*Eco Cities (2023) Volume 4 Issue 2*
doi: 10.54517/ec.v4i2.2497

PERSPECTIVE

# Framework for assessing sustainability of urban transport projects—Case of India

**Darshini Mahadevia[1], Saumya Lathia[1,*], Chandrima Mukhopadhyay[2]**

[1] *School of Arts & Sciences, Ahmedabad University, Ahmedabad 380009, India*

[2] *Consultant to UN-Habitat India, New Delhi 110003, India*

*** Corresponding author:** Saumya Lathia, saumya.lathia@ahduni.edu.in

## ABSTRACT

The majority of the population in million-plus cities of India, especially the lower- and middle-income groups, are largely dependent on public transport (PT), intermediate public transport (IPT), and non-motorized transport (NMT) for their mobility. There is a need to assess such urban transport projects with regard to their contribution to various developmental goals, such as the Nationally Determined Contributions (NDCs) in the context of the Paris Agreement of 2015 and the Agenda 2030 of the Sustainable Development Goals (SDGs), independently as well as in their interactions with each other. Ministry of Housing and Urban Affairs, Government of India published a checklist for project appraisal of urban transport projects in 2015. This viewpoint proposes to expand the existing checklist for assessing public transport projects, i.e., BRTS and city bus services, IPT sector, i.e., auto-rickshaw, E-rickshaw, cycle-rickshaw, and shared mobility like Uber and Ola, and NMT infrastructure, i.e., walkways and cycle infrastructure to include parameters related to climate change mitigation, relevant SDGs targets, and participatory governance.

***Keywords:*** project appraisals; urban transport; Sustainable Development Goals (SDGs); public transport; non-motorized transport

## 1. Introduction

Every new development project is justified using the prevalent rhetoric of the times. Hence, urban transport projects in India are referenced against the prevalent ideas of people-centricity, environmental sustainability articulated as green mobility, and equity and inclusiveness ensuring access to transport, livelihoods, social amenities, and opportunities for all. In the Indian context, the National Urban Transport Policy (NUTP)[1] captures these ideas in its objectives: "To ensure safe, affordable, quick, comfortable, reliable and sustainable access" to the city residents[1]. Its vision states: 'All plans, including the transport plans, must be people-centered for common (i.e., everyone's) benefit and well-being.' The detailed objectives mention improvement in the quality of public transport, accessibility of the marginalized populations to livelihoods and other opportunities such as education, reducing pollution and promoting cleaner vehicle technologies, and reallocation of road spaces from vehicle-centricity to people-centricity (i.e., more space for pedestrian, cyclists and public transport; reduced space for movement of private vehicles and

**ARTICLE INFO**
Received: 17 January 2024 | Accepted: 29 February 2024 | Available online: 27 March 2024

**CITATION**
Mahadevia D, Lathia S, Mukhopadhyay C. Framework for assessing sustainability of urban transport projects—Case of India. *Eco Cities* 2023; 4(2): 2497. doi: 10.54517/ec.v4i2.2497

parking).

To achieve the vision and the objectives, the former national Ministry of Urban Development (MoUD) prepared a toolkit to guide the preparation of urban transport plans and appraisals of urban transport projects. The appraisal component includes assessing the urban transport projects from the perspective of sustainable urban mobility, thereby emphasizing not just reducing greenhouse gas emissions but simultaneously encouraging social and gender equality and promoting economic efficiency[2]. Before we discuss the contents of the checklist, it needs to be mentioned that no other such document has been prepared since 2015. Hence, we presume that this document, 'Appraisal checklist for urban transport projects—Toolkit June 2015'[2], is in use. A new document, 'Appraisal guidelines for metro rail project proposals', of September 2017[3] is available, focusing on only metro rail projects, as the title suggests. The latter document proposes the contents for the Metrorail project proposal and the process of preparation; it is not, in essence, a checklist to assess the sustainability and inclusiveness of these projects. Thus, this paper bases its analysis and recommendations on the checklist prepared by the MoUD to prepare Comprehensive Mobility Plans (CMPs) for a city. Preparing CMPs is an ongoing activity in the metropolitan cities in India.

The MoUD's appraisal checklist seeks information on various aspects of the performance of the individual project. For example, the appraisal document focuses on the public transport systems, i.e., the city bus system and the bus rapid transit system. The document does not include the Intermediate Public Transport (IPT) and hence does not include a checklist for proposing and improving the IPT projects. This is when IPT captures an 11% proportion of the mode share in metropolitan cities and over 13% proportion of the mode share in small and medium cities. The checklist for bus-based public transport system includes surveys required for project proposals, appraisal parameters related to project financials, operation and maintenance, modal shift (from private to public), service levels (coverage, comfort, fatality, integrated ticketing, and average waiting time), reduction in GHG emissions and noise pollution, and energy efficiency.

The appraisal parameters included in the checklist are limited to public transport, non-motorised transport (NMT), and other transport infrastructure (see **Table 1**). The list presented in **Table 1** is selective (not exhaustive). However, it represents specific vital parameters, namely lane segregation and design, level of service, ridership and mode share, safety, and other provisions for transport project appraisals. It also flags conflict issues in PT and NMT projects that require careful policy, planning, and design consideration. **Table 1** has a list of indicators for the appraisal of transport projects. The indicators proposed are for the appraisal of transport project proposals presented to the national government. The indicators for public transport (PT), NMT, and other transport infrastructure have been listed separately. From the reading of this report, it is unclear whether the PT project would be assessed using the indicators listed or if it would be assessed in coordination with the NMT infrastructure provided, as the former would function better when the latter is in place and improved. This table also shows that IPT is excluded from the checklist.

This paper accepts the need for an appraisal mechanism for transport projects. However, it argues for expanding the parameters and variables in this checklist to include two significant international commitments of India: one of the Nationally Determined Contributions (NDCs) pledged under the Paris Agreement signed in 2015[4] and the second of the Sustainable Development Goals (SDGs) to be achieved by 2030. In this paper, we want to build a case for a solid and contemporary lens to the urban transport projects' appraisal, particularly for the Indian context and generally for the countries of the Global South expected to experience rapid urbanization. We propose a new checklist that integrates commitments by India and other countries of the Global South to meet the NDC pledges and fulfill SDG targets amidst high rates of urbanization, high levels of inequality and lags in the SDGs. Section 2 provides a contextual rationale for the paper. Section 3 discusses the arguments for the proposed expansion of the appraisal checklist for urban

transport on four grounds compared to the published one. Section 4 is on the recommendation for the project appraisal checklist and conclusion.

**Table 1.** Examples of appraisal parameters from MoUD's checklist (2015)*[2].

| Parameters | Variables related to | | |
|---|---|---|---|
| | **Public transport** | **Non-motorized transport** | **Other transport infrastructure** |
| Lane segregation and design | Clear lane markings for segregated PT lanes for priority | Segregated NMT lanes for safety<br>NMT crossing | Intersection design for ease of crossing |
| Level of service | PT coverage, average speed, average waiting time, headway time, fleet engine fuel standards, carrying capacity, last-leg connectivity (feeder routes), adequate parking facilities | NMT coverage, street lighting, NMT lane width | Average travel speed of private motorized vehicles, traffic surveillance, peak hour traffic volume in PCU/h |
| Ridership and mode share | PT ridership, PT mode share, shift to PT from private motorized vehicles | NMT mode shares<br>Shift to NMT from private motorized vehicles | IPT mode share and fleet per 1000 people, Motorized mode share, vehicle ownership |
| Safety | PT fatality rates | NMT users' fatality rates | Percentage of roads having speed limit ≥ 50 kmph1, safe stopping sight distance of intersections |
| System design and other infrastructure provisions | Provisions for hawkers vendors along PT networks | Signalized intersection's average waiting time | Average waiting time for pedestrians at signals |
| Conflicts to be negotiated | Share of clean fuel PT fleet | NMT Lane Encroachment due to parking, trees, utilities, street vendors, garbage | Encroachment on NMT lanes by vehicle parking |

* The authors selected indicative parameters from the lengthy checklist spanning five transport appraisal categories. Hence, this is a non-exhaustive list of parameters.

## 2. Contextual rationale—Urban transport situation in India

Here, we present the context of building our argument of including SDGs and climate change mitigation and adaptation in the transport projects' appraisal framework. Indian cities are experiencing a high growth rate of motorization in the last two decades[5]; higher-income and upper-middle-income groups remain the dominant private vehicle users[6], while lower- and middle-income groups remain captive users of public transport (PT), intermediate public transport (IPT) and non-motorized transport (NMT)[7]. The modal share varies depending on city size and types (the economic base), as average trip length, trip purpose, affordability, etc., remain influential variables for mode selection. Limited micro studies point out that low-income women tend to walk (rather than cycle) and hence have low trip lengths, whereas low-income men tend to cycle rather than take public transport[8–10]. With the increase in household income, men tend to shift to private motorized vehicles, firstly two-wheelers and then four-wheelers, whereas women shift to using PT where available or IPT[11,8]. The provisioning and use of PT increases with city size increase; an older study of 2008—no systematic study available since then—shows that in cities with less than half a million population, 34% walked, and only 10% used either PT or IPT[12]. The low share of PT in trip-modes is due to various reasons: low availability and reliability; poor quality, frequency, efficiency, and hygiene; and lack of point-to-point connections. Further, 42% walked or cycled in 30 cities of various sizes[12]. In contrast, in cities with more than 8 million population, 22% walked, whereas 44% used public transport. This difference is due to bias in favour of large cities (5 million plus) in provisioning public transport on the one hand and

the requirement of public transport because of longer trip lengths in these cities compared to smaller cities on the other. Thus, there are multiple challenges related to urban transport in Indian cities: (i) catering to sizeable latent demand for public transport built up on account of non-availability and poor quality, (ii) increasing mobility or trip lengths of a large section of the urban population, among which are low-income women enabling them to access opportunities for livelihood and capability enhancement (through access to education and healthcare infrastructure), (iii) improving NMT infrastructure thereby providing good last-leg connectivity on the one hand and encouraging walking and cycling for short trips, and (iv) shifting vehicles to cleaner fuels. Thus, transport projects must cater to multiple simultaneous SDGs, which we discuss in the next section.

On multiple grounds, the mass transit project-related debate for Indian cities has been surmounted around rail-based versus bus-based systems[13–15]. In light of climate change mitigation, the bus-based system remains the priority due to its flexibility and typical shorter trip lengths (<5 km) in Indian cities. Private sector operators remain critical in bus-based systems, with mutual interests from the public and private sector actors. Some recent successful models, like the cluster bus system in Delhi, were maintained through the Public Private Partnership (PPP) for improved quality of service (QoS)[16]. However, prior studies have indicated that bus rapid transit systems, the definitive version of the bus-based system, are not affordable for the urban poor, and captive users continue to depend on city bus services, IPT and NMT[17,18]. Within the IPT sector, auto-rickshaw and E-rickshaw services grew as an informal urban transport sector and are partially regulated by the public sector due to their popularity. Shared mobility services like Uber and Ola are more recent and run on a private sector-driven model. At the same time, data shows that a higher percentage of people who commute to work using NMT or are walking are often urban poor, who are 'no choice' walkers or users of NMT. They tend to commute for much longer trip lengths than desirable due to the unaffordability of PT/IPT or the non-existence of other transport modes. Hence, the proportion of existing NMT users and walkers must be shifted to a combination of affordable PT and IPT to improve their mobility and comfort.

The examples of the checklist for appraisal of the urban transport projects arose because of national-level missions and programmes launched by the Government of India since 2005, to name a few, Atal Mission for Rejuvenation and Urban Transformation (AMRUT)[19], National Electric Mobility Mission Plan (NEMMP)[20], etc. supporting mainly PT and NMT infrastructure along with nascent efforts to decarbonize urban transport. The first National Urban Transport Policy was introduced in 2006 and revised in 2014. The Institute of Urban Transport, India (IUTI) published a checklist for project appraisal of urban transport, including bus-based public transport systems, such as BRTS and city bus services, and NMT systems in June 2015; examples are presented in **Table 1**. In recent years, the national programmes have aggressively emphasized public transport, mainly rail-based one, leading to evictions while laying networks. The IPT vehicles are being phased out and replaced by cleaner fuel ones. These are negative implications of pushing ahead with low-carbon urban transport projects. Hence, while the future for urban transport in India, as well as in the cities of the countries of the Global South, is aggressive low-carbon options, their implementation has to be mindful of such negative consequences. In other words, the low-carbon urban transport projects must be mindful of their interaction with the SDGs. To be able to do so, we propose in this paper to introduce parameters and variables in the urban transport projects' appraisal framework. As mentioned above, we are using the case of India to do so.

The existing checklist falls short in incorporating the impact of climate change on the urban transport networks and delivery of certain relevant SDGs. The review of country cases and policy argues for expanding the existing checklist on three grounds: first, based on the SDG framework at the target level.

Second, the checklist should be expanded based on incorporating feedback from multiple stakeholders and actors and using practical tools to collect input from non-technical actors. Third, it should be expanded to appraise projects at various stages in their life cycle. A study[21] proposes the expansion of the project appraisal checklist for metro rails in India on the same grounds. This paper proposes additions to the checklist for city bus systems (including the BRTS), IPT, and NMT.

# 3. Proposed expanded project appraisal framework

We argue that the project appraisal for urban transport projects (public transport consisting of BRTS and city bus services, and NMT network consisting of walkways and cycle infrastructure) should be expanded on three grounds.

## 3.1. From the SDG framework perspective

First, the viewpoint argues for expanding the checklist on the grounds of relevant goals and targets of the SDG framework in the urban transport sector at the city scale. Seven of the seventeen SDGs are selected for their solid and multi-faceted relationship with urban transport: SDG1—No poverty, SDG3—Health & well-being, SDG5—Gender equality, SDG7—Renewable energy, SDG8—Economic development, SDG11—Sustainable cities and SDG13—Climate action. This section contains detailed target-wise additions to the checklist by each SDG in **Tables 2–8**. SDG targets that influence the delivery of urban transport services (considering direct and indirect impacts) and yet are absent from the checklist are only included.

**Table 2.** SDG1 no poverty targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| **SDG1: No poverty** | | |
| 1.1 | BRTS: Displacement of informal communities for the construction of BRTS (through dedicated bus lanes stations) or widening of right of way (ROW) for development of NMT infrastructure | While an existing procedure exists to rehabilitate displaced communities, displacement is never considered a negative externality on sustainability in the project appraisal framework. |
| 1.2 | Displacement of informal hawkers due to construction/ upgrading of associated infrastructure like NMT, including road/ROW widening and narrowing down of NMT, also as part of BRTS infrastructure. | Standard guidelines for BRTS for Indian cities include providing space on walkways for vendors. If NMT infrastructure is institutionally developed and maintained by the private sector, informal hawkers could be displaced or restricted due to the newly imposed fee. |
| 1.3 & 1.4 | Transport affordability | While BRTS, city buses, and IPT serve affordable housing and rehabilitation centers in the periphery (10-15 km from the city center), BRTS is still unaffordable to the urban poor, at least in the initial phase (e.g., Ahmedabad). The current appraisal checklist includes a point about affordability. |
| 1.A | Employment of urban poor in the informal IPT sector | Employment of urban poor in the informal sector is not mentioned in the current appraisal checklist. It can be through partial regulation in feeder services' last-leg connectivity wherein the IPT (electrified or not) would create employment. At the same time, loss of employment in certain outgoing modes due to technology change has to be factored in. |

SDG1 (no poverty): Urban transport plays a significant role in poverty reduction by enabling access to economic opportunities and providing employment. SDG1 has seven targets: SDG1.1 & 1.2 on eradicating extreme poverty, SDG1.3 on creating social protection systems, SDG1.4 on equal access to economic opportunities and essential services, SDG1.5 on resilience from extreme weather events, SDG1.5 on resource mobilization for implementing policies and programs, and SDG1.B on sound policy framework for pro-poor development. Urban transport has direct and indirect relationships with all targets; access to economic

opportunities and essential services is crucial for poverty alleviation (SDG1.1 & 1.2); a sizeable socio-economic segment in cities is dependent on public transport and non-motorized transport services to access essential services and economic opportunities, making transport systems a crucial part of public services and social protection policies (SDG1.3 & 1.4); transport systems (roads, public transport) form key of urban resilience as they enable effective rescue and relief efforts post-disasters (SDG1.5); land acquisition to implement large-scale urban transport projects often disproportionately affect urban poor by causing evictions, displacement and gentrification (SDG1.1, 1.2 & 1.A); transport systems core elements of pro-poor policies and strategies in cities (SDG1.B). The checklist does not include the impacts of urban transport projects on vulnerable populations, especially the urban poor. Urban poor are often 'no-choice' pedestrians in Indian cities for much longer trip lengths, in uncomfortable weather, due to unaffordability of public transport, are victims of road accidents due to inferior quality of infrastructure, and have restricted socio-economic mobility. The checklist must be expanded to address these components, including mitigating displacement and resettlement, transport affordability, and access to employment for the urban poor (**Table 2**).

SDG3 (health & well-being): In the presence of inclusive healthcare services, urban transport directly influences health outcomes by providing access to them. SDG3 has thirteen targets: 3.1 & 3.2 on preventing maternal and neonatal mortality, 3.3 on ending endemics and communicable diseases, 3.4 on reducing premature mortality from non-communicable diseases, 3.5 on preventing substance abuse, 3.6 on road accident injury and mortality reduction, 3.7 on universal access to sexual and reproductive healthcare, 3.8 on universal health coverage, 3.9 on reducing mortality from air, soil and water pollution, 3.A on the WHO convention on tobacco control, 3.B on research and development of vaccines, 3.C on training the healthcare workforce, and 3.D on risk reduction and prevention of global health risks. Urban transport planning has multiple direct relationships with six of the thirteen SDG3 targets - access to reliable transport systems, significantly better connectivity between rural and urban areas in the Global South, reduced perinatal, neonatal, maternal mortality (SDG3.1 & SDG3.2); transport sector is one of the largest sources of urban and regional air pollution, a leading risk factor for deaths due to non-communicable diseases (SDG3.4); neighborhoods along the highways and freeways are disproportionately exposed to negative externalities of air pollution, noise pollution, and increased urban heat island effect (due to large road mass), resulting in one of the poorest life expectancies (SDG3.9); road fatalities take 1.35 million lives every year and are among the world's top 10 causes of death (SDG3.6); and lastly, urban transport played a crucial role in providing relief from the pandemic, as well as escalating the virus spread (SDG3.3). Although air pollution reduction and road safety parameters are already included, the checklist must also include disaggregation of various forms of clean fuel and socio-economic indicators of road accident victims (**Table 3**).

**Table 3.** SDG 3 health and well-being targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 3.4 | Reduced air pollution due to modal shift | It is already included. However, a comparison between various cleaner forms of fuel has to be included, as severe air pollution is a challenge in India. |
| 3.6 | Reduced road injuries and death, particularly pedestrians and cycle users, are often the victims of road injuries and death. | While this is included in the current project appraisal, disaggregated statistics of the reduced number of victims based on socioeconomic group and vulnerability condition, such as disabled, children, elderly, etc., is valuable. |
| 3.9 | Reduced noise pollution | Included now. |

SDG5 (gender equity): Transport is crucial to women's empowerment, helping them access economic

opportunities and participate in civic and public life. SDG5 has nine targets: 5.1 on ending discrimination against women and girls, 5.2 on ending violence against women and girls, 5.3 on eliminating harmful practices like child marriage, 5.4 on recognizing women's unpaid care and domestic work, 5.5 on ensuring women's full and effective participation, 5.6 on universal access to sexual and reproductive healthcare, 5.A on equal rights to economic resources, 5.B on empowering women through use of technology, 5.C on strengthening policy on women empowerment. Out of nine targets, six have a strong relationship with urban transport; transport systems enable women's access to economic (SD5.1 & SDG5.5) and civic opportunities (SDG5.5) as well as healthcare services (SDG5.6); women's travel needs and patterns (refer section 2 for details) make them more susceptible to harassment and violence (SDG5.1 & SDG5.2); women's higher dependence on NMT and PT, and their tendency to chain their trips forces them to spend more time in commuting than men, resulting in a higher time poverty (SDG5.4). The checklist falls short on gender-sensitive transport design. The list should include women's personal and sexual safety, access to economic and civic opportunities through affordable integrated fare, off-peak hour services, healthcare services, and employment in the transport sector (**Table 4**).

**Table 4.** SDG 5 gender equity targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 5.1 | Accessibility and mobility (off-peak hour route, frequency, affordable fare for integrated multi-modal system) | Gender equality is included as an objective. However, a detailed disaggregated assessment by modes, social groups, and time of the day is required. |
| 5.2 | Safety regarding harassment (during regular and feeder service) and for IPT and NMT use. | Harassment is included in terms of security. The use of ICT in improving safety may be incorporated. |
| 5.4 | Gender-sensitive design (of stations, bus vehicles, and TOD/TOC) | The parameters of gender-sensitive design are required. |
| 5.B | Women's employment in urban transport (decent work environment) | This is not included but should be included as appraisal criteria to measure sustainability. Examples in India are the IPT sector (Pink E-rickshaws), BRTS, and city bus services. |

SDG7 (renewable energy): Recognizing transport sectors' contribution to GHG emissions, national governments worldwide are adopting cleaner fuels and engines, making electric mobility a global priority. This makes energy demand (especially renewable-nonrenewable share) for urban transport crucial for the future of mobility. SDG7 has five targets: 7.1 on universal access to clean, affordable, and modern energy services, 7.2 on increased adoption of renewable energy, 7.3 on improving energy efficiency, 7.A on international cooperation for clean energy research, and 7.B on expanding infrastructure to supply renewable energy. Urban transport has an indirect relationship with four of the five targets: increased adoption of electric mobility (solar-powered) increases the transport sector's renewable energy adoption (SDG7.2); improved vehicle design and updated standards and norms increase vehicle's energy efficiency (SDG7.3); and E-vehicle chargers, battery swapping stations and several other transport infrastructures enable expansion of renewable energy infrastructure (SDG7.B); and incentives for increased E-vehicle adoption increases access to cleaner vehicles for all (SDG7.1). Although norms on energy efficiency are included in the checklist, the checklist must be expanded to include renewable energy demand parameters. Using renewable energy makes PT and IPT more affordable. It benefits the vulnerable groups dependent on these modes while enabling the 'no-choice' pedestrians and cyclists to shift to cleaner motorized modes (**Table 5**).

**Table 5.** SDG 7 renewable energy targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 7.1 | Energy consumption for BRTS, electric buses, E-rickshaws, and related services | It should be included on the grounds of using renewable sources of energy. |
| 7.2 | The technology of using renewable sources | It should be included, as Indian cities must transition to renewable energy for public transport in discrete models. There are models of using solar panels on top of buses available for bus-based services. Transmission of technology would be necessary here. |

SDG8 (economic growth): Urban transport is crucial for any region's economic growth. SDG8 has twelve targets-8.1 on sustaining economic growth, 8.2 on achieving higher levels of economic productivity, 8.3 on development policies for 'decent work,' 8.4 on sustainable consumption and production, 8.5 on complete and adequate employment opportunities for all, 8.6 on reducing youth unemployment, 8.7 on eradicating forced labor and modern slavery, 8.8 on promoting safe and secure work environments, 8.9 on sustainable tourism, 8.10 on improved access to banking and other services, 8.A on increasing trade aid, and 8.B on implementing Global Jobs Pact of International Labor Organization (ILO). Urban transport has direct and indirect relationships with nine of the twelve targets; transport systems like PT are enablers for better productivity, job creation, and economic growth (SDG8.1) as they open employment opportunities, particularly for those with low mobility- like women, youth, differently abled, socio-economically vulnerable (SDG8.5, SDG8.6); efficient transport and logistics are fundamental for economic productivity (SDG 8.2) - traffic congestion imposes a heavy burden on the economy as it affects workers' productivity by forcing them to lose more time and stress in commuting; transport network maintenance is vital for ensuring safe and secure work environment in cities as streets often function as 'workplace' for a large section of informal workers (street vendors, IPT operators, etc.) (SDG8.3 & SDG8.8); safe and reliable transport systems are crucial in promoting sustainable tourism as tourists often depend on NMT and PT for mobility (SDG8.9); sustainable transport choices form an essential part of sustainable consumption (SDG8.4); and lastly enables access to financial services (SDG8.10). The checklist falls short of three particular targets: direct and indirect benefits of traffic congestion and emission reduction **s**hould be included to measure benefits in terms of time-saving and energy efficiency. Additionally, the inclusion of sustained economic green growth promotes a low-carbon lifestyle (**Table 6**).

**Table 6.** SDG 8 economic growth and decent work targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 8.2 | Reduced traffic congestion | Directly, it contributes to economic development; Indirectly, it contributes to energy efficiency for those vehicles that stay back on the road; it also contributes to adaptation in terms of reducing health issues due to the urban heat island effect. |
| 8.1 | Decent work environment | This includes a decent work environment within the urban transport sector (e.g., electric buses, automated metro rail, etc.). |
| 8.3 | Sustained economic green growth | This is already included in terms of low-carbon transport. However, life-cycle calculations have to be included here. |

SDG11 (sustainable cities & communities): SDG11 has the most substantial relationship with urban transport among all SDGs. SDG11 provides a backdrop for cities to pursue opportunities for creating inclusive, safe, resilient, sustainable, and low-emission communities through ten targets-11.1 on access to affordable housing and basic services, 11.2 on universal access to transport systems for all, 11.3 on inclusive and sustainable urbanization, 11.4 on safeguarding cultural and natural heritage, 11.5 on reducing fatalities

from disasters, 11.6 on reducing adverse environmental impact, 11.7 on access to public spaces, 11.A on supporting urban and peri-urban links, 11.B on integrating climate action policies and plans, and 11.C on sustainable and resilient buildings. Urban transport has a relationship with about nine of the ten targets. Transport plays a crucial role in enabling access and inclusion in two ways: first, by enabling access to affordable housing and basic services, especially for the urban poor residing in peripheral low-income housing (SDG11.1), and second, through universal design and inclusive planning, urban transport systems improve accessibility, mobility and in turn quality of life for all, especially vulnerable socio-economic groups, women, elderly, children and the differently-abled (SDG11.2); if transport planning is not context-sensitive- especially the expansion of road infrastructure or public transport routing- it leads to the loss of natural, cultural, or built heritage (SDG11.3 & SDG11.4); transport systems also enable access to public spaces (SDG11.7) and peri-urban area or hinterlands (SDG11.A); lack of effective integration of land-use and transport leads to urban sprawl and increases a city's carbon footprint, air pollution (SDG11.6, SDG11.B). Inclusiveness for safe, accessible, affordable transport for vulnerable groups with special needs must be included in the checklist. Only the use of a ramp is included in terms of universal access. The checklist should be expanded to comply with all universal access guidelines. Integration of transport and land use is essential to ensure access to basic services and affordable housing for all and hence must be included (**Table 7**).

**Table 7.** SDG11 safe, resilient, and sustainable city targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 11.1 | Connectivity of affordable housing in the periphery. This is a significant challenge in Indian cities. The connectivity should be in terms of route, station, and fare. | Displaced urban poor from the project are rehabilitated 10-15 km from the center/nearest mass transit stations. The PT projects' spatial coverage has to be included. |
| 11.2 | Inclusiveness for safe, accessible, affordable transport for vulnerable groups with special needs. | Only ramp usage is included in the case of NMT infrastructure. It must be extended to vehicle design, bus-stop design, and bus design (low-platform buses) to facilitate the boarding of wheelchairs. Electric buses, the new generation of public transport, have a high potential to be designed inclusively. |
| 11.5 | Inclusiveness for resiliency from urban floods. | The public transport's functioning during the disasters has to be tackled in design. |
| 11.4 | Preserving the cultural heritage. | Protection of cultural heritage to be included |

SDG13 (climate action): The transport sector contributes to about a quarter of the GHG emissions, making a critical element of any region's climate action strategy. SDG13 has five targets-13.1 on strengthening adaptive capacity to disasters, 13.2 on integrating climate action into national policies and plans, 13.3 on capacity building on climate mitigation and adaptation, and 13.A on implementing commitments undertaken in UNFCCC, and 13.B on including women, youth and marginalized communities in climate action planning. Urban transport has a relationship with two of the five targets; if a robust active transport network does not accompany rapid urbanization, it leads to rapid motorization and higher passenger transport demand and emissions. Hence, mitigating GHG emissions from the transport sector directly contributes to overall GHG emissions (SDG13.1 & SDG13.2). The checklist does not consider the impact of climate change on urban transport. Apart from GHG emissions, it is crucial to include the resilience of the urban transport network (dedicated bus lanes, bus stations, feeder services, NMT infrastructure) from extreme weather events. Financing green urban transport should also be prioritized (**Table 8**).

**Table 8.** SDG 13 climate action targets and recommended checklist (Source: By the authors).

| Target | Checklist items relevant for BRTS, city bus, NMT | Rationale for inclusion in checklist |
|---|---|---|
| 13.2 | Mitigation using a Whole life cycle analysis is highly recommended, as mentioned above. | The checklist does not consider the impact of climate change on urban transport. It is imperative to include all these. |
| 13.1 | Adaptation of bus stations/stops, vehicles, and feeder services, including NMT infrastructure, for comfortable use during extreme heat events. | The checklist should include these so that PT functions during disasters to provide relief and evacuation. |

## 3.2. From multiple stakeholders' and actors' input perspectives tools to collect data from non-technical actors on the ground

Second, we argue that the project appraisal should be expanded by considering multiple stakeholders' and actors' perspectives. The project approval often depends on a top-down approach, considering input from all technical actors from the supply side and mainly from those who support the project. Cost-benefit analysis based on a single perspective is often used as a decision-making tool based on 'with the project' or 'without project' scenarios. There are multiple reasons why multiple stakeholders' and actors' perspectives should be considered. There are segregated vulnerable groups, including urban poor, women, informal sector workers living on daily wage, and the disabled population, who, in the absence of urban transport infrastructure to meet unique needs, either do not have mobility or make trips on foot using unusual routes daily. Mass transit projects or highway projects may act as barriers to their mobility. Transport data is often not collected from them due to a lack of suitable data collection tools or willingness and resources to undertake broad community outreach efforts. It is essential to incorporate their travel demand to deliver an inclusive urban transport network. Moreover, since new generations of transport infrastructures are being introduced, such as electric vehicles powered by renewable energy and integrated nature-based solutions with non-motorized transport networks, it is essential to include the views of the people most dependent on these.

First, as evident from the last section on SDG, it is essential to include perspectives from those who have a conflict of interests (e.g., bus operators along the same route; informal IPT operators near the stations), from those on the demand side (e.g., illegal migrant labor), and from those who are affected by the project even though they are not benefitting (e.g., urban poor). Mukhopadhyay, 2018[22] shows a similar account for the BRTS project in Malaysia. From the demand side, input from all vulnerable groups, i.e., urban poor, elderly, disabled, and women, must be taken to deliver a demand-oriented product. Second, a cost-benefit analysis with a single perspective cannot justify such varied input needs. Hence, the policy-led multi-criteria analysis should be adopted to collect qualitative and quantitative input from various stakeholders with conflicting interests[23]. Third, BRTS projects are primarily delivered and maintained with the PPP model in India. While the project appraisal is carried out during the initial approval stage, the project goes through multiple renegotiations and redesign steps after the approval.

## 3.3. From carrying out the project appraisal at multiple stages of the lifecycle perspective

Finally, we argue that the scope of project appraisal should be expanded in terms of running the appraisal at multiple stages of the project's life cycle. Mega-transport projects (BRTS here) are known for their long planning horizon and long planning period due to the mega-scale of the project. A similar study argues for appraising the project at multiple stages of renegotiation on the grounds of accountability for highway projects[24]. However, for an effective project delivery, the project should be designed with enough flexibility to address ridership issues[25].

In order to estimate GHG emission mitigation accurately, it is crucial to adopt the life cycle approach

(LCA) and calculate GHG emissions over each phase. A LCA calculation includes the GHG emission for three components, i.e., vehicle (rail-carriage), hard infrastructure (track, station), and fuel (electricity), throughout the life cycle, i.e., from extraction of raw material, through power generation to recycling/disposal of each component. With the increasing adoption of metro-rail projects across Indian cities and many subnational regions formulating policies on coupling renewable energy to power electric buses and usage of renewable energy like biogas[26–28], this argument becomes vital in ensuring estimation accuracy. LCA is also an effective tool for judicious decision-making; for example, an LCA comparing electric IPT services using renewable energy for feeder services could be compared with non-motorized transport integrated with a nature-based solution to estimate which system has the higher potential to meet last-mile connectivity with highest GHG emission mitigation at a lower cost. As per the existing appraisal checklist, it is not used as a decision-making criterion. Mukhopadhyay, 2018[22] has run a scenario analysis using different fuels (diesel, compressed natural gas, electricity) for a combination of trunk and feeder services in Malaysia's proposed BRTS network operation stage.

# 4. Conclusion and policy recommendations

With the Paris Agreement and the SDG framework signed in 2015, there is scope to evaluate urban transport projects using a new lens. This paper argues that the checklist for project appraisal for BRTS, city bus services, IPT (auto-rickshaw and E-rickshaw), and NMT infrastructure (walkway and cycle infrastructure) should be expanded based on three grounds, i.e., using criteria from the SDG framework, considering input from multiple stakeholders and non-technical actors including those who are directly affected by the transport projects, and appraising the project at various stages in their lifecycle to maintain public sector accountability of public infrastructure. First, the SDG framework recommends considering seven goals and relevant targets to appraise the sustainability of the urban transport components, which, in this paper, are bus-based public transport, the IPT, and the NMT. The SDGs considered are SDG1 (no poverty), SDG3 (health and well-being), SDG5 (gender equality), SDG7 (renewable energy), SDG8 (sustained economic growth and decent work), SDG11 (safe, resilient and sustainable cities), and SDG13 (climate action).

Second, we recommend that multiple stakeholders, not just technical stakeholders, be involved in the assessment of the projects. We recommend that non-technical stakeholders and actors such as the project-affected communities, communities impacted by the land value capture mechanism, and inter-generational users and citizens be involved in decision-making. Their inputs should be collected while planning for and designing the project to effectively use in the planning and decision-making on delivery mode, and not at a post-design stage. Practical tools should be developed to collect information from the non-technical actors on the ground in Indian cities and cities in developing countries.

Third, the recommendation is to undertake project appraisal at multiple stages of a project lifecycle; as such, a project accounts for a longer planning horizon and goes through various stages of redesigning and renegotiation with private sector actors. The project should be appraised at multiple locations to maintain public sector accountability. The framework also addresses sustaining the project from several risks and uncertainties, i.e., climate change (e.g., urban flood, urban heat island effect, sea level rise), disruptive events (e.g., COVID-19), and even economic recession. The lifecycle assessment of projects is essential since the construction and operation of a capital-intensive project are highly impacted, as there is lock-ine of the financial investments. This paper illustrates one way of mainstreaming the global agendas in a country such as India, which is expected to urbanize rapidly over the next half a decade. The paper suggests that these global agendas can be mainstreamed, and localized by including these components in the initial project

appraisal framework. Other fast-urbanizing countries of the Global South could adopt such a framework and include assessment components suitable for their respective urban situations.

This article is based on a critical review of secondary literature and is not grounded through fieldwork or primary data- a standard limitation of review articles. The arguments in the article are context-specific and apply only to geographies with similar socio-economic and urbanization patterns. Moreover, the checklist must be customized for countries and regions with differential socio-economic, demographic, and urbanization patterns. This article lays the ground for future research on localizing and implementing relevant SDGs and the Paris Agreement in different tiers of cities with varied socio-economic bases.

## Conflict of interest

The authors declare no conflict of interest.

## References

1. Ministry of Urban Development (MoUD) and Institute of Urban Transport (IUT). National Urban Transport Policy. Available online: https://www.changing-transport.org/wp-content/uploads/E_K_NUMP_India_2014_EN.pdf (accessed on 18 December 2023).
2. Ministry of Urban Development (MoUD) & Institute of Urban Transport (IUT). Appraisal Checklist for Urban Transport Projects: Toolkit. Available online: https://smartnet.niua.org/sites/default/files/resources/Appraisal%20Checklist%20for%20Urban%20Transport%20Projects.pdf (accessed on 18 December 2023).
3. Ministry of Housing & Urban Affairs Government of India (MoHUA). Appraisal Guidelines for Metro Rail Project Proposals. New Delhi: Government of India. Available online: https://mohua.gov.in/upload/uploadfiles/files/Appraisal%20Guidelines%20for%20Metro%20Rail.pdf (accessed on 18 December 2023).
4. Government of India (GoI). India's Updated First Nationally Determined Contribution Under Paris Agreement. Available online: https://unfccc.int/sites/default/files/NDC/202208/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf (accessed on 18 December 2023).
5. Verma M. Growing car ownership and dependence in India and its policy implications. Case Studies on Transport Policy. 2015; 3(3): 304-310. doi:10.1016/j.cstp.2014.04.004
6. Ahmad S, Puppim de Oliveira JA. Determinants of urban mobility in India: Lessons for promoting sustainable and inclusive urban transportation in developing countries. Transport Policy. 2016; 50: 106-114. doi:10.1016/j.tranpol.2016.04.014
7. Varghese V, Adhvaryu B. Measuring Overcrowding in Ahmedabad Buses: Costs and Policy Implications. Transportation Research Procedia. 2016; 17: 145-154. doi:10.1016/j.trpro.2016.11.070
8. Mahadevia D, Advani D. Gender differentials in travel pattern – The case of a mid-sized city, Rajkot, India. Transportation Research Part D: Transport and Environment. 2016; 44: 292-302. doi:10.1016/j.trd.2016.01.002
9. Goel R, Oyebode O, Foley L, et al. Gender differences in active travel in major cities across the world. Transportation. 2022; 50(2): 733-749. doi:10.1007/s11116-021-10259-4
10. Ek K, Wårell L, Andersson L. Motives for walking and cycling when commuting – differences in local contexts and attitudes. European Transport Research Review. 2021; 13(1). doi: 10.1186/s12544-021-00502-5
11. Mahadevia D. Gender Sensitive Transport Planning for Cities in India, UNEP DTU Partnership, Centre on Energy, Climate and Sustainable Development, the Technical University of Denmark. 2015. http://www.unep.org/transport/lowcarbon/publications.asp
12. Wilbur Smith Associates and Ministry of Urban Development (MoUD). Study on Traffic and Transportation—Policies and Strategies in Urban Areas in India. Available online: http://www.urbanindia.nic.in/programme/ut/final_report.pdf
13. Tiwari G, Jain D. Accessibility and safety indicators for all road users: case study Delhi BRT. Journal of Transport Geography. 2012; 22: 87-95. doi:10.1016/j.jtrangeo.2011.11.020
14. Mohan D. Planning for public transport: integrating safety, environment and economic issues. 2001. http://www.iitd.ac.in/tripp/publications/paper/safety/dmpune.pdf
15. Mohan D. Mythologies, metro rail systems, and future urban transport. Economic and Political Weekly. 2008. 41–53.
16. Sharma KK, Misra SK, Singla AK. Role of Public Private Partnership in Bus Terminals: A Case Study of Punjab.

Think India. 2019; 22(2): 116-128. doi: 10.26643/think-india.v22i2.8680
17. Mahadevia D, Joshi R, Datey A. Ahmedabad's BRT System: A Sustainable Urban Transport Panacea? Economic and Political Weekly. 2013. pp. 56–64.
18. Sarath KT, Munshi T. Effect of Mass Transit Corridor on NMT Users-Case of Ahmedabad BRTS. 2019.
19. Atal Mission for Rejuvenation and Urban Transformation (AMRUT). http://amrut.gov.in/content/
20. National Electric Mobility Mission Plan (NEMMP). Available online: https://heavyindustries.gov.in/writereaddata/Content/NEMMP2020.pdf
21. Mahadevia D, Mukhopadhyay C. How do NDC and UN's sustainable development goals introduce new meaning of sustainability within mega transport project appraisals? Journal of Mega Infrastructure & Sustainable Development, 1:3, 237-254, DOI: 10.1080/24724718.2021.1930946
22. Mukhopadhyay C, MIT. Public Transport and Bus Rapid Transit as a Tool of Decarbonization in Malaysia. MIR-UTM Malaysia Sustainable Cities Program, Working Paper Series. 2018.
23. Ward EJ, Dimitriou HT, Dean M. Theory and background of multi-criteria analysis: Toward a policy-led approach to mega transport infrastructure project appraisal. Research in Transportation Economics. 2016; 58: 21-45. doi: 10.1016/j.retrec.2016.08.003
24. Mukhopadhyay C. A nested framework for transparency in Public Private Partnerships: Case studies in highway development projects in India. Progress in Planning. 2016; 107: 1-36. doi:10.1016/j.progress.2015.02.001
25. Ward EJ, Skayannis P. Mega transport projects and sustainable development: Lessons from a multi-case study evaluation of international practice. Journal of Mega Infrastructure & Sustainable Development. 2019; 1(1), 27–53.
26. Harris A, Soban D, Smyth BM, et al. Assessing life cycle impacts and the risk and uncertainty of alternative bus technologies. Renewable and Sustainable Energy Reviews. 2018; 97: 569-579. doi:10.1016/j.rser.2018.08.045
27. Bi Z, Song L, De Kleine R, et al. Plug-in vs. wireless charging: Life cycle energy and greenhouse gas emissions for an electric bus system. Applied Energy. 2015; 146: 11-19. doi:10.1016/j.apenergy.2015.02.031
28. Vidhi R, Shrivastava P. A Review of Electric Vehicle Lifecycle Emissions and Policy Recommendations to Increase EV Penetration in India. Energies. 2018; 11(3): 483. doi:10.3390/en11030483