Disentangling the relationships between the SDGs and transportation

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ABSTRACT

Transportation is a vital enabler of sustainable development, influencing economic, social, and environmental dimensions. In this research, we discuss and explore the intricate connections between transportation and the UN's Sustainable Development Goals (SDGs), identifying the interconnection between the transportation sector and SDGs. Our investigation highlights the vast role of transportation within the SDGs' scope, which was earlier limited to a few indicators; we stress transportation's transformative potential, including its role in enhancing urban accessibility, reducing greenhouse gas emissions, promoting equity and inclusion, and fostering economic opportunities. Key findings underscore gaps in the current SDG framework, such as limited recognition of active mobility, inequities in access, and underrepresentation of transportation's environmental and social impacts. In addition, thresholds for the different indicators interacting with the transport sector must be defined for a universal, transparent evaluation process. Moreover, there is a need to consider the interlinkage between several indicators within different goals that are closely linked, and their relationship should be considered when evaluated, and they should be evaluated simultaneously and not separately. The paper proposes refining indicators to capture the nuanced relationships between transportation and sustainable development, emphasizing context-sensitive approaches to address regional disparities and informal transit systems. By integrating transportation comprehensively within SDG planning and monitoring, policymakers can unlock its systemic benefits, accelerating progress toward the 2030 Agenda and fostering equitable, sustainable communities.

1. Introduction

The Sustainable Development Goals (SDGs) are a set of 17 global objectives established by the United Nations in 2015 (UN, 2015), adopted by 193 members as part of the 2030 Agenda to transform cities into more livable, sustainable places. These goals, along with their 169 targets and 242 indicators, focus on enhancing human well-being and overall quality of life (Kubiszewski et al., 2022). Their design addresses a broad spectrum of global challenges and promotes a sustainable, inclusive future, seeking to end poverty, hunger, AIDS, and discrimination against women and girls. The SDGs aim to foster economic growth, social inclusion, and environmental protection by balancing social, economic, and environmental dimensions. Nevertheless, implementing such a global initiative poses significant challenges due to individual countries' varying capacities and resources. This

complexity demands an integrated and holistic approach to ensure the successful implementation of the SDG.

Transportation is not merely a way to move people and goods from one point to another, or only to establish a connection between people and their needs, or to help people perform different activities; it has been pivotal in sculpting the physical, social, and economic fabric of cities and regions (Cytron, others, 2010; Yeboah & Asibey, 2019). Transportation is essential to cities' urban growth and sustainable development by supporting economic, environmental, and social development and growth (Miller et al., 2016). The transportation sector is currently facing several challenges that are fueled by the rapid urban population growth, which is driving the urban demand for travel exponentially. According to the UN, the urban population in 2019 is 56% of the world population compared to 34% in 1960, and this ratio is expected to grow up to 67% by 2050.[1] Therefore, developing and maintaining a sustainable transportation system is necessary, but

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challenging considering all the impacts of transport on the different dimensions of sustainability.

Litman and Burwell (2006), Miller et al. (2016) categorized the impacts of transportation systems on sustainability as follows: (I) environmental impacts, in terms of air, noise, and water pollution, climate change, hydrologic impacts, habitat, and ecological degradation, depletion of non-renewable resources; (II) Economic impacts: accessibility quality, traffic congestion, infrastructure costs, consumer costs, mobility Barriers, accident damages, depletion of non-renewable resources; (III) social impacts: equity/fairness, impacts on mobility disadvantages, affordability, human health impacts, community cohesion and community livability, and aesthetics. The impacts of the transportation sector on sustainability are significant, especially its negative externalities, which need to be eliminated to achieve global sustainability and reach the planned SDGs.

The 2030 SDG Agenda was structured, defined, and described in general terms, as it was not based on specialists from different fields, such as transport and mobility, but rather by policy representatives, resulting in some vague descriptions for the different goals that need more clarification and investigation from specialists in the different fields, and specifically in the context of this research, which is the transportation sector (Liu & Yuan, 2023; Pisano & Berger, 2016). One example of the problems related to transportation sector and SDG is not considering all the modes of transportation in the planning and evaluation of the different goals, such as the exclusion of active mobility (walking and cycling); in other words, the focus is only on public transportation (PT) with no consideration for new emerging forms of mobility services, such as shared mobility.[2] Another more general problem, not only related to transportation, is the lack of an appropriate indicator in terms of clarity and the lack of sufficient data to evaluate the indicators (Liu & Yuan, 2023), with no clear directions on how to solve these problems. The clarity of indicators and sufficiency of the data has already been acknowledged by the UN, where the Inter-Agency and Expert Group on the Sustainable Development Goal Indicators (IAEG-SDG) has classified the indicators into three main, tiers based on the methodological development, clarity of used indicators, and global availability of the data.[3] Tier I is the tier where indicators, methods, and data are transparent and available; Tier II is similar to Tier I, except the data is not always produced in the different countries; Tier III, where there are no clear indicators as of March 2024.

Previous trials were also made to connect the different SDGs with transportation; an example is connecting them to the main factors of sustainable transportation attributes or accessibility, affordability, safety, security, and environmental concerns (Thilakshan & Bandara, 2019). Also, the Institute for Transportation and Development Policy[4] identified the role of transportation in SDG in Goal 2: targets 2.3, and 2.a; Goal 3: targets 3.6, 3.9; Goal 7: target 7.3, 7.a; Goal 9: targets 9.1, 9.4, and 9.a; Goal 11: target 11.2, 11.6, 11.7, 11.a; Goal 12: target 12.c; and Goal 13: target 13.2, specifically.

Under the scope of this study, we try to clarify the role of transportation within the scope of the different SDGs, as we do not agree with the current delineation of the role of transport to a limited number of targets. An example of limiting the interaction between transportation and SDG is the work of Brussel et al. (2019), who connected the role of transportation to limited number of targets, specifically, Target 3.6, related to road safety; Target 7.3, related to energy efficiency; Target 9.1 related to sustainable infrastructure; Target 11.2, related to urban access; and Target 12.c related to fossil fuel subsidies. Bakker et al.

(2017) has also linked the SDGs to the transport and connectivity between the Association of Southeast-Asian Nations (ASEAN) in Goals 7, 11, and 13. Also, Ipingbemi and Akogun (2021) stated that transportation is directly linked to five SDG targets: 3.6, 7.3, 9.1, 11.2, and 12c, and indirectly to seven SDG targets: 2.3, 3.9, 6.1, 11.6, 12.3, 13.1, and 13.2.

Transportation plays a profound role across various societal functions and is essential for fostering sustainable community growth and achieving the Sustainable Development Goals (SDGs). Previous efforts to delineate the relationship between transportation and the SDGs have often overlooked or underrepresented the true extent of their interconnections. Therefore, this research comprehensively examines all 17 SDGs, including their targets and indicators, to highlight and define their relationships with the transportation sector. The study evaluates the current level of consideration given to transportation within each goal and assesses the validity of the indicators used in the evaluation process. The main contributions of this research can be summarized in two key areas:

- Highlighting the role of transportation in all the goals, by comprehensively mapping transportation–SDG Interconnections
- Propose additional considerations and modifications for the current indicators to account for the role of transportation in the different SDGs

These contributions will lay the road map for implementing and assessing the different goals, targets, and indicators, considering transportation's role in passenger and freight transportation indicators.

The structure of this article is designed to provide a comprehensive overview of the role of transportation in achieving different goals. We explain the main concepts related to transportation in Section 2. Then, we delve into a detailed analysis of the role of transportation in each of the different goals in Section 3. Finally, we discuss our findings and their practical implications, providing a conclusion in Section 4.

2. Main transportation concepts

This section introduces key transportation concepts for understanding how transport systems intersect with the 17 Sustainable Development Goals (SDGs). These foundational concepts help explain transportation's role in shaping sustainable development's social, economic, and environmental dimensions.

It also presents the metrics for assessing relevant SDG indicators and monitoring progress. By examining these measures, we can evaluate how transportation policies, infrastructure, and innovations support — or hinder — the achievement of the SDGs, guiding stakeholders in identifying gaps, formulating effective strategies, and tracking progress over time.

2.1. Accessibility

Accessibility, the core of transportation systems, and one of the main factors for short and long-term travel decisions, is the ease of reaching different destinations, activities, and opportunities (Miller, 2018). It connects people with the activities they want to perform and ensures their participation in different essential social and economic functions. Accessibility is a multi-dimensional subject that depends on many factors, directly related and sometimes unrelated to transportation. In this section, we briefly discuss the three main dimensions of accessibility to understand how accessibility relates to the different SDGs' indicators and how to monitor and measure it.

The primary dimension of accessibility is the people: passengers, commuters, agents, or users. People's socioeconomic characteristics are decisive factors in their accessibility; these factors could be, but are not limited to, financial, physical, and cognitive abilities and preferences. Socioeconomic characteristics are heterogeneous for different

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individuals, and they define people's ability to use the different modes of transport and, subsequently, their accessibility level. For example, a person without a driving license or a person with a mental or physical disability would have limited accessibility compared to the other population groups that do not have such limitations (Hidayati et al., 2021; Luz et al., 2022).

The second dimension is the transportation system, and here we highlight that historically, PT was considered the central pillar of the transportation system as it is hypothetically accessible and affordable to all population groups. The lack of PT coverage in certain areas significantly reduces accessibility, highlighting the urgent need for improving PT services. PT is usually considered a sustainable mode of transport that can be used inside traditionally congested areas, such as downtown, catering to high demand at a lower cost for the user side, and it is more sustainable when compared to individual modes of transport, such as private cars (Shah et al., 2021). Accessibility to PT is crucial to provide access to daily activities and ensures their ability to participate in the different activities (Olsson et al., 2021). Several barriers could hinder the population's access to PT, such as the availability of system coverage and affordability of transportation systems, which is a crucial aspect of PT accessibility (Yigitcanlar et al., 2019a); other factors include service travel time uncertainties and unreliability (Chen et al., 2019).

Recent advancements in urban transportation, such as shared mobility options (e.g., ride-hailing, carpooling, and carsharing) and future autonomous vehicles, have expanded travel choices. However, shared mobility is not yet integrated into accessibility assessments for various activities. Unlike public transit (PT), shared mobility services are rarely subsidized by local governments. Some innovative subsidy programs have emerged to address gaps in PT operations. For instance, the French government plans to subsidize carpooling in Paris to reduce PT demand Carey (2024), highlighting the potential to incorporate shared mobility into comprehensive transport systems. Therefore, the consideration of new mobility services, when available, should be considered in the evaluation of accessibility to the different opportunities.

The third element of accessibility is the land uses or activities, which is the destination of the agents. The number of activities, spatial distribution, and quality and capacities are essential aspects of defining their level of accessibility (Yang et al., 2021), as the availability of activity alone is not enough to grant accessibility. Still, the destination (activity) capacity, e.g., the number of seats in a restaurant, the number of classrooms in a school, and the number of beds in a hospital, is a significant factor for its accessibility (Renner, 2024; Santos Ventura, 2024). It is also essential to consider the temporal aspect of the activities, or when is it possible to access certain activities, as the temporal availability of certain activities could be limited due to the opening hours of the facility, and therefore, the accessibility to activity is fluctuating based on the time of the day, and the personal time constraints (Wang et al., 2018).

2.2. Transport disadvantaged population

One of the primary goals of the Sustainable Development Goals (SDGs) is to make cities inclusive, which requires addressing the needs of all population groups, and it is essential to pay attention to the population groups that already suffer from transport-related problems, generally referred to as transport-disadvantaged groups. Transport disadvantaged groups are defined by three dimensions:

- Location: These groups often experience longer travel times and limited access to essential activities such as jobs, education, shopping, and healthcare (Bantis & Haworth, 2020; Dodson et al., 2006).
- Transportation System: This includes the availability of transport modes, such as car ownership rates and access to public transit (PT).

- Sociodemographic Characteristics: Groups such as the elderly, people with physical or cognitive disabilities, and single parents often face mobility challenges that contribute to transport-related social exclusion (TRSE) (Bejleri et al., 2018; Delbosc & Currie, 2011; Yigitcanlar et al., 2019b).

These dimensions highlight the barriers that impact daily life and expose these groups to TRSE.

2.3. Transport-related social exclusion

The interest in social exclusion is recent. Social exclusion was introduced relatively recently (during the 1990s) to European policy, and since then, the term has been evolving (Berghman, 1995). Social exclusion is a process whose outcome is generally deprivation (Shaw, 2001). Social exclusion refers to the marginalization of specific individuals or groups from the broader community, manifesting as their limited involvement in routine societal activities, such as employment and education. The diminished engagement contributes to inadequate well-being and highlights the inherently relative nature of exclusion, as it is shaped by the societal context in which it occurs (Berg & Ihlström, 2019; Luz et al., 2022). The social exclusion problem is related to transport and other constructs, such as poverty and politics; however, transportation could be one vital enabler to reach basic needs or activities (Kamruzzaman et al., 2016). Low accessibility levels to transportation lead to loss of opportunities, less or lack of participation in essential activities, and finally to social exclusion, which shows the relationship between transport, accessibility to opportunities, and social exclusion (Churchill et al., 2023).

Assessing social exclusion arising from transportation and mobility challenges poses significant difficulties. Consequently, this issue is typically addressed by comparing various social groups based on factors such as diminished participation, reduced accessibility, or decreased well-being relative to the broader population (Di Ciommo & Shiftan, 2017; Hidayati et al., 2021). Identifying the social groups experiencing inadequate mobility and accessibility, which lead to subsequent social exclusion, is essential to designing inclusive transportation systems.

3. Goals evaluation

This section investigates the vital role of transportation in achieving the 17 Sustainable Development Goals (SDGs) by analyzing how transportation systems interact with and support these objectives, drawing on insights from current literature. It examines the indicators for each goal to highlight their interconnections with the transportation sector, identifying where transportation's role has been overlooked or where indicators lack clarity in capturing these linkages. The analysis assesses how the metrics used to measure progress toward the SDGs shape transport infrastructure and policies. Additionally, it points out specific indicators that fail to adequately reflect the transportation sector's influence, clarifying these gaps to ensure a comprehensive understanding of transportation's critical contributions to sustainable development.

3.1. Goal 1. No poverty

This goal targets eradicating extreme poverty, especially for people living on less than $1.25 per day, guided by seven different targets that tackle different areas of the goal, using 13 different indicators to measure the progress of bridging the gap in the different targeting areas.

Indicator 1.2.2 refers to the proportion of the impoverished population in all dimensions. In contrast, transport poverty is an essential dimension of poverty; currently, it is not included in the general definition of poverty and needs to be included in the national and international guidelines identifying poverty. Interestingly, transport poverty is not limited to the global south, but developed countries

also suffer from the phenomenon, such as the case of the UK, and it is also to be noticed that the most affected groups are the vulnerable groups (Lucas et al., 2016). This indicator could be assessed by the different measures that have been used for defining transport poverty, such as affordability of PT (Guzman & Hessel, 2022; van Dülmen et al., 2022; Vecchio et al., 2024), measures of mobility, or trip generation, trip distance and duration (Lucas et al., 2016), the accessibility to PT, and infrastructure, such as the access of the population to the road network in the global south (Roberts et al., 2006).

It is also important to underline the fact that the transportation system composition differs by the geographical location, e.g., in the global south, a large portion, if not all, of the daily travel demand is handled by paratransit, which is the informal transport system, that is private and loosely regulated by the government (Behrens et al., 2021). The importance of paratransit in such locations reflects PT's poor conditions in most cases and its low supply levels that do not match the high demand (Mokoma & Venter, 2023). Therefore, the evaluation of the different indicators should consider the different contexts, or in other words, all available modes of transport in the examined location should be within the evaluation process, and the indicators should not be limited to predefined modes of transport. Indicator 1.4.1 refers to the portion of the population without access to essential services. At the same time, transport is an essential service and a human right; access to transportation should be accounted for in evaluating this indicator (Guthrie, 2016; Smith & Riggar, 1988).

Indicators 1.5.3 and 1.5.4 target enhancing the national disaster and risk management systems adopting the Sendai Framework, which is a framework proposed by the United Nations Office for Disaster Risk Reduction[5] to be used as instrument to ensure the national resilience against disasters. One of the significant elements to be considered for resilience is transportation infrastructure, which supports the overall societal resilience, and resilience should be considered as an essential element, especially in new projects. Transportation infrastructure is a complex system that is very vulnerable to disasters, especially hurricanes and earthquakes (Zhou et al., 2019). Road and transport infrastructure are essential parts of our daily life. Therefore, these two indicators are directly related to transportation infrastructure, and the role of transportation should not be overlooked. Different measures in the current literature are used to measure the transport system resilience, such as topological metrics (Chopra et al., 2016), performance-based metrics (Twumasi-Boakye & Sobanjo, 2018), and attribute-based metrics (Chen & Miller-Hooks, 2012).

Indicator 1.a.2 evaluates the proportion of government expenditure allocated to essential services such as education, health, and social protection. This expenditure should also account for the accessibility of these services—not only in terms of physical access for different population groups using various modes of transportation but also regarding the capacity of service locations to meet expected demand.

Additionally, Indicator 1.b.1 supports national spending plans to eradicate poverty and promote gender-sensitive strategies. This indicator should also incorporate transport policy and planning instruments that address the mobility needs of different population groups in order to reduce transport-related poverty.

Evidence from regions such as West Timor and Nigeria demonstrates that government investment in urbanization and road infrastructure can significantly contribute to economic growth (Barilee & Benvolio, 2021; Messakh et al., 2022).

3.2. Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

This goal aims to end hunger and undernourishment and the subsequent negative impacts on the population resulting from hunger, such as stunting, malnutrition in children, and anemia in women, in addition to increasing the sustainability of the agricultural system.

Indicator 2.1.1 targets ensuring access to food all year around. The relationship between transportation and food security is well established, as the case of the USA, where (Baek, 2016) found that the accessibility to PT decreases food insecurity in households, especially for the low-income households. Other aspects of transportation were also found to impact food security, as in the case of Nigeria, where (Ayodele & Oluwagbenga, 2023) found that inaccessible and insecure roads are impacting the transport of food products to different markets, and therefore, they impact food insecurity. These two examples show the relationship between transportation and food insecurities at the individual, household, and market levels. They also show that the problem is not limited only to the developing world but also has a presence in developed countries, such as the USA.

The next indicator related to transportation is 2.a.1, or the Agriculture Orientation Index (AOI). This indicator measures the percentage of the agriculture share of government expenditure to the value of agriculture added to the Gross Domestic Product (GDP), including the role of infrastructure. While it is not explicitly stated in the definition of Target 2.1 or indicator 2.a.1, we argue that road and transport infrastructure should be considered in such indicators. Transportation infrastructure, including roads, bridges, and ports, significantly impacts agriculture. For instance, a low-productivity transport system can disrupt the allocation of agricultural resources and reduce agricultural productivity (Hossain et al., 2025; Marion et al., 2024).

Indicator 2.c.1 is concerned with food prices and their control. Transport cost significantly impacts food prices despite being generally overlooked. For instance, transport costs account for around 40% of the total market cost of agricultural products in Australia. Another example is Nepal, where food prices were positively correlated with fuel costs and negatively correlated with road and bridge density, demonstrating the role of transportation and its infrastructure in food pricing. On an international level, the lack of port infrastructure impacted overall food prices in South America (Higgins et al., 2018; Shively & Thapa, 2017; Vakili et al., 2023; Wilmsmeier & Sanchez, 2009).

3.3. Goal 3. Ensure healthy lives and promote well-being for all at all ages

This goal aims to improve the population's health and reduce mortality due to several diseases through 28 indicators. Indicator 3.4.1 targets reducing mortality rates related to cardiovascular disease, cancer, diabetes, and chronic respiratory disease. There is strong evidence between transportation and cardiovascular disease, where the mode of transportation used impacts different aspects of health, such as obesity, hypertension, and level of physical activity, and cardiovascular disease could be reduced by improving urban transport planning (Nieuwenhuijsen, 2018). An example of this is the impact of long-time commutes and the use of private cars and their impact on increased obesity, which is a high-risk factor impacting the increased probability of cardiovascular diseases (Sugiyama et al., 2020). Therefore, this indicator should also consider the relationship between health and transport, as it is a significant relationship that cannot be overlooked. However, it is not currently a part of the indicator evaluation criteria.

Indicator 3.6.1 is targeting reducing injuries and deaths resulting from traffic; according to the World Health Organization (WHO), the leading killer for people between 5–29 years old is road traffic in 2019, causing a significant negative impact on society.[6] The relationship

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between this indicator and transportation is apparent. Minor considerations need to be taken, such as defining different levels of accident severity and the causes or the factors impacting the accident, to define a universal framework to treat these factors and achieve the indicator's overall goal systematically (Zubaidi et al., 2022).

Indicator 3.8.1 targets increasing and granting coverage and access to quality health services. Access to health services is an essential part of transportation services; however, there is no clear definition for the indicator regarding what is considered good coverage in terms of the percentage of the population to be covered by quality healthcare services or what quality healthcare services. Also, it is unclear what strategies should be used to solve the problem of lack of accessibility. Should we increase the number of healthcare facilities, improve the infrastructure of transport connecting people to these facilities, or which of these approaches should be prioritized, or even adopt new strategies, such as Telemedicine as proposed by Palozzi et al. (2020). Also, other dimensions of accessibility, such as accessibility to required medical information, are highlighted to be of high importance, although it is not considered yet, as pointed out by the World Medical Association (WMA) (Royston et al., 2020). In the same direction, indicator 3.8.2 is also trying to achieve universal, affordable access to healthcare. Transport cost is one of the barriers that hinder patient access to healthcare, and it might cause diverse adverse outcomes for the individuals who cannot afford travel costs (Labban et al., 2023; Xing & Ng, 2022), and the transport-related cost barriers were found to be related to cost in the USA for people to access medical facilities (Coombs et al., 2021). Therefore, the indicator needs to consider travel costs as a part of the affordability of the service access.

Indicator 3.9.1 is targeting to reduce mortality rates related to air pollution. The transportation sector is a significant contributor to ambient air pollution, where cities have, in general, higher rates for disease related to the high percentage of pollution due to the high traffic volumes resulting in a higher levels of premature mortality rates (Dedoussi et al., 2020); one-fifth of air pollution-related deaths in the USA, German, and UK are related to land transport emissions (Anenberg et al., 2019; Lelieveld et al., 2015). Also, the general description for the indicator[7] does not mention in detail the sources of pollutant to be considered for reduction, we highlight the role of transportation as one of the significant sources of air pollution, and how it should be tackled to reduce the severity of the problem.

Finally, for this goal, indicator 3.b.1 plans to increase the population covered by all vaccines. The latest COVID-19 pandemic has shown us the importance of transportation, or what is called cold-chain logistics (Fahrni et al., 2022); also, when inequalities of vaccine distribution were investigated, transport-related infrastructure problems were significant (Bayati et al., 2022). Therefore, the role of transportation in providing access to vaccination should not be overlooked, and it should be considered to ensure equitable, equal access to different population groups, especially the vulnerable groups.

3.4. Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

This goal ensures that the education system is inclusive for the entire population at all stages of school and lifelong learning, using ten targets and 12 indicators.

Indicators 4.1.1, 4.2.1, and 4.3.1 measure the participation of the different population groups in terms of age and sex in the different stages of education. The role of transportation to education is prominent where accessibility to school could be a barrier to access education, especially for the peripheral areas of the city, such as the case of Santiago de Chile (Tiznado-Aitken et al., 2021) and major sub-Sahara

cities in Africa (Stokenberga et al., 2024), or even in a more developed country, such as the USA (Preis, 2024; Smith-Onyewu et al., 2025). The level of accessibility to education is not the only measure that should be considered; the quality of the education system should also be evaluated to ensure access to high-quality education. In general, there is a low level of accessibility to high-quality education (Pizzol et al., 2021). It is to be highlighted that the former mentioned studies (Preis, 2024; Smith-Onyewu et al., 2025; Stokenberga et al., 2024; Tiznado-Aitken et al., 2021) evaluated accessibility in terms of travel time; without the consideration for travel costs, which should be included in the accessibility evaluation, because travel costs are a structural barrier that could hinder access to education (Vale, 2020).

Therefore, comprehensive guidelines for accessibility measures considering all the different dimensions of accessibility and barriers to it must be established to define the necessary levels of accessibility for education, including these indicators and other services. These guidelines will ensure that physical accessibility to educational institutions is guaranteed for all population groups. They will also facilitate the evaluation of the aforementioned indicators, considering the transport accessibility to education institutes, their quality, and their capacity to serve the population without any form of discrimination. This thorough evaluation is crucial to ensure that no dimension of accessibility is overlooked.

3.5. Goal 5. Achieve gender equality and empower all women and girls

This goal targets achieving gender equality and empowering all women through 9 targets and 14 indicators. For target 5.1, discrimination against women in transportation should be included in the definition of the target, and an additional indicator should be used and evaluated by the number of incidents reported for such cases. Discrimination against women in transportation, or so-called Gender-Based-Violence (GBV), is an important phenomenon that should be highlighted, tackled, and ended. GBV is a form of aggression against women in several forms, such as verbal and physical, and it impacts women's travel behavior (Orozco-Fontalvo et al., 2019). GBV could lead to nonparticipation in the labor force, loss of economic opportunities, and financial and emotional consequences (Infante-Vargas & Boyer, 2022; Tiznado-Aitken et al., 2024).

3.6. Goal 6. Ensure availability and sustainable management of water and sanitation for all

This goal is ensuring the availability and sustainability of water to all populations through 8 targets and 11 indicators. The only indicator related to transportation is target 6.1, which grants equitable access to safe and affordable drinking water. Previously, the Millennium Development Goals (MDGs) evaluated access to water, and it found that such access is not available to everyone, and around 26% of the world's population lack access to drinking water due to the long travel distances needed (Cassivi et al., 2019, 2018). Therefore, target 6.1 and indicator 6.1.1 should consider the physical accessibility to drinking water resources, especially within an acceptable travel time and distance, and unify evaluation thresholds for lack of accessibility. An example of adequate travel time and distance to water is what (Cassivi et al., 2019) found: a one-kilometer travel distance and 30 min travel time (by walking) as an acceptable threshold for drinking water accessibility in several countries.

3.7. Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

This goal ensures the accessibility to sustainable energy using five targets and six indicators. Indicators 7.1.2 and 7.2.1 measure access to clean energy and the share of the population that uses clean energy. The transportation sector utilizes one-third of the EU's total energy

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[7] https://www.un.org/sustainabledevelopment/health/, last accessed 29/07/2024.

demand; out of it, approximately three-quarters has the potential to be electrified (Dominković et al., 2018), showing the significance of the transportation sector on energy demand and the potential of shifting to a more sustainable resource. Therefore, the role of transportation in these indicators should be taken into account.

Indicators 7.a.1 and 7.b.1 target the support of clean energy use, research, and production, as well as expand infrastructure for new energy. One of the major sectors that could benefit from these targets is the transportation sector, where there should be investment, in terms of cash flow from rich countries to poorer countries, to establish the required infrastructure that supports the use of clean energy sources in transportation, or namely electrification if transportation system (Al-Ghussain et al., 2022; Deveci et al., 2025). Moreover, continuous research on improving the EV battery is significant in reducing the use of unclean energy sources, such as fossil fuels, and considering the use of sustainable sources of electricity production. That said, such development also needs the support of continuous research and investments at a global level (Luca de Tena & Pregger, 2018).

3.8. Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

This goal promotes creating job opportunities that are inclusive, sustainable, and support economic growth using 12 targets and 16 indicators.

Target 8.9 and its only indicator 8.9.1 promote sustainable tourism; in general, the relationship between tourism and transportation is unsustainable due to the high dependency on automobile use and the need "not to travel" to reduce the negative impact of tourism on sustainability (Hopkins, 2020). Tourism impacts local communities on several levels; one of the most damaging impacts that are overlooked is its impact on traffic congestion, which points out the need to reform the way tourists move on long-distance trips, e.g., airplanes and short distance travel, e.g., increase the use of PT (Puchongkawarin & Ransikarbum, 2021; Wikeckowski, 2021). Therefore, the consideration of transportation policies that promote sustainable tourism should be regarded, and negative traffic externalities resulting from tourism should be calculated in indicator 8.9.1, which calculates the tourism direct GDP as a proportion of total GDP and in growth rate.

Target 8.10 strengthens the financial sector by expanding access to banking, and indicator 8.10 counts the number of commercial bank branches and Automatic Teller Machines per 100,000 adults. The target and the indicator are defining the physical access to banking services; that said, there is no clear guideline on the level of accessibility by the different modes of transportation that should be achieved, which might lead to inequitable distribution of the financial resources; an example, if the required ratio is satisfied, but on the same time all the banking facilities are concentrated in one location, that could be only accessed by car, and it has no PT station within an acceptable distance. It is also to be highlighted that currently, there is no research on the exact required accessibility levels to banks or ATMs, which shows that this point is overlooked and needs to be defined.

3.9. Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

This goal targets building resilient infrastructure, inclusive technological progress, and increasing access to information and communication technologies.

Target 9.1 intends to build affordable and equitable resilient infrastructure, including regional and trans-border infrastructure. The target is assessed using two indicators: indicator 9.1.1 ensures access to the road in all seasons of roads, and indicator 9.1.2 considers passengers and freight demand per the different modes of transport.

One-eighth of the world population cannot access national paved road networks (Asher & Novosad, 2020). The investment in infrastructure, and specifically in national road networks, could yield and

support sustainable economic growth for the population (Ng et al., 2019); however, the success of such investment is not always granted and might have slight impacts in terms of growth such as the case of India's 40 billion USD national rural road construction program, which did not achieve the targeted goals of increasing job opportunities and economic growth according to Asher and Novosad (2020). Indicator 9.1.1 is interlinked with indicators 1.5.3 and 1.5.4, which are also related to the impact of transportation resilience on the overall community resilience, especially against disasters; therefore, these indicators must be considered holistically and not separately. While indicator 9.1.2 targets measuring the volume of passengers and freight per mode of transportation, there is no guideline on the indicator's optimal or targeted modal shift and how it would be evaluated. It is clear that moving people in higher capacity sustainable modes of transportation is the goal of all transport planners, even trying to reach zero-car modal share; however, this will be gradually done over a long period, and it needs guidance from the authorities to benchmark the different stages and steps (Ballo et al., 2023; Gonzalez et al., 2021).

3.10. Goal 10. Reduce inequality within and among countries

Goal 10 focuses on reducing income inequality and ensuring social inclusion within and between countries. Targets 10.2 and 10.3 promote social inclusion for all populations without any discrimination. According to the discussion in Section 2.3, transport might be a significant factor leading to social exclusion in case it does not cater to specific population groups based on geographical coverage, fare affordability, and physical and cognitive ability to use (Lucas et al., 2019). The inequity of transport use should be addressed in targets 10.2 and 10.3 and their indicators. These targets and indicators are defined in a general way that supports the promotion of social inclusion, target 10.2, and ensuring equal opportunities in target 10.3

3.11. Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

This goal tries to make cities more inclusive, safe, resilient, and sustainable. We believe this is the goal with most targets and indicators relevant to transportation. As for now, 50% of the worldwide population lives in cities, and this number is expected to rise to 70% by 2025.[8] Based on the expected rise in the number of people in urban areas, the pressure on the city's infrastructure, in terms of housing, road network, and transit network, is expected to increase. Target 11.1 and its indicator 11.1.1 measure the proportion of the population living in slums and informal settlements. It is to be noticed that people living in slums face challenges in terms of access and affordability of transportation; this was the case in several locations, such as Nairobi, Kenya (Pinchoff et al., 2021), and Nagpur, India (Rai et al., 2025). Also, moving people from slums to improved housing, generally in the city's periphery, did not always yield optimum results. These moves even resulted in adverse results, such as isolation of the people who moved, as in the case of the housing lottery in India (Kapse et al., 2012). Also, it has been noticed that the accessibility and affordability of PT are not always considered in the relocation programs, e.g., while the sustainable housing programs for improving Ger areas (GA) in Ulaanbaatar considered a road network in the proposed planning phase, there is no mention for the transportation plans and how it would connect the new housing area to the central area of activities (Ishdorj et al., 2021).

Target 11.2 provides access to a safe, affordable, sustainable transport system. Indicator 11.2.1 measures the proportion of the population accessing PT by sex, age, and disability. While the increased proportion of people accessing PT would be positive, there are no guidelines on

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[8] un.org/sustainabledevelopment/cities/, last accessed 05/08/2024.

measuring this access. Also, there are no guidelines on the accessibility thresholds to be achieved, nor are there policies and plans to increase such participation, such as building new roads and increasing the PT supply, or subsidizing the ticket cost for the different population groups. Also, the indicator is directed more towards specific groups, neglecting that Transport disadvantaged groups might differ based on the context, mainly including more groups than the defined groups discussed in Section 2.2.

Target 11.3 and its indicator 11.3.2 measure the direct participation of civil society in urban planning and management. The indicator does not consider transport planning as part of the urban planning process. The role of transport and urban planning is well established (Mouratidis, 2021), and the role of citizen participation in transport-related decisions is changing the traditional governance process into a more efficient, dynamic process that is fostering the move to the smart cities ecosystem (Cortés-Cediel et al., 2021). Therefore, the merger of transport and urban planning processes should be considered, highlighting the role of transportation in indicator 11.3.2.

Target 11.6 considers reducing the environmental impacts of cities, including air quality, and indicator 11.6.2 measures the acceptable particulate matter (PM2.5 and PM10) in the air as a means of air quality control. The growing urbanization adversely impacts the environment in several ways, backed by the rapid increase in travel demand. Transportation is responsible for one-quarter of the global greenhouse gas (GHG) emissions, as 95% of the used fuel is a fossil fuel, and transportation is the largest source of GHG in 45% of the countries.[9] Therefore, the role of transportation should be stressed, and driving policies to reduce transport-related emissions should be a priority to reduce GHG emissions.

Target 11.a aims to support the linkage between urban, pre-urban, and rural areas socially, economically, and environmentally, and indicator 11.a.1 measures the number of countries with regional development plans targeting a response to population dynamics and ensuring balanced and positive economic growth. One of the major drivers of regional economic planning is transportation infrastructure, as it connects different territorial areas and significantly impacts travel efficiency and subsequent economic growth. For instance, Italy's high-speed rails (HSR) have helped increase economic growth in their corridors (Cascetta et al., 2020). However, these projects have also increased inequality for the population groups that did not have access to the service. Therefore, the role of transportation in regional connectivity is significant, but precautions should be observed by paying attention to disadvantaged groups. Without consideration for the different population groups and their economic and spatial conditions, these projects could lead to adverse effects by driving inequality situations.

Target 11.b aims to increase cities and human settlements' inclusion, efficiency, and resilience to disasters; indicator 11.b.1 measures the number of countries adopting risk management and reduction plans overlapping with target 1.5 (indicators 1.5.3 and 1.5.4) in terms of resilience of infrastructure and transport infrastructure as a part of the disaster management and relief plans, and with targets 10.2 and 10.3 with their role of transportation being a tool for social inclusion and a tool to reduce inequality between the different population groups. Therefore, such targets and indicators need to be further discussed for their potential to merge, and the interlinkage between them should be studied in these target evaluation processes.

3.12. Goal 12. Ensure sustainable consumption and production patterns

This goal ensures the sustainability of consumption and production patterns, whereas target 12.c targets rationalizing fossil fuel subsidizing

to reduce unnecessary consumption and adverse environmental impactsFossil fuel subsidies account for 6.3% and 6.5% of global actual gross domestic product (real GDP) in 2015 and 2017, respectively[10], showing their magnitude and significance on the global GDP When (Solarin, 2020) examined the factors impacting environmental degradation in 35 developing countries, fossil fuel subsidies significantly impacted this degradation, resulting in 13% of the broader vehicle externalities (Coady et al., 2017). The link of this indicator to the transportation sector is significant, as such subsidies are a barrier to shifting to renewable energy sources (Timperley, 2021). One of the reform measures in the transportation field would be subsidizing alternative fuel for vehicles, such as electric charging, which might yield sustainable impacts on the environment (Asgarian et al., 2023).

3.13. Goal 13. Take urgent action to combat climate change and its impacts

This goal is targeting increasing resilience to climate-related hazards and natural disasters. Target 13.1 ensures the strengthening of the resilience and adoption capacity to climate-related hazards and natural disasters, and indicator 13.1.3 also measures the proportion of governments that adopt such plans. This indicator is intricately connected with indicators 1.5.3, 1.5.4, and 11.6, highlighting the complexity and interconnectedness of developing disaster mitigation plans and the role of transportation, as discussed in the mentioned indicators before.

Target 13.2 and its indicator 13.2.1 track countries with long-term climate action plans. As a major and growing source of GHG emissions, the transport sector must be addressed in these efforts. However, no single solution can fully mitigate its impact. Effective strategies include renewable energy, behavioral shifts, technological innovation, and policy measures—often in combination (Cifuentes-Faura, 2022; Dyrhauge, 2022; Regmi, 2021). Thus, transport policies must be integral to all climate mitigation plans and long-term strategies. This also applies to Target 13.b and Indicator 13.b.1. These indicators are also linked to indicators 11.6.2, which evaluates air quality, and this is another example of how different linked indicators should be evaluated together.

3.14. Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

This goal focuses on the conservation and sustainable use of marine resources, with ten targets and ten indicators. Target 14.1 aims to prevent all forms of marine pollution. Maritime transport, which moves around 10 billion tons of goods globally annually, is closely linked to ocean health. However, environmental concerns — especially from operators — have often been overlooked (Walker et al., 2019). A recurring issue is oil spills, which cause significant long-term damage to marine ecosystems and economic losses (Zhang et al., 2019). To mitigate these negative impacts, the transport sector must adopt cleaner fuels, enforce stricter environmental regulations, and implement advanced technologies to prevent pollution. Integrating sustainability into maritime logistics and port operations is essential to reduce the sector's footprint and align with marine conservation goals.

3.15. Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

There are no targets under this goal that could be related to transportation.

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[9] un.org/sites/un2.un.org/files/media_gstc/FACT_SHEET_Climate_Change. pdf, last accessed on 13/06/2025.

[10] www.imf.org/en/Publications/WP/, last visited 13/06/2025.

3.16. Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

This goal targets inclusive, sustainable societies, ensures justice for everyone, and stops discrimination using 12 targets and 24 indicators. Target 16.b and indicator 16.b.1 measure the percentage of the population harassed or discriminated against. This indicator partially overlaps with target 5.1, which also tries to ensure equity and end discrimination, such as Gender-Based-Violence (GBV), and its negative impacts (Infante-Vargas & Boyer, 2022; Tiznado-Aitken et al., 2024). Therefore, the role of transportation should be considered in developing policies and strategies against discrimination; e.g., considering discrimination in the different modes of transportation is an essential part of this goal.

3.17. Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development finance

This goal targets increasing the global partnership for sustainable development through 19 targets and 24 indicators. Target 17.11 and indicator 17.11.1 try to increase the share of less developed countries in global exports; the transportation sector is a supporting pillar to the logistics industry, connecting the manufacturing sites with the material producers, rather than connecting them to the ports of exportation (land, air, and maritime ports) is crucial. Sénquiz-Díaz (2021) analyzed the impacts of logistics performance on the exports of 29 developing countries to find that the quality of logistics infrastructure, in terms of roads and ports, is highly impacting the exports; reached a similar conclusion (Martí & Puertas, 2017), and they recommended enhancing the logistics infrastructure to increase countries' international competitiveness, and subsequently economic growth. Therefore, the national expenditure plans should consider the interlinkage between the investment in transportation infrastructure and the increase in exports, and not only limit the role of the infrastructure to increasing the accessibility to the road network, as in the case of indicator 9.1.1

Target 17.14 advises increasing policy coherence for sustainable development, and indicator 17.14.1 measures the number of countries with such plans. Transportation is one of the major sectors to be considered in such policies to achieve communal sustainability. The impacts of transportation need to be regulated and controlled by policies that reduce or even prevent the unsustainable impacts of transportation (Lowe et al., 2022; Prus & Sikora, 2021; Shah et al., 2021). Several policies could be adopted to increase the sustainability of transportation, such as but not limited to policies to change travel behavior, e.g., encouraging active mobility and use of sustainable modes of transportation, planning-related policies, such as changes in land use and built environment (Sultana et al., 2019).

Target 17.17 and indicator support public–private partnerships (PPP) for infrastructure projects. It is to be noticed that the paradigm of large-scale project financing has changed recently, with a widespread rejection of public funding (Batra, 2021; Liu et al., 2022), paving the road for the evolution of public–private partnerships in developing and developed countries. However, the outcomes of these projects are only sometimes optimum, and many of them tend to fail, especially in transportation-infrastructure projects (Anago, 2022; Le et al., 2022; Nguyen et al., 2021).

4. Discussion

The analysis of the different SDGs considering their interlinkages with the transportation sector has shown a lack of consideration in the current literature and practice, as we have shown interactions between transportation and all the goals, except Goal 15. We identified 45 interactions between the goals, their indicators, and transportation, and we categorized these interactions into seven main categories, as shown

in Fig. 1. Our categorization reflects the principal dimensions through which transportation affects the SDGs, as identified by practitioners. We examined the 45 linkages between transport and various SDG indicators and clustered them by thematic domain. Each of the seven categories corresponds to a distinct aspect of transport systems.

Accessibility and Inclusion capture mobility equity (access to public transit for the poor, disabled, or women — SDG targets inclusive cities and reduced inequalities; some selected indicators are SDG 3.8.1, 3.8.2, 3.b.1, 4.1.1).[11] Also, our analysis shows that accessibility, in its different forms, represents the core of the relationship between SDGs and transportation. Safety covers road and transport safety outcomes (reducing fatalities and injuries, SDG indicator 3.6.1) and ensures that no one is subject to discrimination or violence based on their sex (SDG 5.1.1). Environment and Energy address emissions, air quality, and fuel use (transport is a significant energy consumer; see SDG 7 and climate goals). Infrastructure and resilience refer to the physical networks that are required to ensure the resilience of the communities and countries against adverse conditions (SDG indicators 9.1.1 and 9.1.2), and they capture robustness to climate disasters and disruptions (building adaptive transport systems, SDG 11.5 on disaster resilience). The urban development category encompasses policy and governance, regulations, and institutional frameworks required to regulate planning practices to achieve sustainability (multi-level transport policy and targets, SDG 17).

These groupings align with how transport experts conceptualize sustainable mobility: addressing social goals (access, Inclusion, safety), economic goals (infrastructure, Economy), and environmental goals (emissions, energy, resilience) in an integrated way. UN guidance emphasizes that sustainable transport must "enhance economic growth and improve accessibility" while "respecting the environment" and "improving social equity, health and resilience of cities",[12] and it underlines the need to include policy, social, economic, technological and environmental aspects.[13] Our classification is therefore grounded in domain knowledge of these multi-faceted impacts, grouping indicators by these well-established transport dimensions.

It is also important to highlight that the previously identified categories are not mutually exclusive, but some overlap, such as accessibility and inclusion, and they should not be considered separately, but holistically, due to the complex nature of the interlinkage between the SDGs and the transportation sector. Moreover, this categorization is based on the transportation domain-specific knowledge, which might be affected by the perspective from which it is considered, and other domains might categorize these interactions differently.

Our contribution to this research is achieved by highlighting the role of transportation in the different SDGs. We shed more light on the shortcomings of the current SDGs in terms of missing consideration for one of the significant enablers of the urban environment, the transportation system. We figured out different interactions and identified new areas that need special consideration, such as the concept of accessibility. Almost one-third of the identified indicators interacting with transport are related to the accessibility category, showing its importance for consideration and how it was overlooked in several current indicators. We also identified potential problems in the case of evaluating the different indicators, as there is a need to develop and unify the standards to measure and the procedures to implement in the different SDGs related to accessibility. The lack of sufficient levels of accessibility could lead to social exclusion, especially for disadvantaged groups; however, accessibility is not the only factor causing social exclusion; other factors, such as infrastructure and policies, could lead to social exclusion, showing the complex relationship between the

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[11] For the details of each indicator and the corresponding category refer to Table 1.
[12] (sdgs.un.org, last accessed 13/06/2025).
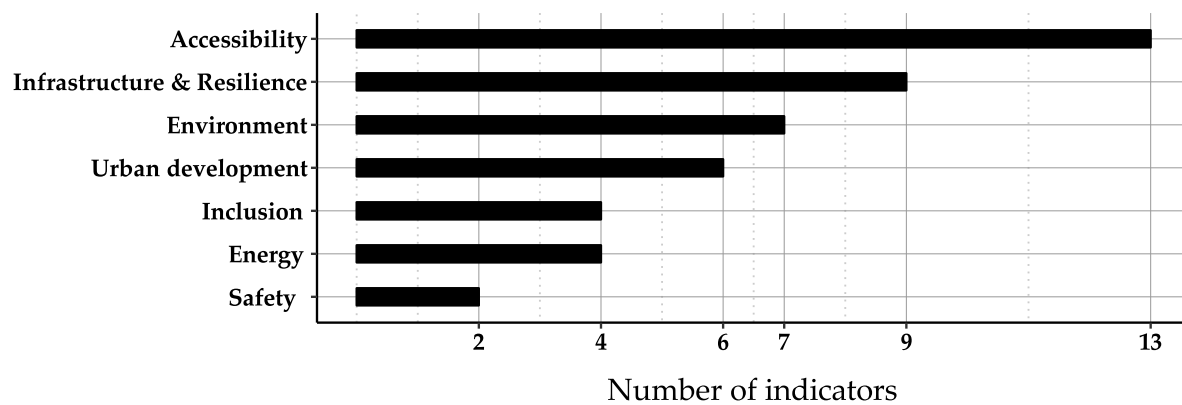[13] (togethersdgs.un.org, last accessed 13/06/2025).

Fig. 1. Main categories of transportation interaction with SDG and their counts.

different SDGs and transport (Archer, 2020). Another example of the overlooked relationships related to transportation is the relationship with the environment, as it was not considered in the case of pollution resulting from transport, over-tourism, and usage of fossil fuel; therefore, these negative externalities of transportation should always be considered in the evaluation of the different indicators. That said, the connection between the environmental category and the energy category is undeniable, where the adoption of universal clean, renewable energy technologies is always encouraged

We also identified the indicators that are closely connected, and they should be considered simultaneously, such as the case of infrastructure and resilience category for indicators 1.5.3, 1.5.4 and 11.b.1, 9.1.1 and 17.11.1, showing the importance of infrastructure design for resilience for climate change, and also the interconnection between the different SDGs. Another case is the indicators 11.6.2, 13.2.1, and 13.b.1, showing the relationship between strategies and actions against climate change and monitoring pollution levels.

To meaningfully operationalize the SDGs in transportation planning and appraisal processes, moving beyond generic alignment and towards the structured integration of transport–SDG interdependencies into planning tools, evaluation frameworks, and decision criteria is necessary. Our contribution identifies a critical blind spot in current SDG discourse: the under-specification of transportation as a fundamental enabler across multiple goal areas, particularly accessibility, environmental sustainability, and social inclusion. Approximately one-third of the transport-related indicators interact with accessibility dimensions, yet this concept is either weakly defined or altogether absent in most SDG targets. To address this, planners should incorporate multidimensional accessibility metrics — accounting for spatial, temporal, financial, and digital accessibility — into long-range transportation plans and project-level appraisal models. This includes the development of standardized yet context-sensitive indicators for measuring accessibility impacts across different population segments, especially disadvantaged groups vulnerable to social exclusion.

Furthermore, the fragmentation of SDG indicators prevents integrated assessment of interventions. For instance, we found that indicators, such as 1.5.3, 9.1.1, and 11.b.1 relating to infrastructure and climate resilience are closely interlinked, but not assessed jointly. Addressing this requires restructuring appraisal frameworks to include bundled indicator assessments that reflect cross-cutting issues, such as the benefits of resilient transport infrastructure for poverty reduction and climate adaptation. Moreover, environmental externalities of transport, such as emissions from fossil fuel use, pollution from overtourism, and the marginalization of non-motorized users, are not systematically captured in existing SDG evaluations. Thus, it is imperative to establish transport-specific environmental accounting protocols aligned with indicators 11.6.2, 13.2.1, and 13.b.1 to capture the different impacts. Lastly, our analysis underscores the need for a governance mechanism that facilitates horizontal coordination across SDG targets in the

transport domain, supported by unified data collection methodologies and institutional accountability. By embedding these operational changes, transportation planning and appraisal can move from symbolic alignment with the SDGs to tangible, measurable contributions to sustainable urban and regional futures.

Fig. 1 shows the counts of each identified indicator per category, and Fig. 2 shows the relationship of each Goal with the different categories of transportation area of focus. Finally, Table 1 shows the category of focus for each indicator. Fig. 2 with the details in Table 1 could be used to understand the interlinkage between the different indicators, and it gives insights on which indicators should be evaluated simultaneously.

5. Conclusions

Transportation is a cornerstone of sustainable development, deeply embedded in the Sustainable Development Goals (SDGs) framework. This paper highlights its multifaceted contributions to economic growth, environmental sustainability, and social inclusion, demonstrating its impacts across all 17 SDGs. Despite its critical role, transportation remains underrepresented in the current SDG framework, often confined to narrowly defined indicators that fail to capture its broader systemic importance and transformative potential. Our analysis underscores transportation's ability to create cascading benefits across multiple SDGs, making it a powerful enabler of progress. Investments in PT, for instance, not only enhance urban accessibility but also contribute to reducing greenhouse gas emissions, promoting social equity, and fostering economic opportunities. These interlinkages emphasize the necessity for integrated, cross-sectoral transportation planning and policymaking approaches.

In detail, we identified transportation's critical role in[14]:

- Goal 1: Reducing transport poverty (No Poverty) by providing accessibility (Target 1.2 and 1.4)
- Goal 3: Reducing road traffic fatalities (Target 3.6) and enhancing healthcare access through improved connectivity (Target 3.8).
- Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all (Target 7.1: access to clean energy, and Target 7.2: increase the share of renewable energy)
- Goal 11: Expanding sustainable PT systems (Target 11.2), a key to achieving inclusive urban mobility.

Despite these significant contributions, gaps in the current SDG framework persist. Active mobility modes like walking and cycling, vital for environmental sustainability and public health, are largely excluded, focusing mainly on private car and PT use. Equity dimensions,

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[14] These four goals encompass 22 of the indicators interacting with transportation.

Table 1
Goals indicators, and the corresponding categories.

| Goal	Indicators	Category
Goal 1	1.2.2 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Accessibility
	1.4.1 Proportion of population living in households with access to basic services	Accessibility
	1.5.3 Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	Infrastructure & Resilience
	1.5.4 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	Infrastructure & Resilience
	1.a.2 Proportion of total government spending on essential services (education, health and social protection)	Accessibility
	1.b.1 Pro-poor public social spending	Urban development
Goal 2	2.1.1 Prevalence of undernourishment	Accessibility
	2.a.1 The agriculture orientation index for government expenditures	Infrastructure & Resilience
	2.c.1 Indicator of food price anomalies	Infrastructure & Resilience
Goal 3	3.4.1 Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Urban development
	3.6.1 Death rate due to road traffic injuries	Safety
	3.8.1 Coverage of essential health services	Accessibility
	3.8.2 Proportion of population with large household expenditures on health as a share of total household expenditure or income	Accessibility
	3.9.1 Mortality rate attributed to household and ambient air pollution	Environment
	3.b.1 Proportion of the target population covered by all vaccines included in their national programme	Accessibility
Goal 4	4.1.1 Proportion of children and young people (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex	Accessibility
	4.2.1 Proportion of children aged 24–59 months who are developmentally on track in health, learning and psychosocial well-being, by sex	Accessibility
	4.3.1 Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex	Accessibility
Goal 5	5.1.1 Whether or not legal frameworks are in place to promote, enforce and monitor equality and non-discrimination on the basis of sex	Safety
Goal 6	6.1.1 Proportion of population using safely managed drinking water services	Accessibility
Goal 7	7.1.2 Proportion of population with primary reliance on clean fuels and technology	Energy
	7.2.1 Renewable energy share in the total final energy consumption	Energy
	7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems	Energy
	7.b.1 Installed renewable energy-generating capacity in developing countries (in watts per capita)	Energy
Goal 8	8.9.1 Tourism direct GDP as a proportion of total GDP and in growth rate	Environment
	8.10.1 (a) Number of commercial bank branches per 100,000 adults and (b) number of automated teller machines (ATMs) per 100,000 adults	Accessibility
Goal 9	9.1.1 Proportion of the rural population who live within 2 km of an all-season road	Infrastructure & Resilience
	9.1.2 Passenger and freight volumes, by mode of transport	Infrastructure & Resilience
Goal 10	10.2.1 Proportion of people living below 50% of median income, by sex, age and persons with disabilities	Inclusion
	10.3.1 Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law	Inclusion
Goal 11	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing	Inclusion
	11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities	Accessibility
	11.3.2 Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically	Urban development
	11.6.2 Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted)	Environment
	11.a.1 Number of countries that have national urban policies or regional development plans that (a) respond to population dynamics; (b) ensure balanced territorial development; and (c) increase local fiscal space	Urban development
	11.b.1 Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	Infrastructure & Resilience
Goal 12	12.c.1 Amount of fossil-fuel subsidies (production and consumption) per unit of GDP	Environment
Goal 13	13.1.3 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	Infrastructure & Resilience
	13.2.1 Number of countries with nationally determined contributions, long-term strategies, national adaptation plans and adaptation communications, as reported to the secretariat of the United Nations Framework Convention on Climate Change	Environment
	13.b.1 Number of least developed countries and small island developing States with nationally determined contributions, long-term strategies, national adaptation plans and adaptation communications, as reported to the secretariat of the United Nations Framework Convention on Climate Change	Environment
Goal 14	14.1.1 (a) Index of coastal eutrophication; and (b) plastic debris density	Environment
Goal 16	16.b.1 Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law	Inclusion
Goal 17	17.11.1 Developing countries' and least developed countries' share of global exports	Infrastructure & Resilience
	17.14.1 Number of countries with mechanisms in place to enhance policy coherence of sustainable development	Urban development
	17.17.1 Amount in United States dollars committed to public–private partnerships for infrastructure	Urban development
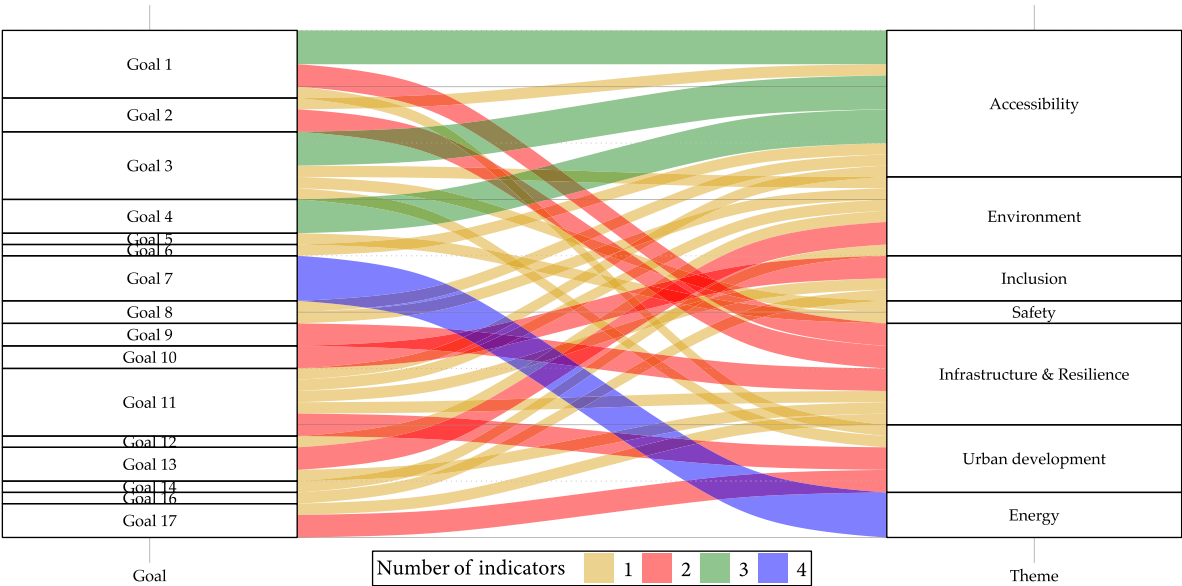
Fig. 2. Relationship between goals and areas of focus (category), for the exact details, refer to Table 1; The Figure was created using ggalluvial package (Brunson, 2020), under the statistical software R (Posit team, 2025).

including gender-based violence and barriers, affordability challenges, and accessibility issues for marginalized populations, remain insufficiently addressed. Moreover, the environmental impacts of transportation, such as noise pollution and habitat disruption, are overshadowed by a narrow focus on greenhouse gas emissions. To bridge these gaps, refined indicators and methodologies are essential. Context-sensitive approaches must account for urban, rural, and underserved regions' diverse transportation challenges. Indicators must be developed to reflect transportation's nuanced impacts, particularly in regions where informal transit systems dominate. Expanding linkages to goals like Goal 5 (Gender Equality) and Goal 16 (Peace, Justice, and Strong Institutions) can further illuminate transportation's role in fostering equity and social justice. Policymakers must carefully navigate trade-offs to achieve sustainable outcomes. For instance, expanding transportation infrastructure may enhance connectivity but risk environmental degradation. Similarly, decarbonization efforts could disrupt fossil fuel-dependent economies, necessitating equitable transition strategies. Integrated approaches — combining PT investments with active mobility promotion, land use planning, and renewable energy integration — offer viable pathways to mitigate these challenges while maximizing synergies. This paper underscores the urgent need to embed transportation more comprehensively within SDG planning and monitoring. A robust, interdisciplinary set of indicators is required to fully capture transportation's multidimensional contributions and align it with sustainability objectives. Stakeholders can unlock its transformative potential by recognizing transportation's systemic importance and addressing its underrepresentation in the SDG framework. Such efforts will accelerate global progress towards the 2030 Agenda and foster resilient, inclusive, and sustainable transportation systems, paving the way for a more equitable and sustainable future.

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CRediT authorship contribution statement

Mohamed Abouelela: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Formal analysis, Conceptualization. **Iraklis Stamos:** Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Conceptualization. **Manos (Emmanouil) Chaniotakis:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Formal analysis. **Constantinos Antoniou:** Writing – review & editing, Writing – original draft, Validation, Supervision, Investigation, Conceptualization.

Declaration of competing interest

None

Data availability

Data will be made available on request.

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