relevant targets in NDC and LTS documents

Country	Total Fuel combustion CO2 (million tons)	% Contribution by Transport	Type of Document	Parameter	Year	Target emissions in the transport sector (due to gasoline vehicle) in 2030: 169.1 kt CO_2e (30% reduction = 72.5 ktCO2e)
South Asia						
Bangladesh	11.6	12%	1st NDC	T_Transport_O_C	2030	A shift in passenger traffic from road to rail of up to around 20% by 2030 compared to the business as usual
				T_Transport_O_C	2030	15% improvement in the efficiency of vehicles due to more efficient running.
				T_Transport_C	2030	GHG emissions reduction of 24% compared to 2030 BAU
				T_Transport_Unc	2030	GHG emissions reduction of 9% compared to 2030 BAU
			Updated NDC	T_Transport_Unc	2030	Transport GHG reduction of 3.39 Mt CO_2e compared to BAU of 36.28 Mt CO_2e
				T_Transport_C	2030	Transport GHG reduction of 6.33 Mt CO_2e compared to BAU
India	295.1	13%	1st NDC	T_Transport_O_C		Increase the share of railways in total land transport from 36% to 45%
			LTS	T_Transport_O_Unc	2025	Indicative 2025 target: 20% ethanol blending in petrol, with a savings potential of approximately INR 30,000 crore/yr.
				T_Transport_O_Unc	2030	Indian Railways to become net-zero by 2030, leading to annual mitigation of 60 million tonnes of CO_2.
				T_Transport_O_Unc	2030	National Logistic Policy aspires to reduce cost of logistics in India to be comparable to global benchmarks by 2030
Sri Lanka	10.2	48%	Updated NDC	T_Transport_Unc	2030	It is expected that the implementation of updated NDCs will result in GHG emissions reduction against BAU scenario by 4.0% in the transport sector (1.0% unconditionally and 3.0% conditionally) equivalent to an estimated mitigation level of 1,337,000 MT unconditionally and 4,011,000 MT conditionally (total of 5,348,000 MT) of carbon dioxide equivalent during the period of 2021-2030
			1st NDC	T_Transport_O_Unc	2025	Reduce unproductive vehicles by 25% in 2025 unconditionally
				T_Transport_O_C	2025	Reduce unproductive vehicles by 50% in 2025 conditionally
				T_Transport_Unc	2030	NDCs for Mitigation intends to reduce the GHG emissions against BAU scenario by 10% in other sectors (transport, industry, forests and waste) by 3% unconditionally and 7% conditionally by 2030.
				T_Transport_C	2030	NDCs for Mitigation intends to reduce the GHG emissions against BAU scenario by 10% in other sectors (transport, industry, forests and waste) by 3% unconditionally and 7% conditionally by 2030.
			Updated NDC	T_Transport_C	2030	It is expected that the implementation of updated NDCs will result in GHG emissions reduction against BAU scenario by 4.0% in the transport sector (1.0% unconditionally and 3.0% conditionally) equivalent to an estimated mitigation level of 1,337,000 MT unconditionally and 4,011,000 MT conditionally (total of 5,348,000 MT) of carbon dioxide equivalent during the period of 2021-2030
Nepal	4.4	34%	1st NDC	T_Transport_O_C	2020	Increase the share of electric vehicle up to 20% by 2020
			LTS	T_Transport_O_Unc		In 2025, electric vehicles (e-vehicles) will account for 25 per cent of all private passenger vehicle sales (including two-wheelers) and 20 per cent of all four-wheeler public passenger vehicle sales (excluding electric rickshaws and electric three-wheelers). Ii) Increase e-vehicle sales to 90 percent of all private passenger vehicle sales (including two-wheelers) and 60 percent of all four-wheeler public passenger vehicle sales by 2030. (excluding electric-rickshaws and electric three-wheelers).

				T_Transport_O_Unc		iii) Develop a 200-kilometer electric rail network by 2030 to support public transport and mass transport of goods.
				T_Transport_O_C	2025	Sales of electric vehicles (e-vehicles) in 2025 will be 25% of all private passenger vehicles sales, including two-wheelers and 20% of all four-wheeler public passenger vehicle sales (this public passenger target does not take into account electric-rickshaws and electric-tempos) in 2025
				T_Transport_O_C	2030	By 2030, increase sales of e-vehicles to cover 90% of all private passenger vehicle sales, including two-wheelers and 60% of all four-wheeler public passenger vehicle sales. By 2030, develop 200 km of the electric rail network to support public commuting and mass transport of goods
			2nd NDC	T_Transport_O_C	2030	By 2030, develop 200 km of the electric rail network to support public commuting and mass transport of goods
Pakistan	55.9	28%		T_Transport_O_Unc	2030	30% Electric Vehicles by 2030
			Updated NDC	T_Transport_O_C	2030	By 2030, 30 % of all new vehicles sold in Pakistan in various categories will be Electric Vehicles (Evs). 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
Sub-Saharan Africa						
Burkina Faso				T_Transport_O_C	2030	Substitution of biofuels for hydrocarbons: biodiesel production units (replace 5% of diesel consumption in 2030) Substitution of biofuels for hydrocarbons: bioethanol production units (replace 10% of super grade petrol consumption in 2030)
				T_Transport_O_C	2030	More rapid improvement in the stock of vehicles (30% reduction in fuel consumption in 2025 instead of 20% for 2030)
				T_Transport_Unc	2030	0.42% below BAU by 2030 [from table]
			1st NDC	T_Transport_C	2030	42% below BAU by 2030 (conditional)
				T_Transport_Unc	2025	Dans le secteur du transport les actions inconditionnelles et les actions dont leur mise en œuvre nécessite une recherche de financement (conditionnel), ont des potentiels de réduction des émissions de GES respectivement évalués à 1 210 Gg CO2eq et 267Gg CO2eq en 2025. Le total du potentiel de séquestration des émissions de CO2 dans le secteur est de 1 477 Gg CO2eq en 2025.
			Updated NDC	T_Transport_C	2025	267Gg CO_2eq en 2025
Côte d'Ivoire	5	41%	1st NDC	T_Transport_C	2030	5,7% below BAU in 2030
				T_Transport_O_Unc	2030	10% of the car fleet will be electric by 2030
				T_Transport_O_C	2030	25% of the car fleet will be electric by 2030
				T_Transport_O_Unc	2030	Mettre en oeuvre les normes Euro VI d'ici 2030 pour les véhicules particuliers; taxi et véhicules utilitaires; d'ici 2050 pour les poids lourds
			2nd NDC	T_Transport_O_Unc	2024	Mettre en place des carburants à très faible teneur en soufre d'ici 2024
Congo	1.2	32%	1st NDC	T_Transport_C	2025	Dans un scénario bas-carbone conditionnel, il est proposé de maîtriser la hausse des consommations d'énergie liées au transport à 70% du scénario tendanciel en 2025, avec une option « carburant renouvelable » (pour 21 à 43% des consommations)
Cabo Verde				T_Transport_O_Unc	2030	electrify at least 25% of its land-borne transport fleet (new vehicles) by 2030 by resorting to RE sources
			Updated NDC	T_Transport_O_C	2030	shares per vehicle category could increase to 50% in favor of public, collective high-passenger load vehicles
Ethiopia	7.2	56%	1st NDC	T_Transport_C	2030	25% below BAU in 2030 (10 Mt CO_2e)

Gabon	0.2	9%	1st NDC	T_Transport_Unc	2025	20% below BAU in 2025
Guinea				T_Transport_Unc	2030	Emission level of 4142 kt CO2 compared to BAU level of 4335 kt CO2
				T_Transport_C	2030	Emission level of 3879 kt CO2 compared to BAU level of 4335 kt CO2
				T_Transport_O_Unc	2025	Application de l’interdiction d’importation de véhicules de plus de 8 ans à horizon 2025 (norme CEDEAO)
				T_Transport_O_Unc	2030	mise en œuvre à l’horizon 2030 de l’interdiction d’importation de véhicules de plus de 5 ans (préconisation de la Commission de la CEDEAO de 2020). Soit 500 000 voitures plus efficaces entre 2025 et 2030.
				T_Transport_O_Unc	2025	Construction à horizon 2025 de 910 km de voie ferrée pour le transport de minerais dont 650 km pour le Transguinéen en substitution au transport routier. Ajout de 390 km entre 2025 et 2030
				T_Transport_O_C	2025	Application de l’interdiction des voitures de plus de 8 ans (norme CEDEAO) dès 2022 soit 500 000 voitures plus travelled d’ici 2025
				T_Transport_O_C	2030	Application de l’interdiction des voitures de plus de 8 ans (norme CEDEAO) dès 2022 soit […] 1 000 000 voitures d’ici 2030
			Updated NDC	T_Transport_O_C	2030	Mise en œuvre du scénario intégré du PDU de Conakry - Une ligne BRT Le Prince Kaloum / Sonfonya par corniche de 33,5km. - Une ligne HRT Kaloum / Kagbelen de 33,5 km. Ces travaux sont estimés à un coût de 422 millions d’euros d’ici 2030 pour un bilan cumulé de – 919 ktC02 d’ici 2030.
Gambia (Republic of The)			2nd NDC	T_Transport_C	2030	22.2% decrease compared to the expected baseline level in 2030
			1st NDC	T_Transport_C	2030	Only one conditional mitigation option was analyzed under the Transport Sector. As shown in Figure 6, deployment of energy efficient vehicles will produce greenhouse gas emission reductions of 40.8 GgCO2e in 2020, 114.5 GgCO2e in 2025 and 193.3 GgCO2e in 2030.
			LTS	T_Transport_C	2030	The long term strategy is to reduce GHG emissions by introducing energy-efficient modes of transports, which have a GHG emission reduction target of 193.3 GgCO2e in 2030. (…) The implementation of the planned mitigation actions will help in reducing GHG emissions in the transport sub-sector from 1,026 GgCO2e to 315 GgCO2e in 2050. This shows that the implementation of the mitigation actions within the transport sub-sector will not lead to the achievement of a net-zero mitigation scenario by 2050. This calls for the need to implement more rigorous mitigation actions in the other sectors in order to achieve a net sink mitigation scenario.
Liberia			1st NDC	T_Transport_O_C	2030	Blend up to 5% of palm oil biodiesel with both gasoline and diesel by 2030 for vehicles. (only through provision of means of implementation by international community)
			Updated NDC	T_Transport_C	2030	the Transport sector, Liberia commits to reducing GHG emissions by 15.1% below BAU levels by 2030
Mali				T_Transport_O_Unc	2030	11% de l’essence remplacee par du bioethanol d’ici a 2030
			Updated NDC	T_Transport_O_Unc	2030	5.4% du diesel remplace par du biodiesel d’ici 2030
Mozambique	4.2	60%	Updated NDC	T_Transport_O_C		Massification of Natural Gas Use: o Construction of ten (10) Compressed Natural Gas Supply Stations, • Importation of one hundred and fifty (150) CNG Buses • Import of one thousand (1000) kits and respective conversion Cylinders for Natural Gas. • Conversion of 1000 cars to NG
Mauritania			Updated NDC	T_Transport_Unc	2030	–92.65 Gg CO2eq, of which 5.21% unconditional
Mauritius	1	25%	Updated NDC	T_Transport_Unc	2030	The contribution by each sector to the 40% mitigation target in terms of avoided emissions (ktCO2eq) is as it follows: Transport: 129 ktCO2eq
Malawi			1st NDC	T_Transport_O_Unc		Increase number of passengers using mass transport by 1% (unconditional)

				T_Transport_O_C		Increase number of passengers using mass transport by 30% (conditional)
				T_Transport_O_C	2040	Modal shift: private to passenger transport – Increasing the share of passenger transport from around 10% at present to around 30% in 2040, reducing GHG emissions from gasoline and diesel use.
			Updated NDC	T_Transport_O_C	2040	Achieving an average national blend rate of 20% ethanol
	1.9	53%		T_Transport_O_C	2030	(…) reduce the number of light load vehicles by about 20%
				T_Transport_O_C	2030	Commission of a mass transport system in City of Windhoek to reduce number of cars (taxis and private) by about 40%
Namibia			1st NDC	T_Transport_Unc	2030	2.3 % below BAU in 2030
				T_Transport_O_Unc	2030	10 000 Electric Vehicles – replacing gasoline
				T_Transport_O_Unc	2030	Promote passenger vehicle fuel efficiency standards (in 80 % of total passenger vehicle population)
			Updated NDC	T_Transport_O_Unc	2030	Light-duty vehicles (LDV) – reducing fuel use by 20%
				T_Transport_O_Unc	2030	8000 More Efficient Gasoline Cars
Niger	1.3	52%		T_Transport_O_Unc	2030	5000 Voitures diesel plus efficaces
			Updated NDC	T_Transport_O_Unc	2030	Restriction on the importation of used carsL 35000 vehicles
			1st NDC	T_Transport_O_C	2030	Blending 10% by volume of Fuel-Ethanol with Gasoline (E10) and 20% by volume of Biodiesel with Petroleum Diesel (B20) for Transport Fuels
				T_Transport_Unc	2030	reducing GHG emissions by about 4 Mt CO_2e by year by 2030
Nigeria	57.2	56%	LTS	T_Transport_O_Unc	2050	The long-term vision in the transport sector that can move the country toward carbon neutrality is a national transport system by 2050 with all having access to a range of affordable transport choices in which not more than 50% of all journeys are by cars, at least 40% of all journeys are by public transport (including trains and BRT) and at least 10% of all journeys are by active travel (e. g. cycling, walking) to generate little to no GHG, keep the air clean, reduce vehicle distance travelled while increasing access and grow the economy
				T_Transport_O_C	2030	100,000 extra buses by 2030
				T_Transport_O_C	2035	Bus Rapid Transport (BRT) will account for 22.1% of passenger-km by 2035
			Updated NDC	T_Transport_O_C	2030	25 % of trucks and buses using CNG by 2030
South Sudan	1	56%	2nd NDC	T_Transport_Unc	2030	44% reduction in GHG emissions compared to baseline (2030 BAU)
Eswatini	0.8	67%	1st NDC	T_Transport_O_C	2030	10% ethanol blend in petrol for use in all vehicles by 2030
			Updated NDC	T_Transport_O_Unc	2030	Introducing commercial use of 10% ethanol blend in petrol by 2030
				T_Transport_O_C	2030	30% of private vehicles are electric by 2030
				T_Transport_O_C		15.8 MW of solar PV for meeting the energy demand of electric vehicles
Seychelles			1st NDC	T_Transport_O_C	2030	In transport, 15-30% reduced oil imports against BAU in 2030
				T_Transport_C	2030	Target emissions in the transport sector (due to gasoline vehicle) in 2030: 169.1 ktCO_2e (30% reduction = 72.5 ktCO_2e)
			Updated NDC	T_Transport_O_C	2030	The 30% electric target is hence revised to 72.5kt ktCO_2 GHG, being more ambitious than in the previous NDC.

				T_Transport_O_Unc	2030	By 2025 mechanism(s) to facilitate importation (pending an appropriate tax regime of electric transport infrastructure must be in place such as electric charging power stations By 2030, 30% of large tourism businesses (DMCs, taxis, etc) must have electric transport in their fleet. By 2030, small and medium tourism businesses (omnibuses, taxis) must have 20% electric transport.
			1st NDC	T_Transport_C	2030	From land transport, emission reductions by 26.5 $ktCO_2e$ in 2025 and 50.13 $ktCO_2e$ in 2030 relative to baseline emissions
Togo	1.3	72%	1st NDC	T_Transport_O_C	2030	In terms of road transport, the planned actions aim to reduce the consumption of fossil fuels in Togo by 20% by 2030
				T_Transport_O_Unc	2025	In the transport category, the improvement and extension of road infrastructure (ongoing and planned in the Government Roadmap 2025) and the promotion of low-emission public transport will reduce the final energy intensity by 10% for motorcycles and 20% for cars and trucks;
			Updated NDC	T_Transport_O_Unc	2025	Increase the share of electric vehicles in the acquisition of new vehicles to 3% by 2025
Uganda	3.8	67%		T_Transport_C	2030	Transport sector GHG emissions under Business-As-Usual conditions will more than double from 4.2 MtCO2e in 2015 to 9.6 $MtCO_2e$ in 2030. If all the main mitigation measures under the NDC scenario are implemented fully, they have the potential to limit the growth of the emissions by 29% to 6.8 $MtCO_2e$ in 2030 as illustrated in the figure 3-6.
				T_Transport_O_Unc	2050	Implement 1,412 km of fully electrified standard gauge rail by 2050.
				T_Transport_O_Unc	2030	Rehabilitation of 634 km of meter gauge railway by 2026 to facilitate modal shift of freight from road to rail. 22% fuel economy improvement of diesel locomotives achieved in 2030 relative to 2015.
				T_Transport_O_Unc	2040	Implement 100 km of fully electrified passenger LRT rail by 2040.
				T_Transport_O_Unc	2040	Implement 75 km of fully electrified passenger metro rail by 2040.
				T_Transport_O_Unc	2030	Implement 61 km of passenger MGR rail in 2030. 22% fuel economy improvement of diesel locomotives achieved in 2030 relative to 2015.
				T_Transport_O_Unc	2030	Implement 101 km of BRT in GKMA in 2030
				T_Transport_O_Unc	2050	TOD reduces motorised travel demand by 5% in 2050.
				T_Transport_O_Unc		5% reduction in VKM and 5% increase in load factor from improved organisation of urban public transport.
				T_Transport_O_Unc	2030	100 km of complete streets or dedicated NMT corridors, constructed in greater Kampala area in 2030 leading to 10% shift in PKM by mode from other passenger modes. Construct 100 km of NMT facilities in secondary cities in 2030.
				T_Transport_O_Unc		1% per year increase in alternative fuel use for all road vehicles - 60% of the increase comes from natural gas. - 20% from ethanol (E10). - 20% from biodiesel.
				T_Transport_O_Unc	2030	Introduction of at least 200 e-buses in GKMA in 2030.
			Updated NDC	T_Transport_O_Unc	2030	Global Fuel Economy Initiative (GFEI) 50 by 50 targets, improvement of fuel economy with 10-year time-lag: 2030: 20% 2040: -35% 2060: -50%
			1st NDC	T_Transport_O_C		Reductions of between 24% and 34% of Business As Usual projections for road transport
South Africa	48.2	12%	LTS	T_Transport_O_Unc	2030	20% reduction in the average vehicle energy intensity (measured in MJ/km) of the South African road vehicle fleet, by 2030.
			1st NDC	T_Transport_O_Unc	2030	Hybrid electric vehicles: 20% by 2030

Zimbabwe	1.6	18%		T_Transport_O_C	2030	Transport fuel economy policy / Fuel efficiency improvement 2025-2030: Motorcycles: 2.2% per year; LDVs: 2.9%/year; Buses: 2.6%/year; HDVs: 2.5%/year
			Updated NDC	T_Transport_O_C	2030	Public transport. 5% shift from private car to public transport in 2030

Notes: Taken from GIZ & SLOCAT. (2023) & IEA (2023b)

Appendix B. Template for Index Mapping And Assessment

Organisation	*Main organisation overseeing the index*
Est. Year	*Year of establishment*
Update frequency	*Frequency of updating the index (annual, biannual, etc…)*
Target group	*Main target group/ consumer of the results*
Coverage	*National/regional/sub-national/local*
Regional focus	*If there are specific regions that are of focus*
# Countries	*Total number of countries included*
# of LMICs	*Total number of LMICs included*
LMICs in South Asia & SSH Africa	*If applicable, note down the countries in the target regions*
Methodology	
Description of the framework	*Main focus and structure of the framework*
Benchmark	*If benchmarking is done, provide a description*
# dimensions	*Total number of dimensions/pillars*
# subdimensions	*Total number of subdimensions/sub-pillars*
# indicators	*Total number of indicators*
Indicators directly focused on surface transport / decarbonisation	*Potentially relevant indicators for developing the surface TDI*
Data imputation	*In case applicable, provide specific techniques used in terms of data imputation*
Normalisation	*Method used for scaling or normalising the indicators*
Weighting	*Method used to weight the indicators and/or dimensions*
Aggregation	*Method used to aggregate the individual indicators and/or dimensions into an index*
Dissemination & Availability	
Communication channels	*Type of communication channel*

Accessibility of input data	*Description of the ease of accessing the input data*
Accessibility of output data	*Description of the ease of accessing the outputs*
Key take-aways for the development of the Surface TDI	
Expected availability of data in the TDI target region	
Core benefits & learnings	

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