ENHANCING SOCIAL INCLUSION AND INNOVATIONS IN URBAN TRANSPORT SYSTEMS IN ASIA-PACIFIC CITIES



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Executive Summary

Inclusive transport and mobility are often overlooked aspects of transport development in most Asia-Pacific countries and there is a growing need for a more concerted effort to prioritize and implement inclusive policies in the realm of transport planning and development to capture the economic and social gains it can provide, while reducing poverty and inequality. These can be achieved by transport as it plays a critical role in providing access to the essential functions of life and services, such as education, healthcare and employment opportunities, which determine economic development and the well-being of society at large.

Increasing concerns about the social aspects of sustainable development are found in urban transport, including universal design, safety, equality, equity, and affordability. Given that these social aspects of urban transport development could hinder the achievement of the Sustainable Development Goals, addressing social concerns in cities and developing barrier-free accessibility and innovative mobility services are vital for socio-economic development. Specifically, inclusive public transport planning has to be implemented to address the needs of all social groups, including women, persons with disabilities, older persons, and low-income households.

As different transport user groups have varying travel behaviours and needs, a better understanding of their differences will help support the design and implementation of more inclusive transport policies for all. For example, persons with disabilities generally make fewer and shorter trips, drive less and rely more on transit and non-motorized modes, make travel decisions to maximize utility under physical, financial and psychological constraints, and are affected by built and social environments when travelling. Walking and public transport (both formal and informal) are the most used modes for women, who also undertake shorter yet more trip-chaining and multi-modal journeys and travel more during off-peak hours than men. However, such transport differences are often not addressed in transport infrastructure projects.

The accessibility, safety and quality of urban transport services can be further enhanced by using emerging technology and innovations to support universal design in new mobility options. For example, smart mobility can help address first and last mile transport demand for different social groups with user-customized and on-demand mobility services. Inclusive urban transport design integrated with innovative technologies will be an important means of increasing the well-being of all transport users.

To address the need for inclusive transport policies while integrating transport innovations, ESCAP's project on "Enhancing Social Inclusion and Innovations in Urban Transport Systems in Asia-Pacific Cities" aims to improve universal accessibility and social inclusion in the transport sector. Its main objective is to increase the capacity of transport policy-makers and planners to design more accessible, socially inclusive and innovative urban transport systems for all social groups and transport users, including persons with disabilities, older persons, women, and low-income households.

This report presents key project findings, including a set of regional guidelines on social inclusion and innovations in urban transport systems. The guidelines were developed based on the principles that transport policies should be inclusive and promote sustainable development and derived from the project findings, each with specific supporting strategies.

The report is presented in four chapters. After introducing the background and aim of the study in Chapter 1, Chapter 2 presents the findings from the national assessments and workshops conducted in four ESCAP member States, namely Azerbaijan, Lao People's Democratic Republic (Lao PDR), Mongolia, and Nepal. To demonstrate how inclusive transport can be promoted in different contexts, four cities also participated in the study, namely Baku (Azerbaijan), Vientiane (Lao PDR), Pokhara (Nepal), and Darkhan (Mongolia).

Chapter 3 presents innovative transport solutions that are currently being adopted in the transport sector, including smart transport systems such as Intelligent Transport Systems (ITS). They have proven their potential ability to reduce traffic congestion, social inequality and negative environmental impacts in the Asia-Pacific region. However, while some countries in the region are world leaders in testing and deploying such technologies, many countries are still in the early stages of utilizing smart transport systems or have yet to initiate the transition towards them, particularly for inclusive transport. Accordingly, this chapter discusses various ways in which innovation could help improve the social inclusiveness of transport.

Considering the findings presented in Chapters 1-3, Chapter 4 presents the regional guidelines and their associated strategies. The five main guidelines are, 1) conduct timely data collection and analysis; 2) mainstream social inclusion in urban transport; 3) integrate transport innovation for social inclusion; 4) enhance capacity building and raise awareness; and 5) promote inclusive consultation and collaboration.

The guidelines developed can be applied nationally, regionally or locally, based on different contexts. As the strategies can also overlap, an intersectionality lens should be adopted while implementing them. Identifying their own desired outcomes and results can further guide ESCAP member States to successfully implement the guidelines based on their priorities. The enforcement of the proposed strategies is just as important as the development of guidelines and strategies. To ensure that the guidelines and strategies are relevant to the local context and effectively enforced, country-specific action plans and clear timelines can be developed to prioritize the most important areas. This will inevitably vary between countries depending on the existing level of social inclusion and innovation in their current urban transport systems.

Table of Contents

Chapter 1. Introduction 1

1.1. The Sustainable Development Goals and Transport 3

1.2. Sustainable Urban Transport Index Analysis 5

1.3. Inclusive Transport, Economic Development and Social Benefits 7

1.4. Development of Regional Guidelines 7

Chapter 2. Inclusive Urban Public Transport Systems 9

2.1. Introduction 9

2.2. Inclusive Transport Systems: Background and status of knowledge 10

2.3. Travel Behaviour of Different User Groups 14

2.4. Observations from Target Cities 16

2.5. Selected Case Studies and Best Practices 25

2.6. Lessons Learned to Develop the Guidelines 31

Chapter 3. Digital Technologies in Inclusive Transport Systems 32

3.1. Types of Applications 32

3.2. Best Practices in ESCAP Member States 39

3.3. Lessons Learned to Develop the Guidelines 53

Chapter 4. Guidelines on Enhancing Social Inclusion and Innovations in Urban Transport Systems 59

4.1. Introduction 59

4.2. Methodology 60

4.3. Regional Guidelines 60

4.4. Conclusions 72

REFERENCES 74

List of Tables

Table 1: Description of Indicators in the Sustainable Urban Transport Index 6

Table 2: Categorization of Smart Transport Services and Systems 36

Table 3: Functions of the Smart Crosswalk Safety System 40

Table 4: Functions of the Smart Intersection Service 43

Table 5: Functions of Barrier-free VRU Service 45

Table 6: Regional Guidelines 60

Table 7: Typology Levels for Accessibility Mapping 65

List of Boxes

Box 1: National Urban Transport Policy of India 27

Box 2: Wher transport application 28

Chapter 1

INTRODUCTION

This report is the outcome of the "Enhancing Social Inclusion and Innovations in Urban Transport Systems in Asia-Pacific Cites" project launched by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in 2022. It examines the linkages between transport, development, social inclusion and empowerment, and presents ways in which they can reinforce each other to create opportunities for economic development and social inclusion (UN-Habitat, 2022; Lucas et al., 2016; Benevenuto and Caulfield, 2019). When mobility options are inaccessible, unaffordable or unsafe, individuals are hindered from accessing those daily activities and services which are essential for living, such as work, education, and health care, a situation referred to as "transport poverty" (Lucas et al., 2016).

It is well-established that the intersection between poverty and infrastructural deficits exacerbates transport poverty, leading to social and economic exclusion which ultimately entangles households in an urban poverty trap. Not only infrastructure, but other factors also contribute to social exclusion in urban and transport planning policies, programmes and decisions. The spread of socially inclusive and innovative urban transport is blocked by a systemic bias in traditional transport planning practices (Lucas et al., 2016). By emphasizing the linkages between transport access and social development outcomes, the guidelines in this report aim to inform policy and planning interventions that prioritize the transport needs of all social groups.

Additionally, the persistent nature of transport poverty has a spatial dimension as it can marginalize the poorest populations in the city due to their high expenditures on transport (as a percentage of income) and characteristically low service densities, which block access to essential opportunities (Priya Uteng, 2012). Transport poverty remains pervasive, especially in the Asia-Pacific region, due to a combination of factors such as the poor supply, design and regulation of public transport services (Kranrattanasuit, 2017; Sohail et al., 2006), the lack of integrated land-use and transport planning (UN-Habitat, 2022; Song et al., 2018; Centre for Livable Cities and Urban Land Institute, 2017), car-centred transport planning practices (Priya Uteng and Lucas, 2017), issues of safety and security in accessing transport (Hidayati et al., 2020), and high levels of social inequality that limit transport affordability (Lucas, 2012). Furthermore, transport-induced exclusion limits intergenerational social mobility by adversely affecting access to education and employment. Consequently, any policy that aims to reduce urban poverty is unlikely to succeed without addressing its spatial dimension, i.e., the geographies of transport poverty in urban regions.

The prevailing challenges are further exacerbated by the outward expansion of cities and towns, deepening the mismatch between the demand and supply of affordable transport options (UNDESA, 2021; UN-Habitat 2022). UN-Habitat stipulates that close to 70 per cent of the world's population will be urban by 2050 (UN-Habitat, 2012). Developing countries have the highest growth rates of both urban population and urban land area, with urban populations estimated to grow by two and a half times and land area expansion expected to increase by 141 per cent by 2070 (UN-Habitat, 2022). Lack of affordable housing combined with weak land-use planning often relegates the poorest urban residents to informal settlements, either in the urban fringes or physically cordoned-off locations that are characterized by poor access to social, economic and transport infrastructures (Nasrin et. al. 2019; Nasrin and Rahman 2019).

Despite consistent research findings that a host of interventions are required to make urban transport socially inclusive, urban transport planning continues to be significantly influenced by car-centric planning traditions (Gössling, 2020). A vast majority of urban residents in the Global South, by some accounts over 80 per cent, cannot afford to own motorized transport. For many urban residents, this translates to walking long distances and relying on public transport to cover daily activities.

Public transport provision in most urban areas in the Asia-Pacific region is fraught with issues related to accessibility (especially for peripheral urban areas), affordability, reliability, safety, and security. Unaffordability often results in suppressed demand among low-income households, compelling them to postpone essential trips and activities. With the limited supply and spatial coverage of the formal public transport system, urban residents are heavily reliant on popular transport, often described as paratransit services, for their daily travel needs. Paratransit or informal public transport is defined as a mode of public transportation that allows for flexibility in its temporal and spatial coverage and that is often cheaper than formal public transport. It usually takes the form of minibuses, open-box vans, autorickshaws, motorcycle taxis, tuk-tuk, sedans, etc. Paratransit services play a fundamental role by filling the gaps where formal public transport options are limited (UN-Habitat, 2022).

Besides the diverse nature of public transport supply, operational and structural inefficiencies also limit their reach. One common area of inefficiency is the mismatch between transport networks and land-use patterns. For example, initiatives aimed at improving public transport infrastructure, such as bus rapid transit (BRT) systems, have been implemented without adequate consideration of land-use planning principles, resulting in mismatches between transport networks and land-use patterns (Centre for Livable Cities and Urban Land Institute, 2017). More research and policy attention needs to be directed at improving the quality, reliability, and service coverage of these systems, as well as at contextually appropriate pathways for reform, to produce a more equitable allocation of transport resources.

Safety and perceived security for public transport and para-transit users are another major concern that diminishes pro-poor accessibility. WHO estimates that 1.2 million deaths occur in traffic each year (WHO 2023). Low- and middle-income countries are highly overburdened by traffic safety problems and are estimated to account for about 93 per cent of global traffic fatalities (Academic Expert Group, 2019). Vulnerable road users (VRUs) are the largest but most underprivileged road user group in developing countries, disproportionally impacted by traffic accidents. Creating safe environments for VRUs has a direct positive impact on several of the United Nations Sustainable Development

Goals. Security concerns are a major impediment faced by girls and women, effectively eroding their capacities to lead fulfilling lives and affecting them in multiple ways, ranging from constrained access to opportunities, compromised physical and mental well-being, being financially dependent throughout their lives, and being trapped in a circle of poverty (Hidayati et al., 2020; Priya Uteng et al., 2019; Hoor-Ul-Ain, 2020; Kondylis et al., 2020; Mansoor and Hasan, 2016; Mazumder and Pokharel, 2018).

The results of the studies of the target cities, namely Baku (Azerbaijan), Vientiane (Lao People's Democratic Republic), Darkhan (Mongolia), and Pokhara (Nepal), are included in this report. Besides the shared traits of rapid urban growth and peri-urbanization, these cities have their own peculiarities that make them ideally suited for comparative analysis and to generate new knowledge on the topic.

1.1. SUSTAINABLE DEVELOPMENT GOALS AND TRANSPORT

The United Nations Sustainable Development Goals (SDGs) have served as a measuring stick for change. The year 2030 has been agreed upon to achieve the SDGs, while 2050 has been set as the target year to meet the objectives of the Paris Agreement. Given recent disruptions such as the COVID-19 pandemic, it has become even more urgent to work simultaneously towards multiple goals, especially where the economic, social, and environmental dimensions of sustainable development are linked. The urban transport sector is one such area. Decades of research work in transport have established the fact that sustainable transport is a pre-requisite for achieving the SDGs.

Sustainable transport has been interpreted in different ways. Often, it is linked to achieving the objectives of universal access, enhanced safety, reduced environmental and climate impact, improved resilience, and greater efficiency. However, the social inclusiveness of transport is often less understood, despite its role in eradicating poverty, reducing inequality, empowering women, and combatting climate change. Additionally, it is often argued that innovations (driven primarily by new technologies), and digitalization are changing the transport landscape. While this holds true to some extent, the digital divide and technology-related exclusion run the risk of exacerbating existing inequalities, including in the field of transport (Priya Uteng et al., 2020).

For example, the interlocking of SDGs and transport can be illustrated through the case of gender and transport. Gender is integral to the SDGs, and several targets include women's equality and empowerment as both an objective and an integral part of the solution. The United Nations High-Level Panel's report entitled Leave No One Behind: Taking Action for Transformational Change on Women's Economic Empowerment (March 2017) concluded that women, society, and governments have critical roles to play in making these objectives a reality. Specific targets include SDG Target 5.2 on "the elimination of all forms of violence against all women and girls in public and private spheres."

Furthermore, urban transport is seen as a key component of inclusive cities. SDG 11.2 states that by 2030, there must be the provision of 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.

Despite increasing attention, efforts to reduce gender inequalities need further push and acceleration. Although there have been advances in equality and empowerment for women in the last decades, numerous challenges remain. Some of these challenges, particularly relating to women's mobility, were exacerbated during the COVID-19 pandemic (UN Women, 2020).

Such discrepancies can be addressed only if the interlinkages between sustainable transport, the SDGs, and their targets are well understood, not only at the sectoral level but at the inter-sectoral level as well. As UN DESA (2021) highlighted, introspection is required on how to address the currently fragmented approach, both within the transport sector and across diverse actors. This is not only necessary but urgent. It is estimated that over a billion people still lack access to an all-weather road, and only about half the world's urban population have convenient access to public transport. It should also be noted that the SDG road safety target, which aims to halve, by 2030, the number of global deaths and injuries from road traffic accidents, has not been met, with road traffic injuries being the leading cause of death among young people aged 15 to 29.

The social inclusiveness of urban transport is another cross-sectoral area which continues to be a neglected domain at multiple levels of policymaking and programme formulations. Vulnerabilities continue to be unevenly distributed across countries, population groups, and geographies. A combination of debilitating factors often coalesces to produce transport-related social exclusion, which gets manifested in constricted opportunities for certain groups (older persons, children and youth, women, low-income population, persons with disabilities, inhabitants of rural areas or informal urban settlements, etc.), and vulnerable areas like small island developing states, land-locked countries, rural and isolated communities, and so on. These factors range from insufficient infrastructure investment, limited resources, poor financial planning, poor cross-border connectivity, and greater exposure to climate change and extreme weather events.

It is often argued that the lessons learned from the COVID-19 pandemic present an opportunity to supercharge the sustainability transition towards the SDGs. However, transitioning towards socially inclusive transport is relatively difficult as the basic tenets of social inclusiveness are still not in place in a vast majority of countries, both in the Global South and North. The transition has primarily been discussed in terms of carbon neutrality. As UN DESA (2021) noted, "Commitments and pledges towards carbon neutrality made by different actors may also presage a relatively rapid transition to low carbon modes and fuels, accompanied by changes in the supporting infrastructure as well as a rapid phasing out of many current vehicle types". The risk of exacerbating inequalities or adversely impacting the environment during this transition is high.

Simplistic versions of the transition, which focus exclusively on reducing local emissions, need to be revamped, and a holistic transformation towards sustainable transport is called for. A holistic approach will need to include multiple methods and multiple stakeholders working towards a shared vision and objectives, through bringing research and practice together. This entails moving away from a singular focus on technology and economy to include lessons relevant from other fields of research and practice such as governance, innovation, tax and finance, behavioural sciences, and collective action. Governance, for example, is crucial in determining how sustainable transport is conceptualized, shaped and implemented. Several international agreements and standards have emerged in response

to environmental concerns related to the transport sector (UN DESA, 2021). These agreements have also led to legislation and regulation at national (and in some cases, sub-national) levels, but most of these agreements, legislations and regulations are focused on the environmental or economic domains, and the social part of the sustainable transport agenda has yet to be framed through such instruments. Similarly, other measures such as government and non-government certification schemes, standards, harmonization, sustainable procurement, congestion pricing and other non-market incentives also primarily address environmental and economic concerns. Both hard and soft measures need to be installed to integrate social development planning across ministries and geographic regions, along with multi-stakeholder engagement and inclusive and participatory decision-making.

1.2. SUSTAINABLE URBAN TRANSPORT INDEX ANALYSIS

The Sustainable Urban Transport Index (SUTI) was developed by ESCAP for cities in the Asia-Pacific region to assist them in assessing SDG target 11.2 and in implementing the New Urban Agenda. It is an Excel-based tool that can be employed to summarize, track and compare the performance of sustainable urban transport systems and services in cities. The index is based on ten indicators to measure elements of planning, access, safety, quality, reliability, affordability, and emissions. Indicators of different scales are normalized on a scale of 1-100 to enable the comparison of the performance of each indicator and to illustrate them in the form of spider diagrams.

In its current form, SUTI is derived by the geometric aggregation of the ten indicators, based on equal weighting. So far, the SUTI tool has been applied to measure the sustainability of the urban transport index in approximately 25 cities in the Asia-Pacific region. Some of these assessments include Colombo, Hanoi, Kathmandu, and Greater Jakarta in 2017, followed by Bandung, Dhaka, Ho Chi Minh City, Surabaya, Surat, and Suva in 2018, and Bhopal, Khulna, Thimphu, Tehran, and Ulaanbaatar in 2019. The following ten SUTI indicators form the basis of the framework and analyses (table 1).

Table 1: Description of Indicators in the Sustainable Urban Transport Index

Indicators	Description	Additional Information	Range		Weight
			Min	Max	
1	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	Experts score the public transport plans	0	16	0.1
2	Modal share of active and public transport in commuting	Modal share of users who use public transport over private motorized vehicle	10%	90%	0.1
3	Convenient access to public transport service	Number of inhabitants living within 500-metre buffer zones	20%	100%	0.1
4	Public transport quality and reliability	Users' satisfaction using a 7-point Likert scale ("Very satisfied" to "Very unsatisfied")	30%	95%	0.1
5	Traffic fatalities per 100,000 inhabitants	Number of persons killed per 100,000 inhabitants	10	0	0.1
6	Affordability – travel costs as a share of income	Percentage of users' monthly income	35%	3.5%	0.1
7	Operational costs of the public transport system	Percentage of operational costs covered by fares	22	100	0.1
8	Investment in public transportation systems	Percentage of transport investment spending	0%	50%	0.1
9	Air quality (PM10)	The city's PM10 mean annual value	150	10	0.1
10	Greenhouse gas (GHG) emissions from transport	Total emissions of GHG	2.75	0	0.1

Source: Sustainable Urban Transport Index (SUTI), available at https://www.unescap.org/our-work/transport/suti.

Using the SUTI framework, relevant data were collected through original household travel surveys conducted specifically to better understand the travel patterns of different social groups. The results of the analysis of the data collected contributed to the development of guidelines presented in Chapter 4.

1.3. INCLUSIVE TRANSPORT, ECONOMIC DEVELOPMENT AND SOCIAL BENEFITS

Transport plays a critical role in the lives of the most vulnerable groups of society by providing access t o the important functions of life and services, such as education, health and employment opportunities, which determine economic development and the well-being of society at large (Adukia et. al. 2020; Adeel et. al., 2016; Akyelken, 2013a; Akyelken, 2013b). Despite this important role, the linkages between inclusive transport and social benefits are not usually evaluated in economic terms. There are only a few studies which have tried to put a monetary value on the social impact of transport (Borker 2021; McKinsey & Company, 2015). For example, the economic repercussions and the loss associated with a forced curtailing of available labour are barely acknowledged at the national or global levels. A study conducted by the McKinsey Global Institute, "The Power of Parity" (2015), presented a compelling picture at the global level. The report modelled a global scenario where women participate in the economy as fully as men and calculated that this would add US$12 trillion to global growth – increasing annual GDP by 26 per cent compared with business as usual by 2025. Studies on gendered mobilities reveal that poor accessibility, low affordability, and security concerns are some of the major factors hampering women's access to the labour market and higher education (Muralidharan and Prakash, 2017; Patel, 2006).

1.4. DEVELOPMENT OF REGIONAL GUIDELINES

The social dimensions of urban transport planning need to be further strengthened in Asia and the Pacific to support the achievement of the Sustainable Development Goals and sustainable transport in general. Therefore, addressing such concerns, including safety, equality, and affordability, and developing barrier-free accessibility and innovative mobility services are vital for socio-economic development. The provision of quality mobility services is also a growing concern in many cities where the population is ageing rapidly. However, the needs of all transport users, including women, persons with disabilities, older persons, and low-income households, are still not adequately reflected in existing transport strategies and policies.

In addition, transport planners in the Asia-Pacific region should utilize emerging technology and innovation in response to these emerging transport challenges. They could introduce the concept of universal design and integrate new mobility options into existing urban transport systems. For example, smart mobility can help address first- and last-mile transport demand for different social groups with user-customized and on-demand mobility services. Furthermore, innovative technologies can enhance the safety, accessibility and quality of public transport services in cities.

To enhance the capacity of transport policymakers and planners in Asia and the Pacific to use emerging technologies to plan and operate more socially inclusive and innovative urban transport systems, regional guidelines were developed. They draw on lessons learned from four urban

transport national assessments in Azerbaijan, Lao PDR, Mongolia, and Nepal, followed by a series of consultations with ESCAP member States, first in the form of an Expert Group Meeting in October 2023[1] and later in a Regional Meeting in June 2024. [2]

The guidelines chart out pathways to transform the way mobility systems are being conceptualized, produced, distributed and utilized by all. Key themes that inform the guidelines include transport justice, accessibility and public transport, vulnerable groups, and governance. Finally, the guidelines assist decision-makers in developing a transport policy framework for improving social inclusion and innovations through strategies on data availability and gap assessment; economic analysis; communications; organizational structure; physical design, and behavioural change.

1 https://www.unescap.org/events/2023/virtual-expert-group-meeting-enhancing-social-inclusion-and-innovations-urban-transport

2 https://www.unescap.org/events/2024/regional-meeting-enhancing-social-inclusion-and-innovations-urban-transport-systems

Chapter 2

INCLUSIVE URBAN PUBLIC TRANSPORT SYSTEMS

2.1. INTRODUCTION

Transport researchers and urban planners have long been interested in the role of transport in social development. Early transport scholars in the 1950s and 1960s observed the impact of various mode choices on urban development. Many studies argued in favour of improving public transport modes such as urban bus systems (Mandl, 1980), as buses can carry more passengers while utilizing less land compared to private vehicles (Anas and Moses, 1979). Early studies focused on how to design a more efficient transport system to reduce congestion and facilitate faster mobility. These economic rationales were later succeeded by environmental concerns in the transport sector, thereby allowing two pillars of sustainable development, namely the economic and environmental pillars, to move forward. However, the third pillar of social sustainability has not been as well developed as the other two. Consequently, the sector often fails to distinguish between different user groups' travel needs, behaviour and demand.

This chapter investigates how planning can support social inclusion through a series of selected case studies and best practices. The chapter focuses on both research and policy tools, namely, 1) studying and understanding differentiated mobility; 2) developing policies and programmes to ensure safe and inclusive mobility; 3) ensuring personal security in transport and public spaces; 4) empowering women, people with disabilities, children, older persons and low-income populations in the transport sector; and 5) stimulating behavioural changes. These thematic areas will be discussed from the perspective of physical and transport planning, specifically with a focus on how planning for mobility[3] can guarantee positive changes in access to education, health and employment opportunities.

[3] Transport is distinct from mobilities. Mobilities encompasses dimensions like access to opportunities, life chances and well-being. The recognition of a new society framed by the convergence of various forms of mobilities has been established through understandings of 'sociology beyond societies' (Urry, 2000) and the 'new mobilities paradigm' (Sheller and Urry, 2006).

2.2. INCLUSIVE TRANSPORT SYSTEMS: BACKGROUND AND STATUS OF KNOWLEDGE

2.2.1. Access to education

Insecure, unaffordable and unsafe transportation often traps children and young people from low-income households in the developing world into a vicious circle of deprivation, particularly through poor access to education (Porter and Turner, 2019; Singh et al., 2018). Urban areas of the Asia-Pacific region are no exception. Such deprivations are often compounded in the case of children or young people with disabilities. Poor access to educational institutions due to poor physical connectivity to public transportation, unsafe travelling conditions, difficulties in travelling with disabilities, or the constraints on the mobility of young girls and women due to domestic circumstances, further contributes to young people's low educational achievements. Cook et. al. (2005) demonstrated that it is more likely for parents in India, Thailand and China to allow girls to carry on with their education if transport services are perceived to be reliable and safe. In another study, Borker (2021) concluded that a correlation existed between young women's college choice in Delhi, India, and their perceptions of route safety, despite the higher transport fares involved. Meanwhile, a study from Chennai, India, found that research participants reported 14 years as the mean age at which they first encountered harassment in travel contexts, and incidences of harassment compounded in late evenings (Mitra-Sarkar and Partheeban, 2011).

Porter and Turner (2019) noted that based on the available material, school pupils from low-income households make more substantial use of informal public transport, bicycling and walking, which exposes them to more traffic injuries. Across the Asia-Pacific region, most roads still lack separate lanes for cyclists or adequate crossings for pedestrians, while motor vehicle speeds are too high (Wismans et. al. 2016). This concern is becoming graver, as 1) cities are expanding in the Asia-Pacific region, leading to increased distances to schools and educational institutes (Li and Zhao, 2015; Zhang et al., 2017); 2) rapid urbanization is accompanied by a rapid increase in personal high-speed motorized transport, rendering walking and bicycling unsafe for children and increasing speeding by young people, which often leads to severe traffic injuries or death (Kitamura et al., 2018); 3) subsidized transport for pupils is far less widespread in low- and medium income countries (Porter and Turner, 2019) and is sometimes marred by severe exclusionary behaviour towards the students; and 4) sexual harassment in the first-last mile, in waiting areas and inside public transport, is a major concern for young girls and women to access educational facilities (Priya Uteng et al., 2021).

Each of these issues can be further unpacked to explore the nuances of how a lack of social inclusion lens in the transport sector is leading to poor access to education. For example, the case of subsidized transport in urban settings, where most public transport services are run by informal shared mobility providers, often leads to harassment of pupils. Sohail (2000) reported that students are often harassed and barred by bus conductors from boarding the buses in Karachi, Pakistan, as they are required to pay only half-fare.

Some studies have concentrated on rural accessibility. However, with the expansion of urban areas, peri-urban, semi-rural, and city fringe zones should be brought into mainstream urban transport plans.

Studies have repeatedly highlighted that road improvements and interventions like bicycle provision in Asia appear to have improved girls' access to education, even more than boys, as Mohsin et al. (2012) showed for Bangladesh, Pilgrim and Chanrith (2012) for Cambodia, and Muralidharan and Prakash (2017) for India.

2.2.2. Access to employment opportunities

The prevalence of employment in the informal sector is noteworthy in Asia, being as high as 65 per cent in some countries (Carr and Chen, 2004). Paratransit, non-motorized vehicles, and a variety of informal modes of transport constitute a major share of the modal split in the Asia-Pacific region and are often the carriers for people working in the informal economy (Priya Uteng and Lucas, 2017). The lack of affordable public transport, combined with strategies to remove non-motorized modes like bicycles (Hasan and Davila, 2018), poses a big setback to the daily mobility and employment of people in the informal sector. Often with zoning legislation separating commercial from residential areas, the group with the lowest mobility are unable to market from their homes and are dependent on others to sell their products, reducing their control over the profits. Furthermore, the lack of transport services at times suitable to women or informal sector workers, the poor personal security of women on public transport, and inaccessibility in the design of the public transport faced by persons with disabilities and other user groups, also impact their freedom of movement. Though a string of problems exists for workers employed in the informal sector, difficulties in access to existing employment opportunities are compounded by the fact that there are not enough affordable housing or transport facilities in easily accessible areas for workers on limited wages and persons with disabilities in low-income households in the Asia-Pacific region (Niño-Zarazúa and Torm, 2022; Truong et al., 2017).

There are multiple variations of limited access to employment opportunities in the Asia-Pacific region. For example, home-based garment manufacturing presents a pertinent case. This sector is primarily run by women in South Asia, but rather than being employed in factories or export processing zones, these women run the production units from their homes. Access to markets is therefore a critical factor for them.

In the Asia-Pacific region, multiple microenterprise credit programmes have sprung up to provide "informal" financial mechanisms for women and persons with disabilities. To illustrate the effect of variation in mobility levels on the economic outcomes for both workers in the informal sectors and participants in micro-credit schemes, studies show how participants are excluded from direct participation in markets and profits due to mobility constraints (Kantor, 2002; Kulkarni, 2011; Bayulgen, 2015; Linn, 2021; Khursheed, 2022). These studies insist that development plans cannot ignore mobility when designing interventions to improve livelihood outcomes of vulnerable producers in the informal sector, which often includes low-income women and persons with disability. Based on the sector's market characteristics, one potentially important intervention is to improve access to the range and quality of markets. Since these issues do not typically get prioritized in development agendas, there is also a lack of studies presenting the current status of the role which transport

accessibility plays in poverty alleviation programmes. In an assessment of microcredit schemes in five countries, namely, Nepal, Viet Nam, Egypt, India, and Kenya, it was found that the lasting impact of credit in reducing the worst manifestations of poverty can be enhanced when it is combined with basic social services and key social development (Nigam, 2000). To that end, access to market and repayment nodes, and basic education and training, are among the most vital elements. Women and people with disabilities often lack direct access to markets to sell their products, access training opportunities, and make networks to access information.

Additionally, the spatial dimensions of transport poverty in the urban areas of the Asia-Pacific region cannot be ignored, as transport plays a crucial "cause and effect" role in the access to employment opportunities, especially in contexts where public transport availability is limited or unaffordable. Furthermore, ways in which accessibility intersects with employment opportunities for both older persons and persons with disabilities remain an understudied topic. Both age and disabilities, like gender, are factors that cut across mobility, access to opportunities, and services from both operational and employment perspectives (Kett et al., 2020).

Employment in the transport sector itself remains highly gender-unbalanced across the Asia-Pacific region. Cases like India's motorbike taxi service Bikxie and Nepal's Safa tempo-drivers are extremely rare due to cultural constraints, perceived safety and security issues, lack of infrastructure provisions for women (such as separate toilets), and the lack of regulatory frameworks for women operators and workers.

2.2.3. Access to Health Services

The lack of transport facilities and the consequent lack of timely access to health services pose a major impediment in many countries in the Asia-Pacific region. This is especially detrimental to the reduction of child and maternal mortality (Patel et al., 2018; Vadrevu and Kanjilal, 2016). Although this topic has been primarily explored in rural regions, it is also an urban concern where slums have severely compromised transport accessibility during emergencies and face affordability issues due to the lack of community-based ambulance services (Priya Uteng, 2012; Priya Uteng and Turner, 2019).

Studies have established that quite often transport barriers make the requisite obstetric care inaccessible for women during pregnancy and at birth (Mian et al., 2015). In an explorative study undertaken in Pakistan to identify which transport interventions have the potential for scalability, the authors highlighted that community-based ambulance services, which were managed with the support of the community and had a relatively simple model, had high scalability potential (ibid). This suggests that locally embedded solutions need to be recognized and bolstered.

Ageing and disability further compound the issue of access to health services. In Thailand, the mobilities of persons with disabilities were hampered by poor physical infrastructure unless they could be specially transported for the entire journey, which was prohibitively expensive for most people (King and King, 2011). In many countries in the Asia-Pacific region, there is often a mismatch between the daily mobility needs of vulnerable populations and the provision of transport infrastructure. At the micro-scale, roads often lack footpaths and ramps and other features that would assist persons

with disabilities and older persons, or the footpaths are in poor conditions, blocked by vehicles, rubbish, vendors or roadside furniture. Crossing the road can be challenging because of poor compliance with traffic signals, crossing signs, lane or direction compliance, a high proportion of two- and three-wheeled vehicles, and deteriorating road surfaces (King and King, 2011). At the macro scale, without accessibility mapping, there is no oversight as to how the lack of integration between land use planning and transport constrains the mobility of older persons and persons with disabilities and their access to health facilities (Cambodian Disabled People's Organization, 2013).

2.2.4. Safety, Security and Stress in Public Transport

Both unsafe and insecure conditions are often accompanied by unpleasant emotions (e.g., fear, anxiety or stress) caused by anticipation or awareness of danger. People's feelings about safety and insecurity on public transport are often related to an individual´s perceived risk of being exposed to crashes and injuries, crimes or insults, incidences of sexual harassment, and/or transmissions of infection and diseases (Dong et al., 2021). Perceived safety can have a positive association with general travel satisfaction, implying that the higher the level of perceived safety, the higher the level of general satisfaction (Friman et al., 2020). Perceived safety is also a prerequisite for high overall travel satisfaction (Sukhov et al., 2021). An analysis of dislikes about public transport found that safety was the most cited concern (Stradling et al., 2007).

In line with research revealing the importance of emotions in risk assessments (Loewenstein et al., 2001; Slovic and Peters, 2006; Dong et al., 2021), anxiety (feeling nervous, tense, worried, and frightened) has a direct negative effect on perceived safety in public transport. Qualitative data (Stradling et al., 2007) can highlight the unwanted stress and anxiety observed in less safe situations. Examples are anxiety when travelling at night or while waiting at the bus stop, or when other passengers seem threatening during travel. Currie and Delbosc (2013) demonstrated that psychological influences, that is "feeling comfortable with people you don't know on public transport," had the largest individual influence on perceptions of safety.

Furthermore, women and girls around the world are subjected to varying degrees of gender-based violence, assault and harassment both in public transport and during its first and last miles (Hollaback and The ILR School, 2015). A large-scale survey of street harassment in 42 cities around the world in 2015 revealed that approximately 84 per cent (from a sample of 16,600 female respondents spread across the world) had experienced street harassment for the first time before they were 17 years old (Hollaback and the ILR School, 2015). In India, 91 per cent of women felt that public transport was very unsafe, unsafe or somewhat unsafe (Shah and Raman 2019). Another study from three main metropolitan areas in Penang, Malaysia, revealed that most women feel insecure while waiting at bus stops; when they are not comfortable with services; when there is no indication of security; and when they receive no information about the bus services (Sham et. al. 2013). Women's perceptions of security while travelling on buses influence their modal preference for buses, and fear and security concerns cause women to shift from public transportation to less sustainable, private transport modes (Verma et al., 2017). Security concerns have thus been shown to have a negative impact on livelihoods and physical and emotional well-being by limiting access to education, work, and leisure, and by restricting the use of public space (Borker, 2021; Whitzman, 2007).

2.3. TRAVEL BEHAVIOUR OF DIFFERENT USER GROUPS

2.3.1. Older persons

The issue of daily mobility, ageing and their mutual interlocking has been studied in different countries (Gorman et. al. 2019). The World Health Organization's World Health Survey (2002-04) indicated that more than 60 per cent of older people in low- and middle-income countries did not access health care due to a combination of the cost of the visit, lack of access to transport, or difficulties in paying the transport costs. Apart from accessing services, constrained mobility has a severely debilitating effect on the quality of life for older persons. The WHO "Study on global AGEing and adult health" (SAGE), involving countries in Asia, Africa and Latin America, identified the most burdensome functioning domains in depression and their impact on the quality of life for older persons (Kamenov et al., 2016). It was found that constrained mobility was a significant factor leading to reduced quality of life. A lack of self-confidence in physical capacities, leading to a perceived risk of falling, as well as concerns regarding traffic safety and personal security, have also been identified as limiting factors (Gormon et al., 2019). This fear of crime and concerns over the safety of public transport are limiting factors in older people's mobility in different settings (Lloyd-Sherlock et al., 2015). Even among the physically active older population who can conduct activities in their daily lives on foot, the fears of falling and of crossing the road in busy urban areas can lead to decreased physical activity and consequently affect self-perceived health and mental well-being, often leading to depression (Whitzman et al., 2013).

The availability of high-quality data is a basic requirement for urban planning. As Wismans et al., (2016) pointed out, even though a significant proportion of victims of road traffic accidents are older persons, research on the impact of traffic accidents on older persons remains undeveloped in the Asia Pacific context. A study in Papua New Guinea further illustrated this point by examining the impact of road development on persons with disabilities (Whitzman et al., 2013), which is equally applicable to frail older persons or those with varying levels of debilitating health conditions. The study found that while road development improved service access, inaccessible road and transport infrastructure remained insurmountable barriers to easy and safe travel. Furthermore, roads were being planned for the needs of vehicle users, and planning around road infrastructure did not involve consultations with persons with disabilities (Whitzman et al., 2013).

Other studies undertaken in urban settings in Pakistan and Malaysia found that age and gender, together with other factors such as car ownership, travel time, travel cost, household size and income, significantly influenced individual choices in transport. The intersection of gender with age further exacerbates the problem due to both social and structural constraints (Nurdden et al., 2007). It was also found that trip-making increases with private car ownership, and that older men make significantly more journeys than older women (Nurdden et al., 2007). These studies focused on higher-income households and demonstrated independent mobility through interactions between car ownership and travel frequency, but despite these trends, there were significant differences by gender. Such differences are more pronounced for low-income households and in settings where passenger trips are primarily taken on public transport, such as buses, rickshaws, and other informal modes. For example, about 88 per cent of all passenger trips in 2014 were on public

transport, such as buses and rickshaws in Dhaka city, Bangladesh, while only 12 per cent of passenger trips were on private vehicles such as cars, jeeps, and motorcycles in the same period (ESCAP, 2018).

The intersection between health benefits and active travel is also a relatively unexplored theme in low and middle-income countries, although some evidence exists. Gorman et al. (2019) highlighted that there is a correlation between increasing age and reduced active travel (walking or cycling), translating into a higher risk of being overweight and having a raised BMI. Similar findings have also been reported from peri-urban areas of Nepal (Vaidya et al., 2014). Another pertinent issue relates to traffic accidents. Despite the high shares of walking in the Asia-Pacific region, the high incidences of road traffic accidents undermine the sustainability of this mode. A better understanding of the intersection of road traffic accidents and ageing would facilitate the development of policies to promote the independent mobility of older persons through walking, cycling and public transport use (Wismas et al. 2016).

2.3.2. Persons with disabilities

Persons with disabilities generally make fewer and shorter trips; drive less and rely more on transit and non-motorized modes; make travel decisions to maximize utility under physical, financial and psychological constraints; and are affected by built and social environments when making travel decisions (Shen et al., 2023; Park et al., 2022; Takamine, 2004). For persons with disabilities living on relatively lower-incomes, access to public transport continues to be problematic, and despite the prevalence of walking, there is very little literature or policy focus which discusses the impact of walking or other innovative modes on persons with disabilities.

A comparative study plotting local accessibility in the United States of America, United Kingdom and Hong Kong, China, highlighted that the perceived safety and levels of service for persons with disabilities are remarkably enhanced after the introduction of accessible design of transport stations or bus stops (Sze and Christensen, 2017). Interactions between the built environment and walking were found to affect levels of satisfaction and perceived safety and security, especially for persons with disabilities and older persons. Accessible design should be implemented from the perspective of an integrated network approach, and priority should be given to passenger concentration points in the multi-modal transport system.

Due to the ease of usage and convenience, persons with disabilities tend to adopt car-based mobility in their daily lives if socio-economic conditions allow for it (Behrens and Görgens, 2019). Apart from the independence, autonomy and safety that private vehicles provide, other factors discourage the usage of public transport. Some examples are the poor availability of transport services, a lack of confidence in using the services, and fear of driver and co-passenger attitudes.

Placing progressive legislation in place to enhance the rights of persons with disabilities has to be followed by interventions to ease access and usage of public transport. Alternative forms of public transport, such as taxi minibuses, pose additional challenges ranging from inaccessible vehicles to the rude behaviour of other passengers, drivers and staff. Measures that could create a more inclusive environment for persons with disabilities include the provision of financial incentives, training

to encourage taxi drivers to pick up passengers with disabilities, disability awareness training, and subsidized fares for people with disabilities (Lister and Dhunpath, 2016).

2.3.3. Women

Transport infrastructure and services are usually not designed with respect to the different travel patterns and needs of women and men (Priya Uteng, 2021; Priya Uteng and Turner, 2019; Mahadevia and Advani, 2016; Verma et al., 2017; Verma et al., 2020; Zolnik et al., 2018). It is essential to first acknowledge and understand that women and men have different transport behaviour, preferences and constraints.

Women's travels are multi-purpose, complex, resource-constrained and often undertaken in off-peak hours. Accessibility to health, education and employment opportunities remains constrained for women due to several social, physical and economic reasons. Transport planning has concentrated primarily on facilitating personal motorized mobility, undertaken in fixed time-space (peak-hour) trajectories. Walking and public transport (both formal and informal) are the most used transport modes. Women also undertake more trip-chaining and have more multi-modal travel patterns than men.

The issue of affordability restricts women to some extent. Constraints on women's mobility keep them away from income sources and services, with negative implications for both economic and social development. Security issues on public transport and in public spaces are critical, especially for women, who may also encounter cultural restrictions placed on their mobility, influencing the time, space and duration of their transport demand.

Transport interventions are needed to facilitate women's access to markets and jobs and to facilitate their access to services (e.g., health centres, schools, childcare centres, and commercial centres). Additionally, the transport sector itself can be a source of employment for women, contributing to livelihoods while also influencing norms within the field of transport to be more mindful of women's needs and preferences. Traditionally, the norms governing the transport sector remain heavily male-dominated in terms of both employment and technical orientation. Issues regarding personal security, traffic safety, affordability, accessibility, availability, acceptability and accommodation need to be taken into account in transport design and planning.

The ways in which different groups of women engage with different forms of mobility vary according to life stage, personal conditions, and contextual circumstances. Knowledge about user differences can offer tools to integrate sustainable practices so that the daily mobility needs of different groups can be mainstreamed.

2.4. OBSERVATIONS FROM TARGET CITIES

Four cities, namely, Baku (Azerbaijan), Vientiane (Lao PDR), Pokhara (Nepal) and Darkhan (Mongolia) were studied to investigate how inclusive transport was being taken forward in their respective contexts. The participating cities provided details on the basic urban and transport structure and composition of the city area, as well as on land use zoning, the structure of the formal transport and road system,

vehicle composition, population structure (density, gender and age, number of persons with disabilities, average household size, etc.) and population projections, housing types, socioeconomic status, employment structure, industrial composition, and so on. Each city also conducted a SUTI assessment as noted in Section 1.2.

Travel behaviour surveys were also conducted to establish a benchmark for developing regional guidelines. All case cities have witnessed increased levels of urbanization and motorization in the past few decades, and the rate of motorization has been rapid since 2000. For example, in Darkhan, the number of registered vehicles doubled from 15,696 in 2012 to 31,283 in 2021. This is partially because the supply of public transport has been lagging (there are only six bus routes in the city). Apart from spatial constraints, temporal constraints (limited operating times) also mar public transport ridership in these cities.

The cities follow a standard planning approach for conducting their urban development assessments, which typically consist of 1) an engineering assessment, 2) an environmental assessment, 3) a social and economic assessment, 4) an infrastructure assessment, and 5) a spatial planning, territory, and landscape assessment. However, there are currently few intersections between these assessments, development goals and an inclusive transport planning agenda. All cities operate under clear guidelines on highways and road constructions, mostly emanating at the national level. For example, the law "About Highways" of the Republic of Azerbaijan establishes the general basis for legal, technical, economic, and organizational design philosophies, constructions, uses, contents, protection, and development of highways and the related engineering constructions, and management of road economy. The transport sector is often simply linked to the engineering details of road and railway construction, and hence the technical, economic (cost-benefit assessments), institutional and legal details are very much in place.

Inclusivity is often understood primarily as adopting universal design principles. The framing of accessibility is also limited to micro-level assessments, which feed into universal design adoption. For example, Baku details its accessibility portfolio by highlighting the presence of ramps and elevators at transit hubs to facilitate movement of persons with disabilities and people with baby strollers; instalment of tactile pavement for people with visual impairments to facilitate entry to stations and platforms, and availability of reserved seats for persons with disabilities in double-decker trains. Furthermore, the safety and mobility of pedestrians in Baku increased by 22 per cent between 2015 and 2021. This increase has been linked to the installation of 191 street ramps, 167 street safety bollards and 136 street guard railings, which in turn were the result of the adoption of universal design principles. Such principles need to be further expanded to include safety and security concerns, as well as gender equality.

A better understanding of the travel behaviour of all transport user groups would provide a comprehensive overview of travel patterns, needs and constraints for the development and implementation of inclusive transport policies. Hence, regular data collection through travel behaviour surveys should be established in transport planning and policy-making processes.

Smart mobility solutions have been employed in automatic toll collection, traffic control centres, big data to analyze bus traffic, vehicle tracking, smart card payment systems, apps for public transport, and information sharing. However, in most countries, big data is not yet being deployed to understand the travel behaviour of different social groups.

2.4.1. Observations from Mongolia

A workshop was organized on 8 November 2023 in Ulaanbaatar to discuss the topic of social inclusion and innovations in urban public transport systems. Different stakeholder groups represented different levels of governments and transport user groups, including persons with disabilities participated in this workshop, and what emerged was a corroboration of the various findings presented above in this chapter.

Workshop participants were given a short introduction to the draft guidelines being developed in this study and were asked to discuss current opportunities and challenges in the urban transport sector in Mongolia. The discussions were carried out in the native language. A summary of the main findings is presented below.

Data collection and analysis

There is a general lack of data on the travel behaviour of different groups, and since available data have not enabled extensive research on the topic of social inclusion and innovation in transport, original surveys were conducted for this project. To develop simple, standard indicators to monitor the progress of inclusive transport planning, there is a need to direct human resources and funding into systematic research. This should be matched with clear conditions for investment and financing that target the goals of inclusive urban transport. Developing indicators to assess and monitor the service quality of urban public transport was also highlighted. There is also a lack of information exchange between different sectors, and cross-sectoral data analysis rarely happens, making it difficult to address transport-related social exclusion.

Regarding the collection and analysis of traffic-accident data, it was highlighted that there is no organized system for collecting data related to traffic accidents. Currently, only the number of accidents is reported, and these reports are typically not followed by analyses. The participants recognized that a better system for both reporting and analyzing accident data is needed, and data analyses can then be further utilized to inform preventive work and long-term planning.

Economics of inclusion

Public transport fares for older persons, persons with disabilities, and students are paid by the government. Currently, there is no system for making decisions based on cost-benefit analysis in Mongolia. In order to truly assess the costs and benefits associated with the various decisions being taken, workshop participants expressed the need for a streamlined process to rationalize decisions. Since the entire cost of public transport is being borne and subsidized by the government, stakeholders emphasized that there was no need for multiple operators. Rather, a clear set of criteria and system for selecting qualified operators needs to be built into the current procurement system.

Gendered mobility

There was unanimous agreement among the participants that public transport was used much more extensively by women than by men. However, ways in which availability, affordability, acceptability, and accessibility of public transport intersected with women's participation in society was a topic which needed further analysis. Participants also expressed the need to introduce women-only public transport services. Another vital point regarding relocation and related issues was that compensation for land acquisition was expressed solely in terms of money and thus issues like connectivity with public transport or established networks were typically not considered in relocation decisions. Framing human-centred urban and transport planning decisions remains a challenge.

Opportunities for a better mobility scenario

Participants recognized the importance of affordable and connected public transport and drew up a list of opportunities and challenges. The list included a wide array of opportunities, such as making repeated payments without accessing a card, different forms of reminders to facilitate the use of public transport, developing a code of conduct for behaviour on public transport and embarking on educational campaigns, revamping public transport frequency and campaigns related to public transport usage, pricing of tickets, and safety and security both onboard and while accessing public transport. It was noted that each topic needed a detailed context-based study. There is also an insufficient supply of buses to cater to the current demand for public transport, and available buses are perceived to be of poor quality.

Smart interventions are needed to upgrade existing bus services in Mongolia, based on a judicious mix of digitalization and a needs-based approach. While popular interventions like smart apps and gate automation were mentioned, a variety of creative interventions were also named. For example, it was mentioned that part of the social care assistance could be transferred directly to the smart card, which in turn could facilitate daily mobility. Similarly, smart solutions like ridesharing certainly have a demand in Mongolia and should be further explored. Apart from these smart solutions, it was deemed important to promote a culture of walking to work if possible. It was also mentioned that some of the current smart solutions were not accessible to some of the target groups of the study.

Transport governance

There is a general lack of inter-sectoral coordination, and the stakeholders expressed a need for integrated development programs. For example, traffic accident and incident logs are not synchronized, and the industry's big-data storage is not being put to optimal use. The current regulatory framework also needs to be further modified to curb the exponential growth in traffic and shift future traffic growth from private to public transport. To this end, solutions, such as tightening penalties, strong controlling mechanisms, introducing regional fees for car driving and digitalizing traffic accident data, were mentioned. Stakeholders expressed a need to link topics like social vulnerability and poverty, which are currently being discussed in Mongolia, to the urban transport sector. It was deemed important to work towards reducing the loss of lives and the exposure of children to traffic-related dangers.

Another important point which was raised related to the male-dominance of the transport sector. It was mentioned that certain amendments to laws and regulations were needed to promote female participation in the transport sector. The provision of clear communication channels, training, adjustment

of working hours, policy support, and a revised policy for education were identified as the crucial elements for a revised structure. Furthermore, multiple issues were raised on the current state of public transport in Mongolia, ranging from training programmes, results-based learning and traffic safety, the lack of electric buses, and the lack of trained drivers for electric buses and trucks, to establishing a cohesive structure which does not get influenced by changing political scenarios.

Engaging with people, campaigns and monitoring mechanisms

Since there is a general perception in urban Mongolia that public transport is for the poor, it was deemed necessary to utilize campaigns, training workshops, etc., to shift public perceptions of public transport. To this end, both budgetary allocations and other means of promoting public transport are important. For example, the participants expressed the need to organize events for parents to set an example for their children.

The current monitoring and feedback mechanisms were found to be lacking in transparency and often follow-up actions. There was a need to clarify and delineate responsibilities which could then be monitored through a set criterion for monitoring and evaluation. Building e-literacy training programmes for citizens, combined with strong advertising, could enhance social participation in the sector.

Social participation of different groups of people, especially vulnerable sections of the urban population, was also found to be missing in the urban transport sector, which resulted in a lack of locally sensitive transport policy. Ways in which innovative solutions could be launched in both digital and non-digital versions need further attention. This could be taken forward by establishing a department that is specifically in charge of public transport and coordinates with other development sectors.

2.4.2. Observations from Lao People's Democratic Republic

A national workshop was organized on 15 – 16 February 2024 in Vientiane, Lao PDR, where different stakeholder groups were represented, including city and national governments, academia and civil society. Some concerns raised in Lao PDR overlapped with those raised in Mongolia.

Data collection and sharing

In addition to the lack of data availability, concerns were raised regarding the lack of data management plans, cohesive data collection methodologies and standards, and clear objectives for data collection. Since inter-sectoral data sharing was lacking, it was proposed that a comprehensive project should be implemented to collate data from diverse sectors that could be analyzed under different thematic topics like accessibility or infrastructure to reflect current travel behaviour by different social groups. Given the lack of connectivity between different transport modes, a dedicated public transport plan needs to be drawn up, which should have suitable budget allocations, a data management plan, tools and capacity building as core modules.

Campaigns, training and pilot projects

Efforts towards campaigns targeting behavioural shifts also need to be put in place. Currently, there is a gap between the existing laws and prevalent practice, which could be a result of unclear laws and regulations. There is a need to steer programs towards the development of policies, infrastructure,

educational systems and inter-sectoral coordination to prioritize multi-modal public transport. The participants expressed the need for pilot projects in various domains of urban public transport. These pilot projects could be designed around educational modules, campaigns, data collection, gathering feedback from the public, decision-making tools, and training courses for delivering good services on public transport, to establish a benchmark module covering different aspects of inclusionary urban public transport.

Fundamental transport challenges

Fundamental transport challenges, such as traffic congestion and parking, as well as the low level of public transport ridership, were also raised by the workshop participants. Such challenges need to be addressed simultaneously with improvements in the social inclusion and sustainability of transport. New transport projects, such as the Bus Rapid Transit line in Vientiane, can also serve as opportunities to increase public transport ridership while improving the inclusiveness of transport.

2.4.3. Observations from Azerbaijan

Some new highlights emerged from the workshop held in Baku, Azerbaijan on 28 – 29 March 2024 that are unique to their national characteristics and local context.

Updated standards and data management plans

One of the main issues raised in Baku concerned outdated standards and norms. Soviet standards regarding vehicle and pedestrian infrastructure often pose challenges for installing bicycle lanes. There is a need to review these outdated norms and standards in light of creating socially inclusive urban transport solutions. As an example, it was cited that national standards were needed for pedestrian lighting. Apart from making consistent standards for the country, there was a need to develop a database and framework for the region. Countries could then further modify the guidelines to suit their context but operate within the main framework provided for the region and member States. In short, regional and subregional integration needs to be further improved.

At the country level, the participants stressed the need to create data management plans which specify which data can be shared and publicized, how to categorize the sensitivity of datasets, and how to protect sensitive data under the privacy law. Currently, both private and public sectors are unclear about which data sets can be shared. Maintaining data transparency was also highlighted as some private organizations collect data for financial gains. This could be linked to an ongoing exercise, where a council along with multiple agencies was established a year ago to coordinate the transport system. This council meets once a month to facilitate discussions in the urban transportation sector.

A host of innovative solutions are either already in place or soon to be launched in Baku. It is imperative to design transport policies based on the data being generated by these systems (e.g. Speed Detection Camera System generating data on average speed, number, size of the vehicles, road capacity etc.) to make urban transport socially inclusive. Similarly, CCTV data can also be used to monitor roads, road congestion, accidents, road maintenance, closed or redirected roads, and broken vehicles. The accident registration system of traffic police can also be further exploited to detect problematic areas, generate detailed information on accidents, and frame suitable recommendations for improvements and solutions.

Transport governance

As in the case of the other national workshops, budgetary constraints, especially regarding implementing inclusive transport projects, were mentioned. Other governance issues were also discussed, such as technology innovation and the cooperation of public and private sectors, and supportive interventions like legislation revision, tax concessions, and budget minimization. It was deemed to be imperative that a cross-ministerial focus be established on the topic of social inclusion in urban transport, as issues around disability, age, education, and gender fall under the purview of line ministries beyond transport.

In addition to the traditional focus on universal design, it was deemed important to set up accessible maps and design mobility applications for persons with disabilities. Similarly, simplified ticketing solutions for multi-modal systems could factor in discounted tickets based on different criteria. Given that Baku is beginning to introduce technologies like QR codes, bank card payments, etc., there was a general concern about optimizing and centralizing the operations.

Administration and enforcement were also highlighted as being important for bringing positive behavioural changes in society. Since an increase in vehicle traffic was identified with multiple transport woes affecting Baku city at large, a few grounded recommendations from the participants included providing school buses to reduce private vehicle usage and increasing safe conditions for walking and cycling.

Smart solutions

The participants emphasized that Baku needs an intelligent transport system to regulate its transport and build itself as a smart city. They also highlighted that currently projects are being developed to set up a smart system that will integrate feeds from all cameras and automate surveillance. There was a general perception that CCTVs and visual facial recognition systems, in combination with active enforcing agencies, would contribute to greater security in urban public transport systems. However, surveillance systems need to be enhanced in privately-owned public transport, where more monitoring is required. Additionally, an integrated database is needed to be able to connect the different information sources. In general, there was a strong emphasis on technology-based innovative solutions like adaptive management of the traffic lights, and sensors for collating accurate information. Currently, a mobile application is under development which will assist transport users to identify alternative routes. It was proposed that this application could be further enhanced to incorporate complaints and proposals into a database, which will be made accessible to different agencies working towards enhancing social inclusion in urban transport.

The topic of social inclusion was also discussed in the context of electric vehicles. There was a need for further research on electric vehicle demand, which could shed light on questions like who and which areas would benefit from electric vehicle policies.

Education, campaigns and monitoring mechanisms

It was mentioned that campaigns and education could identify suitable training for different social groups. These could be launched at the national level through video recordings played in public transport, diploma programmes, as well as training and exchange programs as part of the curriculum of urban and transport planners, engineers and allied fields. Additionally, more work is required to educate transport

engineers and modellers to illustrate how results from modelling exercises can be used to design inclusive projects. Currently, there is a lack of knowledge in the modelling of inclusive transport projects or policies.

Furthermore, monitoring and feedback mechanisms could be built into mobile applications, online systems, etc., which are easily accessible to the general population. Developing such a single mobile application for feedback and monitoring could also be modified to gather information about social demographics, including age, gender, and usage intensity. Elements of social exclusion that exist in the system would then need to be eliminated. For example, there is currently a lack of payment integration, optimal route maps and integration of mobility options which are easily accessible to transport users of all social groups.

Legal frameworks also need to be updated in light of the innovations and technologies taking place in the transport sector, which should be extended not only to emerging tools but also to the domains of education and training. It would be beneficial to build a portfolio of best practices in this regard, drawing on examples in the Asia-Pacific region, such as from Singapore, the Republic of Korea and other countries, which have made significant advances in this field.

2.4.4. Observations from Nepal

The Nepal workshop, conducted in Kathmandu on 3 – 4 April 2024, reiterated many similar issues as highlighted in the previous three workshops.

Data collection, analysis and standards

The absence of routinized data collection and analysis was one of the common primary concerns. Currently, updated travel behaviour data, either in dynamic or continuous form, are not readily available for research or analysis, and are often not linked to decision-making in the transport sector. The current data collection comprises traffic accident data collated by the police, but even for traffic accidents, there is no integrated system for data collection and reporting which is capable of linking hospital and police data on crashes, collisions, and emergency handling in response to traffic accidents.

While it was mentioned that national standards, dedicated institutes and agencies are needed to take responsibility for data collection and analysis, it remains unclear which agency should take the lead in collecting and analyzing data. Participants highlighted that different organizations are conducting their own surveys, but there is a lack of coordination between different government departments and authorities, and it is also difficult to procure data from these surveys. As a result, both data formats and analysis processes are challenging. There needs to be discussion at national, regional and local levels on how to simplify data collection and analysis processes.

It was suggested that both dedicated budgetary allotments and capacity building are required for regular data collection and analysis, and subsequently, these analyses need to feed into channels of decision-making. Currently, there are no simple indicators available for monitoring urban transport to be able to reflect on its inclusive or exclusive nature. It was recommended to introduce simple indicators and standards, which are drawn from international best practices but are suitably tailored to reflect the local context.

Prioritizing public transport

There was a general agreement that more reliable, safer, more convenient and affordable public transport services are required. Stakeholder consultation could be a starting step. It was highlighted that there is currently a lack of consultation with different stakeholders, and therefore varied viewpoints are seldom taken on board in the decision-making routines of the transport sector.

Cost-benefit analyses are often comprised of standardized costs and benefits in formats where there is no specific value assigned to social inclusion as a benefit. To derive realistic costs and benefits for the different aspects of inclusive urban public transport in Nepal, it was suggested that several initiatives should be launched. A few of the suggestions from the participants include the following.

- Create subgroups in different sectors that are assigned the task of streamlining the topic of inclusive urban transport and discuss the costs and benefits in their respective sectors.
- Subsidize urban public transport and outline the related costs and benefits.
- Deliberate over ways to reduce the operating costs of public transport.

On the operational side, there is a need to develop and adopt extensive plans, programmes and measures to ensure better (physical and digital) access for all social groups. Feedback mechanisms which are operational both online and offline to collect feedback from transport users from all social groups can also be created to support the implementation of inclusive transport policies.

Transport workforce, training and capacity-building

The low female participation in the transport workforce was also discussed. Apart from cultural constraints, there is a lack of knowledge and awareness about joining the transport workforce, especially among transport entrepreneurs. This is even more pronounced for women in the rural areas of Nepal. It was unanimously concluded that there is a lack of female representation in drafting transport policies in Nepal. But while there is a very low level of female participation at the decision-making level in the transport sector, there is also a lack of support facilities for female participation in lower-level jobs. This has discouraged women, particularly low-income women, from entering the transport sector in general.

Additionally, there is a lack of training to enable female participation in the transport sector. Only a few private training centres conduct training sessions on entering the sector as drivers, including training for school bus drivers, ambulance drivers or public bus drivers. More informed and inclusive capacity-building is needed even at this level, and to this end, more collaboration between governments, NGOs and the private sector is necessary to improve gender equality in the transport workforce.

The participants further discussed how education and training can play a vital role in positioning social inclusion and gender equity in the transport sector. Currently, there is a lack of recognition, both in the education and training domain, to address the topic of social inclusion. Even from the government's side, there are no specific training programmes for social inclusion in the transport sector. To share good educational programmes, training opportunities and the development of toolkits on this topic, close coordination between engineers and planners was deemed important.

Monitoring, campaigns and education

It was agreed that a combination of soft and hard measures is required to address social inclusion. Campaigns can be developed to target different issues, such as addressing poor driving behaviour which leads to traffic accidents, targeting sexual harassment in public transport, positioning urban transport as an inclusive sector of employment, and so on. Developing monitoring and feedback mechanisms is also essential, as these mechanisms are currently weak or non-existent.

It was also highlighted that there is a deficit of resources to develop monitoring and feedback mechanisms, and it was thus essential that Nepal's Ministry of Physical Infrastructure and Transport was brought on board to address these topics. Addressing the different topics at national, regional and local levels was needed. For example, decision-making planning tools for social inclusion in the local context should be available in both offline and online formats, designed to be user-friendly, easily understood, and easily accessible. However, the format should be decided at the national level so that the same structure can be applied to different regions.

Governance and regulatory requirements

Participants noted the need to develop regulatory standards on social inclusion in the transport sector. These issues are currently difficult to address, particularly in some sectors, such as the construction sector. For example, it is essential to include costs in the initial construction budgets to filter the different plans through the lens of social inclusion. As most policies get developed without proper regulatory frameworks to support them, elements supporting social inclusion become an ad hoc measure. It is therefore essential to provide regulatory frameworks to support inclusive policies from the beginning stages of different transport projects.

There are seven local governments in Nepal. There is therefore a need to know all the provincial and local government provisions, and their mutual associations, to implement guidelines targeting social inclusion in the transport sector. Future solutions must involve coordination among different local provinces and the national government to ensure that standards are met, and facilities are in sync with the proposed schemes. Additionally, inter-sectoral coordination is essential as the interlocking of accessible, affordable, and available mobility provision with other sectors of development is still not well-understood. For example, the potential of transport to affect access to livelihood options and economic mobility has not been well studied in the context of Nepal. Analyzing interlinkages, such as the impact of transport on job opportunities, is crucial for a sustainable future.

2.5. SELECTED CASE STUDIES AND BEST PRACTICES

This section presents selected case studies on the design and implementation of inclusive urban public transport systems. These best practices highlight conditions which should be bolstered to both maintain and potentially encourage the uptake of public transport, walking and cycling. The core message is that transport provision needs to focus on their social impacts. Smart technology integration in the mobility sector also needs careful reviewing, as not all innovations are inclusive, and leaving the outcomes solely to market forces can lead to exclusive outcomes. Additionally, technologies that provide information and technologies which provide a service both need to be available to everyone.

2.5.1. Relevant policies and operational measures

Many countries have developed context-specific access standards, such as the Government of India's large-scale national campaign on accessible public transport. However, whilst these access standards and audits can be contextually relevant, there are no universally comparable definitions of what constitutes accessible travel. To address this gap, a team of researchers from Australia have developed and tested a set of tools in Cambodia which combines access audits and road safety audits with inputs from persons with disabilities to create a Journey Access Tool (JAT). This tool measures personal and interpersonal experiences on a regular journey taken by a person with a disability, for example, when they utilize health, employment or education services, or wider community services. While the tool was an overall success in the trial, the interventions and interpersonal dynamics (e.g. the personal assistants, interpreters and relations of the persons with disabilities) were more difficult to address, as there was a tendency for care-givers and assistants to speak on behalf of persons with disabilities or interpret their views, risking the skewing of the data (King et al., 2018). Key messages may also be overlaid or misinterpreted through the interventions of others (ibid).

Another transport module that aims to address the lack of mobility is special transport services. These are designed to address a service gap and are usually (though not exclusively) for people with mobility difficulties, such as older adults or persons with disabilities. They are also usually (though not exclusively) publicly funded or subsidized. Such services can be set up through locally available transport mechanisms, including motorized auto-rickshaws, cycle-rickshaws, and similar vehicles operated exclusively or partly for mobility-impaired people. The common attribute is that they are all "demand-responsive", which can be interpreted in several ways - pre-booked, scheduled or instant access (Rickert, 2012).

Regarding concerns about road safety, speeding is promoted by road improvements that occur alongside underdeveloped traffic legislation and limited public awareness and knowledge of road safety (Kitamura et al., 2018). They emphasize the importance of appropriate engineering, enforcement and education in low-income countries, but note that education to increase people's road safety awareness is neglected compared to the other two dimensions.

Innovative research methodologies, including walk-along interviews with different social demographic groups, have also been adopted to demonstrate how public spaces are negotiated in different kinds of neighbourhoods (Phillips and Tossa, 2016). These methodologies can ultimately guide the development of programmes focused on driver road safety awareness, defensive driver training, eye testing, vehicle roadworthy inspections with selected upgrades, incentives for safe performance, and implementation of a vehicle telematics tracking system with regular, individual driving behaviour information updates (Van Niekerk et al., 2017).

Box 1: National Urban Transport Policy of India

Realizing the importance of public transport, cycling and walking in cities and equity concerns, the National Urban Transport Policy has the following objectives: (i) to bring about a more equitable allocation of road space to various users through building a people-centric rather than vehicle-centric focus; (ii) to encourage greater use of public transport and non-motorized transport modes by offering central financial assistance for this purpose; and (iii) to enable the establishment of multi-modal public transport systems that are well-integrated, providing seamless travel across modes (Government of India, 2006). Under the Jawaharlal Nehru National Urban Renewal Mission's Urban Infrastructure and Governance component, 24.2 per cent of the total allocations were for transport-related projects. However, only 8.66 per cent were for mass transit development, while 13.3 per cent were for widening roads and building flyovers, and the rest were for parking and other small transport projects (Mahadevia, 2011). Despite a positive shift in policy objectives and priorities, the largest portion of the transport-related funds in JNNURM were spent on road-building instead of allocating them to public transport projects.

The case of Dantewada, India demonstrates how women can tackle inadequacies of the transport system in the face of the inaction of both state and private actors. Lacking any form of public transport connectivity, the tribal women of this remote rural area organized themselves through self-help groups. Through government-sponsored subsidy schemes, they have been successfully running electric rickshaws connecting rural markets, schools and other services.[4]

Perceived safety and personal security are of paramount importance to social groups, but more pronounced for women as they are more susceptible to incidences of crime, violence and varying levels of sexual harassment in urban spaces and urban transport systems. Multiple solutions have been developed to address these concerns, and yet this topic has not received its due in urban and transport planning. For example, one of the tools that has recently been developed to enable policymakers and transport providers in the urban and transport sector to address violence, assault and sexual harassment on public transport is the SHE CAN Tool.[5] It is one of the first tools which directly targets the planning and governance of this issue. This tool is a user-friendly, web-based resource to address sexual harassment and personal security within public transport. Though the tool was initially developed for Africa, it provides an excellent steppingstone to design targeted strategies to combat sexual harassment and security concerns across the world. Additionally, several tools have been developed to address other related issues such as data collection, monitoring and campaigning (Stiuso, 2024) (Box 4).

4 https://www.newindianexpress.com/thesundaystandard/2018/feb/03/chhattisgarh-e-rickshaws-drive-a-change-in-the-lives-of-dantewadas-tribal-women-1767909.html

5 https://shecan-tool.info/

Box 2: Wher Transport Application

"Wher" is a safety reporting navigation app operated by Walk21 Foundation.[6] On the market since January 2018, it is the first application that allows women to navigate safe routes in unfamiliar cities. The app is available for free on Google Android and iOS. Once downloaded, users can log-in via their social networks. They input their mobility habits and select a city to start reading comments and descriptions posted by other women. Each street is divided into three-time frames (day, evening, and night), and streets which have been mapped are colored according to the users' evaluation: green for safe areas, yellow for those to be traversed with caution, and magenta if they are best avoided. User judgments are based on perceived parameters such as lighting, crowd density, and personal feelings. The map also indicates useful services for women, such as public transport stops or pink parking spaces. To date, there are 20 mapped cities, including Turin (the starting city), Milan, Bologna, Rome, Palermo, Naples, and London.

Similarly, in India, an app called "Safetipin"[7] identifies safe zones to help women freely navigate the city (Viswanath, 2016). It is a location-based mobile app that collects safety-related information and conducts audits of different places by calculating a safety score. Users of the app can identify how safe certain areas are and can plan their travel routes and timings accordingly. But apart from facilitating users, Safetipin is also enabling the government to address security concerns. It conducts safety and security audits on the following nine parameters, which can then be directly fed into decision-making processes.

1. Lighting: the amount of illumination after sunset
2. Openness: availability of clear lines of sight in all directions
3. Visibility: how visible is one to others on the street
4. Security: the presence of visible security officers – either police officers or private security guards
5. Crowd: number of people in that space
6. Public transport (connectivity): distance to the nearest public transit stop or station
7. Gender usage: proportion of women and children in the crowd and surrounding area
8. Feelings (of safety): refers to how safe one feels in the area
9. Presence of footpaths or walkways: whether footpaths and walkways are easily accessible.

6 https://startupitalia.eu/lifestyle/wher-la-app-che-rende-le-citta-a-misura-di-donna/

7 https://safetipin.com/

Each of these parameters, except for parameter 8. Feelings (of safety) are measured objectively using a rubric and scored on a scale of 1 to 4 (from poor to good conditions). Data are collected through trained volunteers of partner organizations, such as non-governmental organizations and city governments, and through crowdsourcing from the general public. Data are collected only after 18:00 hours, to address women's increased vulnerability in the evening. Mobile phones with this app are mounted on the windshields of moving cars to take photographs of the roads, streets, and footpaths at regular intervals. All photographs are geo-tagged and carry time stamps, which are later coded on the above-mentioned parameters. A safety score is calculated for each pinned location by aggregating the parameters' scores using the weighted mean function.

Adopting this approach, safety audits can be done at different scales, such as the street scale, ward scale, or even for a specific location, like a bus stop. App users can also contribute by posting their own safety-related experiences or observations. The app founders believe that involving people to crowdsource data will initiate a broader conversation around safety, thereby inducing positive behaviour change. The app also contains a tracking feature that helps friends and family track the user's movements, be adequately informed about their whereabouts, and even raise an alarm if needed. The safety scores that Safetipin has generated in multiple cities around the world have driven city leaders to take action to improve women's safety. For example, in Delhi, the government commenced a citywide project to improve lighting in the dark spots that Safetipin identified.

Around the world, similar tools have been developed that measure different aspects of a safe, inclusive environment. Some of these tools, like the Walkability App[8] developed by the Walk21 group, can be adapted and further explored in different contexts.

Shifting from traditional transport modelling to accessibility modelling is another innovative step which could be highly beneficial for countries in Asia and the Pacific. Apart from the lack of data to establish the traditional four-step transport models, Stott and Stringer (2021) highlighted how the COVID-19 pandemic and the associated reduction in transport services shifted the emphasis on the traditional transport modelling paradigm to a need to rapidly review and re-plan public transport networks to differently serve the most dominant journeys and the most vulnerable groups.

2.5.2. Policy gaps and barriers to the development of inclusive transport

Developing a policy agenda on inclusive transport and defining follow-up programmes require a focused approach, capable of addressing multiple sectors, combining different methodologies, and developing routinized protocols to implement and monitor inclusive policies. There are no simple, short-cut methods to achieve this ambition. But to make a start, attention can be directed immediately to the gaps identified in the national assessments, case study evaluations, and national workshops. It is important to note that these gaps were the basis for the guidelines presented in Chapter 4. These gaps are summarized as follows.

8 https://walk21.com/resources/walkability-app/

1. *Lack of policy governing data collection, harmonization and sharing:* The region lacks a robust and routinised methodology to collect and analyze data. Currently, most countries lack a data policy which governs data storage and mutual sharing of the data being collected. Furthermore, there is no policy targeting cross-sector data harmonization and analysis.

2. *Expertise barrier*: Although several areas where barriers related to available expertise were pointed out, a clear mapping of these areas is lacking. For example, expertise related to accessibility modelling is clearly required. Accessibility modelling is a simplified transport planning technique which requires considerably less technical training than those required by other modelling tools (Stott and Stringer, 2021). The results of accessibility modelling are easier to understand, and given its simplified structure, the chances of this work being repeated in the future in different urban areas by local staff, leading to both spatial and time-based comparisons, are much higher.

3. *Lack of policy packaging and policy monitoring*: Existing and future policies under discussion must be brought together in policy packages to target inclusive development. For example, both the spatial configuration and modal split of urban areas in the Asia-Pacific region are changing rapidly, which necessitates that land use and transport policies are analyzed together and processed as policy packages. To this end, cooperation between stakeholders and sector representatives is of utmost importance.

4. *Regulatory and fiscal gaps*: Several regulatory and fiscal gaps impede the process of prioritizing social inclusiveness in urban and transport planning. For example, there are no regulations which r equire that parameters concerning social inclusiveness be included in the procurement process, nor are there any regulations on increasing female participation in the transport labour market. In the Asia-Pacific region, the female workforce in the transport sector makes up less than 20 per cent (Ng and Acker, 2020). In a review of transport-related legislation and policies in Nepal, Choo (2024) highlighted how four of the five transport-related legislation and policy documents are simply silent on the issue of gender inclusion. In the same vein, multiple informal ride-sharing services, and emerging smart mobility systems such as ride-hailing apps remain unregulated, which has consequences on the level of inclusiveness, safety, and security of these systems (Ng and Acker, 2020; IFC, 2020). The nexus between gender in the transport workforce and the new innovative solutions being launched in the transport sector also needs further examination to explore new opportunities. For example, ride-sharing companies such as Grab in the Philippines and PickMe in Sri Lanka are promoting greater representation of women drivers through special initiatives for women seeking economic independence, such as offering flexible work hours to make it easier for women to join their network.[9]

5. *Lack of public involvement*: The lack of public involvement of different social groups in transport planning or policy-making processes can have severe repercussions, leading to major failings in the sector. Public participation can gather knowledge on the different travel needs, preferences and challenges encountered by transport users of all social groups, which will enable governments to make informed decisions to pave the way for more inclusive transport development.

[9] https://blogs.adb.org/blog/how-increase-representation-women-transport-sector

2.6. LESSONS LEARNED TO DEVELOP THE GUIDELINES

With rapid population growth far outpacing transport investments, cities in the Asia-Pacific region face exceptional mobility challenges, characterized by congestion, poor accessibility, high emissions, and high safety and security risks. Safe, secure, efficient, clean and reliable transport is limited, and their access is subjected to deep multifaceted inequalities in income, transport resources, capabilities and geographic access. In particular, older persons, persons with disabilities, low-income households, children and women may be provided with limited transport choices that are time-consuming, unreliable and prone to accidents and other security risks.

Understanding the needs, values, capabilities, and customs of all social groups is essential for designing inclusive transport systems. The guidelines developed in this study should be visited at different scales (national and local) to inform projects on how to target and evaluate the social impacts of transport planning, policy and legislative interventions. Overlaps between specific SDGs need to be highlighted when designing inclusive urban transport systems, including with SDG 5 (reducing gender inequality), SDG 9 (targeting sustainable, safe and reliable transport across cities and communities) and SDG 11 (using infrastructure innovations and interventions).

Chapter 3

DIGITAL TECHNOLOGIES IN INCLUSIVE TRANSPORT SYSTEMS

3.1. TYPES OF APPLICATIONS

The majority of smart transport services introduced in recent decades can be broadly categorized into these objectives of mobility and safety. During the 1990s and early 2000s, the inception of Intelligent Transport Systems (ITS) brought real-time traffic information services and traffic signal control services aimed at improving mobility. Subsequently, advanced systems focusing on reducing traffic accidents and enhancing safety, such as smart intersection and crosswalk systems, were introduced after 2010. These safety-centric advanced systems target areas prone to accidents, such as tunnels, bridges, and vehicles transporting hazardous goods, or areas where significant damage is anticipated in the event of an accident.

In response to the global emphasis on promoting good health, well-being, and social inclusivity, recent initiatives have begun to prioritize social care measures through smart transport services for vulnerable road users (VRUs), including children, older persons, and persons with disabilities. Addressing the transport infrastructure gaps in rural areas which affect the mobility and accessibility of rural residents to essential facilities such as hospitals, government offices, and urban transport hubs has also emerged as a pressing social issue.

Additionally, in response to climate change challenges, several smart transport services and policies have been implemented to mitigate carbon emissions and promote environmentally sustainable transport practices within urban environments.

Smart transport service applications introduced in recent decades broadly serve the following six goals.

- Better mobility for all
- Better mobility for VRUs and rural areas
- Increased safety through advanced technologies
- Improved safety for VRUs
- Better air quality in urban areas
- Special treatment for high-risk sections

The first category, “Better mobility for all”, is a service provided to all road users and consists of traffic control services that provide information such as congestion zone information, parking facility information, and bus arrival time, or that adjust traffic signals based on collected traffic information. Real-time traffic information services provide drivers with traffic data and the level of congestion on the succeeding road section in real-time, either as messages or colour themes (e.g., red for severe delay, orange for delay, green for normal) through in-vehicle navigation or variable message signs. This service has been adopted by many countries in North America, Europe, as well as Asia and the Pacific, and it has been reported that cities such as London, New York City, and Los Angeles have saved time, fuel, and energy by helping drivers make decisions using real-time traffic information.

Meanwhile, real-time adaptive traffic signal control is based on controlling traffic flows by analyzing various real-time traffic data. This service is currently operated by real-time traffic signal control systems such as SCATS in Australia, SCOOT in the United Kingdom of Great Britain and Northern Ireland (UK), OPAC in the United States of America (USA), and COSMOS in the Republic of Korea. In the case of SCATS in Australia, for example, the application of SCATS shortened travel time by 28 per cent, reduced the number of stops by 25 per cent, reduced fuel consumption by 12 per cent, and reduced emissions by 15 per cent. In addition, the Bus Information System (BIS), which provides bus users with the arrival time of buses at a specific stop using real-time bus location and congestion information, is widely used around the world such as in the Republic of Korea, Singapore, and the United Kingdom.

Smart parking services that provide parking facility location information and parking space status information are also widely used. Additionally, the development of wireless communications technology has enabled remote smart card tagging or smartphone app-based payment when boarding public transport vehicles. In the highway sector, smart tolling systems which enable electronic payment without stopping at toll booths are in operation in some countries.

The second category, "Better mobility for VRUs and rural areas", focuses on services designed to enhance the social participation and welfare of persons with disabilities. These initiatives aim to expand mobility facilities within transport systems, passenger facilities, and road infrastructure, thereby improving the walking environment to ensure safe and convenient movement for people with disabilities. One significant service is the on-demand bus service, which offers flexible route adjustments and schedules, unlike traditional fixed-route public transport systems. This service allows individuals to request bus services at their preferred times, making it particularly beneficial in areas lacking adequate public transport infrastructure, such as rural regions or for those facing transport disadvantages. The adoption of such services has been rapidly increasing worldwide, with notable examples including BCGo and the Ring&Ride West Midlands project.[10] The latter service facilitates over 12,000 trips per month. Additionally, wheelchair-accessible shared mobility services have become prevalent in numerous countries, including the USA, Canada, the United Kingdom, and Germany. Uber WAV in the USA provides wheelchair-accessible rides to passengers, significantly enhancing transport accessibility and convenience for individuals with disabilities.[11]

[10] https://www.battlecreekmi.gov/Faq.aspx?QID=247; https://www.liftango.com/resources/ring-and-ride

[11] https://www.uber.com/us/en/drive/services/uberwav/

The third category, "Increased safety through advanced technologies," encompasses services that alert drivers to potential hazards, such as pedestrians, cyclists, animals, or vehicles, providing warnings or interventions to prevent collisions. For instance, a smart intersection system employs object recognition technology, utilizing artificial intelligence on high-definition CCTV images installed on roads to identify vehicles, pedestrians, and bicycles, and to track their paths. This system anticipates dangerous situations involving recognized road objects in advance, offering various safety-related or traffic control services such as adjusting traffic signals. By incorporating state-of-the-art LED traffic lights, advanced signal controllers, precision traffic detectors, adaptive traffic control, and intelligent street lighting, these technologies aim to enhance the safety and sustainability of transport services. Implemented globally, including in Amsterdam, Pittsburgh, and Beijing, these systems have reduced travel time by 25 per cent, vehicle emissions by 20 per cent, and intersection wait times by 40 per cent in Pittsburgh.[12]

Another example is the smart crosswalk safety system, enabling vehicles to detect pedestrians and facilitate safe crossings. Deployed in cities like New York City, London, and Seoul, this system has shown promising results, with 83.4 per cent of vehicles demonstrating an average speed reduction of 20 per cent in a test conducted in the Republic of Korea.[13] The Intersection Collision Warning System enhances driver awareness by issuing timely warnings about prevailing traffic conditions to vehicles approaching intersections. Widely used in Japan, the United States, and Europe, this system has significantly reduced crashes on major and minor roads. Additional applications include Advanced Driver Assistance Systems (ADAS) and in-roadway digital signs, providing drivers with crucial information about incidents, travel times, detours, emergencies, and more.

The fourth category, "Improved safety for VRUs," aims to enhance the safety of individuals with disabilities, cyclists, pedestrians, and motorcycle drivers. The Emergency Vehicle Priority (EVP) system, which expedites emergency response by automatically adjusting signals along the shortest route during emergency calls, is widely employed in Australia, the USA and Europe. A study from Queensland, Australia, highlights the EVP system's efficacy, reporting up to 26 per cent faster emergency vehicle arrival times, potentially saving lives.[14] School zone safety solutions, including radar speed signs, audible alerts, and speed limit beacons, are prevalent worldwide, safeguarding children during school hours. Moreover, VRU indoor navigation systems assist pedestrians, children, older persons, and cyclists in navigating indoor spaces effortlessly, facilitating swift responses to emergencies. Implemented in the USA, the Republic of Korea, and the UK, among others, VRUs indoor navigation streamlines wayfinding within buildings. Additionally, the advancement of sensors and communication technologies has led to the emergence of smart bus shelter services. These furnish commuters with various information, including bus arrival times, locations, weather updates and air quality, while offering ICT amenities like Wi-Fi and charging facilities, enhancing the overall commuting experience.

12 https://www.cmu.edu/news/stories/archives/2019/october/traffic-moves-at-speed-of-technology.html

13 https://www.kict.re.kr/board.es?mid=a10105060000&bid=pressrls&act=view&list_no=13461

14 https://transmax.com.au/what-we-do/streams/emergency-vehicle-priority/

The fifth category, "Better air quality in urban areas" is dedicated to enhancing citizens' quality of life by mitigating environmental impacts. This category includes Low Emission Zone (LEZ) access control and enforcement, old-diesel vehicle access control and enforcement, and Internet of Things (IoT) air quality monitoring systems. LEZ access control safeguards public health, improves air quality, and mitigates traffic congestion by prohibiting vehicles which emit harmful pollutants from entering designated public areas. Implemented in countries such as the UK, the Netherlands and France, major cities like Amsterdam, Berlin, Copenhagen, and London plan to expand these zones beyond their initial boundaries. These zones aim to transition into zero-emission areas, permitting only zero-emission vehicles, which will eliminate tailpipe emissions. Similarly, diesel vehicle access control initiatives target air quality improvement by restricting the entry of old diesel vehicles. Widely adopted globally, these measures contribute to reduced emissions and improved air quality. Additionally, IoT air quality monitoring systems utilize monitoring devices to assess pollution levels in specific locations, aiding in source identification and pollution reduction while reducing monitoring expenses.

The sixth category, "Special treatment for high-risk sections," encompasses services designed to optimize the operation of high-risk vehicles, such as those transporting hazardous materials like chemicals, explosives, or flammable substances, through continuous monitoring. Smart tunnel monitoring systems, employed in numerous countries such as the USA and the UK, oversee the safety, security, and maintenance of tunnels using sensors that monitor various physical parameters. Notably, the Boston Big Dig project in the United States collects real-time data from sensors installed in downtown Boston to enhance tunnel operations, bolster safety measures, and reduce energy consumption.[15] Similarly, smart tunnels in the UK, France and Switzerland leverage sensor data to monitor potential safety risks and maintenance issues, ultimately improving safety standards, maintenance efficiency, and energy conservation. Additionally, smart bridge monitoring systems, equipped with a range of sensors to monitor structural integrity, vibrations, traffic, and more, are deployed in several countries to enhance bridge safety and operational efficiency. Furthermore, Commercial Vehicle Operations (CVO) fleet GPS tracking systems enable transportation companies to track the location, speed, direction, and other vital information of their vehicles.

A summary of all six categories is presented in table 2.

15 https://www.encardio.com/blog/how-smart-tunnel-monitoring-systems-are-transforming-infrastructure-management

Table 2: Categorization of Smart Transport Services and Systems

Objectives	Smart Transport Services and Systems	Descriptions
Better mobility for all	Real-time traffic information service	Adjusting traffic signal timing by direction in accordance with traffic demand information detected by traffic detectors installed in each direction at a signalized intersection
	Real-time adaptive traffic signal control	Providing real-time traffic conditions and congestion information to drivers via in-vehicle navigation and variable message signs by the collected traffic volume and speed data from forward road sections
	Bus Information System (BIS)	Provide passengers with real-time information about the bus's current location, next stop, arrival time, and other details, via bus stop signage, internet homepage, and mobile app
	Transit signal priority system	Detect vehicles at signal intersections and give them priority where they have the right of way
	Tag-less fare payment	Contactless fare payment through communication between a Bluetooth beacon on the mobility vehicle and the user's mobile phone's Bluetooth
	Smart lane control system	Design effective traffic flow by detecting traffic volume and congestion and allowing or prohibiting lane usage through lane control signals as needed
	Smart parking	Sensors and cameras in parking lots provide real-time visibility into the location and status of parking spaces and guide drivers to parking spots, saving time and reducing greenhouse gas emissions

Table 2: Categorization of Smart Transport Services and Systems (cont.)

Objectives	Smart Transport Services and Systems	Descriptions
	Smart toll system	Tolling and relieving traffic congestion in non-stop high-speed driving environments by applying Wireless Area Networking for Vehicles (WAVE) on multi-lane roads
	Dynamic pricing	Measure the price of a good/infrastructure/ service using supply and demand, competitor prices, and other historical or current external factors in the marketplace
Better mobility for VRUs and rural areas	On-demand bus service	Provide efficient transport to destinations by scheduling vehicles based on passenger demand rather than a set route
	Wheelchair-accessible shared mobility service	A shared transport service that is also accessible to people who use wheelchairs, giving them freedom of movement and the opportunity to participate in society
Increased safety through advanced technologies	Advanced Driver Assistance System (ADAS)	Help drivers operate their vehicles safely by using automated technologies such as sensors and cameras to detect nearby obstacles or driver behaviour and respond accordingly
	In-roadway digital signs	Provide drivers with real-time information, including on traffic, weather, and unexpected events
	Smart intersection system	Detect vehicles entering intersections in each direction and measure service levels to optimize signal cycles and green times and create optimal traffic conditions
	Intersection collision warning system	Provide warnings about vehicles entering intersections to improve driver awareness and help prevent collisions

Table 2: Categorization of Smart Transport Services and Systems (cont.)

Objectives	Smart Transport Services and Systems	Descriptions
	Smart crosswalk safety system	Assist vehicle detection of pedestrians and allow pedestrians to cross safely by floor signals, voice prompts and spotlights
Improved safety for VRUs	Emergency vehicle priority system	Prioritize the shortest route to help emergency vehicles get there faster when they respond to an emergency call
	School zone safety solution	Improve child safety around schools by encouraging vehicles to drive slower in childproofed zones with radar speed displays, audible alerts, and guidance beacons
	VRUs indoor navigation	Provide information to help pedestrians, cyclists, scooterists, and others know their indoor spaces and get to their destinations safely
	Smart bus shelter	Establish "smart shelters" at bus stops, a future-proof integrated system that provides services such as city weather, real-time public transport information, air quality information, advanced ICT facilities such as Wi-Fi and charging stations, and connectivity to emergency services
Better air quality in urban areas	Low emission zone (LEZ) access control and enforcement	Reduce urban pollution and improve air quality by restricting the operation of older, polluting vehicles in certain areas
	Diesel vehicle access control and enforcement	Restrict the entry of older diesel vehicles in certain areas to reduce urban pollution and air quality
	IoT air quality monitoring	Analyze real-time data collected by air quality monitoring sensors to identify pollution sources and provide air quality information to users

Table 2: Categorization of Smart Transport Services and Systems (cont.)

Objectives	Smart Transport Services and Systems	Descriptions
Special treatment for high-risk sections	Smart tunnel monitoring system	Support tunnel safety, security, and maintenance with sensors that monitor and measure the physical parameters of the tunnel
	Smart bridge monitoring system	Continuously monitor bridge movements, vibrations, and structural changes to check bridge health and optimize maintenance cycles to improve safety
	CVO fleet GPS tracking	Optimize operations for vehicle routing and dispatching and improve transport efficiency by tracking vehicle locations in real time and monitoring transport status

3.2 BEST PRACTICES IN ESCAP MEMBER STATES

3.2.1. Republic of Korea

Smart crosswalk safety service

The smart crosswalk safety service in the Republic of Korea offers a range of safety-related features to both vehicles and pedestrians at pedestrian crosswalks, including crosswalks with and without signals, situated in urban areas. Utilizing object detection results from video and radar detection systems, the service provides information such as vehicle approach alerts and pedestrian jaywalking detection.[16] Its primary goal is to enhance pedestrian safety by notifying pedestrians about vehicle approaches and traffic signal phases (green, yellow, and red) through audible alerts and surface signal lights.[17] Additionally, it offers information regarding pedestrian crossings to vehicles via variable message signs or in-vehicle devices using wireless communication. A recent enhancement involves adjusting the traffic signal duration by extending the pedestrian green time based on factors like the number of detected pedestrians or the presence of vulnerable road users such as older persons and children. This feature is currently undergoing demonstration to assess its effectiveness in enhancing pedestrian safety.[18]

16 https://www.wired.co.uk/article/south-korea-smart-road-crossings

17 https://www.wired.co.uk/article/south-korea-smart-road-crossings

18 https://smartcity.go.kr/2022/03/21

The smart crosswalk safety system's main functions are categorized into five key areas: 1) detecting pedestrians and vehicles, 2) providing information and warnings through alert sounds, vocal sounds, and messages, 3) requesting and extending traffic signals, 4) on-site monitoring, and 5) enforcement. Among these functions, the core lies in the safety messaging and warning function achieved through pedestrian and vehicle detection. Pedestrians and vehicles receive information about each other's presence and approach through alert sounds, vocal cues, and LED display messages.

Pedestrian detection is facilitated by recognizing individuals within the detection area using video and radar detection technologies, counting pedestrian numbers, and identifying instances of jaywalking. Recent advancements in pedestrian detection include automatic requests for signal extensions when pedestrians enter the designated detection area, pedestrian counts exceed predetermined thresholds, or vulnerable road users like elderly pedestrians are detected. Vehicle approach alerts warn of vehicles approaching the crosswalk at high speeds or crossing the stop line during pedestrian walk signals. Additionally, the system can enforce signal, speed, and parking regulations by leveraging existing enforcement mechanisms. A summary of the functions of smart crosswalk safety system is shown in table 3.

Table 3: Functions of the Smart Crosswalk Safety System

Category	Functions	Descriptions	System/Device
Detection	Pedestrian detection	• Detection of pedestrians in a crosswalk waiting area or crosswalk • Detection of pedestrians crossing the roadway during a red light	• Pedestrian detection sensor
	Vehicle approach detection	• Detection of vehicles approaching a crosswalk. • Detection of vehicle stop line violations, crosswalk encroachments, and speeding	• Vehicle detection sensor
Information provision and alerts	Displaying pedestrian walk signal remaining time	• Provide pedestrian signals (red, green) to pedestrians with crosswalk floor signals, voice prompts, etc.	• Pedestrian signal auxiliary device, crosswalk queue LED (floor signal), crosswalk LED illumination device, vocal sound device, safety barrier, etc.

Table 3: Functions of the Smart Crosswalk Safety System (cont.)

Category	Functions	Descriptions	System/Device
	Alert jaywalking to pedestrian	• Alerting pedestrians to encroach on the roadway during a red light with a vocal sound alert, LED display, etc.	• Vocal sound device, etc.
	Providing walk signal to pedestrian	• Guiding pedestrians in crosswalks to vehicles with LED lights, crosswalk illumination, spotlights, etc.	• Surface induction LED, crosswalk LED illuminator, crosswalk spotlight, etc.
	Alert stop line violation and speeding to vehicle	• Alerting a vehicle to a stop line violation, crosswalk invasion, speeding, etc.	• Vocal sound alert, in-vehicle LED display, etc.
Traffic signal adjustment	Extension of pedestrian walk signal	• Extension of the walk time when a pedestrian is detected in the crosswalk	• Pedestrian signal extension system, etc.
	Auto-request pedestrian walk signal	• Auto-request of pedestrian walk signal when a pedestrian is detected in the waiting area of a crosswalk	• AI-based pedestrian recognition system, pedestrian signal request function in a traffic signal controller
Monitoring	Onsite monitoring	• On-site monitoring and video recording through CCTV, etc.	• High-definition CCTV
Enforcement	Red-light violation enforcement	• Enforcement of signal violations by vehicles	• Signal violation enforcement system, etc.
	Speeding enforcement	• Speeding enforcement of vehicles approaching and passing through crosswalks	• Speed detection sensor
	Illegal parking enforcement	• Recognizing and enforcing illegal parking near crosswalks	• Parking enforcement system

Table 3: Functions of the Smart Crosswalk Safety System (cont.)

Category	Functions	Descriptions	System/Device
Traffic safety facilities	Facilities for safety improvement	• Physical road accessories to slow down vehicles near crosswalks, prevent pedestrians from jaywalking, etc.	• Speed bumps, anti-skid facilities, protective fences, etc.

The smart crosswalk safety service has been adopted in many cities across the Republic of Korea as part of the national traffic safety enhancement policy.[19] Notably, Seoul has implemented the system at 78 locations within one jurisdiction, capable of detecting pedestrian jaywalking and vehicle approach to crosswalks, and issuing warnings through vocal sounds and surface traffic signal lights.[20] In its first year of operation in 2019, the system demonstrated a significant reduction in vehicles violating stop lines, with figures ranging from 83.4 per cent to 88.4 per cent, highlighting its potential to mitigate traffic collisions between vehicles and pedestrians.[21] A three-year before-and-after study revealed that the smart crosswalk safety systems decreased pedestrian-related traffic accidents by 21.5 per cent, with a notable reduction in fatalities (100 per cent), serious injuries (46.4 per cent), and minor injuries (12.9 per cent). Similarly, Jeju installed the system at four locations within its jurisdiction to prevent pedestrian-related traffic accidents at crosswalks.[22] These systems incorporate features such as smart crosswalk safety stop bars, luminous traffic signs, surface traffic signal lights, vehicle speed traps, and LED displays to indicate warnings to approaching vehicles, thereby enhancing crosswalk visibility and safety signage.

Smart intersection service

The smart intersection service represents an intelligent traffic information system designed to enhance traffic management efficiency. It utilizes high-definition cameras and artificial intelligence (AI)-based object detection algorithms to gather real-time traffic information and traffic volume data. This data is then seamlessly integrated with traffic signal control and optimization functions. By extracting information on direction and vehicle type at intersections and leveraging big data analysis, the system calculates optimal signal timings. This approach effectively improves traffic flow, particularly on major roads experiencing high volumes of traffic during peak and off-peak hours.[23]

The primary functions of smart intersections encompass several key aspects (table 4).

19 https://smartcity.go.kr/스마트횡단보도/

20 https://www.asiae.co.kr/article/2022050207211100965

21 Ibid.

22 https://www.jejudomin.co.kr/news/articleView.html?idxno=204534

23 https://www.korea.kr/briefing/pressReleaseView.do?newsId=156449768&pageIndex=1&repCodeType=&repCode=&startDate=2008-02-29&endDate=2021-05-03&srchWord=스마트

Table 4: Functions of the Smart Intersection Service

Category	Functions	Descriptions	System/Device
Detection	Pedestrian detection	• Pedestrian driveway encroachment or jaywalking detections during pedestrian red lights	• Pedestrian detection system based on AI-based CCTV video analysis algorithm
	Vehicle detection	• Detection of approaching vehicles in intersections. • Detection of vehicle stop line violations, intersection violations and speeding, and video recognition.	• Vehicle detection system based on AI-based CCTV video analysis algorithm
Information provision and alerts	Smart LED display	• Providing traffic safety-related information to drivers	• LED display
	Warning of approaching vehicles	• Providing approaching vehicles to pedestrians	• Vehicle detection system based on AI-based CCTV video analysis algorithm
	Sharing of incident information	• Communicate sudden, hazardous events within the vehicles in front and the fleet behind	• Vehicle-to-Everything (V2X) communications devices
	Congestion analysis	• Analysis and determination of the degree of traffic congestion	• Vehicle detection system based on AI-based CCTV video analysis algorithm
Traffic signal adjustment	Actuated traffic signal control	• Traffic signal extension, shortening, and skipping based on the presence and collected traffic volume of vehicles using an AI-based vehicle detection system	• Vehicle detection system based on AI-based CCTV video analysis algorithm • Advanced traffic signal controller

Table 4: Functions of the Smart Intersection Service (cont.)

Category	Functions	Descriptions	System/Device
	Emergency vehicle priority signal	• Providing priority to emergency vehicles by allowing a green light	• Emergency vehicle detectors and communication devices

First, there is pedestrian and vehicle detection, which involves two subsystems: the pedestrian detection system and the vehicle detection system.[24] The former utilizes pedestrian detection sensors to identify pedestrians within the intersection area, monitoring any encroachment onto the roadway during red signal phases. Meanwhile, the vehicle detection system employs AI image recognition algorithms and sensors to recognize approaching vehicles and detect violations such as crossing stop lines, entering intersections, or speeding. This system also assists in traffic volume counting and congestion level measurement.

Second, the information and warning function plays a crucial role in preventing accidents. It displays safety-related information, such as vehicle approach and pedestrian crossing alerts, via smart LED display boards or vocal warnings based on real-time recognition data of vehicles and pedestrians. Moreover, in intersections equipped with Vehicle-to-Everything (V2X) wireless communication infrastructure, this function facilitates the transmission of sudden and hazardous situations to vehicles behind through Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communication.[25] Finally, the traffic signal control feature enables dynamic adjustments to signal timings based on vehicle presence, traffic volume, and emergency vehicle prioritization. This includes extending, shortening, or skipping signal phases as necessary, with priority signal allocation to emergency vehicles facilitated through emergency vehicle detectors and wireless communication devices.[26]

Like the smart crosswalk safety service, the signalized smart intersection service has also been widely adopted in various cities across the Republic of Korea.[27] For example, Busan Metropolitan City has implemented a smart intersection traffic management system at 18 key locations. Additionally, the system was deployed at five other strategic locations, enhancing traffic management capabilities since its operation began in December 2017. Subsequent expansions in 2018 included eight intersections in the central bus lane section which were equipped with this system, refining traffic analysis by categorizing vehicles into large-sized, small-sized, and buses. This data is then utilized to operate the central bus lane signal system more efficiently in collaboration with the Busan Provincial Police Agency.[28]

24 https://m.boannews.com/html/detail.html?idx=95256

25 https://journal-home.s3.ap-northeast-2.amazonaws.com/site/2020f/presentation/0080.pdf

26 https://m.boannews.com/html/detail.html?idx=95256

27 https://www.korea.kr/briefing/pressReleaseView.do?newsId=156449768&pageIndex=1&repCodeType=&repCode=&startDate=2008-02-29&endDate=2021-05-03&srchWord=%EC%8A%A4%EB%A7%88%ED%8A%B8

28 https://www.busan.go.kr/news/snsbusan01/view?dataNo=61304

Similarly, Anyang City installed a smart intersection system based on artificial intelligence cameras at 21 major intersections, coupled with the conversion of 415 traffic signal controllers from offline to online operation to establish an integrated network system. These AI-equipped cameras analyze traffic conditions in real-time and connect to traffic signal controllers, ensuring optimal traffic flow. Moreover, a "sudden situation detection system" prioritizes emergency medical services, fire trucks, and police vehicles by granting them priority signals, thereby securing crucial response time.[29]

Barrier-free vulnerable road user service

The barrier-free VRU service represents a movement and urban planning initiative aimed at eliminating both physical and psychological obstacles that impede the mobility and social integration of vulnerable groups, including individuals with disabilities, older persons, and pregnant women. Primarily, it focuses on removing barriers that hinder access to facilities, thereby fostering social inclusivity, reducing discrimination, and upholding human rights. Currently, the barrier-free VRU service is being implemented in Busan Metropolitan City, Republic of Korea, with initiatives spanning barrier-free navigation, barrier-free stations, and barrier-free ride-sharing platforms. The functions of such services are presented in table 5.

Table 5: Functions of Barrier-free VRU Service

Category	Functions	Descriptions	System/Device
Barrier-free navigation	Voice-activated navigation	• Provide indoor/outdoor directions and facility information to both the general public and VRUs (seniors over 65 or people with disabilities) with AI voice guidance.	• AI speech recognition technology
	Navigation with indoor positioning	• Provide navigation services through indoor positioning equipment and communication with devices equipped with navigation apps	• Multi-module sensing (hybrid beacons) and coordinate system linkage with digital twin 3D map data for intelligent barrier-free kiosks for in-place positioning

[29] https://m.khan.co.kr/local/Gyeonggi/article/202208031457001#c2b

Table 5: Functions of Barrier-free VRU Service (cont.)

Category	Functions	Descriptions	System/Device
	Intelligent barrier-free kiosks	• Providing digital twin 3D navigation and comprehensive public information to both the socially vulnerable and the general public without smartphones	• Kiosk
Barrier-free station	Transport stations	• Serving as a base area for general public transport and special transport vehicles for all citizens	• Signage monitors • Voice guidance speakers
	Convenience stations	• Convenient and safe transport waiting and community spaces • Providing services for the transport disadvantaged • Providing internal and external convenience services	
Barrier-free demand-responsive transit (DRT)	Demand responsive transit	• DRT system that operates flexibly to meet local needs, allowing users to input data about their trips and calculate optimal routes for DRT operation	• Smart phone apps • Mobility operation platform
	Taxi sharing	• Utilize taxis to connect VRUs	• Smart phone apps • Mobility operation platform

Barrier-free navigation encompasses indoor navigation services tailored to the specific needs of urban railway systems, particularly through the implementation of barrier-free design in subway facilities, the crucial connectors of major transport hubs. These services include voice recognition navigation, indoor positioning navigation, and comprehensive assistance via intelligent barrier-free kiosks. By leveraging these solutions, a wide array of route and location information can be disseminated to both the general public and individuals facing transport disadvantages. In 2022, as part of a barrier-free initiative, Busan Metropolitan City installed 4,500 hybrid beacons for indoor positioning at 20-metre intervals within

stations across Busan Metro Lines 1 to 4. This installation facilitated the provision of precise location and route details to users, leading to tangible economic and social benefits such as reduced transport expenses through seamless taxi-subway transfers and the revitalization of employment and commercial areas through an expanded activity radius.[30]

Barrier-free stations serve as pivotal points for public transport and ridesharing platforms, offering a range of amenities and information tailored to the needs of individuals facing transport challenges. Since 2022, barrier-free ride-sharing platform stations have been established in locations such as Busan. The economic and social impacts of these barrier-free stations are significant, including reductions in travel time, waiting time, and transport expenses for individuals with disabilities compared to traditional transport options.[31] For example, barrier-free ridesharing platforms such as Door-to-Door (D2D) services let individuals access various transport choices, fostering a sustainable ridesharing model that optimizes travel costs through route optimization algorithms. This platform provides detailed services such as barrier-free Demand-Responsive Transit (DRT) and taxi-sharing services, currently operational in Busan. The economic and social impacts are profound, including increased ridership among transport-disadvantaged individuals thanks to automatic vehicle dispatch systems, decreased waiting times and idle periods; reduced consumer expenses; and diminished carbon emissions. Furthermore, the integration of fragmented transport services into a unified platform enhances accessibility for VRUs, thus fostering greater inclusivity in transport.[32]

3.2.2. Singapore

Green Link Determining system

The Green Link Determining (GLIDE) system serves as the central control mechanism for all traffic signals across Singapore, orchestrating traffic flow by dynamically adjusting green times in response to changing conditions. By interconnecting adjacent traffic signals, GLIDE enables vehicles to traverse multiple intersections with minimal interruptions. Utilizing loop detectors, the system detects both vehicle and pedestrian traffic, allowing for real-time adjustments to signal timings to accommodate varying demands. Through the establishment of "green wave" connections between neighbouring intersections, GLIDE facilitates continuous movement for vehicles, minimizing the need for unnecessary stops.[33] This system ensures that the direction with heavier traffic is given more green light time, optimizing traffic flow. Additionally, the system detects when a pedestrian presses a push button at an intersection. When activated, the push-button system ensures that the "green light" is only activated when pedestrians need to cross, minimizing unnecessary wait times for drivers at red lights and maximizing green time when no pedestrians are present.[34]

Green Man+ service

Green Man+ is a system designed to prioritize the safety and convenience of VRUs, such as older

30 http://bsc.itrocks.kr/?doc=sub_02

31 http://bsc.itrocks.kr/?doc=sub_02_02

32 http://bsc.itrocks.kr/?doc=sub_02_03

33 https://www.lta.gov.sg/content/ltagov/en/getting_around/driving_in_singapore/intelligent_transport_systems/green_link_determining_system.html

34 https://www.lta.gov.sg/content/ltagov/en/getting_around/driving_in_singapore/intelligent_transport_systems/green_link_determining_system.html#:~:text=Link%20Determining%20System-,Green%20Link%20Determining%20System,-The%20Green%20Link

persons and persons with disabilities (PWDs), when crossing the street. This system allocates additional green time at signalized crosswalks equipped with Green Man+, providing up to 13 seconds of extra green time for VRUs. To access the Green Man+ service, users simply tap their senior discount card or PWD discount card on a reader mounted above the standard push button on the traffic signal pole. This action extends the green time, ensuring safer and more accessible crossings. Eligible individuals, including senior pedestrians aged 60 years and above, or PWDs who are Singapore citizens or permanent residents, can apply for a senior concession card or PWD concession card through ticket offices or the website. As of 2022, the Green Man+ service has been implemented at over 1,000 pedestrian crossings across Singapore, enhancing road safety and accessibility for VRUs.[35]

On-demand bus service

On-demand bus service is a flexible bus reservation system that enables VRUs to book public transport buses in their desired areas. This service not only optimizes land use and reduces reliance on the traditional workforce but also enhances transport accessibility for seniors and commuters in remote areas. An example of this innovative service was implemented in Sentosa Tanjong Beach, where autonomous shuttles were introduced along a 1-kilometre road in 2018, later expanding to a 5-kilometre route in 2019.[36] This pilot project allowed visitors to conveniently book these autonomous shuttles on demand using their smartphones. The initiative proved successful, with nearly 6,000 passengers transported safely over three months on Sentosa Island.

Autonomous shuttle buses are also operational in Singapore's Science Park 2 and Jurong Island neighbourhoods. Notably, this marks the first time Singapore has utilized driverless buses to collect fares and generate revenue. The decision to implement paid services in 2019 stemmed from the successful experience of transporting approximately 6,000 passengers without incident over three months on Sentosa Island. However, these autonomous buses are currently limited to carrying 10 passengers each and have a maximum speed of 25 km/h. Furthermore, they are not fully autonomous and still require driver intervention in certain sections of their routes.[37]

Contactless fare payment

Contactless fare payment utilizes Near Field Communication (NFC) technology to facilitate seamless fare payments in public transport systems. The Land Transport Authority (LTA) of Singapore has integrated this technology into its account-based ticketing system known as “SimplyGo”. Rolled out in April 2019, “SimplyGo” enables commuters to pay for their bus and train fares effortlessly by scanning their smartphones or smart cards. The fare amount is automatically deducted from the linked mobile wallet or contactless bank card account.

The success of SimplyGo has spurred the development of related services aimed at enhancing convenience for VRUs, including those with disabilities. Collaborations between the LTA and other agencies have led to the testing of various contactless fare payment systems. One such system utilizes radio frequency identification technology to detect commuters' fare cards automatically as they

35 https://www.lta.gov.sg/content/ltagov/en/getting_around/driving_in_singapore/intelligent_transport_systems/green_man.html

36 https://www.smartnation.gov.sg/initiatives/transport/on-demand-shuttle/

37 https://www.asiae.co.kr/article/2021020211395620623

pass through sensors at fare gantries, eliminating the need to physically present their phone or card. This trial is underway at Redhill, Tiong Bahru, Kembangan, and Bedok MRT stations. Additionally, a Bluetooth-enabled fare collection system is being tested, enabling commuters to seamlessly interact with fare gates using their mobile devices. These advancements aim to make public transportation more accessible and user-friendly for all commuters, including those with disabilities.

3.2.3. United Kingdom

Smart bus shelter

A smart bus shelter aims to enhance the transit experience by offering real-time information, interactive displays, and additional amenities to passengers awaiting buses. In London, smart bus shelters provide free public Wi-Fi, display travel updates and emergency information on screens, and incorporate sensors to monitor noise, foot traffic, and air pollution. Additionally, these shelters boast features like LED edge lighting, voice announcements, and accessibility enhancements to cater to individuals with disabilities.[38] By offering a network of smart bus shelters, cities like London can gather comprehensive environmental data in real-time, facilitating the development of effective sustainability strategies across the borough.[39]

Low Emission Zone and Ultra Low Emission Zone enforcement

The Low Emission Zone (LEZ) and Ultra Low Emission Zone (ULEZ) are measures implemented in London to promote the adoption of cleaner heavy-duty diesel vehicles. The LEZ covers most of Greater London, while the ULEZ is a larger zone. Vehicles that fail to meet the emissions standards set by the ULEZ are subject to a daily charge of £12.50, except on Christmas Day. This fee applies to cars, motorcycles, vans, and special vehicles weighing up to 3.5 tons, as well as minibuses weighing up to 5 tons. However, larger vehicles such as lorries, vans, special heavy vehicles weighing over 3.5 tons, and buses, minibuses, and coaches weighing over 5 tons are exempt from the ULEZ charge. These measures aim to improve air quality and reduce pollution levels in London, contributing to a healthier environment for residents and visitors alike.[40]

3.2.4. Sweden

Sustainable public transport services

Public transport systems in Stockholm, Sweden encompass a comprehensive network of approximately 450 bus routes, three shuttle boat routes, a metro system spanning 100 km, and additional trams and local trains. With around 800,000 daily users, the system plays a vital role in the city's transport infrastructure. Through Sweden's concerted efforts and long-term approach, the goal of achieving 100 per cent renewable energy for the metro, buses, and local trains was realized in 2017.

Looking ahead to 2030, the country aims for fossil fuel-free maritime transport, a 75 per cent reduction in emissions compared to 2009 levels, and 15 per cent less energy consumption per passenger kilometre

38 https://www.swlondoner.co.uk/news/03122021-smart-bus-shelters-to-be-introduced-in-croydon

39 https://www.uktech.news/energy/croydon-smart-bus-shelters-20211125

40 https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/ulez-expansion-2023

than in 2011. To meet these targets, green energy was prioritized for heating its buildings, warehouses, and stations, while new construction adheres to stringent recycling and environmental standards. Additionally, noise reduction and emission minimization were emphasized across all services, as well as collaboration with the scientific and business communities for continuous improvement. Stockholm is now exploring the feasibility, costs, risks, opportunities, and benefits of transitioning existing buses to electric alternatives, with a focus on reducing energy consumption, noise levels, and emissions of particles and nitrogen.[41]

3.2.5. Denmark

Bicycle safety systems

Copenhagen has established itself as a global leader in promoting cycling as a viable and attractive mode of transport for residents of all ages and abilities. At the heart of Copenhagen's cycling infrastructure are its four types of bike-friendly pathways: traffic-controlled streets, painted bike lanes, separated bike tracks, and green routes. Each type serves a distinct purpose, catering to the diverse needs of cyclists and ensuring efficient and safe travel throughout the city.

The city's approach to cycling infrastructure design is characterized by simplicity, prioritizing ease of use and accessibility for all cyclists. By implementing measures such as narrowing lane widths, tightening corner radii and incorporating textured surfaces, Copenhagen encourages motorists to adopt a more cautious and considerate approach when sharing the road with cyclists. This deliberate design strategy not only enhances safety but also fosters a culture of mutual respect and cooperation among road users. Painted bike lanes offer dedicated space for cyclists on busy thoroughfares, delineating bike and vehicle traffic and reducing the risk of collisions. Separated bike tracks, on the other hand, offer an added layer of protection by physically separating cyclists from motor vehicles. Off-street paths, including those that run along parks, waterfronts, and highways, provide scenic routes for cyclists while also serving as vital connectors within the city's broader cycling network.

Copenhagen's relentless focus on safety is evident in its meticulous design of intersections, where the majority of cycling accidents occur. Through innovative measures such as dedicated traffic lights and stop lines for cyclists, the city prioritizes the safety of vulnerable road users by minimizing the risk of collisions, particularly during right turns, which are a notorious hazard for cyclists. Bike railings at intersections further enhance safety and predictability, encouraging cyclists to wait patiently and reducing the likelihood of red-light violations.

Beyond its tangible infrastructure, Copenhagen has cultivated a culture of cycling that is deeply ingrained in the fabric of the city. With a low accident rate and high levels of satisfaction among cyclists, Copenhagen has demonstrated that safe and accessible cycling infrastructure can not only encourage more people to cycle but also contribute to a more vibrant and livable urban environment. [42]

41 https://smartcitysweden.com/best-practice/368/sustainable-public-transport-in-stockholm/

42 https://www.visitcopenhagen.com/copenhagen/activities/what-makes-copenhagen-worlds-most-bicycle-friendly-capital

3.2.6. Australia

Sydney Cooperative Adaptive Traffic system

The Sydney Coordinated Adaptive Traffic System (SCATS) is an intelligent, real-time traffic management platform that monitors, controls, and optimizes the movement of people and goods within Sydney. SCATS comprise two primary services: intelligent traffic management and road user priority. Intelligent traffic management optimizes traffic flow by synchronizing traffic signals. Road user priority is an advanced traffic management software capable of prioritizing the movement of essential vehicles through the SCATS Priority Engine (SPE). SPE serves as a valuable tool for facilitating reliable and punctual public transport, expediting travel times for emergency vehicles, and enhancing the efficiency of freight delivery. Moreover, it can be configured to suit the requirements of any road network, offering advanced control over intersections to prioritize the movement of these vehicles. Sydney has realized notable improvements since implementing the SCATS system, including a 28 per cent reduction in travel time, a 25 per cent reduction in the number of stops, a 12 per cent decrease in fossil fuel use, and a 15 per cent reduction in emissions.[43]

Cooperative Intelligent Transport Systems services

The Cooperative Intelligent Transport Systems (C-ITS) framework utilizes connectivity to facilitate direct communication among vehicles, roadside infrastructure, and other nearby road users, such as pedestrians.[44] Enabled vehicles and infrastructure equipped with C-ITS technology can also communicate with central data management systems operated by roadway managers or vehicle manufacturers.[45] The Ipswich Connected Vehicle Pilot is Australia's largest on-road pilot of connected vehicles and infrastructure. Among the technologies utilized are advanced red-light warning (ARLW), road hazard warning (RHW), back-of-queue (BoQ), turning warning for vulnerable road users (TWVR), road works warning (RWW), and in-vehicle speed (IVS). Implemented in Ipswich, Queensland, Australia, from 2016 to 2021, the initiative was led by the Queensland Department of Transport and Main Roads. An analysis of the technology's effectiveness, conducted with 100 per cent penetration of C-ITS devices in new vehicles, revealed a 20 per cent reduction in cumulative crashes and a 3 per cent decrease in fuel consumption and emissions.

The Cooperative ITS Initiative (CITI) represents an international endeavour aimed at advancing cooperative intelligent transport systems. In 2012, Transport for New South Wales initiated investigations into the road safety benefits of Cooperative ITS (C-ITS) technologies. This initiative also saw the establishment of Australia's first C-ITS test facility. Phase 1 of the initiative concentrates on heavy vehicles (trucks and buses), Phase 2 focuses on privately owned light vehicles, and Phase 3 is presently in development. Conducted in Wollongong, New South Wales, Australia, under the auspices of the New South Wales Traffic Safety Center, the initiative has been ongoing since December 2012.[46]

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43 https://www.scats.nsw.gov.au/solutions/products

44 https://austroads.com.au/__data/assets/image/0030/416964/Ipswich.jpg

45 https://www.infrastructure.gov.au/infrastructure-transport-vehicles/transport-strategy-policy/office-future-transport-technology/intelligent-transport-systems-its-cooperative-its-and-telematics

46 https://austroads.com.au/drivers-and-vehicles/future-vehicles-and-technology/trials/citi

The Advanced Connected Vehicles Victoria (ACV2) test aims to develop a connected vehicle system utilizing cellular V2X technology to facilitate communication between vehicles and a network hosting platform. The ACV2 system leverages the existing 4G network to deliver safety warning messages to vehicles with minimal latency. This approach to connectivity offers the potential for widespread deployment without requiring significant investment in roadside infrastructure. The ACV2 system has successfully undergone six road safety-oriented use tests, encompassing scenarios involving speed, intersections, VRU, and rear-end collisions. Implementation of ACV2 took place in Melbourne, Victoria from September 2018 to March 2020.[47]

3.2.7 United States of America

RideMICRO on-demand transit service in North Carolina

Residents of three southeastern North Carolina counties gained enhanced transport options in 2022 through the introduction of on-demand transit, supported by a grant from the North Carolina Department of Transportation.[48] RideMICRO serves as an extension of the public transport network which aims to deliver responsive, affordable, and accessible transit solutions. It not only caters to local residents but also serves neighbouring communities such as Brunswick, New Hanover, and Pender counties. RideMICRO operates with funding amounting to $600,000 from the North Carolina Department of Transportation.

Laguna Beach Local on-demand transit in California

Laguna Beach, California unveiled Laguna Beach Local, a complimentary on-demand transit initiative, on November 8, 2021. This innovative programme provides residents with unrestricted access to local businesses, eateries, retail outlets, governmental services, employment opportunities, and non-emergency medical facilities within the city. Passengers can request complimentary rides at their convenience, with transport facilitated by small hybrid electric vehicles accommodating up to seven passengers. Launched in direct response to resident feedback, Laguna Beach Local enables residents to commute to various destinations such as grocery stores, downtown areas, or social gatherings effortlessly.

COTA PLUS on-demand micro transit pilot programme in Ohio

On July 18, 2019, the Central Ohio Transit Authority (COTA) introduced COTA PLUS, an on-demand micro-transit service operating in Grove City.[49] COTA PLUS offers point-to-point transport at an affordable fare and seamlessly connects passengers to fixed-route transit services operated by COTA. Functioning as an app-based ride-sharing service, COTA PLUS facilitates shared rides for passengers travelling in the same direction. Drivers undergo comprehensive training and background checks to ensure passenger safety and satisfaction. Developed in collaboration with various stakeholders, including the city and local businesses, COTA PLUS addresses mobility barriers hindering access to employment, healthcare, and education. The service caters to the escalating demand for improved mobility solutions evident in many

47 https://austroads.com.au/drivers-and-vehicles/future-vehicles-and-technology/trials/acv2

48 https://www.ncdot.gov/news/press-releases/Pages/2021/2021-10-11-wilmington-microtransit.aspx

49 https://www.masstransitmag.com/alt-mobility/shared-mobility/car-sharing/press-release/21088926/central-ohio-transit-authority-cota-central-ohio-transit-authority-launches-ondemand-microtransit-pilot-program

central Ohio communities, including Grove City. Customers can effortlessly book trips via the COTA PLUS app on their smartphones, ensuring swift and reliable transportation within a 15-minute timeframe. Trips must originate and conclude within the designated Grove City area. Moreover, passengers opting for a point-to-point COTA PLUS trip without utilizing COTA bus services will incur a $3 fare, payable exclusively through the app, as cash payments are not accepted. Additionally, customers availing themselves of COTA PLUS services enjoy seamless fare integration when transferring to fixed-route COTA buses (Routes 3 and 61), eliminating the need for extra payments.

Transit Signal Priority

Transit Signal Priority (TSP) is a traffic signal control algorithm designed to prioritize transit vehicles at traffic signals to reduce travel time, improve accuracy, and enhance efficiency. TSP functions by establishing communication between the signal control system and public transport vehicles. Transit vehicles transmit their location and scheduled time to the signal control system, which then adjusts signal timing accordingly. Common methods (or treatments) of TSP include maintaining a green light for oncoming traffic for a specified duration (typically up to 10 seconds), shortening red signals for transit vehicles, and adjusting the timing of green phases in the traffic signal cycle to accommodate transit vehicle arrivals. Additionally, TSP practices may involve giving red lights to upstream vehicles to facilitate the reentry of buses stopped at stops or signals and providing special bus-only signal phases to enable buses to turn left or bypass vehicles stopped at red lights. The rules for signal priority settings depend on the objectives of the TSP system, agreed upon by transit agencies and signal operating agencies. These rules may include unconditional priority, where all arriving transit vehicles are always given priority, or conditional settings that offer more flexibility based on schedules and traffic conditions. Various on-board and roadside devices are utilized to gather information for conditional rules.

Currently, TSP operations are managed by the Washington State Department of Transportation. Hardware and software installations were implemented along the South Snohomish County 164th Avenue Southwest corridor (Phase 1) and SR 99 corridor (Phase 2). Comprehensive performance evaluations based on field traffic data and actual control settings indicated that schedule adherence rates improved by approximately 16.3 per cent and 6 per cent in Phase 1 and Phase 2 testing, respectively. Moreover, transit travel times were notably reduced, with the average corridor travel time decreasing by 4.9 seconds in Phase 1 and by 54 seconds (4.93 per cent) in Phase 2.[50]

3.3. LESSONS LEARNED TO DEVELOP THE GUIDELINES

Existing transport services have primarily evolved to tackle challenges such as traffic congestion, deficiencies in mass transit, traffic accidents, and the deployment of safety infrastructure, all stemming from the high population density in major urban centres. While these services have made strides in alleviating traffic congestion, reducing accidents, and bolstering public transit in cities, their reach

has had limited success in reaching VRUs and remote rural areas, thereby falling short of fulfilling the fundamental SDG principle of equity. Regrettably, the societal benefits of putting in more resources for

50 https://www.wsdot.wa.gov/research/reports/fullreports/699.1.pdf

extra services are often perceived as inconsequential when weighed against the budgetary, temporal, and labour costs involved, leading many nations and municipalities to adopt a passive stance towards expansion. However, recent strides in digital technology, including sensors, wireless communication, big data analytics, AI, and portable devices like smartphones and tablets, have ushered in a wave of innovative smart transport solutions that are being piloted and implemented worldwide. For instance, emerging sensor technologies facilitate the collection of data that was previously arduous to gather, high-speed wireless communication enables the transmission of vast amounts of information, AI technology and robust computing power allow for the analysis of extensive datasets, and real-time dissemination of processed information to users is achievable through smartphones and tablets. Moreover, smartphones and corresponding applications empower users to directly access desired services, thereby enhancing the feasibility of delivering convenient services across wider geographical areas without additional physical infrastructure that could then be made accessible for all transport user groups.

3.3.1. Smart transport services are bridging accessibility and inclusivity gaps

The paradigm of smart transport services is undergoing a significant shift to address existing gaps in accessibility and inclusivity. In recent years, there has been a notable change in perspective regarding who should receive transport services and how these services should be provided. Smart transport solutions tailored for VRUs, including persons with disabilities, older persons, and children, as well as rural areas have been introduced and implemented across various countries and cities. Representative examples of these innovative approaches include the following.

- **Smart Crosswalk Service:** This safety initiative aims to enhance pedestrian safety at crosswalks by providing real-time information and warnings through alert sounds, vocal cues, and messages. Notably, this system is extensively deployed in numerous cities, with 78 operational points in Seongdong-gu, Seoul, Republic of Korea, serving as a prime example.
- **Indoor Navigation for the Elderly:** Leveraging AI speech recognition and voice guidance technologies, this service offers indoor and outdoor navigation assistance, particularly catering to the elderly population. By enabling voice-activated directions, the system aids elderly individuals in navigating complex environments. Notably, as part of the Republic of Korea's national Smart City Challenge programme, an elderly-specific indoor navigation system has been installed in stations across Busan Metro Lines 1 to 4.
- **Green Man+ Service:** As noted above, the Green Man+ service in Singapore extends green signal times for VRUs. This system, operational at over 1,000 pedestrian crossings in 2022, utilizes smart card authentication to activate extended signal durations, ranging from 3 to 13 seconds, benefiting individuals with mobility challenges.
- **On-demand Bus Service:** This service offers flexible routes and schedules tailored to real-time user demand, in contrast to fixed-route conventional public transport. Increasingly utilized in both urban and rural settings, this service serves populations with varying mobility needs, including VRUs. Noteworthy demonstrations of on-demand bus service implementation include cities such as Incheon, Gangneung, and Wonju in the Republic of Korea, Tanjong Beach in Sentosa, Singapore, as well as Valdosta, Georgia, and Austin, Texas in the USA.

3.3.2. Social issues and global challenges within the transport sector

Smart transport services outlined above serve as compelling evidence that social issues such as regional decline and global concerns like climate change have permeated the transport sector. Regional decline, spurred by urbanization, poses a significant social challenge in numerous countries, particularly in rural areas characterized by small populations and sporadic demand for bus services. Consequently, the quality of public transport suffers, manifesting in extended departure times, limited routes, and overall diminished service quality, which, in turn, deters potential ridership or renders public transit inaccessible. Moreover, the elderly, who face challenges with driving, need reliable public transport options.

Furthermore, in response to the imperative of reducing carbon emissions, governments need to prioritize policies that promote public transport over car-centric alternatives. Addressing these challenges necessitates innovative solutions, with DRT emerging as a promising remedy. Moreover, initiatives such as indoor navigation services, smart bus shelters, IoT sensors for urban emission monitoring, and subsidies for electric vehicles are being introduced in various countries and cities.

3.3.3. Paradigm shift - from hardware-centric to software-centric services

The paradigm of smart transport services is undergoing a gradual transition from hardware-centric to software-centric solutions. Traditionally, hardware systems like digital bus information panels, loop detectors for real-time traffic signal control, and variable message signs for traffic information have constituted the backbone of existing smart transport services. However, in recent years, software aspects such as mobility data platforms, smartphone applications, and artificial intelligence (AI) have emerged as the focal points of innovative services like DRT, indoor navigation, smart intersection management, and smart crosswalk safety.

This shift signifies a strategic evolution wherein existing hardware infrastructure is augmented and optimized through software solutions to enhance service effectiveness. For instance, functionalities like summoning DRT buses or accessing various mobility services on smartphones, as well as leveraging AI technology to analyze CCTV images for traffic monitoring and hazard detection, are now prevalent in some countries.

3.3.4. National policy foundation - crucial role in fostering innovative solutions

As highlighted earlier, numerous innovative smart transport services have emerged and proliferated globally, expanding their reach to encompass comprehensive transport solutions for VRU and rural areas. This progress has been facilitated by national policies, programmes, and investments aimed at fostering the development of new solution ideas.

Exemplary initiatives include the Smart City Challenge project in the USA, the National Smart City programme in the Republic of Korea, and the Smart Nation initiative in Singapore. Notably, the Smart City Challenge project in the USA and the Republic of Korea features a bottom-up approach

to idea development and cultivation. Under this framework, local governments and private entities propose innovative smart transport service ideas, with the central government providing funding support for selected initiatives. This bottom-up approach has proven instrumental in addressing various local social issues through digital technology while also serving as a catalyst for the dissemination of creative ideas to other regions.

For instance, in the Republic of Korea, the Smart City Challenge project introduced pioneering services such as DRT in Incheon and smart crosswalk safety systems in Seongdong-gu, Seoul. Subsequently, the Smart City Solution Creation and Dissemination Programme facilitated the replication of these successful solutions in other municipalities. Additionally, the Smart City Innovation Growth Engine R&D project and the National Pilot Smart City project in cities like Sejong and Busan have spearheaded research and development efforts to innovate future smart transport services and implement them in real-world urban environments. Similarly, Singapore's Smart Nation initiative, led by the central government, supports a range of creative mobility solutions, including smart transport initiatives, autonomous vehicles (AVs), the Centre of Excellence for Testing and Research of AVs (CETRAN), contactless fare payment systems, and on-demand shuttle services.

These national policy frameworks and programmes play a pivotal role in fostering innovation, driving collaboration between public and private sectors, and ultimately advancing the development and deployment of smart transport solutions.

3.3.5. Sophisticated and compassionate solutions for vulnerable road users

Recently, there has been a surge in the introduction of smart transport services tailored specifically for VRUs. While the dissemination of VRU-centric solutions has historically lagged behind other smart transport services, attributed partly to perceived inefficiencies from an economic and quantitative standpoint, recent years have witnessed a significant shift. This change has been propelled by the global proliferation of smart city initiatives and increased recognition of the importance of enhancing traffic safety and mobility for VRUs.

Representative examples of innovative VRU services include a smart crosswalk safety system equipped with AI-powered pedestrian recognition capabilities, which can identify pedestrians and issue verbal warnings accordingly. Additionally, there has been the introduction of wheelchair-accessible shared mobility services, DRT solutions tailored for VRUs in rural areas, indoor navigation services catering to the needs of VRUs, and smart bus shelter facilities designed with VRUs in mind.

As this paradigm shift gains momentum, it is anticipated that VRU-centric smart transport solutions will become increasingly ubiquitous, thereby ushering in a new era of inclusivity, safety, and accessibility in urban mobility systems worldwide.

3.3.6. Shared mobility services are a viable alternative

Shared mobility services are increasingly recognized as a transformative solution to address a myriad of social issues and challenges. While the conventional perception of shared mobility services primarily revolves around substituting private cars with shared vehicles, recent developments have expanded the scope of these services to cater to individuals who face mobility limitations, serve regions with sporadic traffic demand over vast areas, and operate during times when traditional public transport is unavailable.

Notable examples of these inclusive shared mobility services include wheelchair-accessible shared mobility options and on-demand bus services tailored for VRU in rural areas. Despite the lack of comprehensive analyses comparing the effectiveness of on-demand services to their operating costs, on-demand services are rapidly gaining traction worldwide. This surge in popularity can be attributed to their ability to address sporadic demand for bus services through flexible route planning and operational schedules. Furthermore, the convenience of accessing on-demand buses anytime and anywhere via smartphone applications has significantly contributed to their widespread adoption.

As shared mobility services continue to evolve and diversify, they hold immense potential to not only alleviate transport challenges but also foster inclusivity, accessibility, and social equity within communities worldwide.

3.3.7. Existing ITS services are evolving and adapting to meet changing needs

The evolution of Intelligent Transport Systems (ITS) services is evident through the integration of innovative technologies such as big data analytics, AI, high-speed wireless communication, V2X communication, and various sensor technologies. These advancements are enhancing the capabilities of existing ITS services and enabling the development of novel solutions to address transport challenges. For instance, AI technology is being leveraged to optimize real-time traffic signal control, improving traffic flow and reducing congestion. Video analytics, powered by AI, enables accurate traffic counting, while high-speed wireless communication networks facilitate the transmission of vehicle approach information to surrounding vehicles and pedestrians. Furthermore, LiDAR sensors are being deployed alongside existing loop detectors on roads, enabling more precise traffic detection over longer distances. Additionally, electronic toll collection systems are being transformed into smart tolling systems, eliminating the need for lane splitting and streamlining the tolling process. These advancements highlight the evolution of existing ITS services into more efficient and effective solutions. Particularly in countries with advanced software technology, the existing ITS infrastructure serves as a foundation for smart city initiatives.

3.3.8. Lack of feasible sustainable solutions

Despite the growing recognition of the urgency to address climate change, the implementation of effective solutions within the transport sector remains limited. While subsidies and support policies for electric vehicles have been introduced, they primarily target individuals interested in ownership rather than offering comprehensive carbon reduction strategies accessible to the general public.

In urban areas, some cities such as London, UK and Seoul, Republic of Korea, have established LEZs to restrict the entry of older diesel vehicles into city centres. Additionally, numerous countries and regions have deployed IoT sensors to monitor emissions levels. However, there is a notable absence of groundbreaking smart transport services capable of significantly reducing emissions from the transport sector. In some cases, the implementation of LEZs has had severe negative social consequences and is not an inclusive solution. Therefore, the social inclusiveness of these emerging solutions needs to be better assessed and evaluated.

Additionally, the intersection of providing smart transport services and combating climate change remains poorly understood. Policy support is needed to foster innovative smart transport solutions aimed at social inclusivity, which in turn assists in combating climate change by reducing dependence on private transport. By incentivizing and supporting creative ideas in this area, policymakers can stimulate sustainable transport alternatives and accelerate progress towards a more socially inclusive and environmentally friendly transport system.

Chapter 4

GUIDELINES ON ENHANCING SOCIAL INCLUSION AND INNOVATIONS IN URBAN TRANSPORT SYSTEMS

4.1. INTRODUCTION

A structured and systematic approach is needed to enhance social inclusion and innovations in urban transport systems in the Asia-Pacific region. This chapter presents a set of guidelines which were developed through national assessments and regional analysis. These guidelines recognize the intersectional nature of social exclusion (or the "inclusion continuum") and build upon the foundation laid by related works, such as the Gender Equality and Social Inclusion (GESI) transformative approach (Soriano et al., 2023). Collectively, these guidelines promote policy changes to remove systemic barriers and practices and to improve social inclusion and innovations in the transport sector.

The first draft of these guidelines was developed based on a thorough literature review, national assessments and survey findings conducted by the target countries of the project, which was followed by detail discussions in a virtual Expert Group Meeting in October 2023, where the first round of comments was collected from member States and partner organizations. This was followed by additional discussions in four national workshops held in Mongolia (November 2023), Lao PDR (February 2024), Azerbaijan (March 2024), and Nepal (April 2024). Feedback obtained from the workshops was further used to refine the guidelines before presenting them to other ESCAP member States at a regional meeting in June 2024, where additional comments were collected. Since the guidelines are designed to address the entire Asia-Pacific region, a certain amount of flexibility has been maintained to remain open-ended for further modifications at the national levels depending on different needs.

One of the key findings was that data should be collected at regular intervals and disaggregated at the level of gender, age, trip purpose and time of travel, to inform and enable transport planning authorities to adopt a more needs-oriented approach. Additionally, a nuanced mobility-gap analysis approach should be part of the planning exercise. These data gaps, for example in terms of average daily trips and time-use of different demographic groups and households, will shed light on the distribution of mobility opportunities among different user groups.

4.2. METHODOLOGY

Following the literature review, a draft of the regional guidelines was developed using the results of the national assessments of Azerbaijan, Lao PDR, Mongolia, and Nepal, including the analysis of household travel data collected from surveys. The quantitative data collected were synthesized with additional policy analysis at the national and regional levels. Specific attention was placed on better understanding transport demand patterns among different social groups, including low-income households, persons with disabilities, older persons, and women. These were then analyzed to identify policy gaps and design the interventions presented in these guidelines.

As noted in the introduction, the draft guidelines were presented at a virtual Expert Group Meeting in October 2023. The comments received were used to revise the guidelines before they were presented again at four national workshops and one regional meeting between October 2023 and June 2024. Thus, feedback from ESCAP member States, development partners and other experts was used in a stepwise fashion to improve and validate these guidelines.

4.3. REGIONAL GUIDELINES

These guidelines are grouped into five main regional guidelines: 1) conduct timely data collection and analysis; 2) mainstream social inclusion in urban transport; 3) integrate transport innovation for social inclusion; 4) enhance capacity building and raise awareness; and 5) promote inclusive consultation and collaboration. The guidelines and strategies are summarized in table 6 and elaborated below. Depending on the national or local context, there may be overlaps between strategies that would require further modifications.

Table 6: Regional Guidelines

Guideline 1: Conduct Timely Data Collection and Analysis	
Strategy 1.1	Prioritize the regular collection and analyses of travel behaviour and accident data
Strategy 1.2	Integrate travel behaviour and accident data analyses into transport planning decisions
Strategy 1.3	Develop standardized indicators for inclusive transport and accessibility assessment
Strategy 1.4	Include the project impact on different social groups in cost-benefit analyses
Guideline 2: Mainstream Social Inclusion in Urban Transport	
Strategy 2.1	Provide affordable and accessible urban transport
Strategy 2.2	Improve the accessibility of services and opportunities for different social groups
Strategy 2.3	Promote active mobility in combination with public transport
Strategy 2.4	Modify and simplify regulatory frameworks

Table 6: Regional Guidelines (cont.)

Strategy 2.5	Map and address safety and security concerns
Strategy 2.6	Improve gender equality in the transport workforce
Guideline 3: Integrate Transport Innovation for Social Inclusion	
Strategy 3.1	Design smart transport from a social inclusion perspective
Strategy 3.2	Steer national policies to foster innovative transport solutions
Strategy 3.3	Actively consider strategies and policy plans from the regional road map on smart transport for social inclusion
Guideline 4: Enhance Capacity-Building and Awareness-Raising	
Strategy 4.1	Develop organizational and capacity-building strategies
Strategy 4.2	Launch targeted campaigns
Strategy 4.3	Apply monitoring and feedback mechanisms
Strategy 4.4	Implement sustainable and inclusive procurement systems
Strategy 4.5	Develop tools to support the decision-making process
Strategy 4.6	Integrate social inclusion and innovations in transport training and education
Guideline 5: Promote Inclusive Consultation and Collaboration	
Strategy 5.1	Consult and collaborate with different social and transport user groups
Strategy 5.2	Support cross-sectoral collaboration between transport and other sectors

4.3.1. Guideline 1: Conduct Timely Data Collection and Analysis

The lack of data is still a significant constraint in many ESCAP member States. This adversely affects the ability to understand the travel behaviours and patterns of different social and transport user groups. The collection and use of appropriate data in transport policy development will help countries to better identify existing gaps in achieving inclusive and innovative transport goals. Conventional data collection methods, such as household travel surveys, focus groups or interviews, could be coupled with new methods, including big data analytics that could be supported by mobile app-based data collection. Analyses of travel behaviour, constraints and accessibility need to be triangulated and supported by quantitative and

qualitative data collection techniques. Therefore, the costs of data collection and analysis would need to be considered as part of transport planning and policy development processes. The following four strategies support the implementation of this guideline.

Strategy 1.1: Prioritize the regular collection and analyses of travel behaviour and accident data

Different data collection methods and the subsequent analysis of data can be incoporated into transport planning and policymaking processes to build a cohesive picture of the travel patterns, needs and preferences of all social groups. These methods include travel surveys, attitudinal and preference surveys, multi-sited ethnography combined with in-depth interviews, and document analysis and informant interviews. Travel survey data should contain relevant information on all personal daily mobility, including information on multimodal trips, transport modes, distances, and the time of travel. This data can be further enriched with local and regional spatial data from external sources, such as open street maps, as well as census data, registry data and cadastral data. Travel surveys measuring attitudes and perferences and distributed over different types of residential environments (inner-city, outer-urban, suburban, and peri-urban) and population categories within them will assist in capturing habits, attitudes, self-assessments of well-being, perceived barriers and motivations with regard to access to health, education and employment opportunities. Quantitative data collection can be coupled with the collection and analysis of qualitative data, such as multi-sited ethnography combined with in-depth interviews. Examining both qualitative and quantitative data is necessary to gain a full understanding of the mobility experiences, barriers and motivations underlying the decisions that individuals make about modes of transport and routes. Such an examination is also vital in helping to ensure that key questions are adequately identified for quantitative surveys.

Strategy 1.2: Integrate travel behaviour and accident data analyses into transport planning decisions

This strategy specifies that analyses based on disaggregated travel behaviour and traffic accident data should be closely linked to transport planning decisions. Such analyses should include all forms of transport modes, including walking, cycling, public transport, informal and formal shared mobility, and private vehicle-based trips. Disaggregated data analysis can assist in providing more insights on the spatial and temporal dimensions of road accidents, since the location and time of accidents will be different for different social groups, such as persons with disabilities, older persons and women. Additionally, a Knowledge, Attitudes and Practice (KAP) survey can be conducted among different social groups to assess their different travel behaviour and associated risk factors (Lalitha et al., 2015). A KAP survey is a quantitative method with predefined questions formatted in a standardized questionnaire that helps gather quantitative and qualitative information on beliefs and behaviours.

Strategy 1.3: Develop standardized indicators for inclusive transport and accessibility assessment

The representation of all social groups and transport users can be captured and monitored by developing and using a set of standardized indicators across Asia and the Pacific. The set of indicators could also complement transport-related indicators that have been identified and included in the Sustainable Development Goals indicator framework. Appropriate indicators can reflect, track and compare the level of inclusive urban transport systems in cities and be used to assess urban transport systems and services. In addition, transport-related indicators can be used to provide guidance to help countries in the region: (a) to carry out their own inclusive transport assessment

through the identification of the relevant data that would need to be collected; (b) to create essential indicators that can determine the current level of inclusive transport and innovations; and (c) to better design data collection processes and surveys. Indicators are also an important benchmarking tool for countries to monitor and evaluate how inclusive and effective their policies are. Ultimately, the availability of accurate data and the use of standardized indicators that include all social groups will help raise awareness by increasing the visibility of existing transport gaps, including gender.

The collection, storage and analysis of disaggregated data and indicators should be aligned with data protection regulations where relevant. Indicators should be developed and routinely used, but subject to periodical assessment and updates. The ESCAP SUTI, which is an Excel-based tool that consists of ten indicators representing the performance of transport systems and the social, economic, and environmental dimensions of sustainable urban transport, can be further expanded to include more inclusive transport and innovation related indicators.

Strategy 1.4: Include the project impact on different social groups in the cost-benefit analysis

The cost-benefit analysis used in transport decision-making processes should include all social groups. The accessibility of employment, health care and education opportunities have tangible economic benefits. These benefits can be estimated and converted into economic indicators. If these indicators are taken into account in cost-benefit assessments, there could be a substantial increase in infrastructure investments, including for public transport, walking and cycling, and universal design.

In addition to inclusive cost-benefit analysis, social externalities and distributional impacts should also be considered in transport planning processes. An example is the IISD SAVi assessment methodology (Bassi et. al. 2020), which is an assessment methodology that provides policymakers and investors with a comprehensive analysis of how much their infrastructure projects and portfolios will cost throughout their life cycles, taking into account risks that are overlooked in a traditional valuation. SAVi uses a combination of system dynamics and project finance modelling to capture the full costs of environmental, social, economic and governance risks. Moreover, SAVi calculates the dollar value of externalities that result from infrastructure development (IISD, 2024).

Some governments require transport projects to consider distributional impacts in their appraisal processes, such as the United Kingdom Department for Transport's Social and Distributional Impact appraisal and the United States Department of Transport's requirement to include social equity measures in plans and projects. Canada's Gender-Based Analysis Plus (GBA Plus) is an analytical tool used to support the development of responsive and inclusive policies, programmes, and other initiatives in all sectors, including transport. GBA Plus aims to understand who is impacted by the initiative; identify how the initiative could be tailored to meet the diverse needs of the people most impacted; and anticipate and mitigate any barriers to accessing or benefitting from the initiative. GBA Plus is an intersectional analysis that goes beyond biological (sex) and socio-cultural (gender) differences to consider other factors, such as age, disability, education, ethnicity, economic status, geography (including rurality), language, race, religion, and sexual orientation (Government of Canada, 2024).

4.3.2. Guideline 2: Mainstream Social Inclusion in Urban Transport

Existing national inclusive transport policies in Asia and the Pacific include social impact assessments for transport projects and the promotion of inclusive and sustainable development while fostering innovation. Specific goals and targets on inclusive transport and accessibility include universal design considerations in transport facilities, such as providing low ramps on buses and trains; safe walkways, sidewalks and bike lanes; and inclusive and people-oriented transport systems, where public health and well-being are being prioritized. In addition, some countries in the Asia-Pacific region have also introduced women-only public transport services to reduce harassment; bicycle lanes; and safety features, such as proper lighting, surveillance, segregated areas, and staff trained to assist women commuters. While such measures solve micro-level accessibility challenges, mainstreaming social inclusion in public transport needs to be much broader in scope and application. Relevant strategies are described in Strategies 2.1-2.6 below.

Strategy 2.1: Provide affordable and accessible urban transport

It is essential to generate capacity, knowledge and cooperation modalities for both formal and informal public transport systems, in the different hierarchies of local, regional and national transport plans. Providing adequate tax benefits and subsidies to promote public transport could also be made a priority. A better understanding of the travel behaviour needs and constraints of different user groups (Guideline 1) will also support the development of policies that respond to diverse travel patterns in terms of affordability, time of travel, trip duration, access-egress, trip length, trip-chaining and trip purposes.

The affordability and accessibility of public transport are major impediments for low-income transport users. Programmes designed to address transport affordability need to be integrated with other social welfare initiatives. Free public transport tickets, bicycles and other innovative solutions can have positive impacts on low-income households in accessing education, employment, and health care services. In addition to greater affordability and connectivity, public transport provision needs to be more tailored, taking into account temporal coverage and fleet composition to accommodate different mobility needs.

The linkages between Strategy 2.1 and Strategy 1.4 will need to be considered, given the prevalent modalities for financing infrastructure across the Asia-Pacific region. As the public typically bears the cost of implementing transport initiatives, the indirect impacts that subsidies may have on both the demand and supply sides of the market should be considered. Factors such as induced demand, improved human capital, and increased market integration may justify such financial outflows, with the overarching goal of improving the well-being of individuals across all socioeconomic groups. This integration should be reflected in the design and monitoring framework or logical framework of respective transport projects or initiatives to ensure a cohesive pursuit of agreed-upon activities, outputs, and outcomes through a theory of change approach, which is anchored in sustained transformational changes.

Strategy 2.2 Improve the accessibility of services and opportunities for different social groups

The conventional focus in the transport sector has been on increasing the efficiency of the formal transport system, and key success indicators have been defined by the length of roadway or railway built, time savings and distance travelled. To prioritize inclusive transport, there needs to be a shift from increasing mobility to enhancing accessibility. For example, accessibility mapping of different transport modes for various social groups needs to be conducted to determine areas that should be prioritized to support the use of public transport, walking and cycling. In areas that are already built, it is vital to create infrastructure that ensures safe walking and cycling conditions, along with the use of public transport. Route mapping and route planning of both formal and informal public transport can also link low-income areas to employment and education hubs. The mapping of the level of accessibility (table 7) of different social groups can also be integrated with information on land use and facilities, including schools, employment centres and health care services, which will better inform the design of transport infrastructure, routes and networks.

Table 7: Typology Levels for Accessibility Mapping

Spatial Level	Methodology	Output
Macro-regional/city level	Mapping of interaction between land use and accessibility; app-based survey plotting the travel behaviour, travel impedances, public transport route mapping, time use studies, mapping activity participation, personal interviews, ethnographic studies, document analysis and popular media discourse and history of planning to unearth biases.	Accessibility mapping; route mapping; time use mapping and mobility potential of the vulnerable population.
Meso-zonal level	Questionnaire surveys, mapping activity participation, ethnographic studies and focus groups.	Accessibility levels to work; education; social opportunities; health amenities; and training facilities.
Micro-ward level, street level	Safety audits, walkability and bike-ability audits; assessment of walking and bicycling infrastructure and mapping unsafe areas, routes, hotspots; presence or lack of Universal Design solutions.	Micro-level information can be collated and scaled up. For example, design interventions based on local conditions, Universal Design etc.

Strategy 2.3 Promote active mobility in combination with public transport

An integrated transport system is essential in creating an inclusive public transport system. A trip should be inclusive from the point of origin to the final destination. Hence, an inclusive transport system can only be achieved when the first- and last-mile transport options are inclusive as well. Active mobility, which refers to walking and cycling, can complement public transport use. In order to complement public transport with active mobility, public transport stops must also be appealing. Ensuring accessible, safe and secure first- and last-mile transport (walking and cycling) routes requires infrastructure designed with pedestrians and cyclists in mind. This entails, for example, sidewalks and bus stops without hazardous crossings. Different transport user groups, including pedestrians, women, children, older persons, and persons with disabilities, face unequal obstacles due to inadequate infrastructure. Stations and bus stops should, therefore, provide socially and physically secure environments. Examples of inclusive public transport measures could include: reserving seats on buses, trams, metros, and trains for individuals with limited mobility due to disability or pregnancy; providing audio route descriptions from stations to streets and between different platforms in mp3 format; making tactile paving and routes available at every station to facilitate navigation to and from platforms; making trains, buses and trams wheelchair accessible; and creating safe routes through tunnels, bridges and other types of transport infrastructure. Personal security remains an important concern in first- and last-mile connections, and often is a major reason for women to restrict their mobility.

Strategy 2.4: Modify and simplify regulatory frameworks

There are several areas where existing regulatory frameworks need to be modified to keep up with evolving transport needs, as well as changes in transport innovations and services. Supportive regulatory frameworks for accessibility analysis (ITF, 2017), including the regulation of app-based mobility (ITF, 2023), will support the development and implementation of inclusive transport and innovations across all modes. Such regulations would also need to include informal and shared mobility services to regulate the growth of this subsector, while addressing safety and security issues, environmental degradation, unfair competition, and negative trends such as operating without a license or exploiting legal loopholes (Kumar, 2018; Chakraborty and Banerjee 2017). Policy gaps tend to exist due to poor coordination and communication between the various government agencies and stakeholders in regulating and managing urban transport services. Regulatory frameworks set by national governments largely determine the level of implementation, cost, modes, and operations. Therefore, these frameworks should be rooted in promoting a policy environment that can bring together formal and informal transport, and existing and emerging modes, to provide integrated solutions. Greater coordination and deeper communication between various government agencies and stakeholders on the regulation and management of urban transport services will also increase transport system efficiency (CPR, 2016).

As regulatory frameworks set by national governments largely determine the level of implementation, cost, modes and operations, they can be designed to align formal and informal transport services, and existing and emerging modes, to provide integrated solutions that fulfil the criteria of affordable, available, accessible, and acceptable transport.

Strategy 2.5: Map and address safety and security concerns

Personal safety and security have been found to be a major concern among transport users, especially for women and persons with disabilities. Infrastructure design would therefore need to prioritize the creation of safe spaces at both macro and micro levels. At the meso- and micro-level, smart solutions, including mobility apps that are designed to meet the transport needs of women and persons with disabilities and safety auditing routines can be employed to map unsafe areas. Protocols also need to be established on how to transform these unsafe areas, routes and transport corridors into safe and accessible areas (UNEP, 2017).

Furthermore, a structural shift in how safety and security concerns are discussed within the public transport systems is needed. For example, drivers and conductors need to be trained to handle situations of harassment (UN-Habitat, 2018). Additionally, measures such as displaying helpline numbers in public transport, along with voice messages for persons with disabilities, installing emergency buttons and share information about these interventions at transit hubs and stops are crucial.

Strategy 2.6: Improve gender equality in the transport workforce

Transport is a male-dominated sector that contains gender gaps throughout all levels of the workforce across all regions of the world. In Asia and the Pacific, only 15 per cent of the transport workforce were women in 2021 (ILO, 2023). While women do participate in the transport workforce, relatively few women rise to managerial positions. In global supply chains and logistics, women occupy less than 20 per cent of top executive positions across all sectors (Vaughan-Whitehead and Caro, 2017), and it is also more common for women to have less job security and lower-paid jobs than men across the transport sector (Barrientos, 2019; Turnbull, 2013). The historically low representation of women in the transport sector has created gender-biased attitudes and barriers, as well as discriminatory work environments and conditions (Fraszczyk and Piip, 2019; Turnbull, 2013). Such existing bias and discrimination further prevent women from joining the sector, creating feedback loops which need targeted interventions.

Gender diversity in the workplace does not only benefit women but will also benefit society as a whole, economies, the environment and enterprises themselves (ILO, 2019). Greater gender equality or diversity in the transport workforce will not only address the discrimination women face in the workforce as a matter of human rights, fundamental principles, and rights at work, but will also create more economic efficiency, leading to poverty reduction (UN Women, 2016). Attracting and retaining more women in the transport workforce will also allow for better planning and design of transport systems and services that cater to the needs of women users. A multitude of perspectives is required to ensure inclusive transport and mobility systems and services. Increasing the representation and visibility of women at all stages of transport policy, planning, implementation, and usage of transport projects will make transport more responsive to the needs of users and even increase the sustainability of transport development (Fraszczyk and Piip, 2019).

Despite these benefits, women who decide to pursue a career in the transport sector still encounter severe challenges which are attributed to work organization (e.g. opportunity to do part-time work or teleworking); work-life balance (e.g. parental leave, childcare); health and safety at the workplace;

working culture; wages; career, qualification and training, and recruitment (WISE, 2012). Policies which focus on the education and training of women and girls, hiring and retaining of women, as well as the establishment of labour laws that set the legal framework for gender equality, can reduce some of these barriers and will ultimately improve the level of gender equality in the sector (Ng and Acker, 2020).

4.3.3. Guideline 3: Integrate transport innovation for social inclusion

Digitalization and related technologies have brought fast-paced and drastic advancements to the transport sector. However, not all transport innovations are socially inclusive yet. Considering their huge potential, it would be critical to integrate this trend in policies that will further support the development of inclusive transport. For example, smart mobility can be used to develop more user-oriented and -customized services, such as on-demand bus services, applications for mobility safety and wheelchair-accessible shared mobility. Cooperation among local stakeholders, academia, civil society organizations, non-governmental organizations, and different levels of government will further enhance the development of transport innovations for social inclusion. Platforms created through such cooperation can also enhance the responsiveness of transport-relevant offices, agencies and institutions to the evolving travel needs of all social groups, particularly in relation to land use, technology and other disruptions. Strategies 3.1-3.3 highlight how innovations can be further linked to the inclusive design of transport policies.

Strategy 3.1: Design smart transport from a social inclusion perspective

Smart cities and mobility solutions have changed the ways in which urban areas are being planned, utilized and consumed. Social inclusion must be integrated into the development of smart cities and mobility to ensure that all social groups can enjoy their benefits. This can be achieved through recent technological advancements, such as big data, artificial intelligence, and data platforms, which can now collect and analyze large amounts of data in real-time, and provide synthesized information to users through different devices, including smartphones, tablets and vehicle navigation systems. Such technologies can also support the development of demand-responsive transit, which is an alternative mode choice for different social groups, including persons with disabilities, older persons, and rural residents. Visually impaired people will be able to use smart canes that can detect, identify and receive information on arrivals. As social inclusion is gradually mainstreamed into all transport policy-making processes (Guideline 2), transport innovation development will ultimately need to consider its social impacts as well.

Strategy 3.2: Steer national policies to foster innovative transport solutions

Throughout Asia and the Pacific, the urban population is expected to grow and, consequently, so will the need for urban transport will also continue to expand. The adoption of innovative solutions for all transport modes, such as public transport, walking, cycling, and private vehicles, including two-wheelers, can make transport more sustainable in economic, environmental and social inclusiveness terms. For their successful implementation, local characteristics must be integrated into policies for planning, financing, and implementation of transport infrastructure projects, with a focus on both formal and informal modes, private sector participation and innovative financing mechanisms. National smart solution programmes can also be useful to identify and implement creative ideas based on the users' perception of their transport challenges through a bottom-up and participatory approach.

Strategy 3.3: Actively consider strategies and policy plans from the regional road map on smart transport for social inclusion

ESCAP has developed a regional road map to support regional cooperation on sustainable and resilient smart transport systems in Asia and the Pacific (ESCAP, 2023). This regional road map optimizes the use of digital technologies, with a focus on harmonizing policies and strategies, promoting regional cooperation, and addressing challenges for wider deployment, while remaining flexible to the status, needs and challenges of ESCAP member States. It also aims to foster connectivity, integration, inclusiveness, affordability, and resilience in the transport sector, guided by good governance and institutional effectiveness, to ultimately contribute to the region's sustainable development goals. This road map guides countries in Asia and the Pacific on five strategies that are aligned with achieving the SDGs and the Paris Agreement, including a strategy on inclusive transport which is aimed at ensuring access for all. They serve as a unified pathway for the wider adoption of smart transport to ensure the societal success of inclusive transport while supporting the development of national policies and strategies.

4.3.4. Guideline 4: Enhance Capacity-Building and Awareness-Raising

In order to mainstream social inclusion in the urban transport sector, there needs to be a strategic focus on capacity building at multiple levels using a combination of approaches. Strategies 4.1-4.6 present a range of measures to support the building of capacity and the raising of awareness on social inclusion and innovations in urban transport systems.

Strategy 4.1: Develop organizational and capacity-building strategies

The first step in designing organizational strategies is a commitment to adopt an inclusive approach. It is essential to ensure that different social groups are actively engaged right from the inception stage in transport programmes or infrastructure design and execution. A mix of quantitative and qualitative methods can be used in designing, implementing and monitoring transport projects. Furthermore, the specifics of inclusive transport can be addressed through 1) responsibility mapping of different stakeholders and the development of public-private partnership guidelines; 2) intersectoral coordination between ministries; 3) reporting and complaint mechanisms that include the training of public transport operators and staff, coupled with reliable reporting and complaints system with appropriate response mechanisms to address incidents of harassment, assault and violence; and 4) training and capacity-building programmes for public transport workers.

Responsibility mapping can help identify and plot responsibilities among different stakeholders. Public-private partnership guidelines are essential, especially with the use of formal and informal transport services in Asia and the Pacific. Responsibility mapping also considers the roles and responsibilities of different levels of government involved in transport policies, as well as data reporting requirements for monitoring and evaluating these policies.

Intersectoral coordination between ministries across sectors, such as transport, land and urban development authorities, social development, and welfare and employment authorities can facilitate the exchange of knowledge and best practices and enhance capacity. Reliable reporting and complaints systems with appropriate response mechanisms are effective in addressing incidents of harassment, assault and violence, so training of staff in these systems is crucial. The clear assignment of

organizational responsibilities, as well as communications of the responsible party to the public, will also support timely reports or complaints. Low threshold strategies, such as toll-free hotlines, smartphone apps and dedicated phone lines, can help transport users report harassment and other crimes in real-time.

Lastly, training and capacity-building programmes can be developed through four main approaches. They include the top-down organizational approach, which can begin with changing agency policies and practices; the bottom-up organizational approach, through providing skills to staff; the partnerships approach, which involves strengthening the relationships between organizations, and the community organizing approach in which community members are actively consulted. The development of training sessions for public transport drivers and operators should also be made mandatory as part of public transport license requirements.

Strategy 4.2: Launch targeted campaigns

Campaigns can be an important tool for raising awareness of inclusive transport and for actively seeking feedback from different social groups. For example, campaigns targeting sexual harassment and assault on public transport to raise awareness and disseminate information on the topic can be quite successful. Such campaigns have been employed to encourage women and men to report incidents and speak up in order to change attitudes towards sexual harassment and assault. Furthermore, such campaigns can provide the public with information about initiatives to reduce inappropriate behaviour, serve as an appeal for witnesses to come forward, and be used to disseminate pictures of suspects.

One of these success stories includes the Massachusetts Bay Transportation Authority's (MBTA) anti-harassment advertising campaign, where an evaluation conducted four years after a campaign launch indicated that the number of reported sex offences on the MBTA increased by 32 per cent, and the number of arrests for sex offences increased by 96 per cent (Gekoski et. al., 2015). Different campaigns can also be designed to address specific topics and the needs of different social groups through user consultations. However, they must refrain from blaming or shaming the victims.

Strategy 4.3: Apply monitoring and feedback mechanisms

A clear monitoring framework and feedback mechanism can assist in monitoring and in further enabling robust policies and programmes through stakeholder engagement plans using a feedback loop between governments and all social groups of transport users. Such monitoring and feedback mechanisms are critical for accountability, awareness, and improving transport design. They should include public consultation and provide timely information about any transport projects or policies and their potential impacts, as well as feedback and discussion opportunities for all social groups. Such feedback loops can be used to pilot, improve and scale up solutions that incorporate the views of key stakeholders and transport users.

Strategy 4.4: Implement sustainable and inclusive procurement systems

Strategic procurement planning processes can be used to ensure sustainable and inclusive outcomes. With regard to diversity and inclusion, procurement processes need to be defined at various levels, ranging from transport infrastructure design to the hiring of workers. To that end, inclusive conditions

should be clearly formulated and integrated into bid requirements, contract clauses and key performance indicators. Clear channels of information need to be established so that information about the procurement process is available to all. In order to encourage local-level participation that is built on local solutions, system-level impediments should be resolved, including a long time period before payment or unclear procurement systems. Indicators and standards that integrate principles of inclusion can be modified for different contexts, and adapted from the national to regional and local levels.

Strategy 4.5: Develop tools to support the decision-making process

Tools need to be developed to support the decision-making process. They should allow the user to assess and monitor the progress made in the areas targeted for development. For example, decision-making tools have been developed for mainstreaming gender in the transport sector. These include the Asian Development Bank's Gender Toolkit for Transport and Gender Equality and Disability Inclusion Guidelines (ADB, 2013; ADB, 2024), which feature guidance for Asian Development Bank staff and national government on developing gender-responsive and inclusive transport projects. They feature checklists that technical staff can follow and examples of projects that feature gender mainstreaming measures. Tools to support decision-making need to be further expanded to include the conerns of persons with disabilities.

Strategy 4.6: Integrate social inclusion and innovations in transport training and education

Discussions on the social impact of urban transport activities, design and planning need to be integrated into formal transport training and education, including undergraduate and graduate planning and engineering curricula. For example, education on road design should be integrated with the importance of pedestrain pathways and safe cycling lanes. The understanding and education of the social impact of transport will be increasingly critical as the sector continues to be more autonomous, decarbonized and digitalized. The education of future urban and transport planners, engineers and policymakers will need to be focused on the sustainability and inclusiveness of the sector. Such a focus will make it possible to build a foundational knowledge of the essential topics, tools and methodologies to reflect social inclusion in transport decisions. Undertaking an evaluation of current and proposed policies in their local contexts is essential. Campaigns or exposure programs for high school students are also necessary to pique the interest of the younger generation, both men and women, in considering a career in the transport sector.

Guideline 5: Promote Inclusive Consultation and Collaboration

The travel needs and constraints of different social groups will be better understood and addressed if multi-stakeholder engagement is practised and different stakeholders are consulted when transport infrastructure projects or policies are being developed. The strategies set out below are focused on ways to promote consultation and collaboration across stakeholder groups, including different transport users, for a more inclusive process.

Strategy 5.1: Consult and collaborate with different social and transport user groups

Transport planners, engineers and policymakers can focus on user-centric approaches; move beyond conventional designs; better understand user needs and mobility patterns by using disaggregated data; and integrate advanced innovative technology to enhance mobility for all. In addition, participatory

planning and engagement with different social groups about their various travel needs can also support the development of inclusive transport policies. For example, different transport user groups can be consulted when countries are reforming their transport standards. Changes in transport policies can also be developed in collaboration with different social groups, including persons with disabilities, older persons, women, and low-income households, as well as the public transport industry and different levels of government. An impact analysis framework that includes a robust analysis of the costs and benefits of different policy options can also be developed to support informed decision-making.

Strategy 5.2: Support cross-sectoral collaboration between transport and other sectors

The enhancement of social inclusion in transport is a complex problem, which intersects with multiple sectors. The cross-cutting nature of social inclusion and innovations requires multi-ministry and multi-stakeholder engagement. In addition to urban development ministries, transport ministries need to coordinate with line ministries responsible for education, social development, finance, culture, media, and communications to jointly develop comprehensive strategies for the implementation of inclusive transport policies.

A multi-sectoral approach can better align with the accessibility needs of all social groups. Linking transport policies to other relevant sectors, such as social development, can create welfare and social protection programmes built around issues of transport and accessibility, that can enhance accessibility for all social groups.

4.4. CONCLUSIONS

The guidelines presented in this chapter were developed to support the design and implementation of policies on social inclusion and innovations in urban transport systems in the Asia-Pacific region. They are not exhaustive and can be altered to fit the varying contexts present in different countries. The guidelines can also be applied regionally, nationally, or locally. As some of the guidelines and their associated strategies can overlap, an intersectionality lens can be adopted while implementing the guidelines. For example, the intersectionality between gender, age, disability, or income level needs to be further established in any given context, especially in light of different travel constraints associated with accessibility and affordability.

The ultimate goal of these guidelines is to build capacity to improve social inclusion and innovations in urban transport systems. A country-level identification of desired outcomes can further guide countries in successfully implementing the guidelines, based on each country's unique priorities. The enforcement of the proposed strategies is just as important as the development of guidelines and strategies. To ensure that the guidelines and strategies are implemented in a manner that is relevant to the local context, and followed by enforcement protocols, country-specific action plans can be developed with clear timelines and prioritization of different guidelines and their subsequent strategies. This will inevitably vary between countries, depending on the existing level of social inclusion in current urban transport systems.

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