GLOBAL MOBILITY REPORT 2017

Tracking Sector Performance

SUSTAINABLE mobility FOR ALL™

Standard Disclaimer

This publication was produced by the Sustainable Mobility for All (SuM4All™) initiative. The findings, interpretations, and conclusions expressed in this paper do not necessarily reflect the views of the Boards of the SuM4All members or the governments they represent. SuM4All does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of SuM4All or its members concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

ISBN: 978-0-692-95670-0

CONTENTS

FOREWORD

The Global Mobility Report 2017 (GMR) is the first-ever attempt to examine the performance of the transport sector, globally, and its contribution to a sustainable future.

Sustainable transport and mobility are fundamental to progress in realizing the promise of the 2030 Agenda for Sustainable Development and in achieving the 17 Sustainable Development Goals (SDGs).

As members of the international community, we have a shared responsibility to shape the transport agenda. The overall aim is to achieve universal sustainable mobility. This will require greater coherence within the transport sector, to support global decision-making and influence investment. This GMR is a first step in building stakeholder consensus on this path.

The GMR is meant to be a continuing resource, as we plan on updating this report every two years. The proposed targets and indicators herein—which establish the elementary global tracking framework for transport—are based on and complement the SDG indicators that were developed by the Inter-Agency and Expert Group on SDG indicators (IAEG-SDGs) created by the UN Statistical Commission. They establish a baseline for future tracking towards sustainable mobility, and provide the sector with information and tools on which to base policy and investment decisions. This baseline report will be launched in the autumn of 2017.

October 2017
Washington, D.C.

EXECUTIVE SUMMARY

Toward Sustainable Mobility for All™

The world of transport is changing rapidly, and its future path is uncertain. We know that mobility will increase as more people and goods move across towns and across the globe: by 2030, annual passenger traffic will exceed 80 trillion passenger-kilometers—a 50 percent increase compared to 2015; global freight volumes will grow by 70 percent compared to 2015; and an additional 1.2 billion cars will be on the road—double today's total.

Meeting growing aspirations for mobility has the potential to improve the lives and livelihoods of billions of people—their health, their environment, and their quality of life—and to help minimize the effects of climate change. But the future of mobility can also go in another direction: it can engender gross inequalities in economic and social advancement, promote fossil fuel use, degrade the environment, and add to the number of deaths from transport-related accidents and air pollution.

This recognition catalyzed the global momentum from which the Sustainable Mobility for All™ (SuM4All™) initiative emerged. SuM4All is a global multi-stakeholder partnership that speaks with one voice, and acts collectively to help transform the transport sector. Its ambition is to make mobility: (i) equitable—ensuring that everyone has access to jobs and markets through good quality transport regardless of their economic or social status; (ii) efficient—to allow people and goods to move from place to place quickly and seamlessly; (iii) safe—by halving the number of global deaths and injuries from road traffic accidents and other modes of transportation; and (iv) green—by lowering the environmental footprint of the sector to combat climate change and pollution.

The Global Mobility Report 2017

The Global Mobility Report 2017 (GMR) is the first-ever attempt to examine performance of the transport sector globally, and its capacity to support the mobility of goods and people, in a sustainable way. The GMR is built around three components: (i) four global objectives that define "sustainable mobility"; (ii) quantitative and qualitative targets for those objectives, drawn from international agreements; and (iii) indicators to track country-level progress towards those objectives. It covers all modes of transport, including road, air, waterborne and rail.

While the ambition is clear, realism is equally important. Because the sector is scant on indicators and data, this first edition concentrates on structuring the space—the vision—and taking stock of indicators and targets—not yet actually tracking progress toward sustainable mobility. Among all possible transport indicators, it identifies both actual and desirable indicators. Actual indicators consist of those endorsed through the SDG indicators process and those commonly used by practice leaders in transport. This data for over 180 countries will be presented on-line in a user-friendly format via "country mobility snapshots". The methodologies and data for other indicators will be developed over time.

Both actual and desirable indicators form the basis of the **"Elementary Global Tracking Framework for Transport"** (GTF). It is envisaged that the GTF will be used to track actual performance towards sustainable mobility in support of the 2030 Agenda. The GMR will be refined and updated every two years.

Key Findings and Trends

How can transport help economic, social and environmental advancement in a manner that benefit both today's and future generations? This GMR posits that it is no longer enough that transport just provides "access" to jobs, markets and opportunities. Mobility should have four attributes: it should be equitable, efficient, safe and climate responsive. Achieving these four objectives will ensure that mobility needs of the current generation will not be met at the expense of future generations. In other words, that mobility will be sustainable.

Universal Access

Equity and inclusivity are at the heart of Universal Access. This objective accounts for distributional considerations and places a minimum value on everyone's travel needs, providing all, including the vulnerable, women, young, old, and disabled, in both urban and rural areas, with at least some basic level of access through transport services and leaving "no one behind."

In rural areas, where the vast majority of poor people live, limited connectivity is a critical constraint. Based on the current rural accessibility index, about 450 million people in Africa—or more than 70 percent of its total rural population—are estimated to have been left unconnected due to missing transport infrastructure and systems. In urban areas, where an additional two billion people are expected to be living in cities by 2045, the growth in population is far outstripping the growth in public transport, thus limiting access to economic and social opportunities. Urban transport systems and services need to be upgraded—and in some cases planned from scratch—in an integrated way, that ensures the balanced access of urban residents regardless of income, mode of travel, gender, or disability status. Urban mobility should foster and enable cities to flourish, without creating over-dependence on any particular mode of travel.

Women's mobility is of concern in both rural and urban areas. Although there is no database on public-transit-related crimes, there is evidence that security issues constrain women's mobility. The lack of personal security, or the inability to use public transport without the fear of being victimized—whether on public transport, walking to or from a transit facility or stop, or waiting at a bus, transit stop, or station platform—can substantially decrease the attractiveness and thus the use of public transit.

Efficiency

The Efficiency objective seeks to ensure that transport demand is met effectively and, and at the least possible cost. Since efficiency cuts across multiple aspects, the GMR arbitrarily defines the boundary for this objective from a strictly "macro-economic" perspective: the optimization of resources—energy, technology, space, institutions, and regulations—to generate an efficient transport system or network. There are no internationally agreed global targets for efficiency, but there is a belief that the international community should invest in better understanding and measuring this objective—a critical aspect for the future of mobility.

New technology will help improve the efficiency of transport systems. Yet, a recent global survey on digital readiness shows that the transport sector is less ready to embrace digitalization than other sectors. Positive global trends include improvement in logistics performance and fuel economy during the last decade, both of which contribute to reducing the aggregate cost of goods as well as fossil fuel energy consumption. But institutional and regulatory barriers—especially in land-locked developing countries and their transit neighbors—continue to prevent reduction in transport costs.

Safety

The Safety objective aims to improve the safety of mobility across all modes of transport by avoiding fatalities, injuries, and crashes from transport mishaps. There are internationally agreed global targets for road and air transport safety.

Road transport claims the bulk of transport related fatalities worldwide: it accounts for 97 percent of the deaths and 93 percent of the costs. On roads, the fatality risk for motorcyclists is 20 times higher than for car occupants, followed by cycling and walking, with 7 to 9 times higher risk than car travel, respectively. Bus occupants are 10 times safer than car occupants. Rail and air are the safest transport modes. Globally, 40 to 50 percent of traffic fatalities occur in urban areas. Evidence suggests that the highest fatality rates occur in cities in the developing world—the proportion of fatalities in urban areas is high and rising in low- and middle- income countries. The GMR stresses that unsafe mobility in any of these transport modes can pose significant public health risks, and can lead to social and economic losses.

Green Mobility

The Green Mobility objective aims to address climate change through mitigation and adaptation, and to reduce both air and noise pollution. It is related to SDG13 of the 2030 Agenda which aims to take urgent action to combat climate change and its impacts, and is anchored in the Paris Agreement on Climate Change. Its targets will be designed to achieve a net-zero-emission economy by 2050, and improve other dimensions such as air quality and climate resilience by 2030, as set forth in the SDG targets.

In 2012, transport was the largest energy consuming sector in 40 percent of countries worldwide, and in the remaining countries it was the second-largest energy consuming sector. In one projection, energy related CO_2 emissions are expected to grow by 40 percent between 2013 and 2040. The sector already contributes 23 percent of global energy-related greenhouse gas emissions and 18 percent of all man-made emissions in the global economy.

Moving Forward: The Vision

In a future where mobility is sustainable, cities and remote communities in rural areas will all be connected to jobs, markets and opportunities, so that "no one is left behind". Transport will become the lifeline for all, including vulnerable groups as transport services will reach them all. Transport networks will be seamlessly integrated to meet mobility needs through motorized and active modes (such as walking and cycling). Landlocked developing countries will have swift access to the sea and, together with small island developing States, will be fully integrated into the global economy. It will be a future in which transport-related fatalities and emissions are fully minimized.

The GMR will prove to be a valuable multi-purpose tool for policy makers, investors, practitioners, and experts in the transport sector as they work to realize this vision.

ACKNOWLEDGMENTS

A group of multi-stakeholder partners came together to produce this first edition of the Global Mobility Report which examines global mobility using an jointly agreed-upon set of guidelines. It is the first joint output of the Sustainable Mobility for All™ (SuM4All™) umbrella initiative.

We are grateful to the following organizations for their lead role in drafting the GMR: Overview: UN Department of Economic and Social Affairs (UN-DESA) and World Bank (WB); Chapter 1: World Bank (WB) and International Transport Forum (ITF); Chapter 2: Department for International Development (DFID), Union Internationale des Transports Publics (UITP) and Institute for Transportation and Development Policy (ITDP) ; Chapter 3: UN Economic Commission for Europe (UNECE); Chapter 4: CAF Development Bank of Latin America; Chapter 5: Partnership for Low Carbon Transport (SLoCaT). Paris Process for Mobility and Climate (PPMC) and the World Resources Institute (WRI).

The World Bank convened the partners and provided overall secretariat support for the report. The work was conducted under the general guidance of Jose Luis Irigoyen, with a team consisting of Nancy Vandycke, Muneeza Alam, Shokraneh Minovi, H. Stephen Halloway, Emiye Deneke, Xavier Muller, and Yohan Seranath. Cathy Gagnet was the principal editor, and Oleksiy Manuilov designed the report.

The authors are grateful for the support provided by Kristalina Georgieva, Mahmoud Mohieldin, Hart Schafer, Laura Tuck, Elif Kiralti, and Nicholas Bian.

The lead organizations benefited greatly from a wide range of consultations in Washington, D.C., London, Leipzig, and New York. More than fifty organizations contributed inputs and comments.

The Overview section was authored by Nancy Vandycke (WBG), Muneeza Alam (WBG), Irena Zubcevic (UN-DESA), and Julie Powell (UN-DESA).

Chapter 1 (Conceptual Framework) was authored by Nancy Vandycke (WBG), Muneeza Alam (WBG), Javier Morales Sarriera (WBG), José Viegas (ITF), Jari Kauppila (ITF), and Lewis Fulton (University of California).

Chapter 2 (Universal Access, Rural) was authored by Elizabeth Jones (DFID) and Mark Henry Rubarenzya (Uganda National Roads Authority), with inputs from Walid Abdelwahab, Ahmed Al Qabany (Islamic Development Bank), Simon Ellis, Baher El-Hifnawi (WBG), Colin Gourley and Stephen Coyle (DFID), Joseph Haule (Tanzania Roads Fund Board Chair), Jasper Cook and Mike Pinard (ReCAP), Karl Peet (Partnership on Sustainable, Low Carbon Transport), Ko Sakamoto and David Salter (Asian Development Bank), Tyrone Toole (Australian Road Research Board), Marie-Helene Vanderpool (International Road Transport Union), Patrick Mallejacq (World Road Association), Arnaud Desmarchelier (Agence Française de Développement), John Hine (Independent Consultant), Robin Workman and Andrew Otto (Transport Research Laboratory), Shokraneh Minovi, Vincent Vesin, Nicolas Peltier (WBG), Klaus Gihr (KfW), Mir Tanweer Husain (Bangladesh Local Government Engineering Department), and Peter Njenga (International Forum for Rural Transport and Development).

Chapter 2 (Universal Access, Urban) was authored by Alain Flausch (UITP), Clayton Lane (ITDP), Jacob Mason (ITDP), Philip Turner (UITP), Mircea Steriu (UITP), with inputs from Arturo Ardila-Gomez (WBG), Debashish Bhattacharjee (UN-Habitat), Diego Canales (WRI), Irena Zubcevic (UN-DESA), Julie Powell (UN-DESA), Karla Gonzalez Carvajal (WBG), Muneeza Alam (WBG), Nancy Vandycke (WBG), Nicolas Wagner (ITF/STM), Stefanie Holzwarth (UN-Habitat), and Tatiana Peralta Quiros (WBG).

Chapter 3 (Efficiency) was authored by Eva Molnar (UNECE), Moustafa Baher El-Hifnawi (WBG), Cecilia M. Briceno-Garmendia, Gerald Paul Ollivier (WBG), Nina Paustian (WBG), Muneeza Alam (WBG), and Javier Morales Sarriera (WBG), with inputs from Lukasz Wyrowski (UNECE), Marie-Helene Vanderpool and Jens Hugel (IRU), Sheila Watson (FIA Foundation), Frida Youssef (UNCTAD), Sandagdorj Erdenebileg (UN-OHRLLS), Gladys Mutangadura (UN-OHRLLS), Dagmar Hertova (UN-OHRLLS), Thilly de Bodt (ICAO), Esteban Diez Roux (IDB), Ernesto Monter Flores (IDB), and Philip Sayeg.

Chapter 4 (Safety) was authored by Hilda Maria Gomez (CAF), with Soames Job (WBG), Jorge Kogan (CAF),Claudia Adriazola-Steil (WRI), Fred Wegman (ITF), Girma Bezabeh (AfDB), James Bradford (iRAP), Jimena Blumenkron (ICAO), Marc Shotten (WBG), Marco Merens (ICAO), Margaret Mary Peden (WHO), Maria Segui Gomez (FIA) Mark Clintworth (EIB), Meleckidzedeck Khayesi (WHO), Muneeza Alam (WBG), Per Mathiasen (EIB), Rob McInerney (iRAP), Susanna Zammataro (IRF), Veronique Faypell (ITF), Victor A. Aragones (WBG), Milnael Gómez (CAF), and Veronica Raffo (WB).

Chapter 5 (Green Mobility) was authored by Cornie Huizenga (SLoCaT Partnership), Holger Dalkmann (WRI), Patrick Oliva (PPMC), Alyssa Fischer (WRI), and Karl Peet (SLoCaT), with inputs from Heather Allen (Independent/SLoCaT Partnership), Ahmed Al Qabany (IsDB), Hassiba Benamara (UNCTAD), Claire-Marie Bernard (Michelin), Daniel Bongardt (GIZ), Pierpaolo Cazzola (IEA), Maria Cordeiro (WBG), Nick Craven (UIC), Ramon Cruz (ITDP), Francesco Dionori (UNECE), Carlos Dora (WHO), Urda Eichhorst (GIZ), Klaus Gihr (KFW), Joanne Green (Clean Air Institute), Henrik Gudmundsson (Concito), Sandra Hannusch (KfW), Jane Hupe (ICAO), Rob Jong (UNEP), Fanta Kamakate (ICCT), Drew Kodjak (ICCT), Tonilyn Lim (UNIDO), Eric Masanet (IEA), Shomik Raj Mehndiratta (WBG), Joshua Miller (ICCT), Wei-Shiuen Ng (ITF), Margarita Maria Parra (Hewlett Foundation), Tracy Raczek (UNGA), Thiago Hérick de Sa (WHO), Regina Guthold (WHO), Bettina Schreck (UNIDO), Eileen F. Tawffik (WHO), Bronwen Thornton(Walk21), Armin Wagner (GIZ), Almud Weitz (WBG), Mathis Weller (UNCTAD), Petrouschka Werther (Ministerie van Infrastructuur en Milieu), and Sheila Watson (FIA).

Finally, the team would like to acknowledge the support of the Government of the UK Department for International Development, as well as the contributions from all participating organizations.

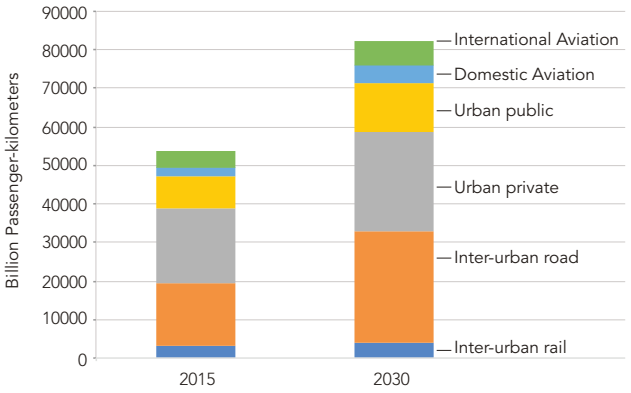
OVERVIEW

MOBILITY FOR A SUSTAINABLE FUTURE

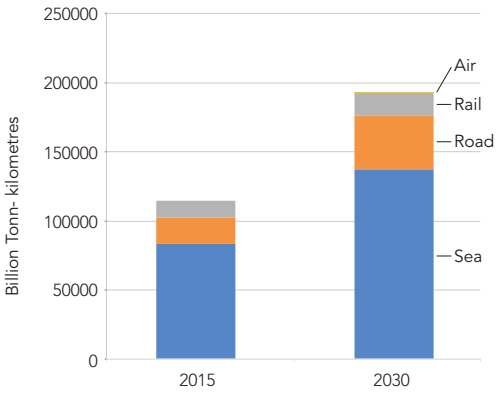
The world around us is transforming rapidly, changing the way people and goods travel within and across cities, regions, and countries. By 2030, annual passenger traffic will exceed 80 trillion passenger-kilometers—a fifty percent increase; global freight volumes will grow by 70 percent (Figure 0.1); and an additional 1.2 billion cars will be on the road by 2050[1]—double today's total. Transport infrastructure and services will have an ever-greater role to play in meeting this additional demand.

FIGURE 0.1: Global Transport Volumes Will Continue to Grow

Passenger Transport Volumes (Business as Usual 2015-2030)



Freight Transport Volumes (Business as Usual 2015-2030)



Source: Organization for Economic Cooperation and Development/International Transport Forum 2017. ITF Transport Outlook 2017. Paris.

[1] https://www.iea.org/about/faqs/transport/

With growing aspiration for mobility, and the strong association between transport and economic growth,[2] getting the pattern of mobility "right" has become a defining factor of the future. Mobility will be shaped by three factors:

Demographics. By 2030, an additional 1.2 billion people with a radically changed socio-economic makeup will fuel new demands for mobility solutions. By then, 16.5 percent of the world's population will be aged 60 or older.[3] This demographic trend—led by OECD countries and joined by transition economies—calls for new solutions that are responsive, age-appropriate, and affordable.

Preferences. People aspire to live in a mobile society where they can move easily from place to place, travel and relocate as needed, and have quick and easy access to a range of goods and services. With the trend toward increased physical movement of people and goods, new opportunities are emerging that allow the "virtual" movement of people and goods as well. Examples include e-commerce, which allows consumers to order goods online, and telecommuting, which enables employees to work away from traditional offices.[4]

Technology. Digital technology will form the backbone of mobility in the future. By 2020, the world will have an estimated 26.3 billion digital devices and connections—this is estimated to be more than three times the number of the world's people.[5] By then over 60 percent of global mobile traffic will be in the Asia Pacific, the Middle East, and Africa.[6] As this connectivity extends to transport systems, it can lead to more equitable, efficient, and safer mobility, and offer great opportunities for countries to reshape the way people, goods, and services travel. In many urban areas, the use of smartphones has catalyzed a move away from vehicle ownership and toward

[2] Calderón, C., and L. Servén 2004. "The effects of Infrastructure Development on Growth and Income Distribution." Washington, D.C.: World Bank.

[3] United Nations, Department of Economic and Social Affairs, Population Division 2015. *World Population Ageing* 2015 (ST/ESA/SER.A/390). New York: United Nations.

[4] http://globalworkplaceanalytics.com/telecommuting-statistics

[5] https://newsroom.cisco.com/press-release-content?articleId=1771211

[6] Cisco 2017. "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021," White Paper.

vehicle sharing, ride hailing and carpooling. However, private car transport accounts for three-quarters of all passenger mobility, making it the predominant means of transport. The main transport technologies in use today came out of the industrial revolution hundreds of years ago.[7] Since then the volume of car traffic has increased tenfold, while cycling and public transport have seen scarcely any growth. Rural communities are particularly vulnerable to digital exclusion and hence cannot benefit from the many digital technologies that streamline transport. However, the potential gains from digitalization are huge, and some are already being realized. For example, Alibaba, an online marketplace company, connects rural residents in China with global markets—both as sellers and buyers—thus allowing them to transport their produce to global markets and have goods like fertilizers and seeds brought to their door step.

TRANSPORT FOR SUSTAINABLE DEVELOPMENT

Sustainable transport and mobility are fundamental to progress in realizing the promise of the 2030 Agenda for Sustainable Development and in achieving the 17 Sustainable Development Goals.

Accomplishing the SDGs will rely on advances in mobility. For example, global progress in reducing greenhouse gas emissions (SDG 13) cannot be realized without decisive action on energy (SDG 7) and sustainable transport, and countries cannot provide food security (SDG 2) or healthcare (SDG 3) without providing reliable and sustainable transport systems to underpin these advances. Young people cannot attend schools (SDG 4), women cannot be assured opportunities for employment and empowerment (SDG 5), and people with disabilities and elderly people cannot maintain their independence and dignity without safe transport that is accessible itself and that enables access to all that people need (SDG 9 and 11). Personal security for all passengers is critical. Goals of biodiversity (SDG 15) and ocean health (SDG 14) also have significant intersections with the promotion of smart, sustainable mobility practices across regions and across modes. Finally, strengthening the means of implementation (SDG17) of the SDGs with coherent policies are also central for transportation.

Two SDG targets are directly transport-related, namely target 11. 2 aiming to, 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; and target 3.6 to, by 2020, halve the number of global deaths and injuries from road traffic accidents Target 9.1 is also transport-related as it is aiming at developing quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. Meeting growing aspirations for the mobility of people and goods in a sustainable way has the potential to improve the lives and livelihoods of billions of people—their health, their environment, and their quality of life—and to help minimize the effects of climate change.

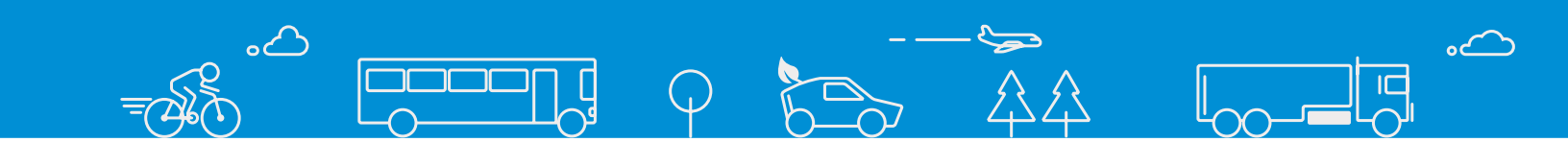
Opportunities associated with making the right decisions on mobility are enormous. For example, improved road safety and reduced air pollution and carbon emission by 7 giga-tons can save hundreds of thousands of lives every year.[8] When considering full transport costs, including vehicles, fuel, operational expenses, and losses due to congestion, sustainable mobility can deliver savings of US$70 trillion by 2050.[9] Also, improvements in border administration, transport and communication infrastructure could increase global GDP by US$2.6 trillion, or 4.7 percent.[10]

[7] Bleijenberg, A. N. (2017). *New mobility: beyond the car era*. Delft: Eburon.

[8] International Energy Agency. Energy Technology Perspectives.

[9] International Energy Agency 2013. Policy Pathways – A Tale of New Cities.

[10] World Economic Forum 2013. Enabling Trade – Valuing Growth Opportunities.



THE VISION

What will the future look like? Imagine cities with quiet streets, clean air, easy and equitable access to work and school, and vibrant community life. Imagine families that travel from their rural home to a city center and then on to visit relatives in another country, using any transport mode—road, rail, waterborne and air transport. And imagine goods crossing borders efficiently, reaching their destination on time, with minimal environmental impact—so that people get what they need and economies develop without compromising opportunities for future generations.[11]

In a future where mobility is sustainable, cites and remote communities in rural areas will all be connected to jobs, markets and social opportunities, so that "no one is left behind". Transport will become the lifeline for all vulnerable groups, including women, the youth and the elderly, persons with disabilities, and the poor, as transport services will reach them all.

Transport networks will be seamlessly integrated to meet mobility needs though motorized and active modes—walking and cycling. Sustainable freight transport systems will support trade and market access at the national, regional and global levels, by linking consumers and producers, importers and exporters. Landlocked developing countries will have swift access to the sea and, together with small island developing States, will be better connected to global markets. This will be a future in which transport-related fatalities and emissions and air pollution are fully minimized.

But the future of mobility can also go in another direction: it can engender gross inequalities in access to economic and social opportunities, promote intensive fossil fuel use with large emissions of greenhouse gases, degrade the environment, increase air and noise pollution, and add to the number of deaths from transport-related crashes.

[11] See Mobilizing Transport for Sustainable Development. Analysis and Policy Recommendations from the United Nations Secretary General's Advisory Group on Sustainable Transport, October 2016.

THE STATE OF TODAY'S TRANSPORT

The potential economic and social benefits of today's transport are significantly offset by the large social, health, environmental, and economic losses associated with traffic congestion, air and noise pollution, and road crashes. The lack of transport services in rural areas, where most of the world's poor people live, limits poverty reduction. Inadequate and poor transport infrastructure and services, including poor accessibility of rural areas to markets and poor transport connectivity (at regional and global levels) create an effective barrier to development, trade and global integration and undermine developing countries' prospects for growth and sustainable development. Without a coherent and ambitious program of actions and financing, these losses and imbalances will increase as the automobile market grows, urban areas expand, and land use remains poorly regulated. The figures are staggering:

- In 2006, more than 1 billion people, or one-third of the global rural population, lacked access to all-weather roads and transport services—a major barrier to social and economic advancement.[12] Substandard rural road access is highly correlated to poverty: in developing countries, 40 percent of food losses occur post-harvest, including degradation and spillage from poor transport conditions.[13] These challenges will remain in the coming years, because the total level of the rural population is projected to remain stable.

- In 2014, 54 percent of the world's population lived in urban areas. The share is expected to grow to 60 percent by 2030, and 66 percent by 2050.[14] Adequate public transport remains inaccessible to a large share of the world's urban population, with uncontrolled growth worsening the mismatch between where people live and where they work and obtain services.

[12] Roberts, Peter, K. C. Shyam, and C. Rastogi 2006. *Rural Access Index: A Key Development Indicator.* Transport Papers TP-10. Washington, DC: World Bank.

[13] World Bank 2017. *Enabling the Business of Agriculture 2017.* Washington, DC: World Bank

[14] United Nations, Department of Economic and Social Affairs, Population Division. 2014. *World Urbanization Prospects: The 2014 Revision, Highlights* (ST/ESA/SER.A/352). New York: United Nations.

- Developing countries pay 40-70 percent more to ship internationally per dollar of import.[15]

- The average volume of international trade of a landlocked developing country is only 60 percent of the trade volume of a comparable coastal country.[16] Transiting through territories of other countries is the main impediment to trade for landlocked developing countries.[17]

- From 70 percent to 84 percent of fuel energy is lost in engine and driveline inefficiencies.[18]

- Between 2010 and 2013, road traffic deaths as a share of population increased by 32 percent in low income countries. In 2013, road traffic death rates in high-income countries were less than half those in low- and middle-income countries. Road traffic crashes are, on average, the leading cause of death for people between 15 and 29 years of age worldwide.[19]

- Forty-nine percent of all road traffic deaths occur among pedestrians, cyclists, and motorcyclists. Road fatalities and injuries—which involve cyclists and pedestrians as well as occupants of motor vehicles—are estimated to reduce GDP by 1 percent to 5 percent in developing countries, straining health care systems and inflicting hardship on the most vulnerable people.[20]

- The costs of crashes can reverse expected efficiency benefits from increasing transport speeds. For example, a one percent increase in vehicle speed can increase fatal crashes by 4.1 percent. Thus, there is a clear correlation between speed and fatalities.[21]

- In 2009, transport was responsible for 23 percent of energy-related greenhouse gas emissions, and its share is growing. In one projection, energy related CO_2 emissions are expected to grow by 40 percent between 2013 and 2040—on average, 1.2 percent per year—under current policy scenarios.[22]

- In 2010, about 184,000 premature deaths—most of them in developing countries—were the result of vehicle-related air pollution.[23] But anticipated improvements in fuels and reductions in vehicle emissions are expected to be slow in reaching developing nations.

- Today less than 18 percent of the world's population has stepped foot on an airplane. However, air travel demand is expected to double over the next two decades leading to excessive amounts of carbon emissions. Left unchecked, carbon emissions from the air transport industry could consume more than 25 percent of the world's carbon budget (for 1.5 centigrade) by 2050.[24]

TOWARD SUSTAINABLE MOBILITY FOR ALL

Over the past few years, the international community has made several commitments related to transport, setting the bar high on what is needed to transform the sector and to ensure that the future is sustainable (Box 0.1).

We have a responsibility to shape the transport agenda. The transport sector can no longer afford a fragmented approach: it is time to bring greater coherence and speak with one voice to guide global and country decision-making processes and investments. The approach adopted so far—where a multitude of actors, including UN agencies, multilateral development banks, manufacturers, and civil society act independently—has failed to bring the necessary

[15] UNCTAD 2015. Review of Maritime Transport.
[16] UN-OHRLLS. 2013. The Development Economics of landlockedness: Understanding the development costs of being landlocked. New York: United Nations.
[17] World Bank–United Nations. 2014. *Improving Trade and Transport for Landlocked Developing Countries: A Ten-Year Review.* Washington, DC: World Bank.
[18] https://www.fueleconomy.gov/feg/atv.shtml
[19] WHO (World Health Organization). 2015. *Global Status Report on Road Safety 2015: Supporting a Decade of Action.* http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/. Geneva: WHO.
[20] Ibid and http://irap.org/en/about-irap-2/a-business-case-for-safer-roads
[21] Nilsson, Goran. 2004. "Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety." Lund Institute of Technology and Society, Traffic Engineering.
[22] IEA (International Energy Agency) 2015. *World Energy Outlook 2015, table 2.1.* Paris: OECD.
[23] World Bank, Transport for Health. "The Global Burden of Disease from Motorized Road Transport." Prepared by the Institute for Health Metrics and Evaluation for the Global Road Safety Facility, p 23, and Annex 2 for country estimates. Washington, DC: World Bank.
[24] https://www.carbonbrief.org/aviation-consume-quarter-carbon-budget

scale of action and financing to unify and transform the sector. Within the UN system, for example, multiple and highly specialized agencies are each carrying responsibility for one part of the transport agenda—for example, the International Civil Aviation Organization on air transport, the United Nations Conference on Trade and Development on transport linked to trade, the UN Economic Commission for Europe on regional land transport, and UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS). Such specialization is replicated beyond the UN system, among all stakeholders and all modes of transport.

A coherent approach to transport is possible. The energy sector embarked upon a similar journey in 2009, when the UN Secretary General Ban Ki-moon appointed an Advisory Group on Energy and Climate Change. The UN Secretary-General Ban Ki-moon's Advisory Group on Energy and Climate Change (AGECC) had a broad high-level membership, including former country presidents, high profile corporate executives, and Civil Society Organizations (CSOs).

The 2010 report "Energy for a Sustainable Future" set out recommendations that provided the foundation for the three goals of Sustainable Energy 4 All (SE4ALL): access, efficiency, and renewables. The report also recommended the appointment of a high-level advisory group to oversee action on these recommendations. The UN Secretary General established the Advisory Board on Sustainable Energy for All, and invited the newly elected World Bank Group President Jim Yong Kim to serve as co-chair.

In parallel, a Global Tracking Framework was developed to track implementation of the goals. These efforts resulted in a uniform and united message from public and private sector stakeholders. This enabled energy to be mainstreamed into all global agreements on sustainable development, and to have the credibility and reliability required to attract private and development finance partners. Without this consensus among stakeholders, SDG 7 aimed at ensuring access to affordable, reliable, sustainable, and modern energy for all—would not have been adopted.

In contrast, the transport community's lack of coherence resulted in no free-standing transport Sustainable Development Goal (SDG). At the Climate Action Summit in May 2016, the World Bank Group president called for action to bring greater coherence and accelerate efforts to unify and transform the transport sector. He proposed to develop, with interested transport stakeholders, a new and strategic global initiative that will support the implementation of the SDGs and transform the sector and received support from the Secretary General Ban Ki-moon.

Inspired by the model of the energy sector, the new initiative—Sustainable Mobility for All™ (SuM4All™)—has emerged as a global partnership that speaks with one global voice and acts collectively to help unify and transform the sector. It brings together a diverse and influential group of stakeholders—multilateral development banks, United Nations agencies, bilateral donor organizations, non-governmental organizations, civil society, and academic institutions with the ambition to achieve a world in which people and goods move equitably, efficiently, safely, and environment-friendly.

SUSTAINABLE mobility™ FOR ALL is evolving toward:

An **advocacy** platform from which to advise not only international, but also national and local policies and investments related to sustainable mobility. Greater predictability will be a critical factor to shape future private investments.

An **action** platform to generate transformative ideas and allow for them to be enacted on a global scale. Partners bring a proven track record of engaging with governments and supporting them on their respective paths towards sustainable mobility.

A platform to mobilize **financing** to support the right policies and investments across countries.

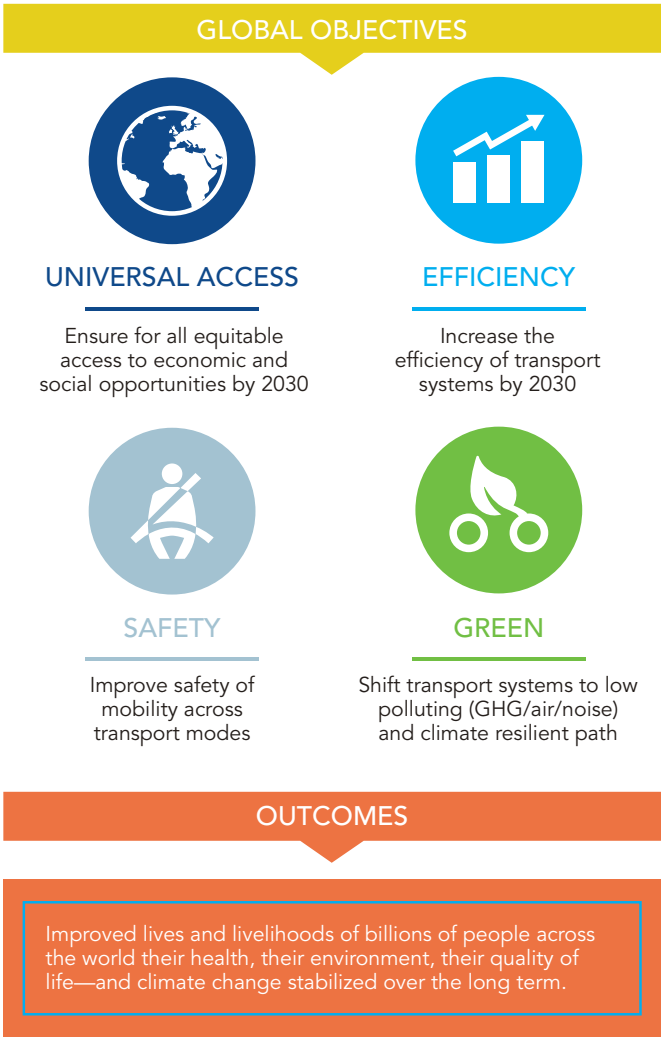
The initiative is currently steered by a committee and a broader group of stakeholders.[25] The name of the initiative— "Sustainable Mobility for All™"—was endorsed by a group of representative transport stakeholders on April 5, 2017.

This initiative aligns with the recommendations issued by UN Secretary General Ban Ki-moon's High Level Advisory Group on Sustainable Transport in November 2016.[26] These recommendations include the need to establish monitoring and evaluation frameworks for transport, and a partnership network among UN organizations and actors outside the UN system.

GLOBAL MOBILITY REPORT 2017

The Global Mobility Report 2017 (GMR) is the first-ever attempt to examine performance of the transport sector globally, and its ability to support the mobility of goods and people, in a sustainable way. The GMR is built around three components: (i) four global objectives that define "sustainable mobility" (Figure 0.2); (ii) (quantitative and qualitative) targets for those objectives, drawn from international agreements; and (iii) indicators to measure country-level progress towards those objectives. It covers all modes of transport, including road, air, waterborne, and rail transport.

FIGURE 0.2: The Vision of Sustainable Mobility for All



Source: Own elaboration

Because the sector is scant on indicators, methodologies, targets and data, the first edition of the GMR concentrates on defining the broad framework—the vision—and identifying indicators without defining new high-level quantitative targets. Among all possible relevant indicators, it identifies both actual and desirable indicators.

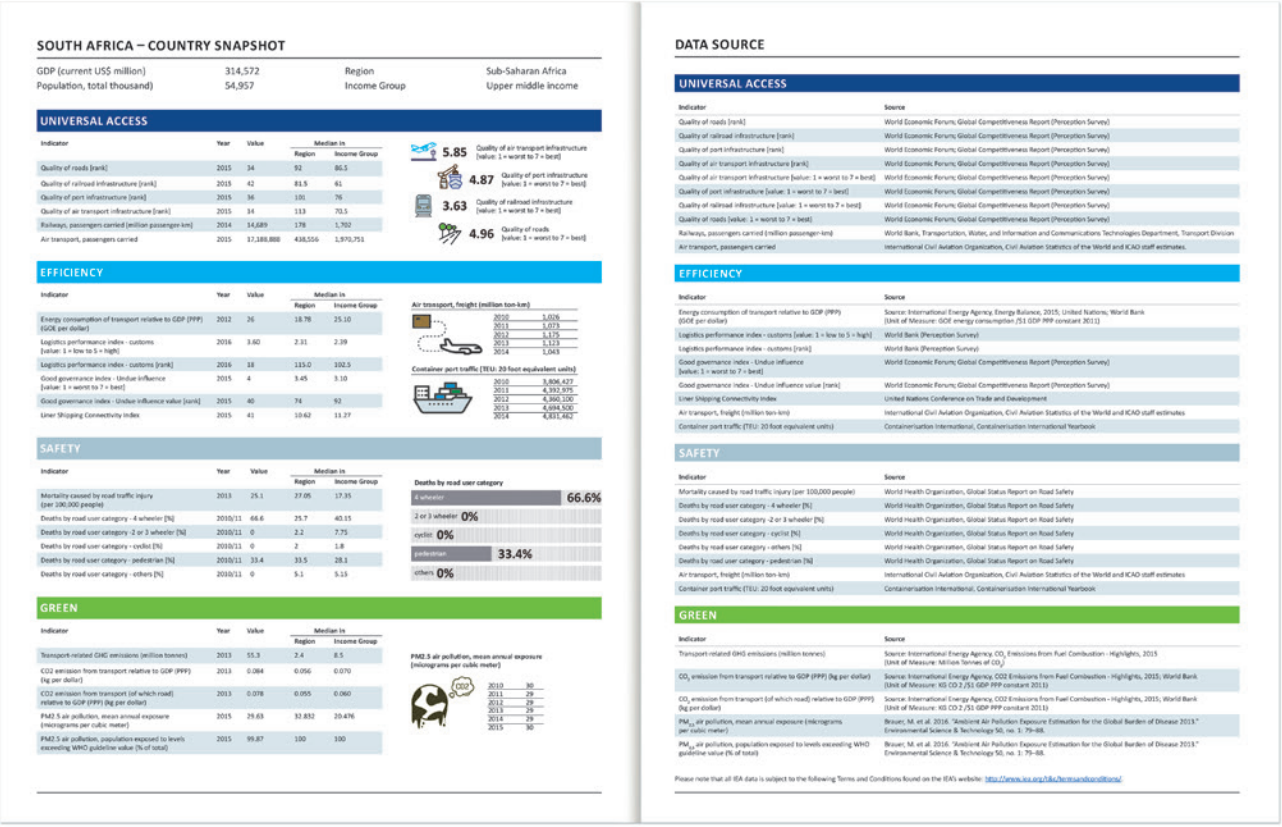
- Actual indicators consist of those well accepted by the international community; these indicators have either been endorsed by the SDG indicators process or are commonly used by practice leaders. Figure 0.3 shows an illustration of a country mobility

[25] The SuM4All Consortium includes multilateral development banks (ADB, AFDB, CAF, IDB, IsDB, EIB, WB, EBRD), UN agencies (UN-DESA, UNECE, UNEP, UNHABITAT, UN Climate Change Support Team, UNIDO, UN-OHRLLS, ICAO, WHO), bilaterals and governments (UK Government, AFD, BMZ, European Commission, GIZ, KfW, Ministerie Infrastructuur en Milieu, DG Milieu en Internationaal, ReCAP) and partnerships, associations, and civil society (GPST, ITDP, ITF, SLoCaT, PPMC, WRI, FIA Foundation, Hewlett Foundation, iRAP, UITP).

For practical purposes, an "Interim" governance structure was established in January 2017, consisting of a steering committee, and five open working groups. The steering committee consists of the World Bank and DFID (co-conveners and secretariat), ITF, UN DESA, IDB (as the chair of the MDB Group on Transport), (private sector representative), and conveners of five open working groups, which consists of DFID (rural universal access), ITDP and UITP (urban universal access), the UNECE (efficiency), CAF (safety), and SLoCaT, PPMC and WRI (green mobility).

[26] HLAG 2016. "Mobilizing Sustainable Transport for Development–Analysis and Policy Recommendations from the United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport." New York: United Nations.

FIGURE 0.3: An Example of Country Mobility Snapshots—South Africa



Source: www.sum4all.org

snapshot. Data for these indicators were collected for over 180 countries, and will be made freely available on-line on the SuM4All website.

- Desirable indicators are those that should be prioritized for development over time, but for which methodologies and/or data are missing.

Both actual and desirable indicators form the basis for the **"Elementary Global Tracking Framework for Transport"** (GTF). Over time, it is envisaged that this GTF will be used to track actual performance towards sustainable mobility. It could then be used by national and local governments to assess where they stand, and how far they are from achieving sustainable mobility. The usefulness of this instrument rests on the premise that "what gets measured, gets done". It would thus provide an objective basis to lay out an action plan of investments and policy reforms to achieve sustainability.

Sectors like energy are in their fourth year of building and refining their GTF, with an effort launched in 2012. For transport, the task ahead is even more challenging. In view of this, this edition of the GMR concentrates on structuring the space, and taking stock of targets and indicators—not yet actual tracking towards sustainable mobility. The GMR will be refined and updated every two years.

Chapter 1 elaborates the conceptual framework. The following four chapters describe each objective of the initiative and how it will be measured, as follows: Chapter 2, universal access; Chapter 3, system efficiency; Chapter 4, safety, and Chapter 5 green mobility. The report has three annexes: Annex 1, the elementary global tracking framework for transport and Annex 2, Transport Related SDG Targets.

BOX 0.1: Annals of Transport Action

- In 2011 and 2015, the high-level Ministerial Conference in Brasilia called for accelerated action on road safety, laying the basis for an ambitious global target of halving the number of deaths and injuries from road traffic by 2020.
- In 2014, the Vienna Programme of Action for Landlocked Developing Countries for the decade 2014-2024 committed to radical changes in 32 countries facing high transport costs, burdensome border procedures, and an inadequate transit and transport infrastructure that prevented them from integrating fully into the global market.
- In 2015, the world leaders came together in New York and adopted the 2030 Agenda for Sustainable Development, including 17 Sustainable Development Goals, which called for bold, ambitious action to save the planet and its people and defined the trajectory for building a sustainable future. While the SDG framework did not provide a clearly defined trajectory for mobility, it provided key elements upon which to build, including: access to safe, affordable, accessible, and sustainable transport systems for all, energy efficiency, road safety, and the prevention of air pollution deaths.
- Following the December 2015 twenty-first annual session of the Conference of the Parties (COP21) to the UNFCCC, heads of State in April 2016 signed an unprecedented climate agreement with ambitious targets to stabilize global warming at less than 2 degrees Celsius.
- At Habitat III, in October 2016, an agreement was reached on the New Urban Agenda and the actions needed to ensure sustainable access in cities.
- In October 2016, UN Secretary General Ban Ki-Moon's High-Level Advisory Group on Sustainable Transport submitted its final recommendations in a Global Outlook Report entitled "Mobilizing Sustainable Transport for Development." The report defined sustainable transport as "the provision of services and infrastructure for the mobility of people and goods—advancing economic and social development to benefit today's and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimizing carbon and other emissions and environmental impacts."
- In October 2016, contracting States of the International Civil Aviation Organization (ICAO) reached a landmark agreement on a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to achieve the international aviation sector's goal of carbon neutral growth from 2020.

CHAPTER 1
CONCEPTUAL FRAMEWORK

Transport builds markets, facilitates trade, links people and connects local communities to the world. The question at stake is how can transport help advancing economic, social and environmental development in a manner that benefit both today's and future generations? Left to its own device, the "market" for transport and mobility tends to over-or under- provide or under-or over- use, the various modes of transport infrastructure and services. In everyday parlance, this results in "waste" for society. This is exemplified by accessibility gaps (the exclusion of vulnerable groups such as women and the elderly), long delays and high costs from poorly integrated transport networks, road fatalities, traffic congestion, and environmental degradation.

How can we achieve a mobility that benefits both present and future generations? This chapter draws on the findings from UN Secretary General Ban Ki-moon's High Level Advisory Group on Sustainable Transport, the Sustainable Development Goals framework and empirical evidence in the economic literature to identify four attributes for mobility to be "sustainable": equitable, efficient, safe and green. This framework posits that it is no longer enough for transport to aim at providing "access" to jobs, markets and opportunities; it has now to ensure that this access has the relevant attributes. By doing so, it will guarantee that the mobility of goods and people benefits both today's and future generations.

At the global level, transport and mobility will thus seek to achieve four objectives:

- Universal Access – This objective accounts for distributional considerations and places a minimum value on everyone's individual travel needs—providing them with at least some basic level of access and paving the way for meeting the mobility needs of all.
- Efficiency – This objective seeks to ensure that transport demand is met effectively, at the least possible cost. Since efficiency cuts across multiple aspects, we arbitrarily define the boundary for this objective from a strictly "macro-economic" perspective: the optimization of resources (*i.e.*, energy, technology, space, institutions, and regulations) to generate an efficient transport system or network.
- Safety – This objective aims to improve the safety of mobility across all modes of transport by avoiding fatalities, injuries, and crashes from transport mishaps across all modes of transport, thus averting public health risks, and social and economic losses associated with unsafe mobility.
- Green Mobility – This objective aims to address climate change through mitigation and adaptation, and to reduce both air and noise pollution.

The inclusion of these objectives substantially increases the complexity of the supply and demand framework. Moreover, there exist complex trade-offs and synergies among these objectives that make the decision-making process for society challenging.

1.1 WHY TRANSPORT

Transport plays a crucial role in connecting people to goods, services, social and economic advancement opportunities, and in fostering development. A review of the economic literature provides solid empirical evidence on the economic, social and environmental benefits of transport.

Improving connectivity between and within countries can bridge stark differences in economic development by strengthening interregional trade. For example, five coastal countries in Africa—Angola, Kenya, Nigeria, South Africa, and Sudan—account for more than 70 percent of Africa's GDP.[1] But in Sub-Saharan Africa overall, estimates suggest that tightening the connectivity between cities by upgrading the primary road network can catalyze trade worth hundreds of billions of dollars.[2]

In Peru, intercity highway upgrades increased the average annual rates of growth for exports by 6 percent and employment by 5 percent.[3] In China, connecting cities with railroads has moderately increased county-level GDP per capita[4], and in India, colonial railways boosted interregional trade and raised real income levels.[5]

Improvements in transport infrastructure can also enhance firm efficiency and affect firm location. Upgrading highway infrastructure has allowed Indian firms to hold inventory for shorter durations, increased the survival rate of existing firms, and induced new firms to open upgraded highways.[6] In Indonesia, expressways have been associated with the dispersion of manufacturing activities.[7]

Transport can play a crucial role in enhancing food security and agricultural productivity. For example, Africa could become self-sufficient in food and create a regional food market worth US$1 trillion by 2030. But farmers will need better access to roads to trade their products. Africa's current food insufficiency is not surprising given the deficiencies in its road infrastructure—the average road density in low-income countries in Sub-Saharan Africa is less than one-third that in other low-income countries.[8] Improving rural road connectivity has been shown to increase agricultural productivity by reducing the travel time to agricultural markets, inducing farmers to adopt modern farming techniques and favor cash crops, and raising market participation. Improving road quality has also been shown to induce migration and shift workers from agriculture to manufacturing.

Reducing rural isolation—by lowering transport costs and travel times, or improving road access and proximity to markets—may have multiple benefits. It is associated with a reduced likelihood of a household's facing multidimensional poverty, with increased school enrollment rates for boys and girls and disadvantaged groups. For example, in Ethiopia, proximity to a road in good conditions reduces the likelihood of being a chronic poor by 36 percent.[9] In addition, better rural transport access is associated with lower morbidity and mortality rates and better health and poverty outcomes.

The placement of transport infrastructure within a city can alter the production mix of the urban economy, affect employment opportunities for the poor, and alter crime rates. For example, evidence suggests that the development of city roads in Colombia has shifted economic activity toward the production of lighter

1 Ali, R., A. Federico Barra, C. Berg, R. Damania, J. Nash, and J. Russ 2015. Highways to Success or Byways to Waste: Estimating the Economic Benefits of Roads in Africa. Africa Development Forum series. Washington, DC: World Bank.

2 Buys, P., U. Deichmann, D. Wheeler 2010. "Road network upgrading and overland trade expansion in sub-Saharan Africa." Journal of African Economies. 19(3). 399-432.

3 Martincus, V., J. Carballo, and A. Cusolito 2014. "Routes, Exports, and Employment in Developing Countries: Following the Trace of the Inca Roads." Working Paper.

4 Banerjee, A., E. Duflo, and N. Qian. 2012. "On the road: Access to transportation infrastructure and economic growth in China." (No. w17897). National Bureau of Economic Research.

5 Donaldson, D. Forthcoming. "Railroads of the Raj: Estimating the impact of transportation infrastructure." American Economic Review. In press.

6 Datta, S. 2012. "The impact of improved highways on Indian firms." Journal of Development Economics. 99(1). 46-57.

7 Rothenberg, A. 2013. "Transport Infrastructure and Firm Location Choice in Equilibrium: Evidence from Indonesia's Highways." Working Paper.

8 Ali, R, A. Federico Barra, C. Berg, R. Damania, J. Nash, and J. Russ. 2015. Highways to Success or Byways to Waste: Estimating the Economic Benefits of Roads in Africa. Africa Development Forum series. Washington, DC: World Bank.

9 Dercon, S., et al. 2008. "The Impact of Agricultural Extension and Roads on Poverty and Consumption Growth in Fifteen Ethiopian Villages." IFPRI Discussion Paper 00840.

tradable goods.[10] Similarly, transport infrastructure has altered the economic landscape of Chinese cities—radial highways have decentralized the services sector, radial railroads have decentralized the industrial sector, and ring roads have decentralized both sectors.[11]

The urban poor rely heavily on public transport for commuting. Without fast, secure, and affordable mass transport, the urban poor are typically forced to walk to work, which is time consuming and limits their job search radius. Thus, the geographic dispersal of the labor market can dampen the gains from industrial agglomeration. A lack of security in the public transit system may also limit the labor market participation and job search radius of the poor, particularly for women, who are more dependent on public transport than men. Even a simple intervention can make a difference: improving nighttime lighting reduced the incidence of crime around bus rapid transit stops in Colombia.[12]

1.2 THE BASIC PRINCIPLES

Conceptually, a supply and demand framework can be used to understand the dynamics of a "market" for mobility, revealing the causes leading to suboptimal outcomes that prevent the realization of all societal benefits of transport, and to identify the requirements that can help achieve sustainable mobility for all. In this framework, transport supply is the provision of infrastructure and services, and transport demand reflects the fulfilled or unfulfilled desire for mobility from users of such infrastructure and services. In economic terms, the equilibrium between supply and demand is vulnerable to a host of market failures which, when left unaccounted for, may lead to an outcome that is not sustainable. Visible signs of these outcomes include the following:

- Vulnerable and special-need groups (including women, children, persons with disabilities, and older persons) are underserved by public and private transport systems. This can happen because users and providers do not carry the full societal costs of excluding vulnerable groups. For example, providers tend to focus on cost effectiveness over equity and inclusion considerations, which has important implications for society in the short and long term.
- Resources are inadequately allocated across geographical areas—considering the benefits from the agglomeration of populations and economic activities, as well as connectivity between countries and regions.
- Transport infrastructure, vehicles and the system are unsafe, and result in traffic crashes and injuries.
- Roads are over-used by private automobiles and motorized two-wheelers to the detriment of public transport systems and active modes, and result in congestion, excessive fossil fuel use, and air pollution. These costs imposed on others are not carried by individual users and providers.

At the heart of these outcomes are the decisions to provide and use transport infrastructure and services that do not take into account sustainability. Each actor makes decisions to satisfy private needs, without taking into consideration the collective present and future needs. This is exemplified by the high level of private (non-shared) usage of automobiles globally. An automobile-centered transport system that overlooks multi-modality, public transport, or active modes leads to congestion on roads, making it costlier to get to places, leading to unsafe situations and contributing to high levels of air and noise pollution and greenhouse gas emissions. Thus, what may be ideal for an individual in the short term does not lead to a sustainable pathway in the long term. This happens even though policymakers have the potential to influence the actor's choice of mobility mode through investment, planning, and regulation. As a result, society may be "mobile"

[10] Duranton, G. 2015. "Roads and Trade in Colombia," Economics of Transport. 4-1-p 16-36.

[11] Baum-Snow, N., L. Brandt, J.V. Henderson, M.A. Turner, and Q. Zhang. 2017. "Roads, railroads and decentralization of Chinese cities." Review of Economics and Statistics. 99-3-p 435-448.

[12] Marcelo, D. 2013. "Impact evaluation of the Transmilenio infrastructure on street robberies." Working Paper.

but such mobility patterns are generally not conducive to a sustainable and inclusive pathway for society.[13]

1.3 THE SUSTAINABILITY CONDITIONS

How can we achieve a mobility that benefits present and future generations?

UN Secretary General Ban Ki-moon's High Level Advisory Group on Sustainable Transport identified the attributes that mobility must embody to ensure a sustainable future as "the provision of services and infrastructure for the mobility of people and goods—advancing economic and social development to benefit today's and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimizing carbon and other emissions and environmental impacts."[14]

The 2030 Agenda for Sustainable Development identifies another important and rich array of characteristics that define a sustainable world. Although there is no Sustainable Development Goal exclusively dedicated to transport, transport is directly reflected in targets SDG 3.6 and SDG 11.2 and indirectly linked to many others (Figure 1.1). Combined, these SDG targets embody four important dimensions for mobility:

- **Universal Access.** SDG target 9.1 addresses the need to develop quality, reliable, sustainable, and resilient infrastructure, and focuses on affordable and equitable access for all. SDG target 11.2 addresses the need for access to safe, affordable, accessible, and sustainable transport systems for all, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons. SDG 3.4, related to diseases such as cancer, heart disease and stroke, links directly to appropriate active transport infrastructure and access to public transport.

- **System Efficiency.** SDG target 7.3 aims at doubling the global rate of improvement in energy efficiency, and SDG target 12.c aims at rationalizing inefficient fossil-fuel subsidies. SDG target 12.3 aims at halving per capita global food waste and reducing food losses along production and supply chains. Similarly, SDG target 9.4 aims at, among others, upgrading infrastructure to make it sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes. In addition, SDG target 17.14 aims at strengthening country level mechanisms to enhance policy coherence for sustainable development.

- **Safety.** SDG target 3.6 is specifically dedicated to road safety, and aims to, by 2020, halve the number of global deaths and injuries from road traffic accidents. In addition, SDG target 11.2 refers to improving road safety in cities, notably by expanding public transport.

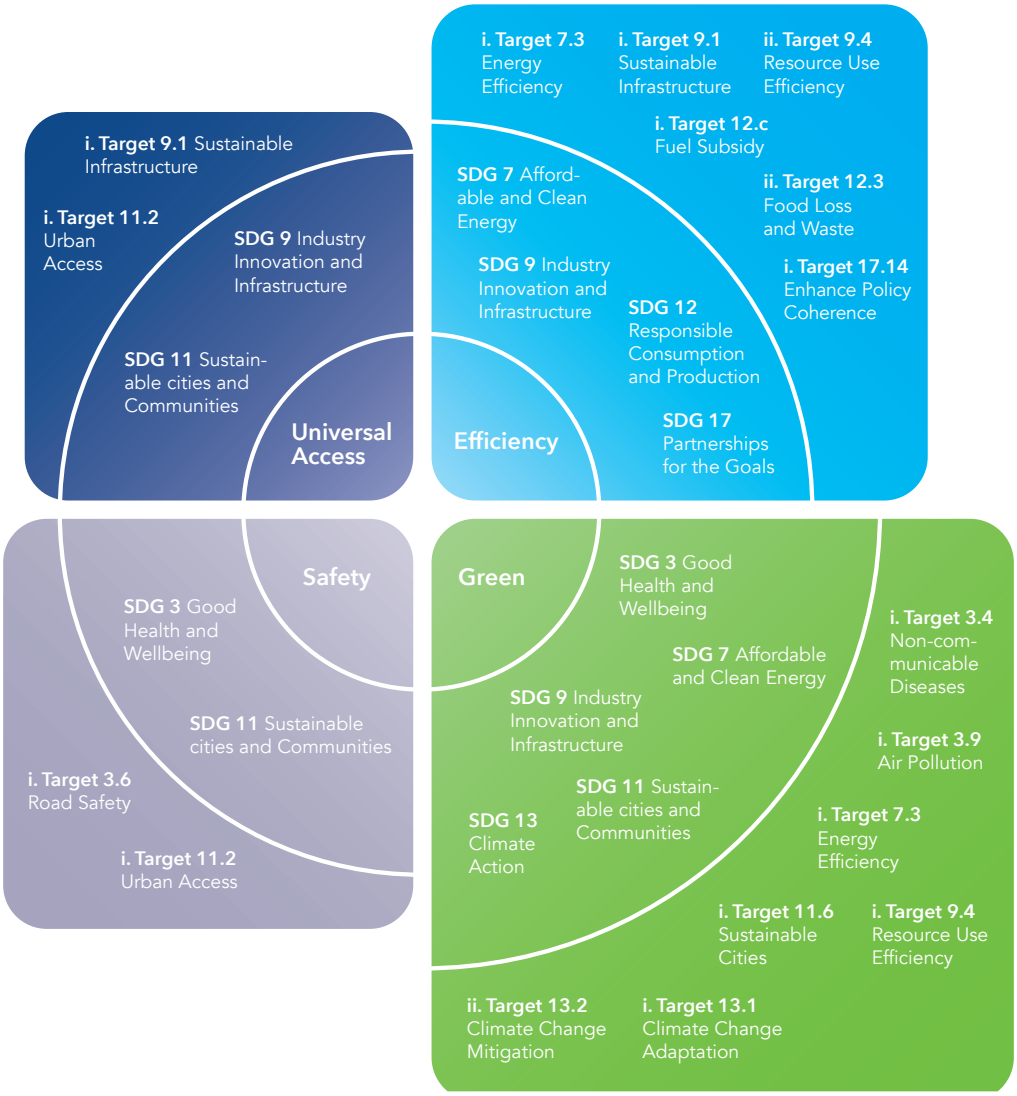
- **Green Mobility.** Green transport is an integral part of the SDGs, and filters into many SDG targets. SDG target 13.2 aims at integrating climate change measures into national policies, strategies, and planning, and SDG target 13.1 aims to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. SDG target 7.3 aims to double the global rate of improvement in energy efficiency, which will have a direct impact on GHG emissions and other pollutants. Similarly, SDG targets 3.9 and 11.6 relate to air pollution—addressing illnesses or deaths and pollution's environmental impacts on cities, respectively. SDG 3.4 relates to non-communicable diseases, such as cancer, heart disease and stroke, all linked to air pollution, noise and lack of walking and cycling. The transport sector plays a pivotal role in the achievement of these targets.

While the 2030 Agenda and its SDGs do not provide a clearly defined trajectory for mobility, they provide key elements that define the conditions under which "sustainable" mobility can be achieved. To achieve this optimal outcome, society should make decisions that support equity of access, efficiency, safety, and

[13] World Bank 1996. *Sustainable Transport: Priorities for Policy Reform.* Washington, DC: World Bank.

[14] HLAG 2016. "Mobilizing Sustainable Transport for Development– Analysis and Policy Recommendations from the United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport." New York: United Nations.

FIGURE 1.1: Four Objectives and SDG Targets



Source: Own elaboration

pollution and climate responsiveness. More broadly, these characteristics provide the basis for defining a set of "global objectives" that underpin "sustainable mobility."

Universal Access

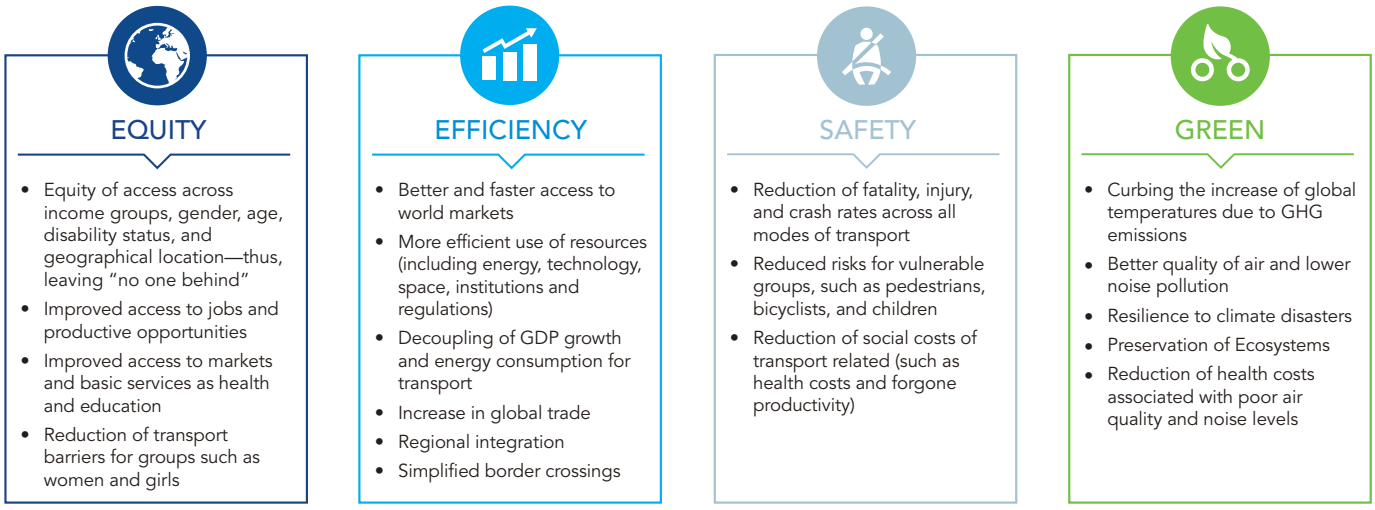
Left to their own devices, market forces generally do not distribute transport infrastructure and services equitably; hence universal access is an important condition for ensuring sustainable mobility. For example, public transport accessibility is often distributed unevenly across locations, and poorer areas often lag in terms of rail and bus service capacity and quality. Similarly, private-vehicle-oriented transport and spatial planning undermine the development of walking and cycling infrastructure. Furthermore, a traditional supply and demand equilibrium might set a transport price that is too high and unaffordable for the poor, making

them unable to access essential transport to work, education, and basic services or forced to walk or cycle long distances in poor conditions.

The Universal Access objective accounts for distributional considerations and places a minimum value on everyone's individual travel needs—providing them with at least some basic level of access.

This objective will ensure that all people have access to transport that meets their basic needs—in their own travel and in the shipment of goods upon which they place a high value and priority—such as commuting to work, and access to schools, medical care, and commerce. Inclusivity is at the heart of this objective. Pursuing this global objective will ensure that access is provided across income groups (affordability), gender, age, disability status, and geographical areas (urban and rural). It will ensure that vulnerable and special-need groups, as well as those living in remote areas, have appropriate access through sustainable transport. Figure 1.2 shows the economic outcomes expected from improved accessibility for all, as well as other objectives.

FIGURE 1.2: Economic and Social Outcomes Associated with the Four Global Objectives



Source: Own elaboration

System Efficiency

Without proper transport policies, supply and demand generally do not result in efficient transport systems. Excessive traffic congestion is an example of inefficiency, as motorists only consider their own travel costs and disregard the additional travel time they impose on other vehicles. Since every additional vehicle reduces the available road space, supply and demand result in excessive traffic congestion, and also inefficient distribution of costs between users: public transport, which consumes significantly less road space per passenger, must compete for limited road space with automobiles. In the same vein and on the positive side, providing additional connectivity can generate benefits across multiple geographic areas. For example, the benefits of a railway line extension or an additional road segment accrue not only to the direct beneficiaries—the firms and residents located in the catchment area of such segment—but also to all other users that are now connected to a larger network, expanding connectivity to the full transport system. Since these positive spillover effects are not accounted for by individual decision-makers, the provision of infrastructure is often suboptimal.

The Efficiency objective ensures that transport demand is met effectively, at the smallest possible cost.

It captures two key concepts: productive efficiency (concerned with the optimal method of producing goods) and allocative efficiency (concerned with the distribution and allocation of resources in society). Since efficiency cuts across many dimensions, the GMR arbitrarily defines the boundary for this objective strictly in macro-economic terms. It will refer to the optimization of resources—energy, technology, space, institutions, and regulations—to generate an efficient transport system at the national, regional or global level. This means that efficiency considerations linked to private cost, such as travel time, vehicle operating cost, and monetary cost are covered under the three other objectives. For example, individual affordability will be covered under the Universal Access objective.

Safety

In a supply and demand framework, the safe use and provision of transport systems are also host to market failures, which makes safety a necessary objective for the achievement of sustainable mobility for all. For example, on the demand side, transport users such as motorists have often times imperfect information about the implications of unsafe driving behavior for themselves or for other motorists. This leads to an increase in risk-taking and reckless driving. Because the costs of a crash are partly borne by third parties—including employers, government, and society—individual motorists do not fully account for the total cost of dangerous driving behavior.

On the supply side, safety features built into the design of transport infrastructure and services can be costly. Therefore, governments may decide to underinvest in road safety or safer modes of transport, choosing to allocate resources in other more visible, less costly infrastructure that can show results in a shorter term. This objective relates to avoiding fatalities, injuries, and crashes due to transport mishaps. Safety can benefit both transport providers and users, particularly vulnerable road users, such as the poor, women and children, seniors and disabled people. Figure 1.2 shows resulting outcomes from achieving safer mobility.

Green Mobility

This objective relates to reducing the impact of transport on climate change— through mitigation and adaptation—and to reducing local air and noise pollution. Both dimensions are typically thought of as externalities of the transport system that individuals, shippers and carriers do not take into consideration when making their transport choices.

An example includes transport investment that favors road over rail or waterborne freight transport, disregarding the lower social costs of modes that have lower emission rates per ton-km. From a passenger transport perspective, another example is the user preference for private automobiles, the use of energy inefficient vehicles, and overlooking commuting distances in living decisions (land use). All these actions lead to over-pollution, climate change, and resource depletion.

While it may not be possible to eliminate emissions and pollution because of cost and efficiency tradeoffs, emissions and pollution must be reduced to a societally optimal amount. Outcomes from green mobility are shown in Figure 1.2.

1.4 SYNERGIES AND TRADE-OFFS

These four objectives—universal access, efficiency, safety, and green mobility—need to be simultaneously factored into the decision-making process, recognizing and accounting for the trade-offs or synergies among them. The inclusion of these objectives substantially increases the complexity of the supply and demand framework. However, understanding these synergies and tradeoffs will ultimately allow us to address the following key questions: What is an optimal combination of safety, green mobility, and universal elements that allows transport to achieve system efficiency? How can transport systems advance sustainable mobility by expanding the benefit frontier to encompass more than one objective?

Below we highlight the various pair-wise synergies across the four objectives. There can of course be combined synergies and tradeoffs between three or more objectives. For example, changes in speed of transport can impact all four objectives at once. In urban environments lowering speeds can result in improved safety, reduced noise pollution, more inclusive access through increased access for those walking and crossing roads or cycling rather than occupying motor vehicles, and better fuel efficiency.[15] Similarly, reducing the need for mobility through increased city density, and proximity of people to the goods and services for which they must travel provides benefits across all four objectives.

Universal Access and System Efficiency

There are several synergies between the improvement of transport system or network efficiency and universal access. First, the efficiency of transport networks tends to increase as more individuals and firms are connected. This is so because expanding a network enhances access for both the newly connected and those who were previously connected, as they now become part of a larger network. Second, a more efficient allocation of road space can reduce traffic congestion and help achieve an optimal level of road use. The alleviation of traffic congestion makes more destinations accessible for travelers for a given amount of travel time. A more efficient supply of public transport services can improve access by leading to more frequent service or more transit routes when using the same resources (the number of buses and drivers).

Improved access also has the potential to generate spatial efficiency benefits. For people, better access can strengthen labor markets—providing opportunities to reach and compete for more productive jobs in different destinations—and increase the efficiency of matching workers to jobs. Thus, such an improvement can reduce spatial mismatch caused by workers not being able to travel to appropriate jobs. For goods, better access can lower shipment costs and result in lower final product costs. Moreover, transport investments that improve access can increase economic productivity in connected areas, reducing the time distances between suppliers, consumers, and competitors, and unlocking the potential for economic growth.[16]

However, in some instances trade-offs between universal access and efficiency can occur. For example, improving access can also reduce system efficiency. This is particularly true when public transport access is provided to areas of low density or otherwise low demand, and where mobility can be provided at a lower cost through shared or private modes of transport. Public transport provision to areas with relatively low load factors—lower demand and use—can lead to higher per-unit costs and sprawl, with longer trips and greater energy use.[17] Similarly, additional road construction in areas that are already well connected tends to induce private transport, increase travel per person, and total traffic.[18] Finally, public transport fares that maximize the efficiency of the system may price out vulnerable groups, reducing their accessibility once affordability is factored in.

Universal Access and Safety

Increased access—when carefully designed and integrated into the transit-oriented development of cities and urban areas—typically improves safety, since it moves mobility toward shorter trips and safer modes such as public transport. To the extent that active modes—walking and biking—are prioritized over vehicle travel, and the appropriate safety systems are in place, it can also provide important safety benefits while increasing access. Moreover, transport invest-

[15] Hosseinlou, M. D., Kheyrabadi, S. A., Zolfaghari, A. 2015. "Determining optimal speed limits in traffic networks" International Association of Traffic and Safety Sciences, 39(1):36-41; and Sakashita C. and Job R. F. S. 2016. "Addressing key global agendas of road safety and climate change: synergies and conflicts". Journal of the Australasian College of Road Safety 27(3):62-68.

[16] Wachs, M. 2011. "Transportation, Jobs, and Economic Growth." *Access Magazine,* No. 38, pp. 8–14.

[17] Guerra, E., and Cervero, R. 2012. "Transit and the" D" Word." *Access Magazine*, 1(40).

[18] Redding, S. J., and Turner, M. A. 2014. "Transportation Costs and the Spatial Organization of Economic Activity." No. w20235. Cambridge, MA: National Bureau of Economic Research.

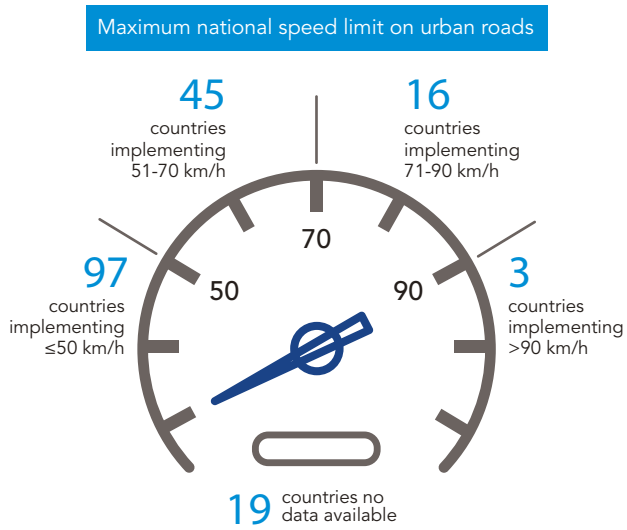
ments that improve overall access—such as public transport projects—can help increase safety throughout the network.

An example of this is developing more integrated streets, with slower traffic movement and more inclusion of pedestrians in street systems.[19]

On the other hand, poorly designed investments that increase access but create conflicts between motorized and active modes of travel are likely to reduce safety and increase fatalities, injuries, and crashes.[20] The ways that various modes of traffic and pedestrians interact and the speeds of vehicles significantly impact safety risks.[21]

While speed may be perceived as enhancing access by reducing travel times to jobs or markets, it increases safety risks. Many countries around the world are prioritizing speed—and presumably access—over safety. A summary of urban speed laws is presented in Figure 1.3. The figure demonstrates the urgent need for speed management. Many countries have no comprehensive speed laws, or lack detailed regulations that limit speeds differently in different situations. Some have national regulations, but with speed limits set as high as 50 km per hour, when even 30 km per hour may not be safe in many urban situations.[22]

FIGURE 1.3: Urban Speed Laws



Source: World Health Organization 2015. Global Status Report.

Universal Access and Green Mobility

Increased access may mean more travelers and more travel, but when accomplished primarily by public transport or active modes it may also provide green benefits in terms of emission reductions and lower air and noise pollution. The key to unlocking this synergy is to reduce passenger travel from less efficient modes (such as single-occupant vehicles) to more efficient modes, or to take advantage of the economies of scale of rail and waterways for goods transport (in terms of emissions per ton-kilometer).[23] As the ultimate green transport modes, active modes of transport are zero carbon and zero pollution options that can clean air, reduce congestion, reduce obesity and other major diseases.

Typically, an expansion of access with public transport and active modes for passenger transport, or with multimodal transport corridors for freight transport, can have little or no negative impact on the environment. For example, a potential increase in emissions due to the increased travel on public transport can be compensated by the induced modal shift and related

[19] Hamilton-Baillie, B., and P. Jones 2005. "Improving Traffic Behaviour and Safety through Urban Design." Proceedings of the Institution of Civil Engineers. *Civil Engineering,* Volume 158 Issue 5, May 2005, pp. 39–47.

[20] World Health Organization. Violence, Injury Prevention, and World Health Organization 2013. "Global Status Report on Road Safety 2013: Supporting a Decade of Action". Geneva: World Health Organization.

[21] World Health Organization 2013. "Pedestrian Safety: a Road Safety Manual for Decision-Makers and Practitioners." Geneva: World Health Organization.

[22] Kröye, Höskuldur R.G. 2015. "Is 30 km/h a 'Safe' Speed? Injury Severity of Pedestrians Struck by a Vehicle and the Relation to Travel Speed and Age." *IATSS Research,* Volume 39, Issue 1, July 2015, Pages 42–50.

[23] Suzuki, H., Cervero, R., and Iuchi, K. 2013. Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development. Washington, DC: World Bank.

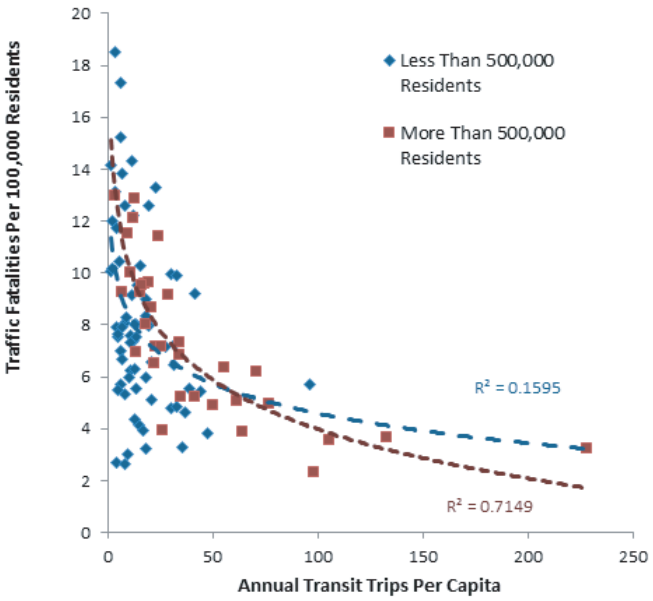
decrease in private car use. Highway expansion, on the contrary, may or may not improve overall access, but increases emissions, therefore improved access should be achieved through other modes such as rail or water to have a positive effect on reducing emissions.[24]

System Efficiency and Safety

There are synergies between efficiency and safety. Improved efficiency can be achieved by increasing passenger or freight throughput for a given number of vehicles, a given amount of vehicle travel, or a given system size. This may directly translate into fewer crashes, compared with a scenario in which more vehicles must be used.[25] This is particularly true when passengers shift from private vehicle travel to public transport systems, which increases efficiency and helps reduce vehicle crashes and fatalities. Studies have found that, for example, when the use of public transport increases from 10 percent to 20 percent of total trips, traffic fatalities are reduced by 15 percent.[26] Empirically, an increase in public transport trips per capita is associated with a decrease in traffic fatality rates. As shown in Figure 1.4, the number of transport fatalities per 100,000 residents decreased when the number of public transport trips per capita rose in cities with populations of 500,000 or more.

For freight transport, a shift to more scale-efficient modes, such as rail and waterways, can reduce the use of resources per ton-kilometer, but can also enhance safety. For example, it has been estimated that the average expected external costs of truck crashes per ton-kilometer are four times as high as the expected external costs of rail crashes per ton-kilometer.[27]

FIGURE 1.4: Relationship between Traffic Fatalities and Transit Trips



For the 32 cities with more than 500,000 residents, the negative relationship between transit travel and traffic fatality rates is statistically very strong (R2 is a very high 0.71). Nearly all large cities with less than 30 average annual transit trips per capita have more than 6 traffic fatalities per 100,000 residents, and nearly all with more than 50 transit trips per 100,000 have less than 6 fatalities per 100,000 residents.

Source: Litman, T. 2016. "The Hidden Traffic Safety Solution: Public Transportation." Washington, DC: American Public Transportation Association.

On the other hand, increased efficiency can hamper road safety if it takes the form of increased capacity, such as road widening, or other system efficiency measures that stimulate demand for more vehicle travel, particularly if it increases vehicle kilometers traveled per capita. As shown in Figure 1.5, in OECD countries there is a strong correlation between higher numbers of vehicle kilometers traveled per capita and traffic fatality rates.

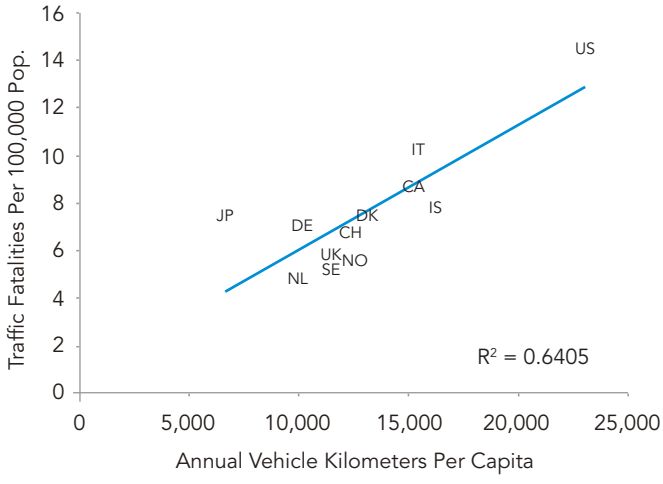
[24] Hansen, M., Gillen, D., Dobbins, A., Huang, Y., and Puvathingal, M. 1993. "The Air Quality Impacts of Urban Highway Capacity Expansion: Traffic Generation and Land Use Change." University of California Transportation Center.

[25] Litman, T., and Fitzroy, S. 2014. "Safe Travels." Victoria Transport Policy Institute. Victoria, Canada: Steven Fitzroy and Associates.

[26] Stimpson, J. P., Wilson, F. A., Araz, O. M., and Pagan, J. A. 2014. "Share of Mass Transit Miles Traveled and Reduced Motor Vehicle Fatalities in Major Cities of the United States." *Journal of Urban Health,* 91(6), 1136–1143.

[27] Forkenbrock, D. J. 2001. "Comparison of External Costs of Rail and Truck Freight Transportation." *Transportation Research Part A: Policy and Practice,* 35(4), 321–337.

FIGURE 1.5: Vehicle Mileage and Traffic Fatality Rates in OECD Countries



CA – Canada
DK – Denmark
DE – Germany
IS – Iceland
IT – Italy
JP – Japan
NL – Netherlands
NO – Norway
SE – Sweden
CH – Switzerland
UK – United Kingdom
US – United States

Source: Organization for Economic Cooperation and Development. OECD Annual Reports and International Road Traffic and Accident Database. Paris.

System Efficiency and Green Mobility

Transport system efficiency can support the green mobility objective by enhancing energy efficiency and thereby reducing greenhouse gas emissions.

Improving system efficiency can cut greenhouse gas and air pollution emissions by reducing vehicle traffic, and by shifting travel to lower emissions modes such as rail or electric vehicles. Shorter trips, active modes, public transport, and lower traffic congestion can also improve transport system efficiency and directly reduce emissions. Comparing freight transport modes, the external air pollution and GHG emission costs of truck transport are estimated to be about 7.6 cents per-ton-mile higher than rail transport.[28]

Similarly, improving the fuel efficiency of vehicles can reduce greenhouse gas emissions and air pollution as vehicles consume less gas to travel the same distances. Examples of actions that simultaneously improve system efficiency and reduce pollution and greenhouse gas emissions include congestion charging and other pricing systems that reduce inefficient vehicle travel,[29] more efficient practices to handle empty truck backhauls, shifts from road transport to mass transit or actives modes with concomitant reductions in emissions,[30, 31] and higher use of vehicles with lower emissions.[32]

Improving energy efficiency can cut energy use per kilometer of vehicle travel and thereby reduce greenhouse gas emissions. Finally, the type of fuel used in vehicles can also have a major impact on greenhouse gas emissions, especially when comparing more traditional energy sources (fossil fuels) to more modern ones (biofuels and electricity).

Much like the tradeoff between efficiency and safety, when efficiency improvements induce more travel—for example, increase in system capacity for transport systems with high initial accessibility levels—a higher amount of emissions is to be expected, except for increases in walking and cycling trips.[33]

[28] Ibid.

[29] Gibson, M., and Carnovale, M. 2015. "The Effects of Road Pricing on Driver Behavior and Air Pollution." *Journal of Urban Economics,* 89, 62–73.

[30] Johansson, C., Lövenheim, B., Schantz, P., Wahlgren, L., Almström, P., Markstedt, A., and Sommar, J. N. 2017. "Impacts on Air Pollution and Health by Changing Commuting from Car to Bicycle." *Science of the Total Environment,* 584, 55–63.

[31] Litman, T. (2014). Smart Congestion Relief. Comprehensive Evaluation of Traffic Congestion Costs and Congestion Reduction Strategies. Victoria Transport Policy Institute, 23 March 2016: www.vtpi.org/cong_relief.pdf

[32] Carrese, S., Gemma, A., and La Spada, S. 2013. "Impacts of Driving Behaviours, Slope and Vehicle Load Factor on Bus Fuel Consumption and Emissions: A Real Case Study in the City of Rome." *Procedia-Social and Behavioral Sciences,* 87, 211–221.

[33] Handy, S., and Boarnet, M. G. 2014. "Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions." California Environmental Protection Agency, Air Resources Board, August, 28, 2015.

Safety and Green Mobility

There are important synergies between safety and green mobility.[34] Well-designed transport systems that focus on multimodality or public transport with good walkability and cycling access, and that operate high capacity, throughput, and load factors, can cut both emissions and crash rates relative to transport systems dominated by private automobiles and a growing two-wheeler fleet. Active modes, green by definition, also improve safety by reducing the risks imposed on other road users, and can improve safety if they are part of a comprehensive effort to make traffic calmer, by lowering posted and enforced motorized vehicle speeds and stimulating walking and cycling. In the same vein, freight transport systems can also reduce air pollution and improve safety with a multimodal approach, leveraging the benefits of rail and waterborne transport.

Another area where green mobility and safety can have synergies is vehicle design. Better designs often make vehicles both more efficient and safer.[35] Government regulations increasingly exploit this synergy, through fuel economy regulations that push toward lightweight vehicles, which also improves the safety of the vehicle.[36] Eco driving programs, which reduce the top driving speeds for both cars and trucks, can also yield important benefits both in cutting emissions and crashes.[37, 38, 39, 40]

However, synergies between green mobility and safety are not guaranteed. A poorly designed walking or cycling project may cut emissions while increasing safety risks. For cyclists, major roads are more hazardous than minor roads, and the presence of bicycle facilities—on-road bike routes, on-road marked bike lanes, and off-road bike paths—are associated with the lowest risk.

---

[34] Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., and Franco, O. H. 2009. "Public Health Benefits of Strategies to Reduce Greenhouse Gas Emissions: Urban Land Transport." The Lancet, 374(9705), 1930–1943.

[35] Jacobsen, M. R. 2013. "Fuel Economy and Safety: The Influences of Vehicle Class and Driver Behavior." *American Economic Journal: Applied Economics,* 5(3), 1–26.

[36] Bento, Antonio, Kenneth Gillingham, Kevin Roth, 2017, "The Effect of Fuel Economy Standards on Vehicle Weight Dispersion and Accident Fatalities." NBER Working Paper No. 23340, April 2017, NBER Program(s). Cambridge, MA: National Bureau of Economic Research.

[37] Ibid.

[38] Jamson, S. L., Hibberd, D. L., and Jamson, A. H. 2015. "Drivers' Ability to Learn Eco-Driving Skills; Effects on Fuel Efficient and Safe Driving Behaviour." *Transportation Research Part C: Emerging Technologies,* 58, 657–668.

[39] Jacobsen, M. R. 2013. "Fuel Economy and Safety: The Influences of Vehicle Class and Driver Behavior." *American Economic Journal: Applied Economics,* 5(3), 1–26.

[40] Reynolds, C. C., Harris, M. A., Teschke, K., Cripton, P. A., and Winters, M. 2009. "The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: A Review of the Literature." *Environmental Health,* 8(1), 47.

TABLE 1.1: Summary of Synergies and Trade-Offs between Objectives

	System Efficiency	Universal Access	Green Mobility	Safety
System Efficiency		*Synergies* - Increasing efficiency can increase capacity to move people and lower costs, increasing access - Higher accessibility leads to benefits related to job density and market competition	*Synergies* - Energy efficient vehicles and systems cut resource requirement, leads to lower GHG emissions and reduced air pollution - Efficient management of empty truck backhauls	*Synergies* - More efficient allocation of road space (bus lanes, BRTs, active modes) along with safety measures (traffic calming) helps organize traffic and make it safer
Universal Access	*Trade-Offs* - Higher access may increase vehicle kilometers, putting pressure on roadway capacities - Providing public transport accessibility to areas with low population density may not be financially sustainable		*Synergies* - Improving public transport accessibility and quality for all, with a shift away from private modes to public transport or active modes, can cut overall vehicle travel and thus emissions.	*Synergies* - Improving public transport accessibility can reduce vehicle travel in terms of total vehicles, improving safety
Green	*Trade-Offs* - Increases in road use efficiency from increasing capacity can trigger increased demand - Future technologies such as driverless cars may increase urban sprawl	*Trade-Offs* - Increased use of motorized transport can trigger more environmental externalities, except for increases in walking and cycling trips		*Synergies* - Increasing public transport use improves system safety while cutting emissions - Better vehicle design and eco-driving can improve safety
Safety	*Trade-Offs* - Improving traffic flow, while efficient, can trigger higher speeds	*Trade-Offs* - Increased vehicle travel can increase the total amount of fatalities, injuries, and crashes if road safety systems are not improved	*Trade-Offs* - When appropriate infrastructure (cycle lanes, sidewalks, traffic calming) is not implemented, pedestrian and cyclists are at a higher safety risk	

Source: Own elaboration

CHAPTER 2
UNIVERSAL ACCESS

The Universal Access objective seeks to ensure that everyone has access to the transport needed to take advantage of economic and social opportunities—both in rural and urban areas, and irrespective of their income, gender, age, disability status, and geographical location. Equity and inclusivity are at the heart of this global objective. The concept of universal access features directly in two of the Sustainable Development Goal targets (9.1 and 11.2) and is at the heart of Habitat III New Urban Agenda. SDG target 9.1 aims to develop quality, reliable, sustainable, and resilient infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. SDG target 11.2 aims to 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. While there is no universally agreed definition of what constitutes universal access, and no internationally agreed specific target for the objective, there is an overall acknowledgement that sustainable transport should "leave no one behind."

The SDGs track universal access through three indicators: passenger volume by mode of transport, proportion of rural population who live within 2km of an all-season road, and proportion of population that has convenient access to public transport. Typically, country level data on quality of transport infrastructure and passenger volumes are available. However, data measuring access to transport infrastructure and services are not available on a global scale. Measuring differential access—by income level, gender, age, disability status, and location—adds further complexity to task.

The paucity of data makes it difficult to assess trends in universal access. However, the accessibility gap is huge. In rural areas, where most poor people live, limited transport connectivity is a critical constraint to access markets and opportunities. For example, based on the current rural accessibility index, about 450 million people in Africa—or more than 70 percent of its total rural population—are estimated to have been left unconnected due to lack of transport infrastructure. In urban areas, where an additional two billion people are expected to be living in cities by 2045, the growth in population is far outstripping the growth in public transport. Furthermore, the lack of access to transport services has disproportionately negative impacts on specific groups like women and girls. For example, 6 in 10 women in major Latin American cities report they've been physically harassed while using transport systems. Considerable work is needed to come up with a universally agreed upon definition of access and define a quantified target for universal access at the global level. In addition, there is an urgent need to collect data on existing indicators and disaggregate these data by different types of users. Filling this measurement gap will allow us to ensure that no one gets left behind.

2.1 METHODOLOGICAL CHALLENGES IN MEASURING UNIVERSAL ACCESS

2.1.1 Definition of universal access

Inclusivity is at the heart of this global objective. It ensures that everyone is provided with at least some basic level of access through sustainable transport services, and "no one is left behind." Ultimately, it provides access to markets (goods) and opportunities (people) across geographical areas (rural, urban), income groups (affordability), gender, age, and disability status. For the purpose of this report, the rural discussion will cover low volume roads and inland waterways and urban discussion will cover urban and peri-urban areas.

In general, the market does not distribute transport infrastructure and services equitably. And yet, ensuring equity in access is of paramount importance. For example, women and men have different trip patterns and mobility constraints, resulting in gender differences in mode of transport used, and travel patterns related to trip purpose, frequency, and distance of travel. Whether in urban, peri-urban, or rural areas, women tend to make more trips than men. However, walking remains the predominant mode of travel for many women in developing countries, as other transport modes like public transport are often not used, because they are too expensive, are located too far away, or are unsafe. In the future, addressing the mobility needs of all will become more important than ever. There are now more than one billion persons with disabilities in the world. And virtually all the world's regions are likely to see growth in the share of older people in their respective populations.

When assessing the extent to which access is universally provided, one should look at both the availability and usability of infrastructure and services. Infrastructure availability refers to the existence of the physical infrastructure, such as roads, bridges, ports, or rail. Usability refers to the condition of the infrastructure (e.g. maintaining the infrastructure in fair condition). Services availability refers to the existence of transport such as animal-drawn carts, buses, motorcycle taxis, or lorries. Services usability refers to the reliability, safety, comfort, and ease of access to different modes, travel time, and affordability.

2.1.2 Universal access in global agendas

The Universal Access objective is embodied in two Sustainable Development Goals:

- **SDG Target 9.1:** Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
- **SDG Target 11.2:** 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.

Given the public transport focus of target 11.2, it is specifically relevant for urban areas and hence for universal urban access. The Inter-Agency Expert Group (IAEG) has agreed to use the "proportion of population that has convenient access to public transport, by age, sex, and persons with disabilities" to measure it (SDG indicator 11.2.1). Similarly, target 9.1 focuses on providing affordable and equitable access to regional infrastructure for all. This is specifically relevant for rural areas, as connecting rural areas to regional infrastructure will be important to achieve this target. The importance of rural access is recognized by the IAEG; they have agreed to use the proportion of rural population living within 2 km of an all-season road (also known as the rural accessibility index, SDG 9.1.1) as one of the indicators to track this target.

The Habitat III New Urban Agenda (NUA) underlines the need for accessible cities, and focuses on equal access to all services, including transport. In addition, it stresses "age and gender-responsive planning and investment for sustainable, safe, and accessible urban mobility for all, and resource-efficient transport systems

for passengers and freight, effectively linking people, places, goods, services, and economic opportunities." It also supports a focus on the needs of marginalized groups, to tackle urban inequality in urban development and transport planning and provision in support of the SDGs. It proposes several measures—from financing to coordination of policies and integrated urban planning to advance these goals.

In many respects, the NUA goes beyond the specific urban agenda: it has a direct impact on rural access through urban-rural linkages. The agenda specifically commits to strengthen urban–rural connectivity with sustainable transport and mobility options. The provision of access through rural transport services and infrastructure can connect farmers and fishermen with "the local, subnational, national, regional, and global value chains and markets."

At present, the international dialogue on transport focuses on urban access and low-carbon transport. There is limited discussion and engagement on low volume rural access. The only significant achievement has been the acceptance of the Rural Access Index as one of the 10 transport-related indicators in the Sustainable Development Goals indicators framework. Also, the domestic budget of low-income countries, and lending of multilateral development banks in those countries, is titled towards rural transport. In spite of this, universal access in rural areas has failed to make it into any recent international agreements. Explicit reference to universal access in rural areas in international and national fora will be crucial in defining actions, targets, indicators, and achieving progress.

2.1.3 Measuring universal access

There are two initial challenges in measuring universal access through sustainable transport: (i) the absence of a universally agreed upon definition of "universal access," and (ii) the difficulty of measuring due to low data coverage, lack of shared methodology, and multiple sub-groups to be considered to proxy the "for all" dimension of universal access.

Measuring universal access requires multiple pieces of information, including residential location, a complete road network and road quality, a complete transit network, the schedule, use, and speeds of public transit on the network, the location of destinations (including jobs and markets), the demographics of existing users of transport, and an assessment of the needs of vulnerable groups. Because of its data-intensive nature, measuring universal access in urban and rural areas remains a major challenge. Often universal access itself cannot be directly measured, because of a lack of data, lack of access to data, or lack of capacity to conduct the measurement.

To improve measurement, consideration needs to be given to local and national level capacity for data collection, particularly in areas that will experience mass urbanization, and those with high levels of informality in public transport. Moreover, universal access data needs to be supported by relevant basic transport and contextual data (e.g. population size, etc.)—these data are not needed to measure universal access directly, but rather to provide the right context in which to interpret the indicators and data that measure universal access.

In addition, new methods of data collection such as remote sensor data (collected by technology companies) and crowdsourced data (for example, Open Street Map) should be explored to revolutionize the measurement of universal access. There is a need to examine ways to align interests with the private sector for data sharing. Such an alignment could be achieved by developing new tools, such as Open Algorithms, which facilitate improved access to data by better addressing private sector privacy and business propriety concerns.

While consistently measuring universal access is the ultimate objective, measuring access in the same manner in all areas of the world is challenging, given resource constraints. As an alternative, we define appropriate levels of access measurement for cities and rural areas with different data availabilities and capacities to collect and report access data. The GMR proposes to use three levels—basic access, intermediate access, and advanced access. For cities and rural areas with

low data availability, quality, or measurement capacity, the "basic access" indicators permit measurements to be made and targets to be set with very limited data (most of which can be obtained remotely as well as locally). These indicators focus on the basic provision of infrastructure and services that form the backbone of the mobility system. By focusing on basic transport data, these indicators are only proxy indicators of access, and are not inclusive of many often-neglected groups. For cities and rural areas with greater data availability, quality, and measurement capacity, the indicators are designed to robustly assess a variety of barriers to access, and usability of the transport system is notably linked with geospatial information, including a variety of equity measurements.

As we move from "basic access" to "intermediate access" to "advanced access," the measurement of access shifts from the provision and use of transport to access to sustainable mobility and opportunities—jobs, markets, social services, recreational activities, and more.

1. **Basic access.** Measurement is based on a simple methodological approach using data that is already collected regularly (e.g. road inventory data collected from road agencies; data collected from transit operators by the International Association for Public Transport (UITP), remotely sensed data (e.g. urban extent grids), crowdsourced data (e.g. open street maps), or other readily available data (e.g. rapid transit station locations)). Measurement focuses heavily on the provision of transport, preferably including informal transit and paratransit. This will allow for a basic understanding of SDG indicators 11.2.1 and 9.1.1.

2. **Intermediate access.** Measurement is based on more detailed methodology, collecting data that requires higher government capacity. Indicators in this category can be more robust and people-focused. The primary aim will be to collect information on the proposed main indicator (for example, geospatial data on primary, secondary and tertiary road networks and road condition). Both SDG indicators 11.2.1 and 9.1.1 fall under this category.

3. **Advanced access.** Measurement is based on the most detailed methodology, collecting geospatial data that requires high levels of government capacity but delivers a robust set of data covering a variety of aspects of access with the most people-focused indicators. This will collect information beyond the proposed main indicator (e.g. access to urban opportunities and access to markets in rural areas).

It will be important that the levels of measurement (basic, intermediate, and advanced) are mutually supportive but become gradually more detailed, incorporating survey information, geospatial data, and information that can be collected on an annual basis.

2.1.4 Indicators to measure universal access

The overall target

The Universal Access objective aims to "ensure equity in access to economic and social opportunities by 2030." Attainment of SDG target 11.2, by focusing on urban access, and SDG target 9.1, by focusing on rural access, should be the main targets (to be achieved by 2030) for the Universal Access objective. While both SDGs acknowledge that transport should "leave no one behind," there is no internationally quantified target for this objective.

Setting a unified global target for "access for all" will be a long and drawn out process. Instead, we propose that countries set their own voluntary targets that account for their individual circumstances, needs, national and local capacities, and political realities. This will allow us to set a target that is ambitious enough to spur real action, but is not so far-reaching as to be ignored.

Commonly used indicators and data that measure access at the country level include measures of quality of transport infrastructure by mode (road, rail, port and air transport) and volume of passengers carried by mode.[1]

Rural access index (SDG target 9.1.1)

The principal indicator for universal access in rural areas proposed by the IAEG-SDGs for SDG target 9.1.1 is: Proportion of the rural population that lives within 2 km of an all-season road, more commonly known as Rural Access Index (RAI).[2]

The choice of this indicator reflects the importance of access to all weather roads in rural areas. In many Low-income Countries (LICs) and Lower Middle Income Countries (LMICs), low volume rural roads and rural access roads are often narrow, and do not provide all-season access. The lack of all-season roads is especially problematic in countries with rainy seasons, when low volume roads often become impassible by tractors, motorized two-wheelers or even non-motorized traffic (NMT) (bicycles or animal-drawn carts). This difficulty locks people into subsistence farming as markets become regularly inaccessible. The poor quality of low volume rural roads also results in significant damage to produce en route to markets, and so reduces its value and the income to the farmer. In many areas, safe footpaths, footbridges, and waterways may be required in conjunction with, or as an alternative to, roads.

The original RAI methodology (from 2006) relies on household-level survey data. To circumvent this issue, in 2015 the World Bank (with funding from the UK Government through DFID) developed a new methodology that uses detailed geospatial road network, road quality, and population data to measure the RAI. This new methodology was piloted in eight countries. While countries generally have an indication of their strategic arterial network of higher volume roads, many low-income countries have no (or very limited) information, in terms of the inventory and condition of their rural network of predominantly low-volume roads.

To circumvent this issue, DFID is exploring further development of the RAI methodology through the World Bank and Research for Community Access Partnership (ReCAP), using satellite imagery.[3] The significant technological advances over the past ten years mean there are opportunities for utilization of new technologies and methodologies to make significant advances in the data for the sector and the effectiveness of the sector. High-resolution satellite imagery is now available worldwide, and covers many of these inaccessible areas. Therefore, it has the potential to provide inventory data and condition assessments of entire networks. It is important to investigate the suitability of cost-effective, sustainable, high-technology solutions that can be used to gather appropriate information on a country's rural network for maintenance management purposes.

This approach has been piloted in northern Nigeria, on earth and gravel roads, with some success; but there are some issues that would have to be resolved if the technique is to have a wider application. Northern Nigeria is sparsely vegetated, which makes it ideal for satellite imagery, but this approach may not be feasible for tropical areas where the tree cover would make locating roads difficult. The age and cost of the imagery can also be a restricting factor. However, the results of the Nigerian trials demonstrate that inventory and condition of roads can be established relatively accurately using satellite imagery. Tentative condition indicators from satellite imagery have been developed through correlations with manual assessments, but their suitability needs to be tested for different geographic and climatic environments.

The UN Statistical Commission and the IAEG support the RAI for inclusion as one of the SDG indicators (9.1.1). The low global coverage of this index has re-

[1] The Report of Study on Sustainable Urban Transport Index for Asian Cities by UNESCAP identified, reviewed and selected a total of 10 urban transport index, some of which are reflected under the indicators to measure universal access, and other as indicators for the safety and green mobility pillar.

[2] See: http://www.research4cap.org/Recap-news/Lists/Posts/Post.aspx?ID=38

[3] The first phase of this work was applied to eight pilot counties: Ethiopia, Kenya, Mozambique, Tanzania, Uganda, and Zambia in Africa, and Bangladesh and Nepal in South Asia.

sulted in the UN Statistical Commission ranking it as a Tier III indicator. The above updated methodology and increased coverage of the RAI will be a crucial part of tracking the Rural Access Goal and in raising the RAI to Tier I or Tier II by end-2018.

Other indicators—which measure these additional aspects beyond access to transport infrastructure—should complement this principal indicator. Methodologies or data for these indicators are not yet available. Indicators to consider include:

- Proportion of rural roads in "good and fair condition" (as developed by the new RAI)
- Percentage of markets accessible by all-season roads
- Percentage of national government budget spent on low volume rural transport infrastructure.

Access to transport services in rural areas

An adequate and connected rural transport network needs to be complemented with several other features to successfully provide access for all. Convenient and affordable transport services that allow rural residents to reach markets and basic services are also essential. Access can be delivered through a variety of modes, including motorized (such as motorcycles and motorcycle ambulances) and active modes (such as the use of bicycles and animal drawn carts crucial in hauling farm input and transporting crops to market). The selection of transport mode will have an impact on the type of infrastructure to be constructed, *i.e.* narrower structures predominantly to service motorcycles.

Another important measure is the transport cost. In the agricultural supply chain, the first few miles from farm or village to the first market are more expensive than the other miles. The ton-km costs for these movements for unimproved access can be two to three times more expensive than for subsequent movements, where improved access is provided.

While the RAI focuses on availability of infrastructure, the GTF proposes to develop a set of indicators to reflect its use, with an overall indicator such as "Percentage of the rural population with access to affordable and reliable passenger transport services."

Other proposed indicators include:

- Ratio of national to local passenger transport fares (collection of data on rural passenger transport US$ per km for short distance and long distance trips which would be disaggregated by most common modes, e.g. bus, motorbike, other IMT)
- Percentage of household monthly expenditure spent on transport
- Percentage of rural population with at least daily transport service—from Living Standards Surveys (LSS)
- Percentage of households that make one motorized trip per month.

Access to public transport (SDG target 11.2.1)

The principal indicator for universal access in urban areas is the agreed SDG indicator 11.2.: Proportion of population that has convenient access to public transport, by age, sex, and persons with disabilities.

It provides a good estimation of the level of access to public transport, but its calculation is based on the availability of data on the location of residences and households.[4] An annual household survey or census will prove infeasible, at least in the short term. Furthermore, there is no internationally agreed methodology to proxy the "for all" dimension that is at the heart of the SDG 11.2.1. This means that access to public transport cannot yet be broken down by gender, age, or disability status.

[4] The International Transport Forum at the OECD has already collected data similar to this indicator for more than 1,000 cities around the world, measuring the population within 1 km of a transit stop, and the population within 1 km of a mass transit stop.

To counter this issue, two measures of public transport—which are regularly reported and updated at the local level—can be used effectively as proxy indicators for access. These are the annual vehicle-km data offered by public transport services, and the number of public transport journeys made annually. To allow comparisons across cities, the total figure—for both vehicle-km (VKM) and journeys—can be divided by the number of residents within the urban area analyzed. These could be listed as basic indicators.

Public transport VKM per capita can be a good proxy for access to public transport, with the assumption that when public transport operators plan and set up the network in the city, they have access to data or estimates on residential and employment location, and are looking to provide services equitably to city residents. To capture differences in the level of access among various areas or neighborhoods in the city, the VKM figure will also need to be differentiated by area of the city or public transport line.

Journeys per capita by public transport can be a 'post-facto' proxy for access to public transport, as using a service automatically implies that an individual has had access to it (but does not give a precise indication of convenience as proposed in the SDG). While admittedly changes in the level of public transport demand per capita may occur because of factors not directly related to access, this indicator is widely reported by formal public transport operators or authorities, allowing for frequent monitoring.

Additionally, as the core of the 11.2 indicator refers to access to public transport services, data on the number of stops per inhabitant can also be used as a proxy indicator for the level of access provided. Furthermore, this data should be differentiated according to the mode of transport serving the stop (suburban rail, metro, tram and light rail transit, BRT and bus and informal or paratransit, if possible). Rapid public transport modes include metro, light rail (tram), and bus rapid transit (BRT), where due to the specific infrastructure required for their operations, detailed information regarding stop locations should be readily available and reported by public transport authorities and operators. Rapid public transport infrastructure serves as the backbone of effective public transit infrastructure in large cities, which in turn is the basis of widespread access via sustainable transport modes in large cities. Thus, by measuring proximity to rapid public transport stations, we gain an understanding of the level of investment in public transport relative to population.

Rapid public transport station location data is readily measurable remotely and easily updated annually. Residential population data must also be regularly updated, but since this data changes at a significantly slower pace, it is not necessary to update this information every year. However, in locations where data is only collected after long intervals, new estimation techniques may need to be adopted to increase the frequency of population data collection.

While many urban mobility frameworks propose indicators for passenger transport, the same cannot be said for freight. It will be necessary to identify how a city can best report on the proposed indicator on SuM4All given the fact that many of the freight journeys will occur outside of the boundaries of metropolitan areas.

The proposed basic access indicators are:

- Length of public transport lines (particularly high capacity but also informal public transport if possible) per area, dedicated bicycle lanes and sidewalk coverage (this parameter will also help to determine urban density, *i.e.* people/sq km)
- Vehicle fleets per motorized transport mode (public transport and all other modes, such as taxis and shared taxis, informal/paratransit (if possible) motor cars, and motorized two-wheelers (annual update)
- Number of public transport journeys by mode of transport (annual update)
- Vehicle-km offered per public transport mode (annual update)
- Number of public transport stops per area (annual update)
- Passenger volume by mode of transport.

UN-Habitat suggests the "national sample of cities approach" as a tool to monitor and report the performance of cities at the national level. Integrating this framework and other frameworks with such an approach could be particularly valuable for countries facing data unavailability and constraints in data collection capacity. A standardized sampling approach can help reduce countries' data collection burden, and ensure the sampling of a consistent set of cities that is representative of territory, geography, and history, to report on national urban progress in a systematic manner.[5]

Over the course of 2017, UN-Habitat aims to work with stakeholders and cities to refine the metadata and methodologies on SDG 11.2.1 (and proposed supporting indicators) and test such an approach. These refinements will be reflected in future GTF.

Population within 500 m of frequent public transport stop

No universally agreed definition exists for "convenient" access to public transport. One way to address the methodological gap in SDG indicator 11.2.1 is by measuring this in terms of distance—one option is to measure it as the "percentage of the population within 500 m of a frequent public transport stop/station." Like SDG indicator 11.2.1, this measure can also be subdivided into a more inclusive metric disaggregated by gender, disability status, age, income, and social status. To do so would require population data with this additional information at the local tract or neighborhood level.

In addition to this indicator, the proposed intermediate access indicators are:

- Average percent of income spent on transport per resident (affordability)
- Modal share of different passenger modes in the city (public transport, walking, cycling, private vehicles and motorcycles and taxis, including informal/paratransit if possible). The aim should be to increase the use of sustainable transport modes. Consideration should also be given to applying this to freight transport (inter-modality)
- Passenger km travelled by mode of public transport (annual update)—using this indicator, the average length of public transport journeys (Tier 1) can also be assessed (inter-modality)
- Goods VKM travelled in the city per capita (freight).

Jobs accessible within 60 minutes by transport mode in the city

The SDG indicator 11.2.1 focuses on the access to sustainable transport services and not on the access to opportunities. It is therefore desirable to complement it with additional indicators that reflect the full range of access issues and benefits that are relevant at the city level.

These include:

- Passenger access—the ability of passengers to reach destinations
- Freight access—the ability of goods to reach destinations
- Urban planning Geographic Information Systems (GIS) data, which would enable looking beyond trip origin (dwellings) and analyzing destinations—gauging the impact of city planning on access levels
- Distribution of costs and benefits of different access options
- How to deal with informal/paratransit contexts
- Inclusivity across income—disparities in access by income and affordability level
- Qualitative access—travel time, safety, security, comfort, user information, etc.

[5] Criteria for sampling can be found in the guiding document https://unhabitat.org/national-sample-of-cities/

Advanced access indicators like the percentage of jobs and urban services accessible within 60 minutes by each transport mode in the city can be used to measure access at a more robust level. This captures agglomeration and the improvement in job access due to better transport. It requires more detailed data on transit service frequency in addition to a full street network, data on residential population densities, and a complete picture of employment locations. It also requires a modelled network of public transport services and their operations and speeds throughout the day, preferably in a standardized format, such as the general transit feed specification (GTFS). While street grid data and population location data are readily available globally via Open Street Maps and WorldPop, employment location data is often inaccessible, even in developed countries.

With a model of the city, job and service accessibility can be calculated for each census tract centroid, weighted by population, and averaged for the metropolitan region. This measure could be subdivided into a more inclusive metric disaggregated by gender, disability, age, income, and social status. This would require population data with this additional information at the local tract or neighborhood level.

In addition to this indicator, the proposed advanced access indicators are:

- Accessibility of the public transport network to persons with disabilities or in vulnerable situations (percent of vehicles allowing wheelchair access, percent of stations per network with step-free access, etc.) (usability)
- Reduction in the percent of women who are deterred by fear of crime from getting to and from public transport (usability)
- Number of jobs and city services (e.g. hospitals, schools, etc.) accessible to the average city resident by public transport, walking, and cycling (access to services).

2.2 TRENDS IN UNIVERSAL ACCESS

2.2.1 Access for rural communities

Relatively little progress has been made with respect to local roads providing access for rural communities in developing countries, such as in Sub-Saharan Africa. Local communities—who are typically the major beneficiaries of improved access—are usually highly motivated to work on the local road system, especially if this is paid work. Pilots that mobilize local communities to carry out local road maintenance and improvement have often been highly successful. However, translating this success to a large scale has foundered due to management and institutional blockages.

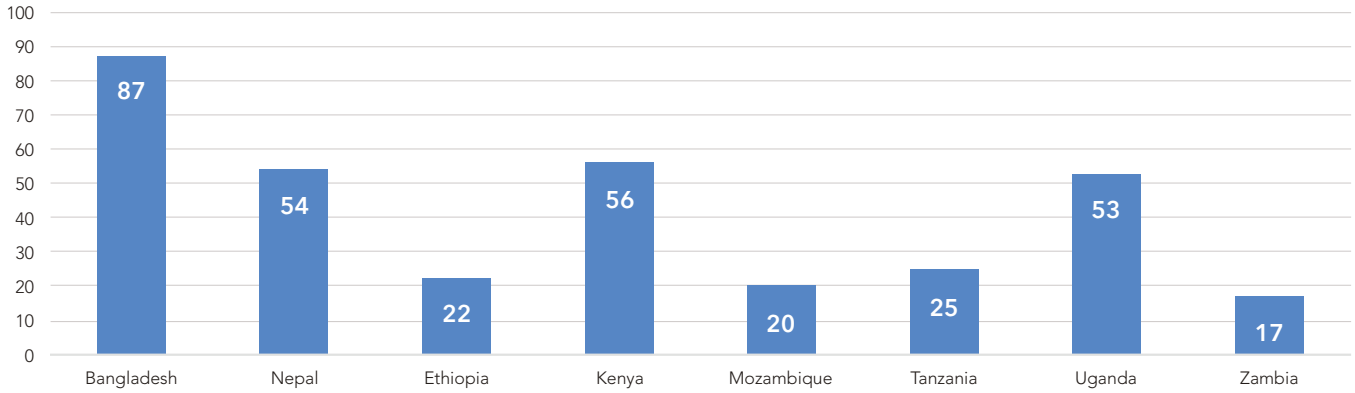
Based on the current RAI, about 450 million people, or more than 70 percent of the total rural population, are estimated to have been left unconnected in Africa.[6] Based on a new methodology using satellite imagery, the RAI shows interesting trends. Rural access varies significantly across these countries, from 17 percent in Zambia to 56 percent in Kenya. In total, it is estimated that about 34 percent of the rural population in these countries is connected, with roughly seven million people left disconnected (Figure 2.1).

In contrast, in South Asia, more progress has been seen. For example, through the Government of India's National Rural Roads Program (Pradhan Mantri Gram Sadak Yojana or PMGSY) started in 2000, all-weather road connectivity was provided to all habitations above a certain population threshold.[7] India has one of the largest and densest road networks in the world. However, a large part of the 2.7 million km rural road network was in poor condition—until the year 2000, around 30 percent of the country's population (about 300 million people) lacked access to all-season roads. It will be important to ensure that the Universal Access objective is informed by and linked to large and influential rural road programs such as PMGSY.

[6] It is unfavorably compared with other developing countries where RAI is on average 94 percent (Gwilliam 2011).

[7] The threshold is defined as a population of 500 persons and above in the plains areas of India, and 250 persons and above in hill states, the tribal areas, and the desert areas of India.

FIGURE 2.1: Rural Accessibility Index for Eight Pilot Countries—Percentage of Rural Population with Access

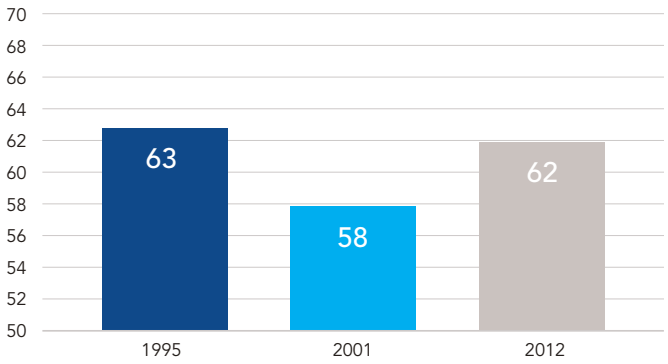


Source: World Bank 2016. "Measuring Rural Access: Using New Technologies".

2.2.2 Urban density and motorization rates

Urban density in developed cities worldwide appears to be increasing (Figure 2.2). A number of cities worldwide are introducing policies to stop and reverse urban sprawl, and are introducing a more concerted approach to urban planning, linking it with transport planning. Higher densities are often associated with improved urban access via sustainable modes, by reducing the distances to destinations and creating conditions supportive of public transport, walking, and bicycling.

FIGURE 2.2: Evolution of Average Urban Density in 19 Developed Cities



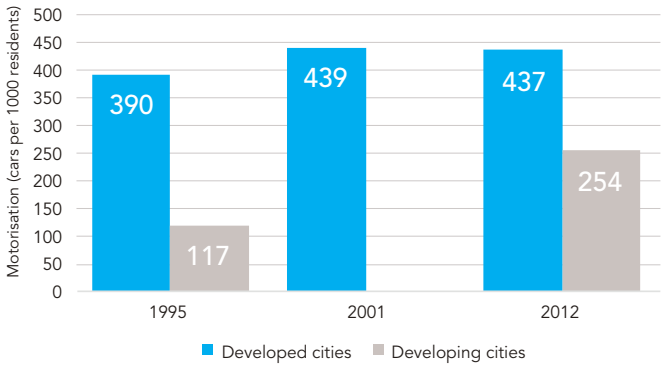
Source: Union Internationale des Transports Publics. Mobility in Cities Database.

This trend is also observed in Latin American cities, with most of the growth in urban population being done by policies of urban infill. Largely, across developed countries, people are moving back to cities rather than away from cities.

For the cities in developed countries covered by the Mobility in Cities Database (MCD), the previously growing trend in motorization appears to have been stopped. Motorization has largely remained stable in cities within developed countries over the 2001–2012 period. In cities in developing countries, on the other hand, particularly emerging economies, motorization rates have grown significantly since 1995 (Figure 2.3). Policies will need to be put in place to reverse this trend and avoid the problems that are already present in cities in developed countries. The trend is even more worrying, as most of the urban growth predicted for the coming decades is going to take place in developing countries.

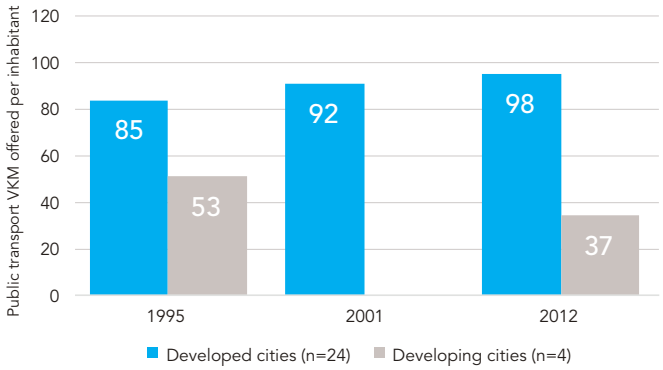
The same trend is also seen in Latin American cities, where motorization rates have been growing rapidly between 2007 and 2015, according to data published by the Urban Mobility Observatory of CAF development bank of Latin America. The trend is worrying because car and motorized two- wheeler ownership theoretically improves access for individuals, yet this improved level of access for a part of the population

FIGURE 2.3: Evolution of Average Level of Motorization in Cars per Thousand Residents, in 27 Developed Cities and 5 Developing Cities



Source: Union Internationale des Transports Publics. Mobility in Cities Database.

FIGURE 2.4: Evolution of the Average Level of Public Transport Supply, in Vehicles per Kilometer, in 24 Developed Cities and 4 Developing Cities



Source: Union Internationale des Transports Publics. Mobility in Cities Database.

comes with increased external costs that are spread across the entire urban population and beyond. Some of these external costs are reflected as increased road safety risk, social segregation, increased air and noise pollution, inequitable distribution of urban space, increased GHG emissions, and others.

2.2.3 Supply of public transport services

As explained above, the level of public transport supply is a basic but essential indicator helping track the level of access provided to citizens, because if public transport services are not being provided, urban residents cannot have access to economic and social opportunities. As most of the expected growth in urban populations will take place in developing countries, tracking the evolution of public transport supply there will be necessary, and will require significant capacity building for cities to measure this basic indicator of access.

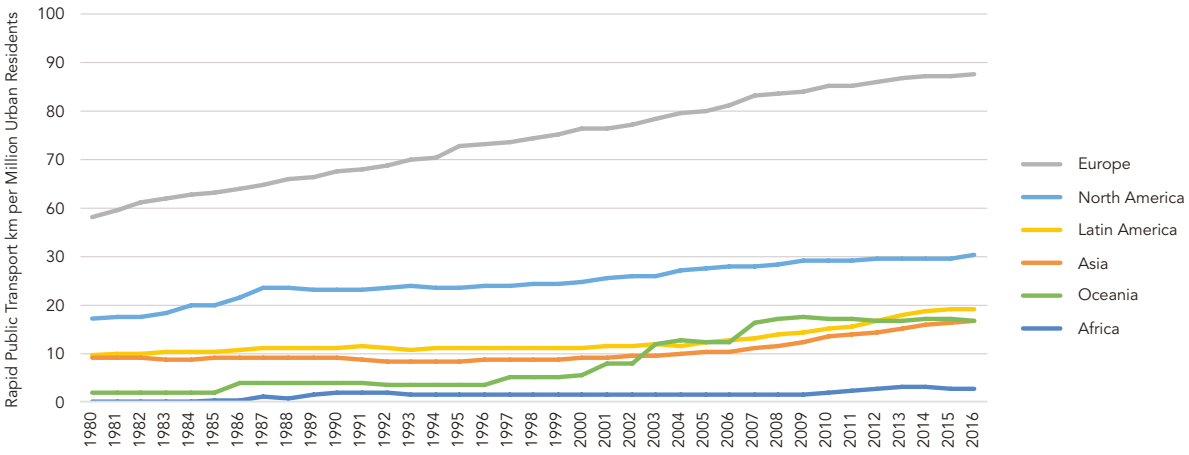
As observed from the—admittedly limited —sample of cities tracked in the MCD database, while public transport supply overall nearly doubled during the period 1995–2012 in developing cities, the growth in urban populations has outpaced these developments. As a result, the overall level of public transport supply per capita decreased over the observed timeframe (Figure 2.4).

The supply of rapid transit kilometers in urban areas can give a sense of investment in infrastructure that boosts access. In all regions, the supply of rapid transit has been increasing relative to the urban population, particularly since 2000, with by far the highest ratio found in Europe (Figure 2.5). The composition of that increase, however, varies significantly in each region. Latin America experienced heavy investment in BRT, while Asia experienced strong growth in metro transit services (Figure 2.6).

2.2.4 Public transport demand

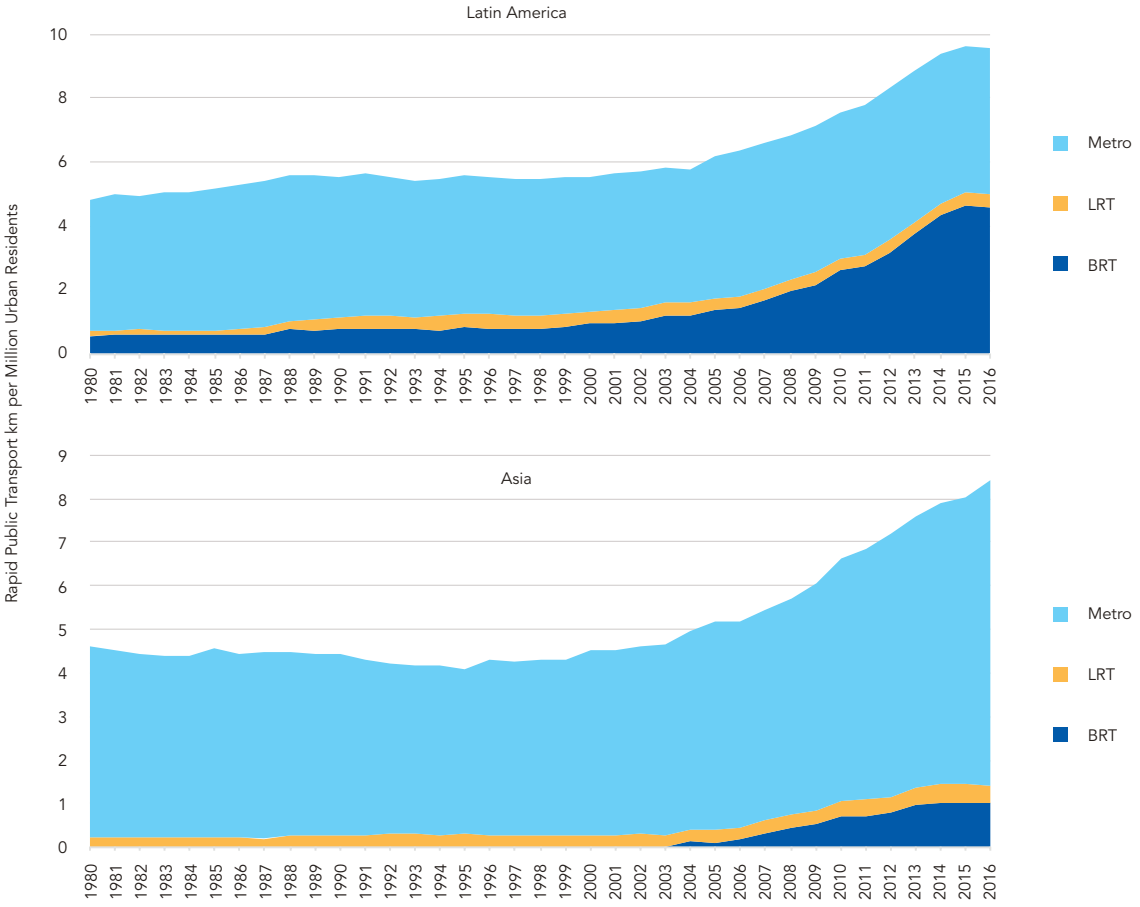
In terms of the other proposed proxy for public transport access, the trend observed in the cities covered by the MCD is roughly similar to public transport supply. For cities in developed countries, moderate growth in both total volume and the demand per capita was observed, while for cities in developing countries the number of journeys by public transport grew at a higher rate. But even with larger increases in urban population, the public transport rate of use, in journeys per capita, is actually decreasing (Figure 2.7).

FIGURE 2.5: Supply of Rapid Transit Relative to Urban Population



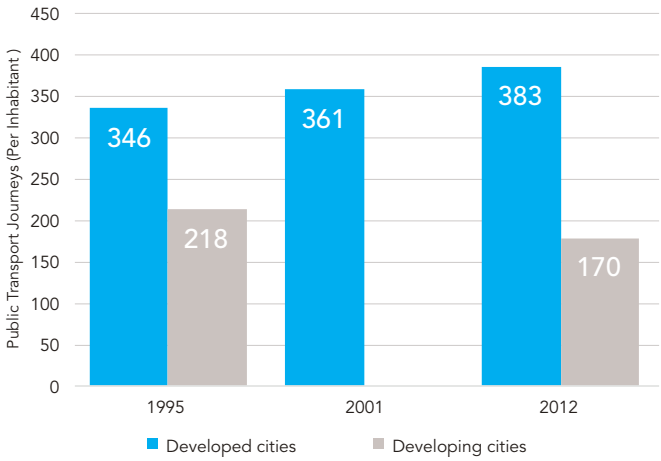
Source: Institute for Transport & Development Policy 2017. Rapid Transit Database.

FIGURE 2.6: Composition of the Growth of Rapid Transit Relative to Urban Population



Source: Institute for Transport & Development Policy 2017. Rapid Transit Database.

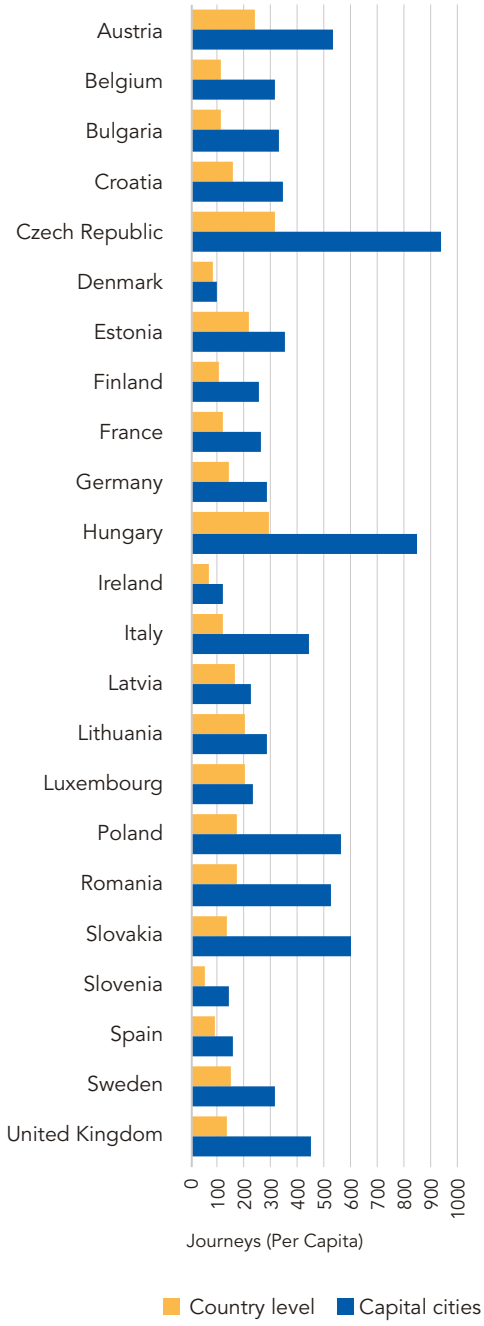
FIGURE 2.7: Evolution of the Average Level of Public Transport Demand, Journeys per Capita, in 25 Developed Cities and 4 Developing Cities



Source: Union Internationale des Transports Publics. Mobility in Cities Database.

For the number of journeys per capita taken on urban and suburban public transport services, national and local authorities in the European Union collect and report data using relatively comparable methodologies. Using data from the UN Department of Economic and Social Affairs (DESA) on the urban population living in the respective countries, UITP was able to track the evolution of the rate of journeys per capita annually. The observed drop in the journey rate after 2008 is linked in many of the EU countries with the economic slowdown and the ensuing loss of jobs in that period. As expected, in all countries with available data, residents of the biggest cities have significantly higher rates of public transport use than the national average. The capitals—which are generally the largest cities in the countries, particularly in the EU—have higher rates of use, quite often accounting for more than half of the total number of journeys in the country (Figure 2.8).

FIGURE 2.8: Journeys per Capita in the EU Countries and their Capitals, 2014

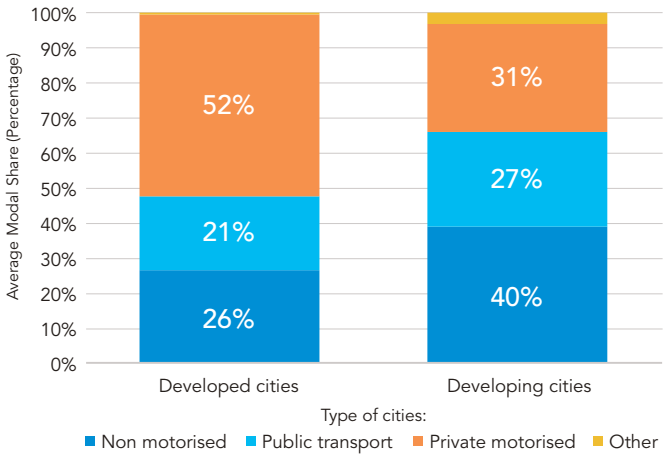


Source: Union Internationale des Transports Publics. Mobility in Cities Database

2.2.5 Modal share of public transport in urban areas

The analysis of the modal shares split in the cities of the MDC reveals that there are significant differences between cities in developed countries—where the majority of daily urban trips are made by private motorized modes—and those in developing countries (Figure 2.9). Developed and developing countries face different challenges vis-à-vis access. In developed countries, the primary challenges to improving access refer to time spent in traffic, integrating the schedules of public transport services to make them competitive with private modes, or promoting and prioritizing non-motorized transport. In developing countries, a main challenge is posed by physical and financial barriers to access, whereby some residents cannot take full advantage of the opportunities in their city because of a lack of safe infrastructure or accessible or affordable transport services.

FIGURE 2.9: Average Modal Split in 42 Developed Cities and 10 Developing Cities



Source: UITP Mobility in Cities Database

The evolution of the modal share in developing cities highlights their specific challenge: while the national economic performance is improving, the share of trips made on walking, cycling, and public transport have been decreasing. This has increased the negative externalities associated with private motorized transport, which are already apparent in cities within developed countries.

2.2.6 Mobility for women in cities

Security issues create a significant burden on women's mobility. The lack of personal security, or the inability to use public transport without the fear of being victimized—either while traveling on board a public transport mode, walking to or from the transit facility or stop, or waiting at a bus, transit stop, or station platform—can substantially decrease the attractiveness of public transit. Globally, there is no database on public-transit-related crime, generally country data is often not comparable across modes, and data on personal security is not widely circulated.

According to a recent report by the Thomson Reuters Foundation, six in ten women in major Latin American cities report they've been physically harassed while using transport systems. In many cases, respondents reportedly had little confidence that authorities would investigate an abuse report, or respondents doubted that fellow public transport users would come to their rescue if they were in trouble. Even in cities in developed countries, a large share of women felt unsafe waiting on a railway platform during the day; a figure that rises sharply to 53 percent at night.

2.2.7 Mobility for persons with disabilities

There are more than one billion persons with disabilities in the world, of whom between 110–190 million experience very significant difficulties. This corresponds to about 15 percent of the world's population. The prevalence of disability is growing due to population ageing and the global increase in chronic health conditions. Patterns of disability in a particular country are influenced by trends in health conditions and trends in environmental and other factors—such as road traffic crashes, natural disasters, conflict, diet, and substance abuse. While not a unique urban issue, disability has an important urban access element attached to it.

Disability is more common among women, older people, and households that are poor. Lower-income countries have a higher prevalence of disability than high-

er-income countries. Stereotypical views of disability emphasize wheelchair users and a few other "classic" groups such as blind people and deaf people. However, the disability experience varies greatly, notably in urban areas. While disability correlates with disadvantage, not all persons with disabilities are equally disadvantaged. For example, school enrollment rates differ, with children with physical impairments generally faring better than those with intellectual or sensory impairments.

Persons with disabilities face widespread barriers in accessing services (health, education, employment, transport, and information). These include inadequate policies and standards, negative attitudes, lack of service provision, inadequate funding, lack of accessibility, inadequate information and communication, and lack of participation in decisions that directly affect their lives.

2.2.8 Mobility for children and youth

Despite the fact that children and youth are a growing proportion of the population in many urban areas around the world, in terms of urban transport they are an overlooked and vulnerable segment of the population. Children and youth under 24 represent 47 percent of the total population in developing countries and 29 percent of the population in developed countries. Rates in some regions of the world are in higher contrast: in Sub-Saharan Africa, children and youth age 0–24 represent 63 per cent of the population of the region. It is estimated that by 2030, 37 per cent of the world's population will be under the age of 20. Children and youth, by virtue of some of their most common modes of transport—walking, bicycling, and travelling by two-wheeler—are some of the most vulnerable road users.

Children and youth take trips each day by multiple modes; yet have constraints on mobility and accessibility based on their age, income, physical size, and degree of personal freedom to travel. They are particularly vulnerable in terms of road safety and air quality. There is a lack of data from urban areas in both developed and developing countries on children and youth travel behavior by travel mode, trip purpose, age, and gender. However, the opportunity is ripe to shape the next generation of urban transport users by collecting data and developing policies or plans that are more inclusive and promote safe and sustainable travel behavior—and a diversified transport infrastructure that provides opportunities for employment, education, and equality, reduces conflicts, and promotes health, leisure, and participatory planning.

2.2.9 Mobility for ageing populations

In parallel with the growth in urban populations, another phenomenon which is due to have a significant impact on urban mobility is population ageing. The year 2005 was the first year when the number of 'middle-aged' people (between 25 and 64 years) surpassed the number of young (under 25 years) people. At the same time, the number, and proportion of, older people (over 65) is growing at the fastest rate recorded. By 2030, the number of people aged 65 and over is set to more than treble compared with 1990—by then they will make up 11.7 percent of the world's 8.5 billion inhabitants. The ageing of the population is likely to have significant effects on mobility, particularly due to a reduction in daily mobility that is generally associated with (partial) retirement. Additionally, the effects of ageing—such as reduced vision and delayed reaction, which also have safety implications—are likely to affect the number of trips taken by car, thus offering an opportunity for public transport and shared mobility modes to fill in the gap.

It is important to mention that while virtually all the world's regions are likely to see a growth in the share of older people in their respective populations, the trend is likely to be significantly different from one world region to the other. China is expected to undergo one of the biggest demographic shifts in terms of age structure, while at the same time the country's population is expected to plateau from 2025 onwards. In 1990 more than 50 percent of Chinese residents were under 25, a share that is expected to decrease to just 26 percent

in 2030. The demographic balance in Europe will be leaning disproportionately towards older people. Europe will be home to 17 percent of the world's people ages 65 and over, while having only 8.6 percent of its total population.

2.3 SCALE OF THE CHALLENGE

In both developing and developed countries, rural connectivity is an ongoing challenge, especially as economic and social activities and opportunities are often based in cities, towns, and markets. Rural areas are experiencing deep transformations. The size of the world rural population has stopped growing while urban population keeps increasing at a sustained pace and has outnumbered the rural population. The decreasing importance of agriculture makes it less attractive for private and public investment. Rural population is ageing everywhere, even if deep asymmetries in life expectancy continue to persist, particularly in sub-Saharan Africa. Furthermore, farming is becoming a more hazardous activity as more unpredictable and frequent climatic events affect it. Rural areas are expected to further decline, this will lead to a highly concentrated urban world.

Rural areas are trending towards disparate prosperity. In the future, the socio-economic divide may increase by consolidation of geographic inequalities between and within the rural areas and between rural and urban areas. Rural areas, (especially the more remote ones) can easily fall into the margins of globalization. Urbanization could induce the conversion of some of the most fertile agricultural land and thus limit economic activities in rural areas. Furthermore, rural areas may either benefit or suffer from the digital connectivity. This depends on whether an increasingly connected system or a growing digital divide emerges. The future of rural areas remains uncertain.[8]

By 2050, the world's urban population is expected to have grown by 2.5 billion people, reaching 66 percent of the total global population. Africa and Asia together will make up nearly 90 percent of this increase until 2050, and, with this boom, economic mass will continue to shift from the mature economies toward the emerging markets. In 2015, there were 29 megacities of more than 10 million people, and by 2030 there will be an additional 12 megacities, with ten of them in Africa and Asia. In addition, recent decades have seen the rise of polycentric metropolitan regions consisting of a number of connected large urban areas, which present a new set of challenges for transport planning.

Currently, in much of the world urban growth is poorly planned or managed, and the result is often sprawl and inadequate transport and infrastructure. 'Informal' transport options—unregulated private operators running small- to medium-capacity low-performance vehicles such as collective taxis and mini-buses—often fill the gaps, but can on their own not meet the needs of all people. Formal and informal transport both contribute to a host of challenges in cities in terms of safety, congestion, and pollution, disproportionately affecting the poor. In many cities in developed and developing countries alike, congestion, pollution, shifting economic centers, and demographic patterns present imminent threats to lives and livelihoods.

The transport landscape in urban agglomerations is often highly inequitable, with the poor and persons with disabilities left with inadequate means to access the economic and social centers of the cities. The burden of climate change adds another layer of urgency and complexity to the problems decision makers must address in their quest to ensure sustainable urban access. It is important to note that in some developed countries, urban centers, in fact, have diminishing populations and pockets of very low density.

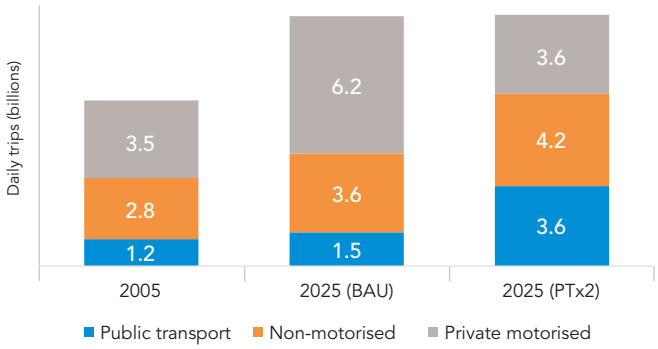
About 7.5 billion trips were made every day in urban areas worldwide in 2005. The share of daily trips made by public transport was about 16 percent, walking and cycling about 37 percent, whereas private motorized modes had about 47 percent—about 3 times the share

[8] Bourgeois, R. 2015. "What Future for Rural Areas: Seven Plausible rural transformations". Development 58 (2-3), 177-186.

of public transport. While the market share of public transport was situated somewhere between 10 percent and 20 percent in Asia-Pacific, Europe, Latin America, and MENA (Middle East and North Africa), it was less than 5 percent in North America and Sub-Saharan Africa, and about 45 percent in Eurasia.

The number of daily trips made in urban areas could increase by 50 percent between 2005 and 2025, reflecting both the projected growth in urban population and an increase in the number of daily trips made by each urban resident.[9] This increase would manifest itself primarily in developing economies, where most of the growth in urban populations in expected. UITP has developed two scenarios for urban mobility developments, labelled Business-As-Usual (BAU) and doubling the market share of public transport (PTx2) (Figure 2.10).

FIGURE 2.10: Scenarios for Urban Mobility Developments



Source: Union Internationale des Transports Publics. Mobility in Cities Database.

If the trends observed in the last decade of the 20th century were to prevail—BAU scenario, the most notable change in urban transport patterns between 2005 and 2025 would be the shift from walking and cycling to private motorized vehicles. Public transport would see a small erosion of its market share in all world regions. The number of trips made by public transport would increase by about 30 percent while the number of trips made by private motorized vehicles would increase by almost 80 percent. Against this background, the footprint of urban mobility would become increasingly visible.

Alternatively, doubling the market share of public transport worldwide and keeping stable the share of walking and cycling would make it possible to decouple the growth of mobility in urban areas from the growth of its societal and environmental costs—the PTx2 scenario. The modal split resulting from the PTx2 scenario would be more balanced, with urban trips being shared almost evenly between public transport, walking and cycling, and private motorized vehicles. The underlying idea is not to reduce the number of trips made by private vehicles but rather to keep it at its current level (about 3.5 billion trips per day) and to ensure that all extra mobility would be provided by sustainable modes of transport.

The study 'A Global High Shift Cycling Scenario' shows the high potential for economic savings and savings of GHG emissions from a High Shift Cycling scenario, where public transit, walking, and cycling specifically are given high priority. GHG emissions could be cut in half, potentially resulting in a 2 gigaton reduction of annual emissions by 2050. The increase in cycling and e-bike use would save the world a cumulative US$24 trillion between 2015 and 2050.[10]

Moving forward, cities in developed and developing countries face various challenges as they improve access. In developed countries, the primary challenges include decreasing the amount of time people spend in traffic, integrating the schedules of public transport services to make them competitive with private modes, and promoting and prioritizing active modes of transport. In developing countries, the main challenges include overcoming the physical and financial barriers that limit people's ability to take advantage of the opportunities and services in their towns and cities because of a lack access to safe infrastructure or affordable transport.

[9] Based to research conducted by UITP.

[10] https://www.itdp.org/a-global-high-shift-cycling-scenario/

CHAPTER 3
SYSTEM EFFICIENCY

The Efficiency objective aims to ensure that transport demand is met effectively at the least possible cost. It captures two key concepts: productive efficiency (concerned with the optimal method of producing goods), and allocative efficiency (concerned with the distribution and allocation of resources in society). The scope of the efficiency objective is limited to the "macro" perspective, where efficiency refers to the optimization of resources—energy, technology, space, institutions, and regulations—to generate an efficient transport system at the regional, national and global level. It is associated with transport systems, *i.e.*, the interconnection of transport modes to balance supply and demand.

The concept of efficiency features directly and indirectly in several SDG targets, including energy efficiency (7.3), fossil fuel subsidies (12.c), food losses (12.3), resource-use efficiency (9.4), infrastructure upgrading (9.1), and policy coherence (17.14). While there are no internationally agreed upon global targets for efficiency, qualitative direction is given in some of the SDGs (e.g., SDG7.3: By 2030, double the global rate of improvement in energy efficiency). Transport network efficiency is becoming increasingly important as countries strive to integrate further into global value chains. Total freight transport demand is expected to triple within 35 years. Significant differences exist across countries. For example, compared with developed countries, developing countries have higher trade costs and lower levels of trade integration. Similarly, high-income OECD countries have more efficient regulations for truck licenses and domestic operations, a more comprehensive system for ensuring the quality of truck operations and a higher degree of openness to foreign competition. In addition, contracting Parties to United Nations Conventions in general have in place more efficient systems to facilitate border crossings for international transit, or have established coherent systems of international road, rail or waterways networks. Regarding fuel efficiency, while globally the average fuel economy has consistently improved from 2005 to 2015, the rate of improvement has slowed down in the most recent years.

The most challenging aspect of efficiency is having the right metrics and the data to measure them. Some of the key aspects of efficiency of mobility to date remain unmeasured. These include integration across transport modes and harmonization of regulatory barriers, for example.

3.1 METHODOLOGICAL CHALLENGES IN MEASURING EFFICIENCY

3.1.1 Definition of efficiency

The Efficiency objective will ensure that transport demand is met effectively at the least possible cost for society, given a set of available resources. In everyday parlance, *efficiency* refers to lack of waste. For the GMR, the concept applies to "transport systems", *i.e.*, the network of roads, rail, ports, and airports.

An efficient transport system has transport modes seamlessly integrated, optimal traffic volumes (which reduces congestion and cross-border delays), and makes the minimum use of energy resources per unit of transport, among other characteristics. In turn, an inefficient transport system has long delays and high costs that are detrimental to competitiveness, economic growth, and development in general.

We consider two types of efficiency:

- Productive efficiency is concerned with the optimal method of producing goods and services – producing goods and services at the lowest cost. Resources used include energy, technology, space, institutions and regulations.

- Allocative efficiency is concerned with the distribution and allocation of resources in society. This occurs when there is an optimal distribution of goods and services, considering consumers' preferences. This concept is close to societal efficiency—the optimal distribution of resources in a society, considering all external costs and benefits as well as internal costs and benefits.

Transport cost can be measured in private terms (individual travel time and monetary cost) and social terms (aggregate use of resources, such as energy, technology, space, institutions and regulations).

In general, both users and providers make demand and supply decisions based on their own interest and private cost. When all these individual decisions are added up, the results are not efficient from a societal perspective. In other words, there is a significant gap between private cost and social cost, and the results can be improved upon from a societal point of view.

For example, the pursuit of self-interest will result in high social cost, such as the exhaustion of critical non-renewable energy resources, disruption of fragile ecosystems (air pollution, land degradation), or countries excluded from global trade.

The literature defines transport efficiency in different ways, for example, applied to particular mobility markets or issues such as traffic congestion, production scale, land use, energy use, and regulations, among others. Transport efficiency can also be defined from a macroeconomic perspective (transport networks, trade volumes) or microeconomic perspective (individual travel decisions), national or regional, service provider or user, urban, rural and inter-urban, passenger or freight.

Efficiency cuts across the three other objectives of the SuM4All initiative. For example, improving transport system efficiency can reduce greenhouse gas emissions and air pollution (*i.e.* the green objective) by reducing vehicle traffic, and by shifting travel to lower emission modes, such as public transport.

In view of this overlay, the GMR arbitrarily defines the boundary for the efficiency objective strictly in macroeconomic terms. It will refer to the optimization of resources (energy, technology, space, institutions and regulations) to generate an efficient *transport system* (at the regional, national or global level). This means that efficiency considerations linked to private costs, such as affordability, individual travel time, vehicle operating cost are covered under the three other objectives.

3.1.2 Efficiency in global agendas

The Efficiency objective is, among others, embodied in five **Sustainable Development Goals**:

- **SDG 7.3** By 2030, double the global rate of improvement in energy efficiency.
- **SDG 9.1** Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
- **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.
- **SDG 12.c** Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.
- **SDG 12.3** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including postharvest losses.
- **SDG 17.14** Enhance policy coherence for sustainable development.

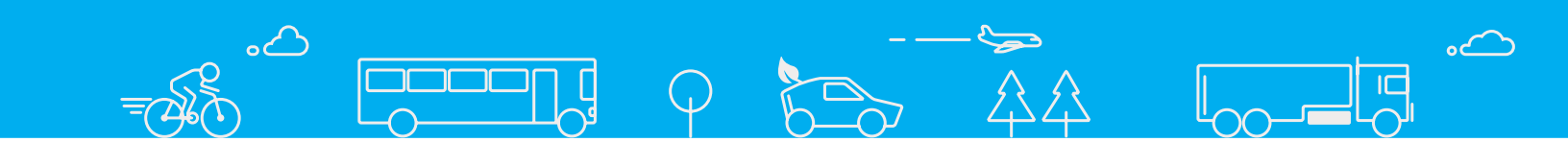
Moreover, the Efficiency objective is at heart of the United Nations conventions and agreements. For example, infrastructure agreements managed by UNECE and by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) provide a basis for a long-term development of coherent international networks for the various modes of inland transport and thus facilitate international travel for people and freight, and border crossing facilitation conventions help to establish effective transit system for moving freight.[1, 2]

Another important international agreement that reflects the Efficiency objective is the Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024 (VPoA), which, among others, focuses on transport corridors and trade for land-locked developing countries. It relates to fundamental transit policy issues, transport infrastructure development and maintenance, and international trade and trade facilitation, amongst other priority areas. International transport corridors are particularly important for linking countries, and more so for connecting landlocked developing countries to global markets and value chains, and for fostering regional integration. In addition to their geographical impediments, these countries face challenges linked to the high trade and transport costs, limited or low quality infrastructure, delays at borders and bottlenecks related to customs procedures and border crossing regulations. The VPoA relates directly to the spatial scope of the efficiency, focusing on trade integration aspects that enhance the competitiveness and productivity of firms and workers.

In addition to the global mandate set by the VPoA, the transport dimension of WTO's Trade Facilitation Agree-

[1] List of Conventions managed by UNECE: a) The European Agreement on Main International Traffic Arteries (AGR), b) The European Agreement on Main International Railway Lines (AGC), c) The European Agreement on Important International Combined Transport Lines and Related Installations (AGTC), d) The European Agreement on Main Inland Waterways of International Importance (AGN), e) Convention on the Contract for the International Carriage of Goods by Road (CMR), f) Additional Protocol to the CMR Concerning the Electronic Consignment Note (e-CMR), g) Customs Convention on the International Transport of Goods under Cover of TIR Carnets (TIR Convention), h) International Convention on the Harmonization of Frontier Controls of Goods, i) Customs Convention on Containers, j) European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), and k) Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be used for such Carriage (ATP).

[2] List of Conventions managed by UNESCAP: a) Intergovernmental Agreement on the Asian Highway Network, b) Intergovernmental Agreement on the Trans-Asian Railway Network, and c) Intergovernmental Agreement on Dry Ports.



ment ("Bali TFA") also sets directions for cross border movements through TFA article 11, on freedom of transit. The achievement of efficiency relies on the existence of a sound and conducive institutional and regulations, based on the national ratification and implementation of international harmonization conventions (*i.e.* UN Customs Convention on the International Transport of Goods Under Cover of TIR Carnets (TIR Convention, 1975), or the Convention on the Contract of International Carriage of Goods by Road (CMR, 1956).

3.1.3 Measuring efficiency

There are multiple challenges in measuring efficiency in transport systems: (i) the absence of a universally agreed upon definition of "efficiency" and boundaries within the overall transport sector, and (ii) the multi-faceted aspect of "efficiency." For the purpose of the GMR and the SuM4All Initiative, "efficiency" will focus on *transport systems*, which includes aspects of multimodality, border crossing, trade and logistics, high-volume roads, and resource efficiency. From this *macro-economic perspective*, resources include capital, labor, energy, technology, space, institutions, and regulations.

3.1.4 Indicators to measure efficiency

The overall target

The Efficiency objective aims to meet the demand for mobility at the least possible cost by 2030. More specifically, since this objective captures the macroeconomic aspects of mobility, it will seek to "increase the efficiency of transport systems." There is no internationally quantified target that summarizes the several aspects of this objective.

Connectivity index

This connectivity index is a composite index that captures the cost, time and reliability of a transport network that enables users to connect domestically within the country to internal provinces, cities and rural or urban areas (domestic connectivity), with neighbors and regional peers (regional connectivity), and globally with the rest of the world. It considers the importance of multimodality, involving road, rail, waterborne, and air transport, as a multimodal system can leverage the efficiencies across modes. A more competitive and productive economy is expected as a result of improved connectivity.

In its simplest form, costs refer to out-of-pocket payments for a transport service. Time accounts for the door-to-door time the passenger or cargo spends on route, and reliability can be measured in several ways using variance in delivery duration, coefficients of variation,[3] among others. These 3 metrics could also be packaged in a 'normalized" version of cost and time: this is unitary costs ($/km, $/ton-km, $/passenger-km) and speed (km/hour).

This composite index should be complemented by additional indicators. Some of these additional indicators are commonly used in the transport sector, while others will need to be developed.

- *Liner shipping connectivity (commonly used indicator).* This indicator is a proxy of the accessibility to global trade. It can be thought of as both a measure of connectivity to maritime shipping and as a measure of trade facilitation. Data for this is available from the United Nations Conference on Trade and Development.[4]

- *Air connectivity index (commonly used indicator).* This indicator measures the integration in the global air transport network. Data on this indicator is available from the International Civil Aviation Organization (ICAO) and the World Bank.

- *Freight volumes by mode of transport (IAEG-SDG proposed indicator).* Country level data with global coverage are available for container port traffic and

[3] Standard deviation relative to the mean.
[4] unctadstat.unctad.org

air transport freight volume. This indicator is the same as SDG indicator 9.1.2 for freight.

- *Freight connectivity (indicator to be developed).* This is the ratio of local freight costs from farm to market or port (absolute and per ton-km). Costs per tonne-km are highest in the first few miles from farm to market or port.[5] This ratio would be worked out by collection of the following data: (i) The average cost for the country, expressed US$ per ton-km, of moving dry bagged commodities, such as grains, fertilizer, cement, sugar, salt, over 300 km on major highways; (ii)) The average cost, expressed per ton-km, of moving dry bagged commodities between market town and village, between 10 and 40 km, where the village lies on a rural road or track. Surveys are completed by local road transport operators.

- *Percentage of agricultural potential connected to a major port or market by a certain road category within a given time period (indicator to be developed).* Connecting farms to markets is a measure of efficiency of how transport networks can unlock economic activity, productivity, and growth. This indicator would measure market accessibility of agricultural production zones using a certain road category within a certain time period. The higher the percentage the better connected the country is.

- *Proportion of world population who live within 100 km of an international airport.* This indicator measures aggregated passenger connectivity regional and international perspective. The methodology is available from ICAO. The known locations of international and domestic airports across the world are integrated and mapped with global census and population distribution data.

- *Accession to the UN transport conventions.* This indicator measures the number of UN transport conventions acceded to by a country.

- *Truck Licensing Index (0-11).* This indicator comes from the Enabling the Business of Agriculture database from the World Bank. The transport indicators from this database measure regulatory and administrative constraints affecting the provision of reliable and sustainable commercial road transport services.

- *Rail lines (indicator to be developed).*

- *Average age of vehicle fleet (indicator to be developed).*

Institutional and regulatory barriers

Supply chain efficiency is becoming increasingly important as countries strive to enter global value chains. Addressing barriers that constrain efficient transport and trade facilitation can improve each nation's international competitiveness. This requires a systematic approach that combines transport infrastructure and services provision with improvements that simplify unnecessary legal and administrative cross-border procedures.

The logistics performance index measures this by capturing six important dimensions: (i) the efficiency of customs and border management clearance; (ii) the quality of trade and transport infrastructure; (iii) the ease of arranging competitively priced shipments; (iv) the competence and quality of logistics services—trucking, forwarding, and customs brokerage; (v) the ability to track and trace consignments; and (vi) the frequency with which shipments reach consignees within scheduled or expected delivery times. This index is obtained from a survey of logistics professionals who are asked questions about the foreign countries in which they operate and cover.

Furthermore, as countries, contracting parties to the United Nations conventions and other global and regional transport and trade agreements, are obliged to implement standards and norms prescribed by these conventions and agreements, they typically have in place efficient systems for international transit and trade facilitation. Therefore, accession to relevant

[5] R. Workman data from Nepal.

United Nations and other global and regional transport conventions can be a good proxy measure for addressing institutional and regulatory barriers by countries.

Technology use for transport

The rapid expansion of information and communication technology (ICT) has changed the landscape in which transport stakeholders operate. ICT enables and facilitates the collection, analysis, and distribution of information. In the transport sector, accurate and timely information is critical. Smart technologies, such as traffic and mobility management systems, and public transport management systems help to manage rapid urbanization and growing traffic congestion. This is an increasing area of importance in both developing and developed countries, and should help in reducing the large number of backhauls for trucks. The index is proposed to measure the percentage of freight/shipments (by value or by weight) that are using these platforms.

The use of technology to increase efficiency in the transport sector cuts across all dimensions and levels, ranging from user information, asset management, electronic payment, faster inspection of goods, emergency and accident management, domestic and regional exchange of information, to interactions between administrations and service operators, drivers and passengers, or tracking of shipments. The indicator proposed here focuses on one area—the use of virtual marketplaces for connecting shippers and logistics providers to consolidate freight, reduce cost, and reduce emissions.

Energy consumption of transport

This measures the energy efficiency of the transport network in generating GDP, *i.e.* how much energy consumption generates one US$ of GDP. Data on transport sectors energy consumption is available through the International Energy Agency. Normalizing this by GDP is straight-forward.

3.2 TRENDS IN EFFICIENCY

Total freight transport demand is expected to triple within 35 years, growing from 112,000 billion ton-kilometers in 2015 to 329,000 billion ton-kilometers in 2050. Global freight transport demand is projected to grow 3.3 percent annually from 2015 to 2030, and 3.1 percent annually from 2015 to 2050. Air freight volumes are expected to grow faster than other modes, at about 5 percent annually (Table 3.1).[6]

TABLE 3.1: Annual growth rate for freight transport demand

Global compound annual growth rate (%), baseline scenario

	2015–2030	2015–2050
GDP	2.7	2.5
Freight Transport Demand	3.3	3.1
Rail	3.0	2.6
Road	3.2	2.8
Aviation	5.6	5.4
Sea	3.4	3.3

Source: Organization for Economic Cooperation and Development/International Transport 2017. ITF Transport Outlook 2017. OECD Publishing. Paris.

Most freight transport demand is met via maritime channels today (around 70 percent in terms of ton-kilometers) and the share is projected to remain relatively steady overtime: it is projected to grow to 75 percent by 2050). By 2050, the highest flow of goods in both directions will be on the transport corridor between the United States and Asia.[7]

The remaining 30 percent of freight transport demand is met mostly by rail and road transport, with air transport accounting for only a marginal share in terms of ton-kilometers (air transport usually carries high value, low weight freight). Rail and road freight are expected to increase by a factor of 3.7 from 2015

[6] ITF (2017), ITF Transport Outlook 2017, OECD Publishing, Paris.
[7] Ibid

to 2050. However, the share of rail and road transport in terms of ton-kilometers is expected to fall. By 2050, rail and road transport will account for 25 percent of global freight volume. Most of the growth in rail and road freight volume will come from developing economies. Volumes are expected to triple in the non-OECD economies: by 2050, these economies are projected to account for 80 percent of all rail and road freight transport demand. Regionally, the fastest growth will take place in Africa.[8]

The spatial organization of transport can be conceptualized at three different levels—global, regional and local. The major nodes that structure spatial organization at the global level act as gateways. These global nodes are supported by port, airport, and telecommunication activities. At the regional level, metropolitan areas can be considered the nodes. These regional nodes areas are connected by rail lines, highways, and waterways. At the local level, employment and commercial activities can be thought of as the main structuring elements. Together these three levels allow for various types of mobility ranging from locally-based commuting to global trade flows.[9] (Figure 3.1)

These gateways are major centers of commercial activity. They have access to huge markets and transport substantial amounts of cargo. In this respect, for example, the Shanghai metropolitan area is the world's most significant hub—it has a global gateways index of 5.2 percent (a 4.6 percent component for containers and a 0.6 percent component for air cargo—meaning that Shanghai handles 5.2 percent of the world's commerce. The world's 25 largest hubs vary in the modal composition of the index. Gateways such as Hong Kong, Dubai, New York and Tokyo have a higher air cargo component than the average. In contrast, several gateways have a marginal air cargo function, these include Ningbo, Qingdao, Rotterdam, Kaohsiung, Antwerp, and Hamburg.[10]

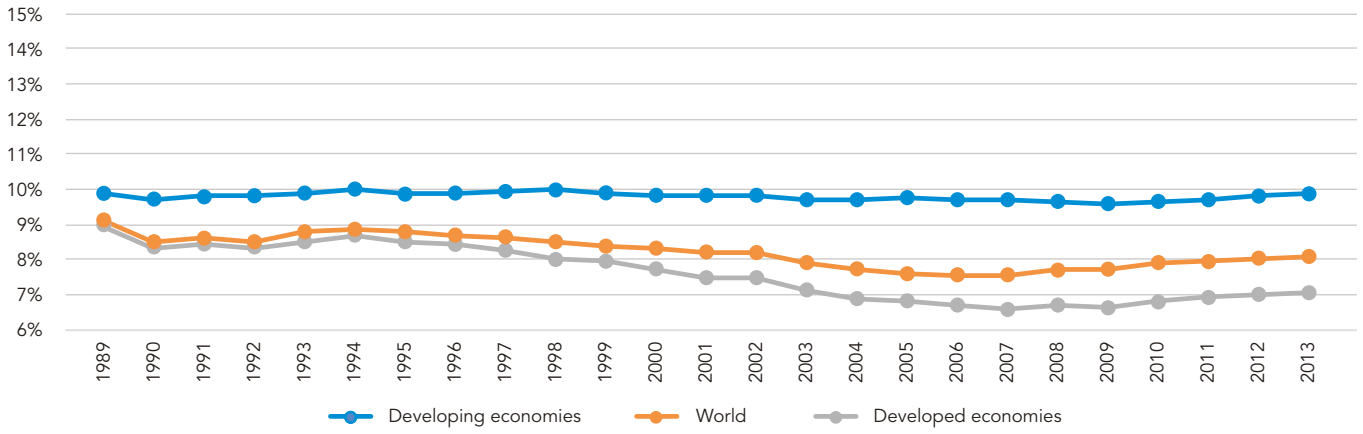
FIGURE 3.1: Data Quality of Transport Data sets

Source: Jean-Paul Rodrigue 2017. "Transport and Spatial Organization" The Geography of Transport Systems, 4th edition.

Another aspect of spatial efficiency, the UN estimates that, on average, the level of development in Landlocked Developing Countries (LLDCs) is 20 percent lower than it would be if the countries were not landlocked, due to low connectivity to the global economy and high costs of transport. On a different note, developing countries pay 40–70 percent more to ship internationally per dollar of import, as shown in Figure 3.2. Regardless of trade composition, higher shipping costs and lower levels of trade integration are in general observed in developing countries. Several factors have contributed to this imbalance in transport

[8] Ibid
[9] https://people.hofstra.edu/geotrans/eng/ch2en/conc2en/ch2c3en.html
[10] Ibid

FIGURE 3.2: Freight Costs as a Percentage of Import Value



Source: UNCTAD estimates. Data: 10 year moving average

costs—trade imbalances, trade and port reforms, low trade volume, and shipping connectivity.[11]

Regarding shipping connectivity, only 17–18 percent of country-pairs are linked to each other through direct port service. The remaining pairs must connect through a third country hub to trade bilaterally. While it may not be cost effective to connect all country-pairs directly, economical distances (captured by the liner shipping connectivity index and network connectivity) may affect trade integration in developing countries. For example, bilateral liner shipping connectivity, measured by UNCTAD, is more strongly correlated with freight costs than distance, which for developing countries often leads to lower trade cost with high income countries than among themselves.[12, 13]

Access to efficient transport logistics (as part of modern supply chains) has been found to increase farmers' income by 10 to 100 percent. Transport costs can account for one-third of the price of agricultural inputs in some Sub-Saharan African countries. One important consideration are the regulations that affects the provision of commercial road transport services for agricultural products—including licenses, quality of trucking operations, and cross-border transport. This is measured for 62 countries across all regions of the world by "the World Bank's *Enabling the Business of Agriculture*."

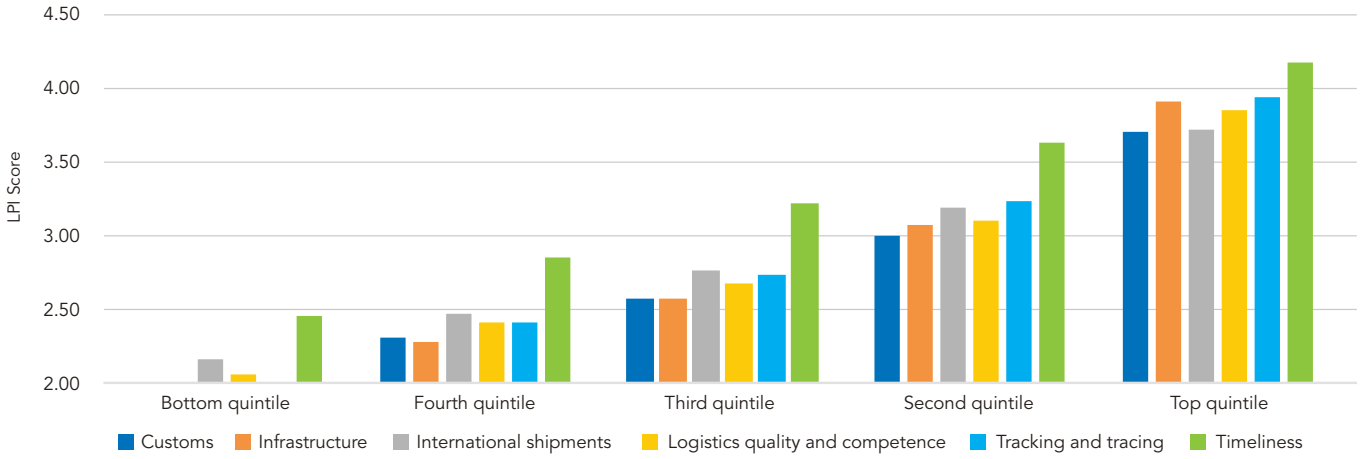
Strong transport regulations can catalyze integration of farmers into the global food supply chain, while burdensome regulations can have the opposite effect. Data from Enabling the Business of Agriculture show that high-income OECD countries have more efficient regulations for truck licenses and domestic operations, a more comprehensive system for ensuring the quality of truck operations, and more openness to foreign competition. Developed countries displaying the strongest performance on the measured regulations have a strong body of harmonized regulations. In contrast, developing countries often have weaker transport regulations because of their domestic and cross-border trucking regulations: they do not require a license at the company level, they do not establish norms for the transport of perishable products and they do not have any rules on cross-border transport.[14]

Customs and border agencies continue to under-perform systematically in comparison with the other

[11] UNCTAD (2015), Review of Maritime Transport
[12] UNCTAD (2015), Freight Rates and Maritime Transport Costs
[13] World Bank (2013), Developing Countries Face Higher Trade Costs

[14] World Bank. 2017. Enabling the Business of Agriculture 2017. Washington, DC.

FIGURE 3.3: Logistics Performance Index Component Scores, by LPI quintile



Source: Arvis, J-F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., Raj, A., Naula, T. 2016. Connecting to Compete 2016: Trade Logistics in the Global Economy-The Logistics Performance Index and Its Indicators. World Bank.

components of the Logistic Performance Index (Figure 3.3). This implies that customs clearance acts as a bottleneck across the globe and simplifying procedures at the borders can significantly improve supply chain efficiencies. Furthermore, there is considerable heterogeneity across countries in the efficiency of supply chains—the average Logistic Performance Index (LPI) for the highest quintile countries is roughly 50 percentage points higher than the average for the lowest quintile countries. This gap between the countries is widening. The WTO Trade Facilitation Agreement has the potential to improve efficiency. It entered into force on 22 February 2017 and, as of 7 August 2017, has been ratified by 121 WTO Member States that include 19 landlocked and 20 transit countries.[15]

Each year new countries accede to the key United Nations conventions and take steps to implement them. Since 2015, e.g. three additional countries acceded to the TIR Convention (Pakistan (2015), China (2016) and India (2017)) bringing the total number to 71 contracting parties. There has been new accession also to other Conventions: the Republic of Moldova acceded to the Customs Convention on Containers in 2016 and Turkmenistan to the Convention on Harmonization of Frontier Controls of Goods in 2016 bringing the number of contracting parties to these agreements respectively to 40 and 58.[16]

New technology can help improve the efficiency of transport systems. Yet, a recent global survey on digital readiness shows that the transport sector is less ready to embrace digitalization than other economic sectors.[17] Embedding information communication systems into transport networks can improve their efficiency. Examples of this include passenger information systems, integrated electronic ticketing systems, real-time traffic management centers, automated control systems allowing vehicles and roadside equipment to communicate, and so on. Embedding information communication systems in freight transport can facilitate inter-modality between modes of transport and coordinate the movement of goods though easier and faster border crossings. For example, transporting a container of avocados from Mombasa in Kenya to Rotterdam in the Netherlands takes 200 interactions and

[15] UN Report 2017. Implementation of the Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024.

[16] http://www.unece.org/trans/conventn/agreem_cp.html the statement is valid as of August 2017.

[17] PS Consulting 2017. The future of transport boardroom.

more than 20 documents. The cost of this documentation process equals the cost of the actual shipping.[18]

Globally, energy consumption of transport relative to GDP has dropped between 2008 and 2012. In 2008 the world consumed 27.33 tons of oil equivalent (TOE) per million dollars of GDP, and in 2012 the world consumed 25.80 TOE per million dollars of GDP. However, there is considerable heterogeneity across regions in this measure, with North America consuming the highest amount of energy for transport relative to GDP—37.97 TOE per million dollars of GDP in 2012—and South Asia consuming the lowest amount of energy for transport relative to GDP—12.17 TOE per million dollars of GDP in 2012. In 2012, the energy consumption of the transport sector relative to GDP was 47 percent higher in high income countries relative to low income countries. This difference likely stems from differences in level of economic development, trade openness, and mobility patterns across countries, regions and income groups.

Historically, transport fuels have been subsidized to the tune of billions of dollars, thereby encouraging unsustainable energy consumption practices. These practices have had clear negative effects in terms of GHG emissions and air pollution. The International Energy Agency (IEA) has estimated the 2008 fossil fuel subsidies to be $557 billion.[19] Of this, 56 percent of the total—US$312 billion—was spent to subsidize oil products, 36.6 percent, or $204 billion, was spent to subsidize natural gas, and the rest was spent on coal. In 2007–08, thirty-seven developing countries subsidized gasoline and diesel fuel at more than a million dollars per year.[20] Based on fuel price data collected by GIZ[21] for 174 countries, approximately 21 countries in 2014 were assessed as having subsidized gasoline fuel. But 41 countries—approximately 24 percent of all countries surveyed—were assessed to have diesel fuel price subsidies.[22] In many countries, diesel prices are more heavily subsidized because diesel fuel affects the movement of goods.

The recent trend in oil prices might have reduced the importance of oil subsidies—since 2016 oil prices have been in the US$27 to US$42 per barrel range, about a quarter of the 2008 peak crude oil price of US$145. This reduction in prices is expected to be permanent with oil prices expected to hover around $50 per barrel for the foreseeable future.[23] If left unchecked, this reduction in oil prices may further foster unsustainable energy consumption practices.

It is possible to reduce average vehicle fuel consumption by 50 percent by 2050 even without further technological breakthroughs by using existing cost-effective technologies.[24] As shown in Table 3.2, while globally the average fuel economy has consistently improved from 2005 to 2015, the rate of improvement has slowed, from 1.8 percent in 2005–08 to 1.2 percent in 2012–15 and 1.1 percent in 2014–15. Turkey has shown the highest level of improvement in vehicle fuel efficiency followed by the United Kingdom and Japan, measured as percentage improvement relative to 2005. Another important factor in determining fuel economy is type of vehicle and vehicle size, which are individual decisions that depend on the cost of fuel.

Within this global average there are significant differences between OECD and non-OECD countries. The rate of improvement has been falling from 2010 onward in OECD and EU countries—from 2.8 percent in 2008–10 to 1.3 percent in 2012–14. In contrast, the rate for non-OECD countries has generally been improving since 2005—from 0.1 percent in 2005–2008 to 1.6 percent in 2014–15.[25]

[18] HLAG 2016. "Mobilizing Sustainable Transport for Development–Analysis and Policy Recommendations from the United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport." New York: United Nations.

[19] Implicit subsidy is defined as the difference between a reference price and the actual end-user price.

[20] Andreas Kopp, Rachel I. Block, and Atsushi Iimi (2013) Directions in Development-Environment and Sustainable Development, "Turning the Right Corner Ensuring Development through a Low-Carbon Transport Sector", WB.

[21] GIZ, International Fuel Prices 2014.

[22] Subsidies were estimated using a price gap approach where US fuel prices were assumed to be subsidy free.

[23] https://hbr.org/2016/03/what-low-oil-prices-really-mean

[24] GFEI has shown that by using existing cost-effective technologies it is possible to reduce average light duty vehicle fuel consumption in gasoline-equivalent liters (Lge) /100km by 50 percent by 2050.

[25] https://www.globalfueleconomy.org/media/418761/wp15-ldv-comparison.pdf

TABLE 3.2: Average Fuel Economy in Light Duty Vehicles, 2005-2015

		2005	2008	2010	2012	2014	2015	2030
OECD amd EU average	average fuel economy (Lge/100 km)	8.8	8.2	7.8	7.6	7.4	7.3	
	annual improvement rate (%per year)	-2.3%	-2.8%	-1.6%	-1.3%	-0.5%		
		-1.8%						
Non-OECD average	average fuel economy (Lge/100 km)	8.5	8.5	8.4	8.2	8.0	7.9	
	annual improvement rate (%per year)	-0.1%	-0.3%	-1.4%	-1.2%	-1.6%		
		-0.8%						
Global average	average fuel economy (Lge/100 km)	8.8	8.3	8.1	7.8	7.6	7.6	4.4
	annual improvement rate (%per year)	-1.8%	-1.6%	-1.3%	-1.3%	-1.1%		
		-1.5%						

Source: International Energy Agency 2017. International Comparison of Light-duty Vehicle Fuel Economy 2005-2015: Ten Years of fuel economy benchmarking.

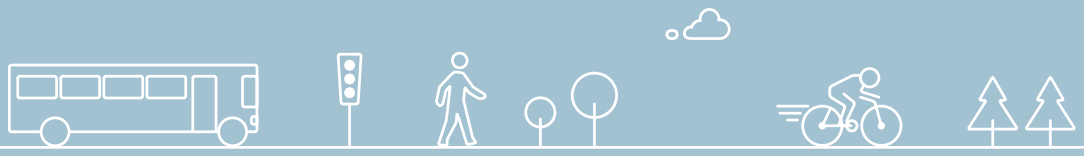
From 70 percent to 84 percent of fuel energy is lost in engine and driveline inefficiencies. Improving fuel economy can contribute significantly to reducing GHG emissions and helping to meet the under-2 degrees Celsius climate target of the Paris Agreement.

3.3 SCALE OF THE CHALLENGE

The most challenging aspect of efficiency is having the right metrics and data to measure it. Some of the key aspects of efficiency of mobility to date remain unmeasured. These include integration across transport modes and harmonization of regulatory barriers, for example. The future needs for the mobility of goods and people are expected to increase many fold. This means that efficiency will become increasingly important in the future—with global supply chains and efficient logistics at the heart of meeting future needs. This will require leveling the playing field across countries in terms of integration into these supply chains. However, to date there is significant heterogeneity cross the world in terms of logistics—the average logistic performance index varies by more than 50 percentage points across countries globally. This difference in logistics efficiency directly translates into differences in cost of transport that can have a distortionary impact on trade integration.

With the expected changes, it will be more important than ever that countries accede to and implement the United Nations conventions and other global and regional transport and trade agreements and introduce norms and standards and thus put in place effective international transit and trade facilitation systems. To meet the future needs efficiently, we must ensure that we are not locked into unsustainable paths today. The historical subsidization of transport fuels and current low global prices in crude oil have encouraged unsustainable energy consumption practices, and we must revert this trend. In addition, current technological breakthroughs should allow us to reduce average vehicle fuel consumption.

CHAPTER 4
SAFETY



The Safety objective is aimed at avoiding fatalities, injuries, and crashes from transport mishaps across all modes of transport. Unsafe mobility in any transport modes can pose significant public health risks and lead to social and economic losses.

While numerous agencies—international, governmental, and non-governmental—have attempted to address the safety of discrete modes of transport, there has been no overarching effort to set an overall target for safety of mobility and to collect reliable global data on transport safety. However, there are internationally agreed targets for road and air transport safety. Road safety is featured directly in two Sustainable Development Goal targets (3.6 and 11.2). SDG target 3.6 is specifically dedicated to road safety, and aims to halve the number of global deaths and injuries from road traffic accidents by 2020. This target is measured by tracking the death rate due to road traffic injuries. In addition, SDG target 11.2 refers to improving road safety by expanding public transport. Air transport safety is covered in the Global Aviation Safety Plan 2017–19.

On roads, the fatality risk for motorcyclists is 20 times higher than for car occupants, followed by cycling and walking, with 7 to 9 times higher risk than car travel, respectively. Bus occupants are 10 times safer than car occupants. Rail and air are the safest transport modes. Globally, 40 to 50 percent of traffic fatalities occur in urban areas. Evidence suggests that the highest fatality rates occur in cities in the developing world: the proportion of fatalities in urban areas is high and rising in low- and middle- income countries. Air transport has seen a continuous reduction in the number of fatalities and fatal crashes over recent years, and some regions have begun to experience zero fatalities. Similarly, based on data for the EU and North America, safety performance on railways has also improved over the last 20 years.

The absence of a unified safety objective highlights the need for a stronger strategic approach to the safety of all modes of transport. To this end, we propose a unified target that builds on SDG 3.6 and focuses on reducing the number of deaths and accidents from transport crashes. The proposed target is to halve the number of global deaths and injuries from road traffic accidents by 2020 (SDG target 3.6) and to reduce by 5 percent the fatalities and injuries in each of the other modes of transport—waterborne, air, and rail transport. However, it will be a challenge to measure safety with accurate, timely, and quality data on fatalities and injuries related to each other mode of transport, and with sufficient information to identify the principal causes of crashes or incidents.

4.1 METHODOLOGICAL CHALLENGES IN MEASURING SAFETY

Historically, reliability, timeliness, costs, and volume of people and goods transported have taken priority over safety when planning transport. Also, transport costs and the benefits of transport projects are often calculated excluding the costs of fatalities, injuries, and crashes, because measuring safety has proven quite challenging. We are still far from having comprehensive, universally agreed upon data to measure and monitor transport incidents, their risk factors and their consequences as they happen around the world on an everyday basis. For example, suicides are included in railways statistics but they are excluded from road-related statistics.

While the various aspects of road safety are well measured, there are challenges in measuring safety. For example, the definition of road crash death varies in practice across countries, from death at the crash scene to deaths within 30 days of a crash from injuries received. Added to this is the difficulty of collecting and collating the comprehensive crash data required for measuring and monitoring road crashes in low- and middle- income countries, which suffer most of the total transport death and injury burden. Finally, it is difficult to collect reliable intermediate outcome data critical to safety in low-and middle-income countries, such as exposure (the number of kilometers traveled in each transport mode), vehicle or boat or ship safety features and maintenance, levels of risky behavior, such as drunk-driving or impaired captaincy, and collection of data on road crashes in urban areas of low-and middle-income countries. However, intermediate data on some factors is improving, with more observational data on seat belt use, helmet use, and speeds, in addition to road infrastructure star ratings and risk mapping.

4.1.1 Definition of safety

First and foremost, safety relates to the prevention of deaths. But it also includes the prevention of serious injuries and property damage. The scope of the Safety objective encompasses all modes of transport—air, waterborne, rail, and road transport safety for all users, including passenger and freight transport. However, in practice the focus of the objective is on roads, because deaths and serious injuries from road crashes far outnumber the deaths and injuries from other modes. Further, there are large variations in risk among road users, with pedestrians, cyclists and motorized two-wheeler riders bearing the largest risk of all.

To improve the safety of mobility, we need to design, construct, and operate the transport systems in such a way that fatalities and injuries to users and non-users can be minimized. However, there is still insufficient appreciation by road planners and builders, vehicle manufacturers, and by both urban and rural transport planners, of the importance of incorporating the safety of all users as a critical strategic objective. Society needs the commitment of all stakeholders to have safer roads and responsible behavior by all road users. All modes of transport have some data on fatalities and less data on injuries. However, there are fundamental differences in the management and operation between transport modes and the way to measure safety. The waterborne, rail, and air transport sectors are managed differently from road transport. For example, the road systems are open, with many government actors that manage them, while the other modes are generally closed, and thus have few professional actors with strong traditions of regulations, laws, and inspections.[1]

4.1.2 Safety in various global agendas

Road transport

Despite the preventable nature of road traffic injuries, road safety was neglected by global health and development agendas until 2004. The WHO then set up the UN Road Safety Collaboration (UNRSC) to facilitate international cooperation and strengthen global and regional coordination among UN agencies and other international partners to carry out actions aimed at

[1] European Transport Safety Council, ETSC 2001.

decreasing road fatalities.[2] The Global Road Safety Partnership at the International Red Cross was one of the few initiatives before 2004.

With the support of member countries, the UN Decade of Action for Road Safety 2011-2020 was launched with a UN General Assembly resolution in 2010. Its objective is to reduce and stabilize the increasing trend in road fatalities from the current forecast of 1.9 million per year to fewer than one million per year—a 50 percent reduction.

The importance of safer roads is recognized specifically in the following two SDGs:

- 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents.
- 11.2: 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.

Other recent key global initiatives include the appointment of a UN Special Envoy for Road Safety, the creation of the High Level Panel for Road Safety (HLP) supported by the FIA, the creation of the Global Road Safety Facility at the World Bank, the Global New Car Assessment Programme, and the international Road Assessment Programme. On 15 April 2016, the GA adopted resolution A/RES/70/260 on "improving global road safety".

The Habitat III New Urban Agenda establishes the need to improve road safety and integrate it into sustainable mobility and transport infrastructure planning and design. It also establishes the need to adopt, implement, and enforce policies and measures that actively protect and promote pedestrian safety and cycling mobility, and the development and implementation of comprehensive legislation and policies on motorcycle safety—given the disproportionally high and increasing numbers of motorcycle deaths and injuries globally, particularly in developing countries. It also establishes the importance of children's safety, and requests safe school routes, because every day more than 500 children die worldwide on their way to school or home.[3]

Rail transport

There is no global railway initiative on safety. However, the International Union of Railways works to maintain and further improve safety levels.

Air transport

The agenda for air transport safety is captured in the Global Aviation Safety Plan (GASP) 2017–19.[4] The International Civil Aviation Organization (ICAO) has a strategic objective dedicated to enhancing global civil aviation safety and focused primarily on the state's regulatory oversight capabilities. The objective is set in the context of growing passenger and cargo movements and the need to address efficiency and environmental changes. In line with the strategic objective on safety, GASP outlines the key activities for the three years. The GASP objectives call for states to put in place robust and sustainable safety oversight systems and to progressively adapt them into more sophisticated means of managing safety.

Waterborne transport

Although there is not a waterborne transport initiative on safety at the global level, there are some key conventions proposed by the International Maritime Organization as standard:

[2] The group holds biannual meetings, and developed the UN Global Plan for the Decade of Action on Road Safety.

[3] Habitat 3 final statement.

[4] See ICAO DOC 10004 for details. ICAO has established five comprehensive strategic objectives, which are revised on a triennial basis.

- International Convention for the Safety of Life at Sea (SOLAS) 1974, as amended
- International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto, and by the Protocol of 1997 (MARPOL)
- International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) as amended, including the 1995 and 2010 Manila Amendments.

4.1.3 Measuring safety

One of the main challenges in transport safety is to make the populations and governments aware of the risks of transport and that injuries are avoidable. To achieve this measurement is key. Three terms can be used to measure risk in transport—crashes, exposure, and risk.[5]

The most widely used measure of exposure in transport is the number of kilometers traveled for each travel mode. In some cases, useful additional insight is provided by taking into account the speed of travel, in which case exposure is expressed as the amount of time spent in the traffic system. Many developments in recent years, including the installation of electronic and telecommunication equipment inside vehicles and infrastructure and the widespread use of mobile phones, have made it easier to collect up-to-date and reliable information on a variety of parameters that could be of importance in the calculation of vehicle exposure and risk.

The term risk is used in many contexts, including comparing risks between different parts of the transport system, different transport modes, or even different activities outside the field of transport. While theoretically, it is optimal to have various activities exposed to equal risks (to establish a fair distribution of risks), an equal distribution of risk is not practical. It is more useful to search for ways to make each segment of the transport system as safe as possible, keeping cost-effectiveness considerations into account. Measuring risk between modes of transport helps keep track of the relative safety of the various modes. Risk is typically measured as deaths or injuries per mode of transport at a country or city levels. This can be by trip, or by passenger kilometers, or by time spent during travel, as well as injuries per mode of transport. However, this information is very difficult to obtain in many countries.

Road transport safety

Obtaining accurate data on fatal and non-fatal injuries at national, local, and city levels is a major challenge to road safety measurement. While a number of relevant data sources exist, including health system data, police data, and insurance data, most low-and moderate-income countries do not have sound death and injury data. Gaps in data on deaths include crashes not being reported to police, patients dying later in hospital with no follow-up of status, patients not brought to hospital, hospitals not reporting data centrally for collation, and errors in recording the cause of death. Despite these data limitations, estimates of deaths and injuries exist. Globally, the World Health Organization (WHO) estimates that 1.3 million people died on roads in 2015. The WHO has been producing the *Global Status Report on Road Safety* (2013 and 2015), which contains country level data covering the three areas identified below, and is currently defining the indicators for better tracking of the goals of the UN Decade of Action Global Plan for Road Safety 2011–20.[6]

The Decade of Action identifies the following key areas of action and hence measurement:

- Magnitude of road traffic fatalities, including data issues, emergency care, and multi-sectoral action
- Legislation and road user behavior
- Safer vehicles and roads.

[5] Based on A.S. Hakkert and L. Braimaister 2002.

[6] Global road safety is managed by many organizations including UN Road Safety Collaboration, the Multilateral Development Bank Road Safety Working Group, and the Global Alliance of Road Safety Non-Governmental Organizations.

Now, data estimates by the WHO and the Global Burden of Disease are used for global tracking of road safety, especially fatalities.

While progress has been made in allowing international comparisons of fatality data using comparable estimation methods for deaths, it is more difficult to make cross-country comparisons of non-fatal injuries. Data on non-fatal injuries are inaccurate, or are under-reported in many countries, because of the lack of a standardized definition for these types of injuries. Furthermore, an accurate assessment of injury severity requires specialized training or the use of algorithms to bring hospital discharge data into the severity measures. However, severity indicators are not standardized across countries—a situation further complicated by issues related to access to healthcare (WHO 2015 *Global Status Report*). The first effort to standardize severity indicators has been developed in the European Union with the recent adoption of the definition of seriously injured as someone sustaining injuries of level MAIS3+, *i.e.*, seriously injured[7].

Rail transport safety

Data on railway safety come from the International Union of Railways (UIC). It is available for the European Union, but does not have global coverage. UIC produces two reports annually, the UIC Safety Report and International Railway Statistics, which contain data on the safety performance of some UIC member railways. Examples of the indicators measured include crashes and casualties, crash and crash rate trends, causes of crashes, crashes by type, fatalities and injuries, passenger safety, railway staff safety, and the UIC global safety index. More aggregated levels of safety data are also available; examples of these aggregates include the number of crashes caused by collisions, derailments, rolling stock, level crossings, and so on.

While these data are generally reliable, they are mostly collected by the railways and the national government regulators. The collection requirements vary on a regional basis, but for the most part are similar within neighboring countries.

In addition, the member states of the EU collect what are known as Common Safety Indicators (CSIs). The European Railway Agency is the European agency publishing these indicators. CSIs contain information about crashes based on a set of common definitions and statistical methods.

Air transport safety

The International Civil Aviation Organization (ICAO)[8], a specialized agency of the United Nations, was created in 1944 to promote the safe and orderly development of international civil aviation throughout the world. ICAO produces annual safety reports and sets the standards and recommended practices (SARPs) necessary for aviation safety, security, efficiency, and environmental protection on a global basis. Within the context of aviation, safety is "the state in which the possibility of harm to persons or of property damage, is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management."[9]

Waterborne transport safety

Data on waterborne safety come from the International Maritime Organization (IMO), a specialized agency for maritime transport created by the United Nations. IMO functions as a global standard-setting authority for the safety, security, and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted, and universally implemented (IMO 2017).

[7] European Commission. Serious Injuries 2015. European Road Safety Observatory www.erso.eu accessed July 25, 2017

[8] ICAO is the primary forum for cooperation in all fields of civil aviation among its 191 member states.

[9] Extract of ICAO DOC9859 *Safety Management Manual*.

The IMO uses the Global Integrated Shipping Information System (GISIS) which contains information related to marine casualties and incidents, and the full marine safety investigation reports submitted to the IMO by reporting administrations.

For collecting information on ship casualties, the organization identifies ship casualties at four levels: very serious casualties, serious casualties, less serious casualties, and marine incidents.

A marine casualty[10] can be understood as any event directly connected with the operation of a ship that has resulted in the death of, loss of, or serious injury to a person; the loss, presumed loss, or abandonment of a ship; material damage to a ship or to marine infrastructure external to a ship; the stranding or disabling of a ship or the involvement of a ship in a collision; or severe or potential for severe damage to the environment, brought about by the damage of the ship.
A marine incident can be understood as any event, or sequence of events, other than a marine casualty, which has occurred directly in connection with the operation of a ship that endangered, or if not corrected, would endanger the safety of the ship, its occupants, any other person, or the environment.

4.1.4 Indicators to measure safety

The overall target

The Safety objective aims to halve the number deaths and injuries from road traffic accidents by 2020 (SDG target 3.6) and reduce by 5 percent the fatalities and injuries in each other mode of transport (waterborne, air, and rail transport) by 2020.

To track progress towards this proposed target, the following proposed principal indicator will be used: "number of global deaths and injuries from road traffic accidents by 2020 (absolute number) and number of fatalities and injuries in each other mode of transport (waterborne, air, and rail)."

This proposed principal indicator will be supported by several proposed supporting indicators. To identify a long list of possible supporting indicators, below is a stocktaking of existing indicators for measuring safety by mode of transport.

Road transport

The WHO keeps track of several indicators that are included in the Global Status Report on Road Safety series. The number of fatalities per country is the major outcome indicator, followed by several other indicators that are distributed according to the Global Plan in five pillars, currently in a review process that will end by 2018:

- Safety management
- Safe roads
- Safe vehicles
- Safe road users
- Post-crash care.

Rail transport

The EU requires member countries to measure rail safety based on a set of Common Safety Indicators. These indicators have common definitions and statistical collection methods and could be extended to cover non-EU countries.

Two of the main safety issues in railways around the world relate to pedestrians entering the railways' right of way, and to automobiles being hit by trains at level crossings. The Common Safety Indicators allow for measuring the scale of both these challenges by measuring safety both in terms of crashes happening within the railways and crashes at a level crossing or with pedestrians.

[10] According to the European Marine Casualty Information Platform (EMCIP).

The Common Safety Indicators cover the following:

- Significant crashes
- Deaths and serious injuries
- Suicides
- Precursors of crashes
- Economic impact of crashes
- Technical aspects (level crossings by type and automatic train protection systems)
- Management of safety.

Air transport

Air transport is entering slowly but surely into an era where it will be faced with rare events similar to those of the nuclear industry. The air transport community is therefore focusing on implementing and measuring the strength of preventive risk controls for enhancing safety oversight and managing operational safety risk. Starting in 2013, ICAO and IATA have increasingly harmonized the crash analysis processes and have developed a common list of crash categories to facilitate the sharing and integration of safety data between the two organizations. The following categories resulted from the harmonization:

- Controlled Flight into Terrain (CFIT)
- Loss of Control in-Flight (LOC-I)
- Runway Safety (RS)
- Ground Safety (GS)
- Operational Damage (OD)
- Injuries to or Incapacitation of Persons (MED)
- Other (OTH)
- Unknown (UNK).

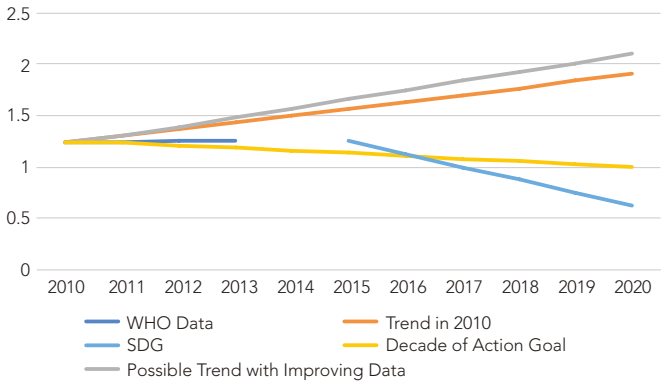
4.2 TRENDS IN SAFETY

Road transport

The number of road traffic deaths—1.3 million in 2015—has remained constant since 2007, despite the growth in global population and motorization from 2007 to 2013. In 2015, WHO reported there was a 4 percent increase in global population and 16 percent increase in motorization from 2010 to 2013. Geographically, in order of frequency of deaths—the highest to lowest number of fatalities per 100,000 people—the regions were classified as follows: (i) Africa (26.6); (ii) Eastern Mediterranean (19.9); (iii) Western Pacific (17.3); (iv) South East Asia (17.0); (v) Americas (15.9); and (vi) Europe (9.3). Since 2007, the total number of road deaths has remained stable, even though the vehicle fleet has grown 15 percent. WHO estimates that from 2007 to 2013, traffic deaths decreased in 88 countries, and grew in 107 countries.

Figure 4.1 shows the evolution of the fatalities on roads (in millions) since 2010, the trends in 2010 according to WHO, the Decade of Action goal, and the Sustainable Development Goal.

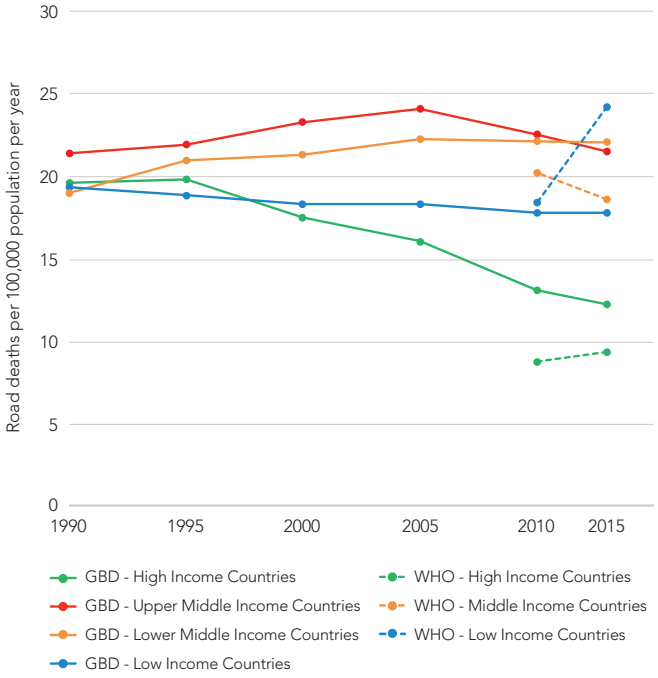
FIGURE 4.1: Fatalities on Roads, Decade of Action Goals, and SDG Objectives (millions of fatalities)



Source: Based on International Transport Forum's calculation

Figure 4.2 shows the trend in deaths per 100,000 people in low-, middle-, and high-income countries, contrasting the improvement in high-income countries with the lack of improvement or worsening in middle and low-income countries. It also shows the variation in estimates from WHO and the Global Burden of Disease Study. The figure shows stark differences across country income, and differences in estimation methods.

FIGURE 4.2: Trends in Road Crash Deaths per 100,000 People, for Low-, Middle-, and High-Income countries



Source: Based on International Transport Forum's calculation

In low-income regions, fatality rates on roads per 100,000 inhabitants are almost three times those of high-income regions (Figure 4.2). Half of the traffic deaths occur among motorcyclists (23 percent), pedestrians (22 percent), and cyclists (5 percent); 32 percent occur among car occupants; and the remaining 19 percent occur among unspecified road users. Key reasons for this difference include the lack of effective regulation and enforcement of unsafe behavior such as speed, the safety levels of road infrastructure, and the safety of vehicle fleets.

Many countries have adopted a safe system approach, embracing the vision of zero deaths and serious injuries—accepting that human error is inevitable, but should not result in death or serious injury. These countries have been more successful in managing road safety than other countries.[11] The safe system approach demands improvement of roads, speed limits, vehicles, post-crash care, and human behavior, to protect people in the event of crashes.

Motorcycles are not effectively managed in safe system advocacy, especially safe system promoted speed limits which ignore the failure of the proposed limits to protect motorcycles. The limits proposed by safe system are for occupants in cars with seat belts on only. From a young age, males are more likely to be involved in road traffic crashes than females. About three-quarters—73 percent—of all road traffic deaths occur among men. Among young drivers, young males under the age of 25 years are almost 3 times as likely to be killed in a car crash as young females.[12]

In many low- and middle-income countries, females represent a quarter to half of all fatalities. As motorization increases, it is possible that the proportion of females represented in the statistics may increase. Despite the imperative for improved road safety, as of the end of 2015, 32 percent of countries had not acceded to any of the 10 conventions on road safety under the purview of the UNECE's Inland Technical Committee on Land Transport.[13, 14] Most of these countries are in Central America and Africa, with some in Latin America and Asia. WHO assessed that basic

[11] Mooren, L, Grzebieta, R., Job, R.F.S. Williamson, A. 2011. "Safe System–International Comparisons of this Approach," in *A Safe System–Making it Happen: Proceedings of the Australasian College of Road Safety Conference September 2011.* Melbourne; and International Transport Forum. 2016. Zero Road Deaths and Serious Injuries Leading a Paradigm Shift to a Safe System.

[12] http://www.who.int/mediacentre/factsheets/fs358/en/ (accessed June 22, 2017)

[13] UNECE conventions on road safety: a) 1968 Convention on Road Traffic, b) 1949 Convention on Road Traffic, c) 1949 Protocol on Road Signs and Signals, d) 1968 Convention on Road Signs and Signals, e) 1958 Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be fitted and /or be used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, f) 1997 Agreement concerning the Adoption of Uniform Conditions for Periodical Technical Inspections of Wheeled Vehicles and the Reciprocal Recognition of Such Inspections, g) 1998 Agreement concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts which can be fitted and/or be used on Wheeled Vehicles, h) 1957 European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), i) 1970 European Agreement concerning the Work of Crews of Vehicles Engaged in International Road Transport (AETR), j) 1975 European Agreement on Main International Traffic Arteries (AGR).

[14] UNECE "SDGs and the UN Transport Conventions--Under the purview of the UNECE Inland Transport Committee"

safety regulations in only 28 percent of countries—representing 7 percent of the world's population—have comprehensive road safety laws on five key risk fators: drinking and driving, speeding, and failing to use motorcycle helmets, seat-belts, and child restraints. Significant progress can be made by implementing and enforcing basic legislation that addresses these important risk factors.

Road traffic injuries are the leading cause of death for young people ages 15 to 29. Male and young drivers are more likely to speed. Other factors that may influence speed include alcohol. Younger and novice drivers are also at a much higher risk of road traffic crashes compared to older and more experienced drivers when under the influence of alcohol.

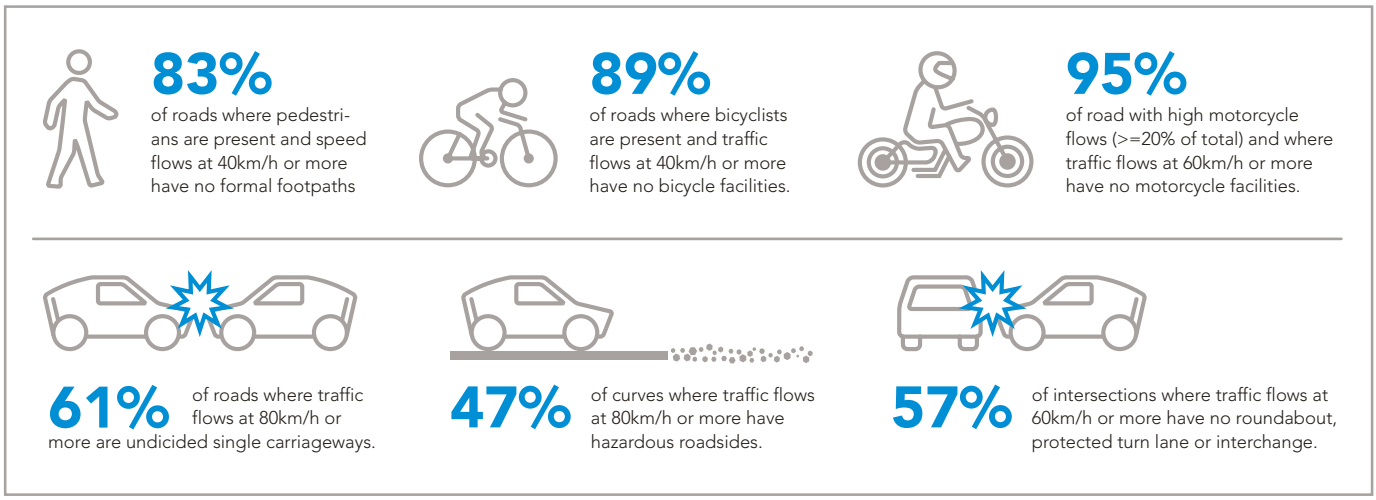
In terms of distracted driving, younger drivers are also more likely to text and drive, which can increase their chances of being in a traffic crash.

Road infrastructure is mainly constructed with the needs of motorists in mind, although a 2016 report by UNECE indicates that 49 percent of all road traffic deaths occur among pedestrians, cyclists, and motorcyclists. However, the likelihood of dying on the road as a motorcyclist, cyclist, or pedestrian varies by region. Africa has the highest proportion of pedestrian and cyclist deaths, at 43 percent of all road traffic deaths. These rates are relatively low in Southeast Asia.

This partly reflects the level of safety measures in place to protect different road users—especially the most vulnerable ones—and the predominant forms of mobility in the different regions, considering the increasing number of motorcycles around the world. The active modes, such as biking and walking, are very vulnerable forms of mobility, yet they are the most sustainable and equitable; thus, they need special attention (Figure 4.3).

Improving the safety of pedestrians and bikers will not only directly benefit these users, it is also likely to have a spillover effect over other motorized users, mostly motorcycle ones. Along with the direct impact on crash-related injuries, there are additional health benefits to promoting the active transport use (walking and cycling) of the road network, such as environmentally-related health effects (less air pollution, less noise) and the physical exercise-related health benefits. Improvements on the road network are essential for this transport modal shift.[15]

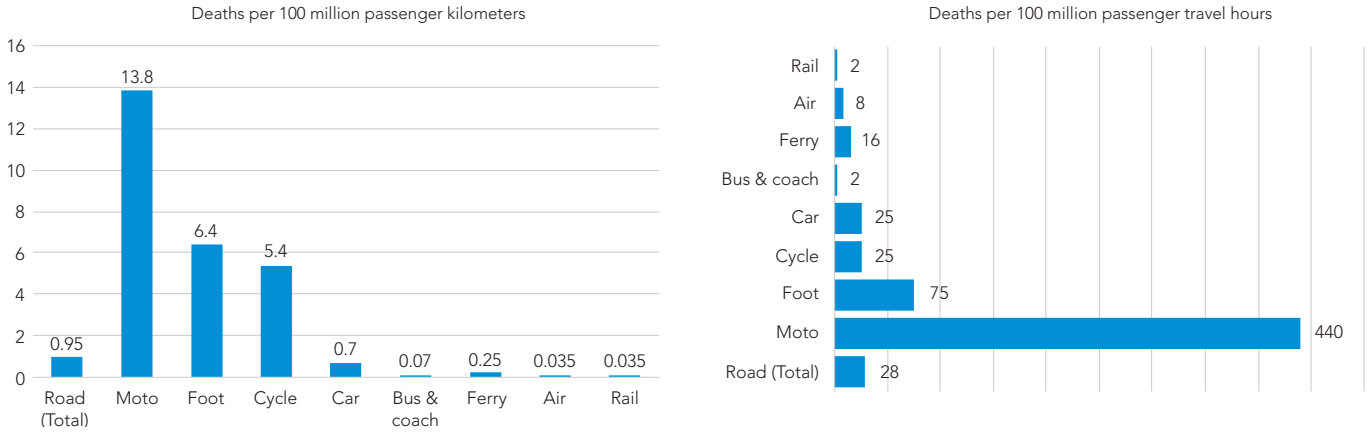
FIGURE 4.3: Statistics on Protection offered by the road network by User Type



Source: International Road Assessment Programme 2015. "Vaccines for Roads". 3rd edition.

[15] ITF Research Reports (2013) Cycling, Health and Safety. ISBN: 9789282105955 (PDF);

Figure 4.4: Distribution of Deaths by User Type due to Road Crashes



Source: European Transport Safety Council 2003. "Transport Safety Performance in the EU: A Statistical Overview."

A study by the European Transport Safety Council (ETSC) in 2003 shows that overall road traffic has the highest fatality risk in all modes of transport: it accounts for more than 97 percent of the deaths and 93 percent of the costs. However, it is important to note that within road transport not all modes are equal. It is important to distinguish between fatality risks for motorcycles, foot, cycle, car, and bus, because the risks differ significantly among the types of road users (Figure 4.4). The death rate by passenger-kilometers is the highest for motorcyclists (13.8 deaths per million passenger-kilometers), followed by the two active modes of mobility (the death rate for those on foot is 6.4 per million passenger-kilometers, and for those on cycles is 5.4 per million passenger-kilometers). To put things in perspective, the fatality risk for motorcyclists is 20 times higher than for car occupants, followed by cycling and walking, with 7 and 9 times higher risk than car travel. In comparison, rail and air are the safest modes, and bus occupants are 10 times safer than car occupants.

A similar picture emerges when we consider passenger-hours travelled instead of passenger-kilometers. The star rating of a road provides an objective, evidence- based measure of the safety performance of road infrastructure. According to the International Road Assessment Programme (iRAP), a 5-star rating is the safest, and a 1-star rating is the least safe. The iRAP star ratings are available for pedestrians, cyclists, motorcyclists, and vehicle occupants, and more than 800,000 km of roads have been assessed by governments, civil society, and development partners worldwide. More than half of all roads assessed are only 1 or 2-star standard for each road user, according to iRAP's 2015 report, with crash risk per kilometer travelled typically halved for each incremental improvement in star rating.[16]

The star rating is made up of the impact key road features have on the primary crash types that kill and injure, including head-on, run-off-road, and intersection crashes, as well as pedestrians and cyclists moving along or crossing a road. Simple deficiencies, including the lack of footpaths, lack of cycle lanes, no motorcycle facilities, undivided roads, dangerous roadsides, and unsafe high-speed intersections help explain the high-risk environment facing road users across the world (OECD, 2016).

Globally, 40 to 50 percent of traffic fatalities occur in urban areas. The World Resources Institute provided the reported fatality rate per 100,000 inhabitants for about 60 cities in different regions of the world.[17] The highest fatality rates occur in cities in the developing world. The proportion of fatalities in urban areas is high

[16] iRAP (2015) Vaccines for Roads III, London, UK

[17] World Resources Institute 2015. "Cities Safer by Design: Guidance and Examples to Promote Traffic Safety Through Urban and Street Design." Version 1.0, Figure 1.1. Washington, DC: World Resources Institute.

and rising in low- and middle- income countries. And it is expected that by 2050, 70 percent of the world's population will be living in cities.

Therefore it is important to prepare cities with an urban form and design that enables and promotes sustainable and safe forms of transport, such as rail and mass transport; makes safer the sustainable but unsafe modes of walking and cycling; and finds ways to make cars and motorized two-wheelers safer. Improving safety on urban roads will provide adequate access to jobs, services, and goods for all.

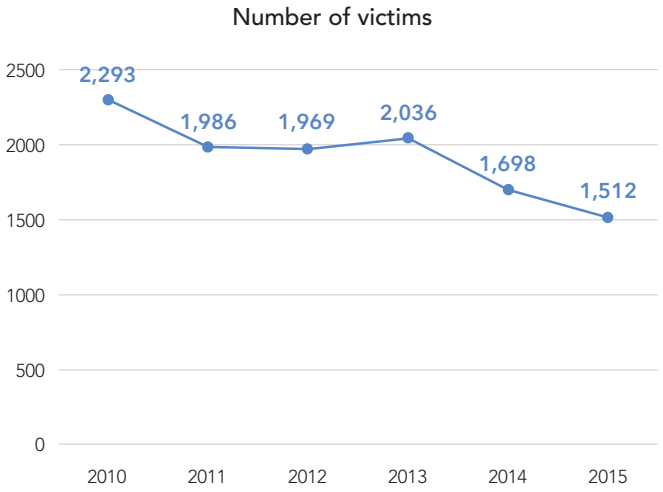
Environments that are friendly to active transport modes contribute to reducing road injuries and to increasing public transport use, particularly for more vulnerable users, including women, children, persons with disabilities and older persons.

Much more progress needs to be made on the five pillars of road safety identified by the WHO. WHO's Global Status reports measure progress on implementation of the five pillars for advancing road safety: (i) road safety management; (ii) safer roads and mobility; (iii) safer vehicles; (iv) safer road users; and (v) improved post-crash response and hospital care. For example, WHO, in relation to road safety management, reported in 2015 that from 2010–2013 "…17 countries have amended their laws on one or more key risk factors for road traffic injuries to bring them into line with best practice." In relation to safer vehicles, WHO reported that "…just over half of all countries have enacted good seat-belt laws."[18]

Rail transport

Data on railway safety performance is readily available for systems in the EU and North America. However, these data are difficult to obtain for other regions of the world. Based on readily available data, safety performance on railways has improved over the last 20 years. Figure 4.5 shows safety statistics for the main European railways; and as can be seen, the number of crashes and fatalities has gone down since 2010. Railways within the EU have evolved toward a more integrated continental railway system, where the EU requires national governments to comply with EU interoperability and safety requirements. This has allowed EU railways to establish safety management systems to improve their safety performance and their ability to operate outside their national boundaries.

FIGURE 4.5: International Union of Railways Safety Statistics for 21 EU Member Countries

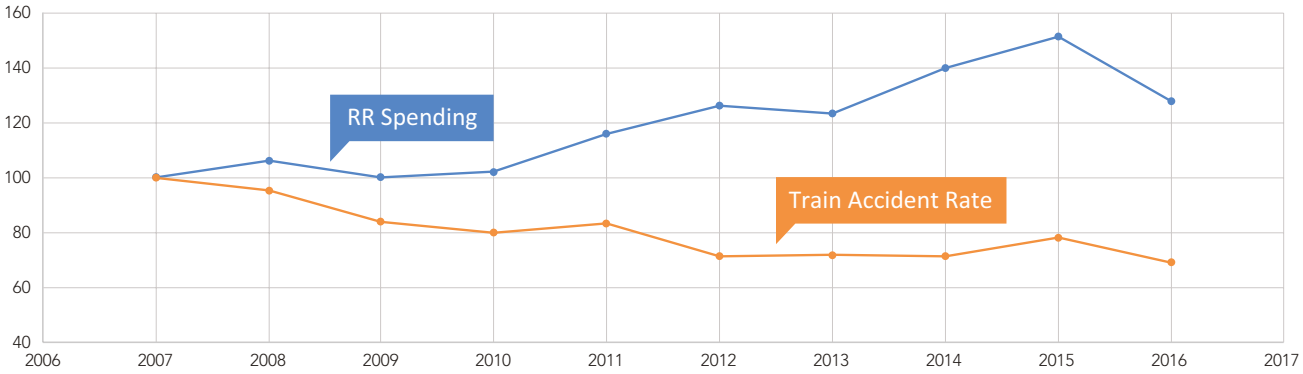


Source: International Union of Railways 2015. "Significant Accidents 2014 Public Report"

In North America (U.S., Canada, and Mexico), the performance has been similar. Figure 4.6 shows U.S. train crashes since 2007. Such performance is likely the result of both a proactive regulatory body and the ability of the North American railways to invest in safety related measures, infrastructure, and equipment. What is important to note is the impressive reduction in train crashes of around 44 percent. Safety improvements have been more modest on road and rail level crossing crashes and trespasser safety.

[18] WHO 2015. Op. cit.

Figure 4.6: U.S. Train Crashes, 2007–2016



With an average of $26 billion spent annually in recent years on upgrades to and maintenance of the privately-owned freight rail network, the train accident rate on America's freight railroads has been at an all-time low. In fact, from 1980 through 2016, railroads have spent approximately $635 billion on infrastructure and equipment, as a result train accidents have decreased 44 percent since 2000.

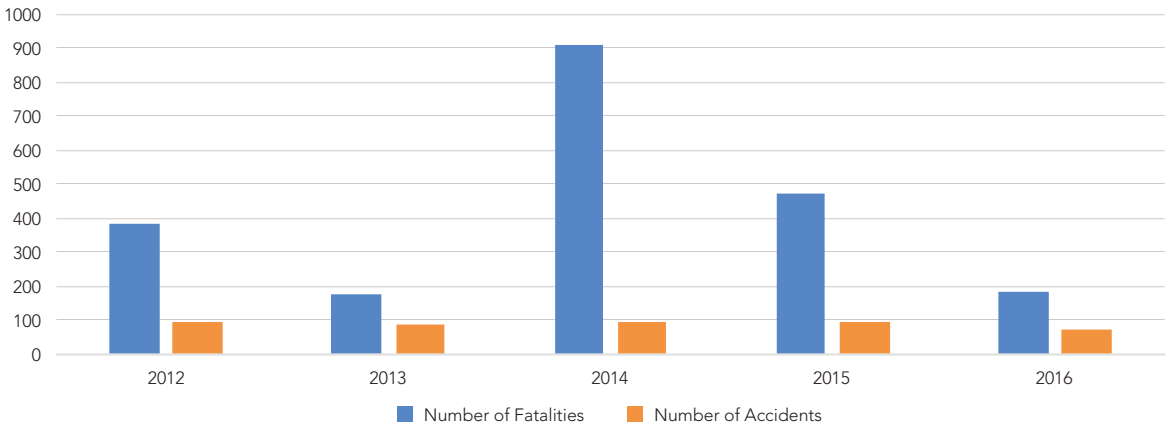
Source: Association of American Railroads 2017. "Railroads: Moving America Safely Report".

Air transport

Air transport has seen a continuous reduction of the number of fatalities and fatal crashes over recent years. Some regions have begun to experience zero fatalities in commercial scheduled aviation over a one-year period. An aspirational goal for air transport is to achieve zero fatalities worldwide within the next decade. Crashes happen mainly in three categories: runway safety related crashes, like excursions or overruns; controlled flight into terrain, such as hitting a mountain through loss of spatial awareness; or loss of control in flight, where the flight crew loses control over a functioning aircraft. Operational safety now focuses on those categories by collecting data from normal operations to build early warning systems.

The reduction in the crash rate to 2.8 crashes per million departures—a 7 percent decrease compared to 2014—represents the lowest rate in recent history (Figure 4.7). Extremely notable was that the Africa–Indian Ocean Regional Aviation Safety Group (RASG-AFI) region did not have any fatal crashes in 2015, and three of the five RASG regions each experienced only a single fatal crash in 2015.

FIGURE 4.7: Accident Records for 2012–2016 Scheduled Commercial Flights



Source: Civil Aviation Organization 2016. "Annual Safety Report".

Waterborne

Based on the Annual Overview of Maritime Casualties and Incidents 2016, in 2015 in Europe there were 3,296 maritime casualties and incidents involving 3,669 ships. During that year, 36 ships were lost.

4.3 SCALE OF THE CHALLENGE

The Safety objective faces several challenges. The first challenge is to shift population behavior to reduce unproductive travel, and to incorporate safety in transport planning, giving priority to the safest transport modes and incorporating safety in people's decision-making processes. The second challenge is for all countries to implement the roster of interventions with known effectiveness to reduce risks, to carry out very good cost-efficient and cost-saving measures, with a focus on making cycling and walking—the most sustainable modes—safe, and reducing the risks of motorized two-wheelers. The WHO- developed Save LIVES package captures the priority and proven interventions for large-scale action globally[19].

The third challenge is to ensure that the integration of transport-aid related technologies—ranging from autonomous passenger cars to automated traffic control systems—prioritizes safety in all decision-making algorithms and in determining how the transition between non-automated and automated fleets gets done.

A fourth challenge is to measure safety with good, timely, and quality data on fatalities and injuries in each mode of transport, and with sufficient information to identify the principal causes of crashes or incidents. This is more critical when related to injuries. The level of information is very poor in many countries, and it is not consistent enough for comparisons between countries. It is also important to have accurate information on risk, measured as passenger-kilometers, ton-kilometers and travel times.

The main challenges measuring road safety can be identified as: (i) how to measure the performance and implementation of national and local road safety plans; (ii) how to measure the safety of motorized two-wheelers; (iii) how to measure the safety of existing vehicle fleets; (iv) how to measure the safety in design and operation on roads in urban and rural areas; (v) an adequate way to measure post-crash assistance such as medical assistance and attention to victims; (vi) how to measure the effectiveness of systems that protect the most vulnerable and yet the most sustainable forms of transport, walking and cycling; and (vii) how to incorporate the real cost of road crashes in road transport planning, as well as including the benefits of preventing them.

The challenges faced by rail transport are twofold. The first challenge is to collect and analyze worldwide information on rail transport, including the number of incidents, victims, and localization of the crashes. Today this information is only available for Europe, collected by the UIC, and partially available for the United States. The second challenge is to improve safety measures for car and pedestrian crossings, anticipating urban expansion and conflicts that might happen between trains and trespassers, including cars and pedestrians.

One of the biggest challenges in air transport is how to maintain an extremely safe system, knowing the traffic is constantly increasing and new actors are entering the aviation system. These new actors include integration of regular commercial space transport operations into controlled airspace and remotely piloted aircraft systems, which change the way air operations are controlled. In addition, climate change may increase environmental hazards and therefore the risk of crashes in all categories.

The Global Integrated Shipping Information System, called GISIS, which contains information related to marine casualties and incidents, and the full marine safety investigation reports submitted to the International Maritime Organization by reporting administrations, is not corroborating the data.

[19] http://www.who.int/violence_injury_prevention/publications/road_traffic/save-lives-package/en/

CHAPTER 5
GREEN MOBILITY

The Green Mobility objective aims to address climate change through mitigation and adaptation, to reduce both air and noise pollution. The importance of Green Mobility is such that several international agreements relate to it directly and indirectly.

Green mobility is reflected indirectly in seven SDG targets (3.4, 3.9, 7.3, 9.4, 11.6, 13.1, and 13.2), and in the Paris Agreement under the UN Framework Convention on Climate Change (UNFCCC) and its related Nationally Determined Contributions (NDCs). SDG target 13.2 aims to integrate climate change measures into national policies, strategies and planning, and SDG target 13.1 aims to strengthen the resilience and adaptive capacity to climate-related hazards and natural disasters in all countries. SDG target 7.3 aims to double the global rate of improvement in energy efficiency, which will have a direct impact on GHG emissions and other pollutants. Similarly, SDG targets 3.9 and 11.6 relate to air pollution—addressing illnesses or deaths and its environmental impacts on cities, respectively. The transport sector plays a pivotal role in the achievement of both these targets. Finally, SDG 3.4 relates to non-communicable diseases, such as cancer, heart disease and stroke, all linked to air pollution, noise and lack of walking and cycling. The 2030 Agenda does not specify a quantitative target to be reached by 2030 for green mobility. However, the Paris Agreement calls for global carbon reductions in order to hold global warming to a specific target of well below 2 degrees Celsius. To help achieve this, its goal for the transport sector is to decarbonize and decrease the current level of emissions to a low-carbon scenario by mid-century.

In 2012, transport was the largest energy consuming sector in 40 percent of countries worldwide, and in the remaining countries it was the second-largest energy consuming sector. In one projection, energy related CO_2 emissions are expected to grow by 40 percent between 2013 and 2040. The sector already contributes 23 percent of global energy-related greenhouse gas emissions and 18 percent of all man-made emissions in the global economy. Air pollution—both ambient (outdoor) and household (indoor)—is the biggest environmental risk to health. Ambient air pollution alone kills about three million people each year. Physical inactivity is estimated to be responsible for more than 3 million deaths and $50 billion in economic losses. Evidence from a few countries suggests that traffic noise has the second biggest environmental impact on health after air pollution.

The Green Mobility objective proposes four different quantified targets to be achieved by 2030 and 2050, one for each of the four key dimensions— climate change mitigation, climate change adaptation, air pollution, physical inactivity and noise pollution. Much of the data required to assess progress against the Green targets are readily available at a national level. The set targets are consistent with international agreements (where they exist). For example, for climate change mitigation we adopt the target set by the Paris Agreement. To meet this target, we aim to limit carbon dioxide (equivalent) emissions to 3 to 6 gigatons by 2050. For air quality, no internationally agreed quantitative target exists. We propose to substantially reduce premature deaths and illnesses from air pollution from transport-related sources by 50 percent by 2030. Similar targets exist for the other two dimensions as well.

5.1 METHODOLOGICAL CHALLENGES IN MEASURING GREEN MOBILITY

While the various aspects of green mobility are well measured, there are three key challenges in measuring the Green Mobility objective: (i) the absence of a universally accepted definition and measurement methodology for "green;" (ii) the multi-faceted aspect of "green;" and (iii) the difficulty of differentiating between risk perception and actual risk in the case of adaptation to climate change.

5.1.1 Definition of green mobility

Green mobility is a broad concept that aims to reduce a diverse set of environmental impacts caused by the transport sector. A significant body of literature exists on the comprehensive impact of transport on the environment and human health. Much of this evidence comes from analysis at the micro level: a proliferation of rating systems, life cycle impact methodologies, and classification schemes exist to help the transport sector improve its environmental footprint on a system-by-system basis. In this chapter we set macro-level, aspirational "green" targets at the global scale, which can be monitored regularly and give an overall indication of the progress the sector is making.

This chapter focuses on two primary impacts: climate change and air and noise pollution. While other important environmental and human health impacts, such as biodiversity and water pollution, are important, they are not included in the targeted scope of the Green Mobility objective. The climate focus aims to substantially reduce greenhouse gas (GHG) emissions from the transport sector and to enhance the climate resilience of transport infrastructure and systems. This is in line with targets set by the Paris Agreement on climate action and adaptation. The objective also sets targets for the two highest-impact forms of pollution as identified by the WHO—air pollution and noise pollution.[1] These targets aim to minimize the impacts of transport-related air and noise pollution in line with the Sustainable Development Goals.

Although conceptually fully aligned with SuM4All, the Green Mobility objective differs in its time horizon for proposed climate change related targets and indicators. While targets and indicators proposed for the three other objectives are aligned with the 2030 SDGs, the climate change targets and indicators are set for 2050, in line with the Paris Agreement on Climate Change. With that in mind, this chapter also includes intermediate targets to be achieved by 2030.

5.1.2 Green mobility in various global agendas

The Green Mobility objective is reflected in seven SDG targets, the Paris Agreement under the UN Framework Convention on Climate Change (UNFCCC) and its related Nationally Determined Contributions (NDCs), and several other agendas, including the 2015 Sendai Framework for Disaster Risk Reduction and the 2016 New Urban Agenda.

The Green Mobility objective specifically contributes to achieving the objectives of the Paris Agreement under the UNFCCC, namely *holding the increase in global average temperature to well below 2 degrees Celsius above pre-industrial levels, and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius.* This requires peaking global GHG emissions as soon as possible, and achieving zero net emissions in the second half of this century.

The NDCs represent a unique opportunity to increase bold mitigation and adaptation measures in transport and other sectors. For the first time, all parties to the UNFCCC have communicated their commitments to reduce emissions and increase resilience.

[1] Study by the WHO identifies noise and air pollution as the two highest impact forms of pollution in the European Union and Norway http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf

The Green Mobility objective also contributes toward achieving the following SDG targets:

- SDG 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination.
- SDG 7.3: By 2030, double the global rate of improvement in energy efficiency.
- 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.
- 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.
- SDG 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
- SDG 13.2: Integrate climate change measures into national policies, strategies, and planning.

The Green Mobility objective also responds to transport-related aspects of other global agreements. The 2015 Sendai Framework for Disaster Risk Reduction calls for greater climate resilience in transport system infrastructure; the 2016 New Urban Agenda calls for climate-friendly, accessible transport systems and improved walkability and bikeability in cities, among other sustainable transport commitments; and relevant WHO guidelines exist for air quality, physical health, and noise levels. The New Urban Agenda, in particular, repeatedly calls for sustainable, low-carbon, accessible transport for all, both in cities and to promote rural-urban linkages.[2]

In the case of international air and waterborne transport, the Green Mobility objective under SuM4All will also take into account relevant international agreements reached through the International Civil Aviation Organization (ICAO) (2016 Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[3]) and follow ongoing developments through liaising with the International Maritime Organization. The CORSIA agreement is part of ICAO's comprehensive basket of CO2 mitigation measures for international aviation, which also includes aircraft technology, operational improvements and use of sustainable alternative fuels for aviation.

5.1.3 Indicators to measure green mobility

Much of the data required to assess country level progress against the Green objective are readily available at a national level—in particular, greenhouse gas emission data are available from the International Energy Agency (IEA), the Intergovernmental Panel on Climate Change (IPCC), the International Transport Forum (ITF), and other sources. A growing body of research tracks global and national level emissions, health and mortality statistics, noise pollution, and supportive economic indicators. Methodologies for estimating correlations between pollution, emissions, and human health are also increasingly well established, and will require little additional effort aside from tracking and recording progress specific to the transport sector.

However, the capacity to collect and aggregate transport data at the local level—particularly in developing countries—suffers from many limitations. This lack of capacity is especially relevant to noise pollution targets, for which there are not standard methods for local data collection and reporting. This challenge will need to be addressed in the coming years, as countries take action on the SDGs.

[2] See for example article 114: "We will promote access for all to safe, age- and gender-responsive, affordable, accessible and sustainable urban mobility and land and sea transport systems, enabling meaningful participation in social and economic activities in cities and human settlements, by integrating transport and mobility plans into overall urban and territorial plans and promoting a wide range of transport and mobility options […]"UN-Habitat (2016) "New Urban Agenda" http://nua.unhabitat.org/pillars.asp?PillarId=7&ln=1

[3] International Civil Aviation Organization. 2016. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). http://bit.ly/VHXXT4

Setting and measuring the climate adaptation target also presents important challenges. This target will require a new methodology that can track the progress made by countries toward strengthening resilience and adaptation to inevitable climate-induced events. It can build on existing data and policy analysis, surveys, and the use of a planned Transport Vulnerability Index. Indicators may include incidents related to climate change that affect transport systems, systems designed with resiliency features, or national level policies and assessment programs that encourage adaptation and resilience of transport infrastructure.

An initial framework for measuring progress against the Green Mobility objective is outlined below. This framework lays out four ambitious targets for climate change mitigation, climate change adaptation, air pollution, and noise pollution. The targets define a specific, quantifiable desired achievement against which the global transport community should measure progress using the proposed primary indicator. Each target also includes several proposed supporting indicators that can contextualize progress and present trends in actions countries are taking to achieve the more general targets.

Climate change mitigation

For climate change mitigation, the Green Mobility objective aims to reduce global transport sector GHG emissions as consistent with limiting the global average temperature increase to well below 2 degrees Celsius above pre-industrial levels by 2050. The desired achievement is 3-6 GT CO_2 equivalent by 2050 (absolute in aggregate; specific targets to be determined for each sub-sector and income level above).

The proposed principal indicator for tracking mitigation is global GHG emissions from the transport sector, disaggregated by purpose, income, and mode. Currently, data supporting this indicator is collected and published by the IEA and has been analyzed and published by the IPCC. Direct GHG emissions in their calculations take into account modal share, fuel choice, fuel carbon intensity, the energy intensity of vehicles, and total activity (number of journeys and journey distance).[4]

The proposed supporting indicators further contextualize emissions trends by disaggregating aggregate emission targets by both passenger and freight transport modes, normalizing emissions against economic value produced, and measuring uptake of alternative fuels and low emission vehicles, which are to be drawn from data with a range of sources including IEA, UITP, UNFCCC, and the World Bank.

Climate change adaptation

For climate change adaptation, the Green Mobility objective aims to strengthen resilience and adaptive capacity of transport systems to climate-related hazards and natural disasters in all countries. The desired achievement is X countries taking action to reduce vulnerability by 2030 and Y countries taking action by 2050, with the value of these variables to be determined.

The proposed principal indicator for tracking adaptation is the number of countries that have taken action to build resilience against climate-related hazards and national disasters within the transport sector. The methodology for tracking this target will be based on a Transport Vulnerability Index, which is yet to be developed. This index will take into account policies that provide for adaptation and resilience measures within transport, funds invested in resilience-building actions, specific actions taken by countries to build resilience of their transport sectors, and more. Much of this data will be qualitative. While this methodology is being developed, asset management systems used by cities can serve as a temporary proxy to understand

4 Sims R., R. Schaeffer, F. Creutzig, X. Cruz-Núñez, M. D'Agosto, D. Dimitriu, M.J. Figueroa Meza, L. Fulton, S. Kobayashi, O. Lah, A. McKinnon, P. Newman, M. Ouyang, J.J. Schauer, D. Sperling, and G. Tiwari, 2014: Transport. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter8.pdf

and evaluate adaptation measures in select localities. However, these systems can only serve as an effective proxy if they include intentional investments in adaptation measures and specific metrics for monitoring system resilience.

Within the Vulnerability Index a few select supporting indicators will also be developed. These indicators will identify steps being taken by countries to build resilience in the transport sector to climate-related disasters, and incidents affecting the sector that were caused by climate change, to be drawn from MDB investment data, UNFCCC planning data, and other sources. The Vulnerability Index will be developed in the near term, and will be mainstreamed by 2030. The data in the index will be populated through infrastructure surveys, policy analysis, and existing disaster data.

Air pollution and physical activity

For air pollution and physical activity, the Green Mobility objective aims to substantially reduce premature deaths and illnesses from air pollution and physical inactivity from transport-related sources and choices. The desired achievement is: (i) 50 percent reduction by 2030 compared to 2010 baseline (relative) or (ii) fewer than 60,000 deaths globally by 2030 (absolute); and (iii) percentage of adults walking or cycling for transport increased by 20 percent by 2030.[5]

The proposed principal indicator for tracking air quality is the number of premature deaths per year from air pollution caused by transport, with country-level data available from the Institute of Health Metrics and Evaluation.[6] Analysis will be conducted using the WHO Disability Adjusted Life Year (DALY) metrics and mortality data or an equivalent, and IEA data on transport sector emissions or an equivalent, to determine the causal relationship between transport sector specific emissions and deaths and DALYs caused by ambient air pollution. The proposed supporting indicators for this target will contextualize air quality by WHO standards and disaggregate air quality data by type and source based on data from UNEP, WHO, the World Bank, and other sources. With respect to physical activity, indicators that contextualize the average daily time walking and cycling for a transport motive, the percentage of adolescents walking and cycling for transport to school, and the average time they spend on such activities, are also proposed.

Noise pollution

For noise pollution, the Green Mobility objective aims to substantially reduce global mortality and burden of disease from transport-related noise levels. The desired achievement by 2030 is to reduce by 50 percent the number of urban dwellers exposed to excessive noise levels.

The proposed principal indicator for tracking noise is the percentage of urban dwellers exposed to L_{den}/L_{night}[7] annual average noise levels from transport above 55 dB/40 dB (percent of total inhabitants). Studies will be conducted to extend WHO's environmental burden of disease (EBD) methodology to a broader set of countries and regions, based on available and potentially expanded data, to determine causal linkages between noise levels and health indicators. The proposed supporting indicators for this target will measure average noise levels for different types of vehicles (based on EEA, WHO, and available national data), as well as average and peak noise levels in different contexts, which are the focus of the proposed principal indicator.[8]

[5] A relative approach (A) to the target would facilitate amendments in the 2010 baseline after addressing the underestimation on the number of premature deaths attributable to transport-related sources. The baseline estimates for 2010 may be underestimated, as acknowledged by the authors of the calculations. In 2012, there were 3 million deaths worldwide from ambient air pollution (all sources). SDG 3.9.1 (ambient and household air pollution) was 6.5 million in 2012 (WHO estimates).

[6] Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation. Transport for Health: The Global Burden of Disease from Motorized Road Transport. Seattle, WA: IHME; Washington, DC: The World Bank, 2014.

[7] L_{den} corresponds to average day-evening-night noise levels, and L_{night} corresponds to nighttime noise levels.

[8] Note that noise from trains and aircraft tends to have a much lower impact in terms of overall population exposure, but remains an important source of localized noise pollution. European Environmental Agency (2016). «TERM 2016: Transitions towards a more sustainable mobility system» (p. 22) http://bit.ly/2qTW09C

5.2 TRENDS IN GREEN MOBILITY

5.2.1 Climate change mitigation

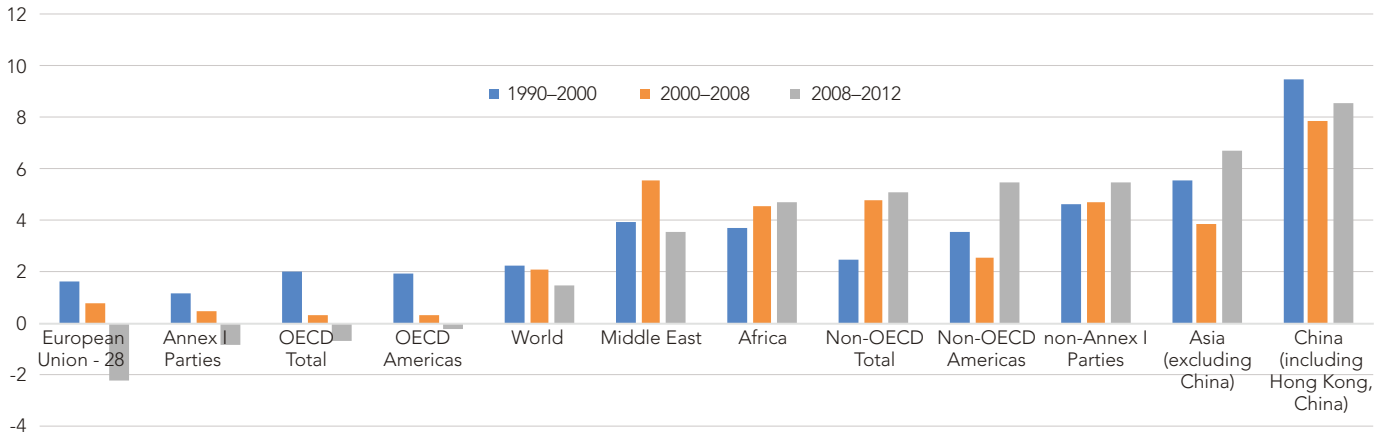
The transport sector presently contributes 23 percent of global energy-related greenhouse gas (GHG) emissions and 18 percent of all man-made global economy-wide emissions.[9]

Global transport emissions grew at an average annual rate of 2 percent from 1990–2012, and up to now remains among the fastest growing sectors of CO_2 emissions from fuel (Figure 5.1).

Achieving the climate mitigation target will require optimizing the contributions from the transport sector. Some key trends vis-à-vis greenhouse gases include:

- In 2012, transport was the largest energy consuming sector in 40 percent of countries worldwide, and in most of the remaining countries, transport was the second largest energy consuming sector.
- It is expected that by 2017, transport GHG emissions from non-Annex I countries will be larger than those from Annex I countries (Annex I countries being developed countries and "economies in transition").[10]
- Many countries that currently have very low transport emissions per capita are showing significant growth in this sector, and will need to take additional measures to keep transport emissions in check.
- Transport sector emissions growth in Annex I countries (developed countries and "economies in transition" averaged 0.5 percent from 1990 to 2012, with a negative GDP growth rate of –0.8 percent from 2008–2012, and non-Annex I countries averaged 4.8 percent with a positive GDP growth rate of 5.5 percent from 2008–2012.
- Annex I countries in particular have limited transport emissions growth to well below GDP growth rates, and even non-Annex I Parties have kept

FIGURE 5.1: Transport CO_2 Emissions Growth across Regions



Source: Partnership on Sustainable Low Carbon Transport 2015. "Analysis of National Transport Sector Emissions, 1990 - 2012". Based on IEA, CO2 emissions from fuel combustion, 2014.

[9] See: http://www.itf-oecd.org/transport-outlook-2017 (access date June 20, 2017).

[10] Annex I and non-Annex I countries were an important part of the vocabulary of the Kyoto Protocol and generally refer to the different responsibilities countries had in terms of emission reductions under the Kyoto Protocol. Annex I countries include the industrialized countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States. These countries were expected to reduce emissions while the Non-Annex I countries, mostly developing countries, did not have such an obligation. http://unfccc.int/parties_and_observers/items/2704.php

transport growth below GDP growth over the 22-year period 1990–2012, albeit by a much narrower margin, demonstrating the potential to decouple economic growth from transport emissions growth.

- Countries that have kept gasoline prices above US$1/liter from 2000 to 2012 show clear reductions in transport emissions growth; however, transport CO2 emissions have grown at a rapid rate in countries that have kept gasoline prices artificially low due to fuel subsidies.

Among roughly 160 Nationally Determined Contributions representing 187 countries that submitted them as of August 1, 2016, 75 percent explicitly identify the transport sector as a mitigation source, and more than 63 percent of NDCs propose transport sector-specific mitigation measures.[11]

On an economy-wide scale, mitigation measures proposed in NDCs are expected to fall well short of a 2 degrees scenario, let alone the more ambitious 1.5 degrees scenario[12]. Based on existing transport-related policies and levels of ambition expressed in NDCs, the transport sector will also not be on track for a 2 degrees scenario by 2030 through the targets and measures proposed (assuming proportional sectoral contributions).

Active transport modes, including walking, cycling and other small-wheels modes can contribute to reducing greenhouse gases emissions, air and noise pollution, especially in urban areas.

In the case of international aviation, ICAO Member States agreed in 2010 with the sectoral goals for improving 2 percent annual fuel efficiency and keeping net CO_2 emissions from 2020 at the same level (carbon neutral growth from 2020), and are currently exploring a long-term goal for the sector. The achievement of such goals is monitored by Member States' Action Plans, which are submitted to ICAO and regularly updated.

5.2.2 Climate change adaptation

Specific information on the impact of climate change on transport infrastructure and services is not readily available at a global scale. While there have been recent efforts to address transport adaptation at a regional scale, a common, cohesive, and systematic approach to understanding the climate impacts on transport systems is not available.[13] The current global methodologies for assessing of vulnerability to climate change at the national level do not disaggregate to present estimates specific to the transport sector. Figure 5.2 provides an overview of the vulnerability to climate change that considers six sectors including infrastructure.

However, the absence of a methodology to quantify the impacts of climate change on transport does not mean that these impacts are not understood. There is a growing body of work identifying and raising awareness around the potential impacts of climate change on transport systems more generally.

Some such examples are outlined in Table 5.1, which include sea level rise, extreme heat, increased precipitation intensity, and accelerated freeze-thaw cycles. These examples are more qualitative in nature, and thus the intent of a forthcoming Transport Climate Vulnerability Index will be to systematically quantify this type of analysis to better rate, understand, and draw conclusions from potential impacts to make informed economic and policy decisions.

It is acknowledged that decisions on climate adaptation are generally made from a position of uncertainty. Thus, it is essential to "predict, then act" in developing transport adaptation responses, which involves predicting the most likely set of future scenarios, establishing the best near-term decision from among these scenar-

[11] Based on Analysis by SLoCaT. In addition, 9% of NDCs include a transport sector emission reduction target, and 12% of NDCs include assessments of country-level transport mitigation potential.

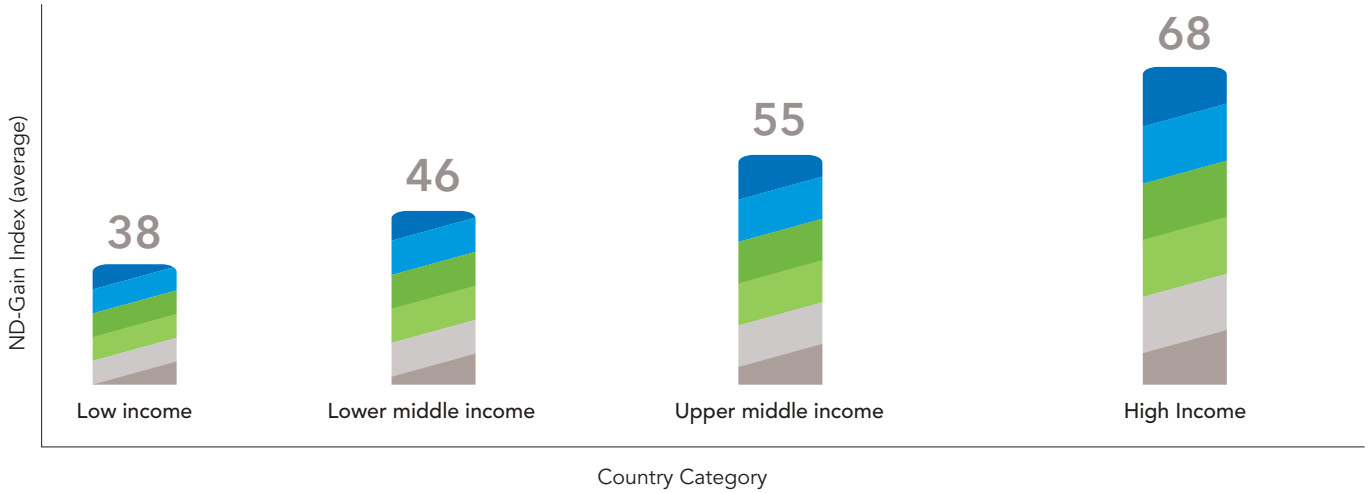
[12] SLoCaT (2016) Nationally-Determined Contributions (NDCs) Offer Opportunities for Ambitious Action on Transport and Climate Change. http://www.ppmc-transport.org/overview_indcs/

[13] See EEA (2014) 'Adaptation of transport to climate change in Europe' https://www.eea.europa.eu/publications/adaptation-of-transport-to-climate

ios, and deciding how sensitive the decision is likely to be to the overall predictions. Taking these steps can result in more robust decision-making processes, which in turn can help to identify available strategies, to determine the shortcomings of these strategies, and through this process to develop adaptation strategies to reduce vulnerabilities in the transport sector. Climate change adaptation, despite being mentioned at an economy wide scope in 83 percent of the 160 NDCs submitted to date, has generally received much less attention than mitigation in NDCs. The transport sector is mentioned in general terms among climate adaptation measures in only 16 percent of NDCs, and an even smaller number of countries—4 percent—identify transport-specific adaptation strategies.

In the case of international aviation, ICAO Member States have been assessing climate change risks to airports and other infrastructure as well as impacts on air transport operations, to identify appropriate adaptation measures.

FIGURE 5.2: Global Adaptation Index across Food, Water, Health, Ecosystems, Human Habitat, and Infrastructure Sectors.



The ND-GAIN index summarizes a country's vulnerability to climate change and other global challenges. I uses six measures describing exposure, sensitivity and capacity in each of six major sectors: food, water, health, ecosystems, human habitat and infrastructure. These 36 measures are combined to give a vulnerability score for each country. The ND-GAIN index also includes an estimate of a country's readiness to absorb and apply resources to actions to adapt to reduce its vulnerability. Readiness is based on 9 measures that indicate its economic, governance and social capacities. The figure shows the overall vulnerability score based on 2013 data.

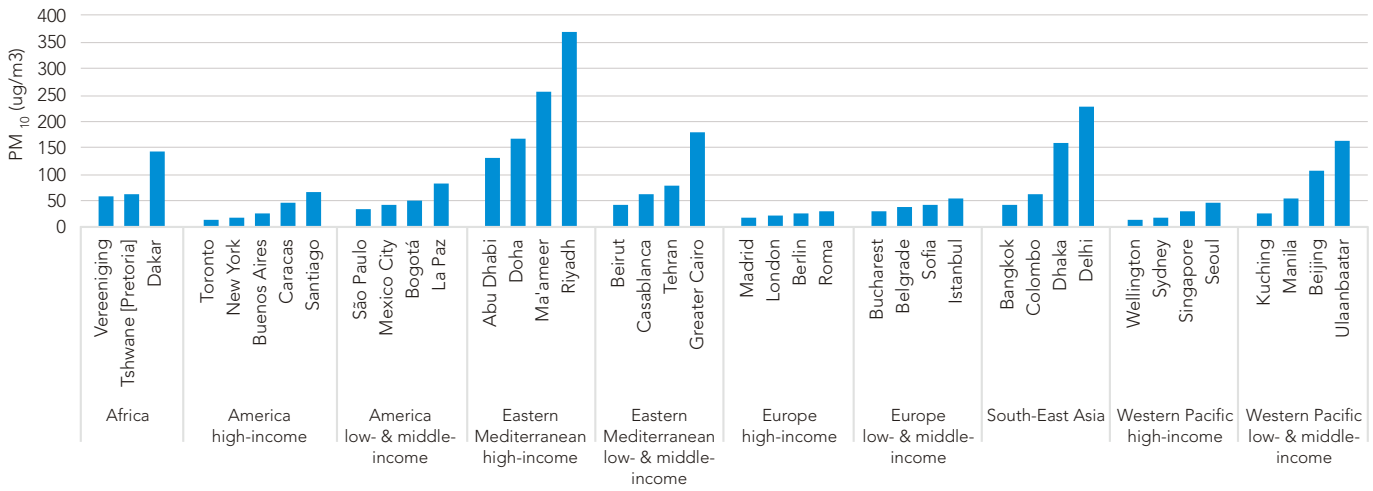
Source: Partnership on Sustainable Low Carbon Transport

TABLE 5.1: Climate Change Impacts in the Transport Sector

CLIMATE HAZARD	POTENTIAL IMPACT
Sea Level Rise, Storm Surge, and Flooding	• Damage to port infrastructure and disruptions in port operations and shipping traffic. • Loss of coastal waterway systems and/or disappearance of barrier islands. • Damage to, or inaccessibility of, low-lying coastal infrastructure such as roads and railway beds, tunnels, and underground rail/subway corridors (Titus 2002). • Aggravated coastal flooding as storm surges build on a higher base and reach further inland leading to road, rail, and airport closures, for example (U.S. Climate Chnage Science Program 2008).
Strong Wind and Storms	• Greater likelihood of infrastructure failure and disruptions of transport operations for all modes of traffic. • Increased threads to bridges. The structural integrity of long span bridges is vulnerable to strong winds as are auxilary infrastructure such as road signs, traffic signals, overpasses, train stations, and toll collection stations. • Damage to overhead lines for railways, power supply, signs, lighting features, and increased tree fall leading to the closure of railway tracks and roads. • Delays and cancelation of flights and unreliable air travel services. • Damage to cranes and terminal facilities. • Safety hazards for vehicles.
Increasing Precipitation Intensity	• Flooding of roads, railways, and tunnels causing traffic disruptions and road/rail closure. • Slope failures and landslides (road/rail). • Washout of gravel and earth roads and railway tracks. • Erosion and scouring or washout of bridges or other works for waterway crossings. • Increased sediment loading of drainage works leading to increased maintenance requirements and costs. • Potential increases in sudden snow loading on bridges and overhead or suspended works. • Potential for sudden icing of drainage works causing flooding.
Changes in Precipitation (Averages)	• Increased drought, reducing the navigability of inland waterways. • Settlement of infrastructure and road beds due to increased aridity or lower water table affecting the base stability.
Extreme Heat	• Increased pavement deterioration, softening, and cracking, rutting, and bleeding. • Rail track deformation and buckling. • Thermal expansion of bridge joints. • Increased energy consumption due to refrigeration of transported goods and use of air conditioning. • Increased forest fires resulting in land infrastructure closure and failure.
Rising (Average) Temperatures	• Longer shipping seasons in the Arctic, opening of new shipping routes. • Reduced winter maintenance costs. • Longer construction season. • Decreased viability of ice roads.
Extreme Cold	• Increased thermal crackings of pavements and runways. • Brittle failures of railways tracks.
Increased Freeze Thaw Cycles	• Increased fatigue failure for most infrastructure, particularly roads. • Weathering of the vehicle fleet.
Permafrost Degradation	• Base stability of most infrastructure is affected resulting in substantial failures.

Source: Adapted from Ziad Nakat, 2010, "Climate change adaptation in the transport sector," background paper for Fay, M., Block R. I., and Ebinger J. (eds), Adapting to Climate Change in Europe and Central Asia, World Bank Group; & Ebinger, J., Vandycke N. 2015. Moving Toward Climate-Resilient Transport: The World Bank's Experience from Building Adaptation into Programs. World Bank, Washington, DC.

FIGURE 5.3: PM_{10} Levels for selected cities by region, for the last available year in the period 2011-2015



Source: World Health Organization 2016. "Urban Ambient Air Pollution Database Version 0.2 - Data Summary".

5.2.3 Air pollution and physical activity

Air pollution—both ambient (outdoor) and household (indoor)—is the biggest environmental risk to health. Ambient air pollution alone kills around 3 million people each year.[14]

Because the extent and severity of health damage caused by air pollution depends on the extent of human exposure, air pollution from transport is primarily an urban issue. WHO's database on air pollution contains data on outdoor air pollution monitoring from almost 3,000 cities in 103 countries, and is compiled from publicly available sources. Air quality is represented by annual mean concentrations of PM_{10} and $PM_{2.5}$ (PM_{10} is particulate matter 10 micrometers or less in diameter, and $PM_{2.5}$ particulate matter 2.5 micrometers or less in diameter). Both these measures are greatly impacted by the transport sector (Figure 5.3).

In low-and middle-income countries, 98 percent of cities do not meet air quality guidelines, compared with 56 percent of cities in high-income countries.[15] As a result, only 10 percent of people around the world live in cities that comply with WHO air quality guidelines. Some of the most populous and rapidly expanding cities in the world suffer the most, as population growth leads to increases in congestion and fuel consumption, especially in the transport sector.

Diesel vehicles, mainly trucks and buses, account for most of the fine particulate matter emitted from mobile sources. Very fine particulate matter originates mainly from diesel fuels, and may penetrate deep into the lungs of the exposed population.[16] These particles can cause cancer, cardiovascular disease, respiratory disease, and premature death. Non-methane Volatile Organic Compounds (NMVOCs) are emitted by diesel and gasoline engine vehicles. Harmful lead additives once widely used to increase the octane rating of petrol cheaply have largely been phased out worldwide. Other pollutants still are prevalent in transport emis-

[14] Based on WHO data.

[15] The statistics are based on data for cities with more than 100 000 inhabitants. Air quality guideline comes from WHO. Source: WHO Ambient air pollution: A global assessment of exposure and burden of disease. http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf?ua=1 Accessed May 12, 2017.

[16] According to the Urban Air Quality Database for 2016 (WHO). Particulate matter under 10 microns in diameter is known as PM_{10}, and that below 2.5 microns in diameter is known as $PM_{2.5}$.

sions, however, including nitrogen oxides (NOx) and sulphur oxides (SOx)—which can cause harm to human health in large concentrations—and black carbon, which has both health and climate impacts.

By 2030, advances in vehicle emission controls can cut air pollution from light and heavy-duty vehicles by almost 70 percent compared to 2010. To realize technological improvements in vehicle emission levels, it is necessary to reduce sulfur levels in diesel fuel to below 50 parts per million, and preferably to less than 10 parts per million.[17]

Regarding international aviation, since the 1980s ICAO has been developing and updating global standards for aircraft engine emissions that affect air quality, such as NOx and Particulate Matter (PM) (as contained in Annex 16, Volume II of the Convention on International Civil Aviation),[18] and such standards are implemented by Member States to minimize the impact of aircraft operations on local air quality and health.

Conservative estimates show that physical inactivity has been responsible for an estimated 3.2 million deaths[19] and $54 billion economic losses[20] globally (in international dollars, adjusting for purchasing power). Active transport provides health and economic gains through increases in physical activity and reductions in obesity and other diseases (e.g. cancer, heart disease, stroke).

The transport sector has potential to increase physical activity[21] through active modes linked to robust public transport systems, as public transport density is found to be one of the three key environmental attributes associated with levels of physical activity.[22]

Increases in physical activity and societal gains due to transport interventions are consistent. For instance, in São Paulo (Brazil), a shift towards a sustainable transport scenario could avert nearly 1,200 premature deaths per year only through increases in physical activity.[23] Physical activity will at the same time reduce air pollution.

5.2.4 Noise pollution

In the European Union and Norway, traffic noise has the second biggest environmental impact on health after air pollution.[24] Traffic noise has a variety of adverse impacts on human health. Community noise, including traffic noise, is recognized as a serious public health issue by the WHO, which reports that Europeans lose at least one million healthy life-years annually due to disability or disease caused by traffic noise.

In 2012, at least 125 million people—one in four Europeans—were exposed to daily road traffic noise levels exceeding the assessment threshold specified under the EU Environmental Noise Directive (Figure 5.4).

As a result, at least 10,000 cases of premature deaths from noise exposure occur each year, with road traffic the dominant source. Noise from trains and aircraft tends to have a much lower impact in terms of overall population exposure, but remains an important source of localized noise pollution.[25] Data suggest that noise exposure remained relatively stable between 2007 and 2012, which is likely to continue in the future with projected transport demand. Therefore, it is unlikely that noise pollution will significantly decrease by 2020.[26]

[17] ICCT (2013), "The Impact of Stringent Fuel and Vehicle Standards on Premature Mortality and Emissions." ICCT's Global Transportation Health and Climate Roadmap Series. October. Page 3.

[18] ICAO (2006), "Convention on International Civil Aviation." http://bit.ly/2xxtH0y Accessed August 24, 2017.

[19] WHO. http://www.who.int/topics/physical_activity/en/

[20] Ding, D et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. The Lancet 388.10051 (2016): 1311-1324.

[21] Pratt, M et al. (2012) The implications of megatrends in information and communication technology and transportation for changes in global physical activity. The Lancet 380.9838: 282-293.

[22] Sallis J, et al. (2016) Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study. Lancet. 387(10034):2207-17.

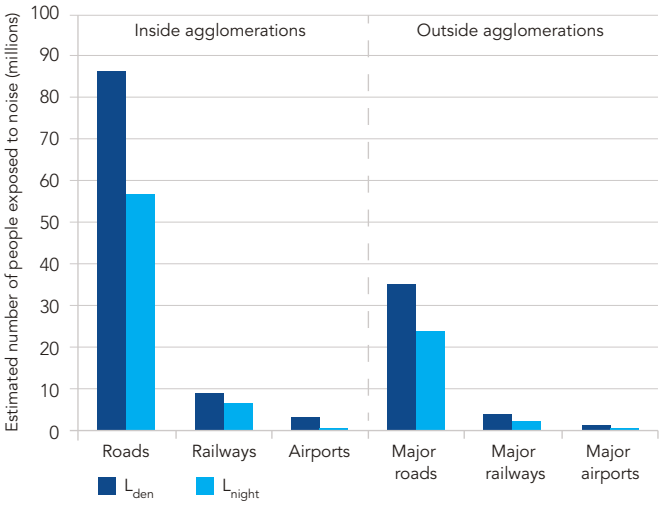
[23] de Sá, Thiago Hérick, et al. "Health impact modelling of different travel patterns on physical activity, air pollution and road injuries for São Paulo, Brazil." Environment international 108 (2017): 22-31.

[24] WHO (2011), "Burden of disease from environmental noise: Quantification of healthy life years lost in Europe." http://bit.ly/2r2dSwy.

[25] European Environmental Agency (2016). «TERM 2016: Transitions towards a more sustainable mobility system» http://bit.ly/2qTW09C

[26] Ibid

FIGURE 5.4: Exposure to Unhealthy Traffic Noise in EU Member States (Excluding Croatia) in 2012



Source: European Environment Agency 2016. "Transitions towards a more sustainable mobility system".

Conservative estimates show that the social costs of traffic noise in the European Union amount to at least €40 billion per year—0.4 percent of total GDP, with the bulk of these costs—about 90 percent— caused by passenger cars and lorries.[27] A preliminary analysis shows that each year more than 245,000 people in the European Union are affected by cardiovascular diseases that can be traced to traffic noise. About 20 percent of these people—almost 50,000—suffer a lethal heart attack, dying prematurely.

Traffic noise typically reaches harmful levels in the urban areas of many developing countries.[28] Similarly, regarding airport noise across a wide income spectrum, the relative burden is higher for developing nations, and lower for developed nations.[29]

In the case of international aviation, the ICAO has been developing and updating global standards for aircraft noise (as contained in Annex 16, Volume I of the Convention on International Civil Aviation).[30] Aircraft manufactured today are 75 percent quieter compared with the 1960s. ICAO has also established a global policy for addressing aircraft noise[31], which aims at minimizing the number of people affected by aircraft noise in the vicinity of airports, and which has been implemented by ICAO Member States.

5.3 SCALE OF THE CHALLENGE

The targets set for the Green Mobility objective, especially on climate change mitigation, call for the transformation of mobility. Achieving these targets requires that the transport sector be part of a net-zero- emission economy. Radical action could include the net de-carbonization of transport. Reduction of transport's pollution contribution is also expected to have large positive impacts on the other objectives discussed in the conceptual framework.

The optimization of these co-benefits is a key characteristic of the approach to environmentally sustainable transport under SuM4All. A specific type of co-benefits would be achieved through combined action on mitigation of, and adaptation to, climate change. This is especially relevant when new transport infrastructure and services are being established, which as indicated will be needed in support of realizing universal urban and rural access.

The Green Mobility objective identifies key global targets and indicators for measuring progress toward this transformative paradigm. Yet, while the potential for co-benefits is great, the distance remaining to reach these targets appears greater still. Currently, the global land transport sector emits roughly 7.7 gigatons (Gt) CO2e, and business-as-usual emissions are projected to be 13–15 Gt by 2050; yet meeting Paris Agreement targets will require reducing transport emissions to 2–3 Gt in the same timeframe. In addition, the Green

[27] CE Delft ((2007). «Traffic noise reduction in Europe» http://bit.ly/2mQ75aE.
[28] WHO (2011), "Burden of disease from environmental noise: Quantification of healthy life years lost in Europe." http://bit.ly/2r2dSwy
[29] Qinxian He, et al (2014). "Estimation of the global impacts of aviation-related noise using an income-based approach." http://bit.ly/2rap9Lp
[30] ICAO (2006), "Convention on International Civil Aviation." http://bit.ly/2xxtH0y. Accessed August 24, 2017.
[31] ICAO (2008). "Guidance on the Balanced Approach to Aircraft Noise Management" http://bit.ly/2ioNVXN

Mobility objective states a desired achievement of reducing premature death and illness from transport-related air pollution by 50 percent by 2030; yet only 10 percent of urban dwellers currently live in cities that comply with WHO air quality guidelines. Further, this objective aims to reduce by 50 percent the number of urban dwellers exposed to excessive noise levels by 2030, yet one in four Europeans were exposed to road traffic noise levels exceeding desired thresholds in 2012, and steadily growing demand for transport makes it increasingly unlikely that noise pollution levels will significantly decrease by 2020.[32] Finally, assessing the distance toward transport climate adaptation objectives is even more difficult in the absence of clear baselines and a well-defined Transport Climate Vulnerability Index.

The transformation of the transport sector, in support of climate and other environmental goals, needs to be largely completed by 2050 or shortly thereafter, with all modes of transport—road, rail, air, waterborne transport for people and goods—being part of the global systemic transformation. It will involve new consumption patterns and behavioral changes, major technological innovations, the emergence of new mobility ecosystems, and the creation of new business models. Such a change, both in scope and urgency, calls for unprecedented immediate and coordinated mobilization of all transport sector players, public and private, including policy makers, economic and corporate players, and the full participation of civil society. The transport sector alone cannot realize such ambitious targets and will need to gain the full cooperation of other sectors that interact with it, especially the energy sector and the urban development sector.

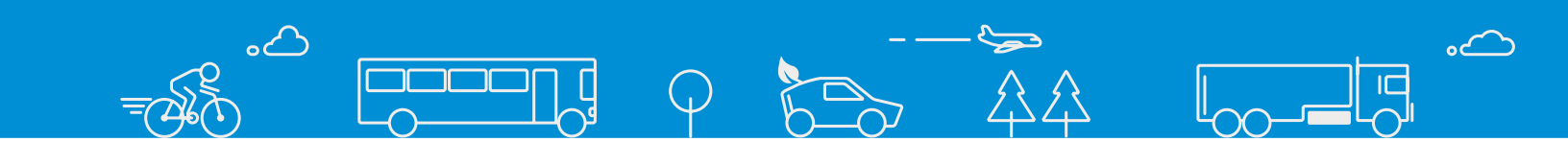
Climate change scenarios are uncertain, and the severity of climate impacts also varies greatly with the geophysical risk exposure of individual locations, their resilience, and adaptive capacity. Nevertheless, decisions on adaptation must be made today, especially with respect to long-lived transport infrastructure assets that have the potential to lock in development patterns for many decades. Pro-active adaptation can be a low- or no-regret option, in cases where project savings accrued over the infrastructure life cycle offset the higher construction and operational costs of inaction. Decision making on adaptation, especially in the case of transport infrastructure and systems with a long lifetime, needs to consider flexible responses to a changing climate allowing for adaptive management. Effective, transformative action on transport needs to consider the demand for transport, which is articulated in an indicator around average trip lengths because, while technological improvements and mode shifting will be essential to achieving long term success, they will not be sufficient to achieving full decarbonization. More efficient transport systems and less impactful fuels and engines will go a long way towards creating transport systems that are less harmful to the environment and communities. And by rethinking the way communities are designed and land -use is planned, communities can reduce the load on transport systems altogether, and with large societal gains[33].

Beyond this exists the challenge of climate change adaptation, which is an essential issue to tackle, and which will become increasingly relevant over the coming decades. A green mobility system must be a sustainable mobility system, and a mobility system can only be sustainable if it is able to withstand extreme weather events and changes to the surrounding environment. Also, sustainable passenger and freight transport systems must adapt to climate change to maintain reliability and increase market share, in order to achieve their full mitigation potential.

[32] European Environmental Agency (2016). «TERM 2016: Transitions towards a more sustainable mobility system» http://bit.ly/2qTW09C

[33] Stevenson, M. et al. (2016) Land use, transport, and population health: estimating the health benefits of compact cities. Lancet, Dec 10;388(10062):2925-2935.

ANNEX 1
ELEMENTARY GLOBAL TRACKING FRAMEWORK FOR TRANSPORT



KEY PRINCIPLES

Global Objectives - Sustainable mobility is anchored around four objectives:

- Universal Access
- System Efficiency
- Safety
- Green Mobility

Targets. The 2030 Agenda for Sustainable Development contains SDG target 3.6 on road safety (other modes of transport are not included). A significant investment is needed to define and propose universally acceptable targets for other modes of transport with regard to safety as well as for the three other global objectives.

Indicators. The selection of indicators is guided by the following principles:

- Primarily national (or urban/rural) in scope
- Relevant to assess progress toward sustainable mobility
- Limited in number, but remaining open-ended and adaptable to future needs
- Broad in coverage
- Understandable, clear, and unambiguous
- Conceptually sound
- Building on and complementing the indicators developed by IAEG-SDG with a view to support Member States in implementing the 2030 Agenda
- Dependent on cost-effective data of known quality.

The focus of this effort has been on the development of principal indicators for each objective. The principal indicators are overarching, and based on outcomes. Whenever possible, this corresponds to the relevant SDG indicator. They are directly linked to the targets set for each objective and will be used to track progress.

Each principal indicator is reinforced by a handful of supporting indicators, which are used to track sub-dimensions of the principal indicator and indicate progress towards the targets. These indicators can be outcome as well as output based. Supporting indicators are divided into existing (or commonly used) and desirable indicators. The desirable indicators will be developed over time.

Data. The year 2015 is chosen as a starting point because it is the most recent year for which all necessary data are available. It also provides a 15-year period—coinciding with the SDG timeline—during which progress can be charted. Once the methodology for choosing indicators is defined, and the appropriate data sources are identified, it will be possible to compute baseline indicators for the year 2015, against which we can track progress.

Methodologies. Methodologies will be developed to construct indicators to track country-level progress toward the targets.

* For international aviation, ICAO and its 191 Member States develop and update global policies, Standards and guidance for aircraft noise and emissions, including ICAO Assembly Resolutions A39-1, A39-2, A39-3, and the Convention on International Civil Aviation, Annex 16 - Volumes I, II and III.

UNIVERSAL ACCESS

Global Objective: Ensure for all equitable access to economic and social opportunities by 2030

Target	TBD (Access for all through transport infrastructure and services, leaving no one behind)
Principal Indicator 1 (rural)	Proportion of the rural population who live within 2 km of all-season road (SDG 9.1.1)
Principal Indicator 2 (urban)	Proportion of population that has convenient access to public transport, by age, sex and persons with disabilities (SDG 11.2.1)
Supporting Indicators:	1. Quality of roads • 1.1: Quality of roads [value: 1= worst to 7 = best] • 1.2: Quality of roads [rank] 2. Quality of railroad infrastructure • 2.1: Quality of railroad infrastructure [value: 1= worst to 7 = best] • 2.2: Quality of railroad infrastructure [rank] 3. Quality of port infrastructure • 3.1: Quality of port infrastructure [value: 1= worst to 7 = best] • 3.2: Quality of port infrastructure [rank] 4. Quality of air transport infrastructure • 4.1: Quality of air transport infrastructure [value: 1= worst to 7 = best] • 4.2: Quality of air transport infrastructure [rank] 5. Passenger volume by mode of transport • 5.1: Railways, passengers carried (million passenger-km) • 5.2: Air Transport, passengers carried
	6. Proportion of rural roads in "good and fair condition" (as developed by new RAI)* 7. Percentage of markets accessible by all-season road* 8. Percentage of national government budget spent on low volume rural transport infrastructure* 9. Percentage of the rural population with access to affordable and reliable passenger transport services* 10. Ratio of national to local passenger transport fares (collection of data on rural passenger transport US$ per km for short distance and long distance trips which would be disaggregated by most common modes e.g. bus, motorbike, other IMT)* 11. Percentage of household monthly expenditure spent on transport* 12. Percentage of rural population with at least daily transport service – from Living Standards Surveys (LSS)* 13. Percentage of households that make one motorized trip per month* 14. Length of public transport lines (particularly high capacity but also informal public transport if possible) per area, dedicated bicycle lane and side walk coverage (this parameter will also help to determine urban density *i.e.* people / sq km)* 15. Vehicle fleets per motorized transport mode (public transport and all other modes, such as, taxis and shared taxis, informal / paratransit (if possible) and motor cars, motorized two-wheelers (annual update)* 16. Number of public transport journeys by mode of transport (annual update)* 17. Vehicle km offered per public transport mode (annual update)* 18. Number of public transport stops per area (annual update)* 19. Percentage of the population within 500 m of a frequent public transport stop/station* 20. Average income (percent) per resident spent on transport (affordability)* 21. Modal share of different passenger modes in the city (public transport, walking, cycling, private vehicles and motorcycles and taxis, including informal / paratransit if possible). The aim should be to increase use of sustainable transport modes. Consideration should also be given to applying this to freight transport. (inter-modality)* 22. Passenger km travelled by public transport by mode of transport (annual update) – using this indicator the average length of public transport journeys (Tier 1) can also be assessed. (inter-modality)* 23. Goods VKM travelled in the city per capita (freight)* 24. Percentage of jobs and urban services accessible within 60 minutes by each transport mode in the city* 25. Accessibility of the public transport network to persons with disabilities / vulnerable situations (percent of vehicles allowing wheelchair access, percent of stations / network with step free access etc.) (usability)* 26. Reduction in the percentage of women who are deterred by fear of crime from getting to and from public transport. (usability)*

SYSTEM EFFICIENCY

Global Objective: Increase the efficiency of transport systems by 2030

Target	TBD (Meet the demand for mobility at the least possible cost for society)
Principal Indicator	Connectivity index*
Supporting Indicators:	1. Energy consumption of transport relative to GDP (PPP) (GOE per dollar) 2. Logistics performance Index – Customs Clearance Component • 2.1: Logistics performance index – customs [value: 1=low to 5=high] • 2.2: Logistics performance index – customs [rank] 3. Good Governance Index – under influence component • 3.1: Good Governance Index – Under Influence [value: 1=worst to 7=best] • 3.2: Good Governance Index – Under Influence [rank] 4. Air and linear shipping connectivity index 5. Freight volumes by mode of transport • 5.1: Freight volume by air transport (ton-km) • 5.2: Mail volumes by air transport (ton km) • 5.3: Freight volumes by road transport (ton-km) • 5.4: Freight volumes by road transport (ton-km) • 5.5: Container port traffic (TEU: 20 foot equivalent units) 6. Accession to the UN transport conventions 7. Truck Licensing Index (0-11)
	8. Freight connectivity* 9. Percentage of agricultural potential connected to a major port or market by a certain road category within a given time period* 10. Rail lines* 11. Average age of vehicle fleet*

SAFETY

Global Objective: Improve safety of mobility across transport modes

Target	1. Halve the number of global deaths and injuries from road traffic accidents by 2020 (SDG target 3.6) 2. Reduce by 5 percent the fatalities and injuries in each other mode of transport (waterborne, air, and rail transport) by 2020
Principal Indicator	1. Number of deaths and injuries from road traffic accidents by 2020 (absolute number) 2. Number of fatalities and injuries in each mode of transport (waterborne, air, and rail transport)
Supporting Indicators:	1. Distribution of road deaths by use type • 1.1: Death by road user category – 4-wheeler [%] • 1.2: Death by road user category – 2- or 3-wheeler [%] • 1.3: Death by road user category – cyclist [%] • 1.4: Death by road user category – pedestrian [%] • 1.5: Death by road user category – others [%]
	2. Indicators for overall transport sector: • 2.1: Increase in modal shift for safer and efficient modes of transport in urban areas (safer modes: mass transit, rail transport, metro, BRT) and increase walking and biking providing safe facilities for them as they are the most efficient and equitable modes of transportation* • 2.2: Decrease in number of fatalities and serious injuries among pedestrians and cyclists, while increasing their mode share in urban areas* 3. Indicators for road safety: • 3.1: Progress with 5 Pillars of Road Safety as defined in Global Plan and WHO´s document on road safety targets and indicators[1]* • 3.2: % of existing roads that have safety rating or high-risk spots or sections identified and improved in each country* • 3.3: Countries that have compulsory road safety audits and inspections or minimum star rating standards for new roads* • 3.4: Countries that have speed limits consistent with safe system principles* • 3.5: Number of cities (more than 500.000 inhabitants) that have road safety plans consistent with safe systems and focus in particular on (of) vulnerable users* • 3.6: Number of national Road Safety lead agencies* • 3.7: Effective legislation and enforcement of key road safety legislation* • 3.8: Countries acceding to each core UN convention on road safety* • 3.9: Countries with road safety crash mitigation protocols* • 3.10: Countries with licensing processes for all drivers that include written and practical examination (cars, trucks, motorized two-wheelers, professional drivers)* • 3.11: Number of countries with a sound crash database* 4. Indicators for aviation: • 4.1: Number of fatalities in scheduled commercial air transport* • 4.2: Countries having implemented an effective safety oversight system* • 4.3: Countries having implemented an effective State Safety Program* 5. Indicators for rail transport: • 5.1: Number of countries that have a specific safety railroad department or administration* • 5.2: Number of railways that have a Safety Management System (SMS) in place* • 5.3: Number of countries that have an effective safety protocol or regional rail safety agreements* • 5.4: Number of train and passenger train operators with guidelines for emergency response/preparedness* • 5.5: Number of countries that have active programs to promote safety in the road/rail level crossing* • 5.6: Number of countries that have active programs to prevent trespasser crashes* 6. Indicators for waterborne transport: • 7.1: Maritime casualties*

[1] The WHO, leader of the United Nations Road Safety Collaboration Group, UNRSC, is defining: "Voluntary global performance targets for road safety risk factors and service delivery mechanisms" that will be finalized in 2018.

GREEN MOBILITY

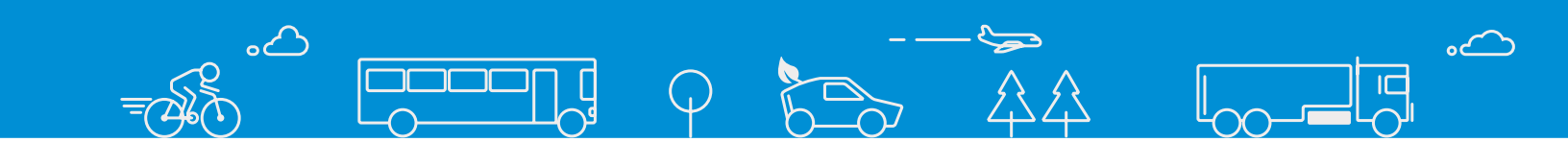
Global Objective: Shift transport systems to low polluting (GHG/air/noise) and climate resilient path.

Sub-Objective 1	Reduce global transport sector GHG emissions as consistent with limiting global average temperature increase to well below 2 degrees Celsius above pre-industrial levels by 2050.
Target	3-6 GT CO_2e by 2050 (absolute in aggregate; specific targets to be determined for each sub-sector/income level)
Sub-Objective 2	Strengthen resilience and adaptive capacity of transport systems to climate-related hazards and natural disasters in all countries.
Target	(X countries) taking actions to reduce vulnerability by 2030 and (Y countries) by 2050
Sub-Objective 3	Substantially reduce premature deaths and illnesses from air pollution and physical inactivity due to transport-related sources and choices.
Target	(A) 50 percent reduction by 2030 compared to 2010 baseline (relative) or (B) fewer than 60,000 deaths by 2030 (absolute); and (C) percentage of adults walking or cycling for transport increased by 20 percent by 2030
Sub-Objective 4	Substantially reduce global mortality and burden of disease from transport-related noise levels.
Target	Number of urban dwellers exposed to excessive noise levels reduced by 50 percent by 2030
Principal Indicators	1. Global GHG emissions from the transport sector (GT CO_2e), disaggregated by purpose (pkm and tkm), income (HIC, MIC, and LIC), and mode (cars, 2- and 3- wheelers, light commercial vehicles, medium and heavy trucks, buses, and minibuses, domestic and international aviation, and domestic and international shipping) 2. Number of countries that have taken intentional action to build resilience against climate-related hazards and national disasters within the transport sector 3. Annual premature deaths due to air pollution and physical inactivity from transport-related sources (# of deaths/year) 4. Percentage of urban dwellers exposed to Lden/Lnight noise levels from transport above 55dB/40dB (percent of total inhabitants)
Supporting Indicators	1. Transport-related GHG emissions (million tonnes) 2. CO2 emission from transport relative to GDP (PPP) (kg per dollar) 3. CO2 emission from road transport relative to GDP (PPP) (kg per dollar) 4. PM 2.5 Air pollution, mean annual exposure (micrograms per cubic meter) 5. PM 2.5 Air pollution, population exposed to levels exceeding WHO guideline value (% total)
	6. Indicators of Climate Change Mitigation • 6.1: (SDG 9.4.1) GHG emissions from transport per unit of value added (MT CO2e/unit GDP, calculated from transport UNFCCC/IEA emissions data and World Bank GDP growth data)* • 6.2: Low emission vehicle share of light-duty 4-wheel and motorized 2-wheel vehicle sales, (percent of total sales, calculated from OICA vehicle sales data and IEA electric vehicle data)* • 6.3: Share of alternative fuels in transport (by gCO2e/MJ for each fuel type), (% of total fuels, calculated from IEA biofuels data and electric vehicle data)* • 6.4: Modal share of passenger transport (by private transport, public transport, walking, cycling, air), (percent of total pkm, calculated from UITP Mobility in Cities database)* • 6.5: Modal share of freight transport (by rail, water, air, road), (percent of total tkm, calculated from World Bank freight data) * • 6.6: Average trip length per country (by passenger transport and freight transport mode), (km)*

GREEN MOBILITY

Supporting Indicators	7. Indicators for Climate Change Adaptation • 7.1: Incidents/climate change related disasters/losses/damages/disruptions to transport service (number of total incidents, data sources TBD)* • 7.2: Time and GDP loss due to climate-related disruptions to service (minutes and $/year, data sources TBD)* • 7.3: Investment in retrofitting existing transport infrastructure investments to withstand extreme climate conditions or climate disasters ($, calculated from MDB/IFI transport investment data)* • 7.4: Percentage of new transport infrastructure investments designed to withstand extreme climate conditions or climate disasters (% total infrastructure, calculated from MDB/IFI transport investment data)* • 7.5: Percentage of countries or transport companies that have adopted adaptation plans that cover transport infrastructure (% total countries/companies, calculated from UNFCCC NAPs/NAPAs, available private sector data sources)* • 7.6: Percentage of countries, sub-national regions, and cities with structured vulnerability assessments incorporated into the road and transport management systems (% total countries/sub-national regions/cities, calculated from available data from national, subnational and corporate networks) 8. Indicators for Air Quality and Physical Activity • 8.1: Emissions of PM10, PM2.5, black carbon, NOx, SOx, and VOCs from passenger and freight vehicles (tonnes/year, calculated from WHO/World Bank data)* • 8.2: Percentage of cities with air quality levels in compliance with WHO guideline values disaggregated by type (PM10 and PM2.5) and income (HIC, MIC, and LIC) (% of all cities, calculate • • 8.3: Share of countries with Euro 6 equivalent vehicle emission standards in place for light-duty and heavy-duty vehicles, disaggregated by income (HIC, MIC, and LIC) (% of all countries, calculated from UNEP/Partnership for Clean Fuels and Vehicles data)* • • 8.4: Share of countries with low-sulphur (max 50 ppm) and ultra-low-sulphur (max 10 ppm) standards for gasoline and diesel, disaggregated by mode (land, maritime transport) income (HIC, MIC, and LIC) (% of all countries, calculated from UNEP/Partn • 8.5: Average minutes per day walked or cycled by adults for transport (minutes/day) • 8.6: Percentage of adolescents walking or cycling for transport to school (%) • 8.7: Average minutes per day walked or cycled by adolescent for transport to school (minutes/day) 9. Indicators for Noise Pollution: • 9.1: Percent change in average noise level for cars/vans (% dB, from WHO/EEA and other available time series data)* • 9.2: Percent change in average noise level for lorries/buses (% dB, from WHO/EEA and other available time series data)* • 9.3: Percent change in average vehicle noise (axel, engine, exhaust, tires) inside agglomerations (% dB, from WHO/EEA and other available time series data)* • 9.4: Percent change in average tire noise outside agglomerations (% dB, from WHO/EEA and other available time series data)* • 9.5: Reduction in average vehicle noise (axel, engine, exhaust, tires) inside agglomerations (dB)* • 9.6: Highest vehicle noise level under any operating conditions (dB, calculated from OICA and other available data)*

ANNEX 2
TRANSPORT RELATED SDG TARGETS



Objective	SDG Target	SDG Indicator(s)
Universal Access	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all*	9.1.1 Proportion of the rural population who live within 2 km of an all-season road (Tier III)
		9.1.2 Passenger and freight volumes, by mode of transport (Tier I)
	11.2 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*	11.2.1 Proportion of population that has convenient access to public transport, by age, sex and persons with disabilities (Tier II)
Efficiency	7.3 By 2030, double the global rate of improvement in energy efficiency	7.3.1 Energy intensity measured in terms of primary energy and gross domestic product (GDP) (Tier I)
	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all*	9.1.2 Passenger and freight volumes, by mode of transport (Tier I)
	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	9.4.1 CO2 emission per unit of value added (Tier I)
	12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possibleadverse impacts on their development in a mannerthat protects the poor and the affected communities*	12.c.1 Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels (Tier III)
	12.3 By 2030, halve per capita global food waste atthe retail and consumer levels and reduce food losses along production and supply chains, including postharvestlosses	12.3.1 Global food loss index (Tier III)
	17.14 Enhance policy coherence for sustainable development	17.14.1 Number of countries with mechanisms in place to enhance policy coherence of sustainable development (Tier III)
Safety	3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents*	3.6.1 Death rate due to road traffic injuries (Tier I)
	11.2 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	11.2.1 Proportion of population that has convenient access to public transport, by age, sex and persons with disabilities (Tier II)

Green	3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	3.4.1: Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (Tier II)
		3.4.2 Suicide mortality rate (Tier II)
	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	3.9.1 Mortality rate attributed to household and ambient air pollution (Tier I)
	7.3 By 2030, double the global rate of improvement in energy efficiency	7.3.1 Energy intensity measured in terms of primary energy and gross domestic product (GDP) (Tier I)
	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	9.4.1 CO2 emission per unit of value added (Tier I)
	11.6 By 2030, reduce the adverse per capitaenvironmental impact of cities, including by paying special attention to air quality and municipal and other waste management	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted) (Tier I)
	13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	13.1.1 Number of countries with national and local disaster risk reduction strategies (Tier II)
		13.1.2 Number of deaths, missing persons and persons affected by disaster per 100,000 people (Tier II)
	13.2 Integrate climate change measures into national policies, strategies and planning	13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other) (Tier III)

Note: The SDG targets marked with * are directly related to the transport sector. The remaining SDG targets are indirectly related to the transport sector.

SUSTAINABLE mobility™ FOR ALL