Strategies for sustainable transportation in road way system in urban areas

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Abstract. The current trajectory of the global transportation system is widely acknowledged to be unsustainable. Many people think it's time for a radical shift in how things are done, how things look, how money is spent, and so on. New technologies will have varying long-term negative implications across all cultures, developed and developing alike. The growing interest in the alternative method to sustainable development may be attributed to the convergence of concerns about environmental quality, social equality, economic viability, and treatment of climate change due to rising CO2. Because sustainable growth is crucial for the future of any era, but particularly in this century, it deserves a lot of attention in this article. Society, the economy, and the environment are the three main components of sustainable development in the transportation industry. Sustainable transport needs equilibrium between these three areas to meet its minimum requirements. The importance of transportation to sustainable development must be bolstered by implementing sustainable practices. These tactics include public transportation advocacy, demand management, better road management, pricing regulations, vehicle technological advancements, the use of clean fuels, cultural enrichment, and transportation planning. In this research, we assess how transportation factors into sustainable development initiatives and what impact such methods have. Keywords: Transportation, Urban Areas, Strategies, Sustainability.

1 Introduction

Increased interest in sustainable development results from various issues, including climate change, economic growth, social justice, and environmental protection. (Ushakov et al., 2019; Stokes & Seto, 2019; Tran et al., 2020) provided the first comprehensive concept of sustainable development, and its importance cannot be overstated in any era. In all directions, work has begun to improve sustainable development. Sustainable transportation development is receiving a lot of focus in industrialized nations (Tran et al., 2020a, Gutiérrez et al., 2022; Mahmoudi et al., 2019; Tan & Ismail, 2020). Sustainable modes of transportation protect environmental and human health, ensuring the continuation of economic growth and social harmony. Sustainable development strategies are discussed, and the study goes on to break down the importance of transportation across three domains: social, economic, and ecological

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The report concludes with an assessment of various approaches to achieving sustainable transportation, including but not limited to: public transportation expansion, demand management, road improvement, pricing policies, vehicle technology advancement, clean fuel use, cultural enrichment, incentive and disincentive design, and transportation planning.

1.1 Sustainability

A process must continue operating at a constant quality or grade to be sustainable. The word refers to the possible lifespan of essential human ecological support systems, including the planet’s climatic system, systems of industry, forestry, agriculture, and fisheries, and human societies in general and the different systems on which they rely, from an environmental point of view according to (Kraus & Proff, 2021; Ushakov et al., 2021).

Fundamentally, sustainability is an ongoing process that does not have a beginning or end: For a process to be considered sustainable, it must have the potential to endure across time. One example is people who have a steady salary but nevertheless manage to get into debt because they spend more than they bring in. It's possible that eventually, both savings and the ability to get more borrowing may be depleted, bringing a stop to this process (Liu et al., 2021).

1.2 Sustainable Development (SD)

According to Karjalainen & Juhola (2019), the evolution satisfies the current generation without compromising the potential of future generations to do the same. Sustainable development is not a static equilibrium but rather a dynamic process in which resource extraction, financial allocation, technology advancement, and institutional reform are reoriented to meet current and future human needs better. The basic definition of sustainability has been expanded to include three major points:

Society. Refers to circumstances that might benefit a generational redistribution of wealth according to individual production levels. This means that people or organizations may engage in risky endeavours of their choosing and benefit from the results. To conflate social welfare programs (socialism), when the productive portion of the population accepts or is pressured to support the non-productive section, is to mistake redistribution with equality. Therefore, social justice cannot be achieved by central planning or socialism (Karjalainen & Juhola, 2019; Ren & Huang, 2020).

Economy. What has to happen for economic efficiency to rise in resource and labour use. It prioritizes productivity, adaptability, and the delivery of products and services in response to consumer demand (Sultana et al., 2019; Tang et al., 2020). Under these conditions, production factors should be distributed freely, and markets should be unrestricted.

Environment. Involves leaving a smaller "footprint" on the environment than what is already being used. This refers to the provision of resources (soil, food, water, electricity, etc.) and the proper disposal of countless wastes. Its fundamental principles are resource minimization and recycling (Hamurcu & Eren, 2020; Stokes & Seto, 2019).

Development that satisfies the requirements of the present without jeopardizing future generations’ capacity to satisfy their own needs is called sustainable development. We must use, develop, and safeguard resources at a pace and in a way that allows people to fulfil their present requirements and that also allows future generations to meet their own needs if we are to stay sustainable for many years into the future according to Tang et al (2020).

Karjalainen & Juhola (2019) defined a sustainable transportation system as "one in which fuel consumption, vehicle emissions, safety, congestion, and social and economic access are of such levels that they can be sustained into the indefinite future without causing great or
irreparable harm to future generations of people around the world." Access to people, places, commodities, and services should be ensured through a sustainable transportation system that is kind to the planet, acceptable to society, and profitable for business.

2 Sustainable Development and Transportation

Sustainable transportation has yet to be defined uniformly. However, it is undeniable that an understanding of transportation's impacts on the economy, ecology, and society is necessary for achieving sustainable mobility (Kraus & Proff, 2021; Mahmoudi et al., 2019). For several reasons, the transportation system cannot be maintained indefinitely. Three of the biggest problems are the scarcity of oil, the high number of deaths and injuries caused by cars, and the spread of urban sprawl. Less crucial, but still not negligible, are the harmful effects of petroleum-based pollutants on air quality. Congestion, almost to the point of gridlock in many cities, which leads to noise pollution, structural damage from motor vehicle vibration, water pollution from runoff from streets and highways, the loss of wetlands, open spaces, and historic facilities, and ocean pollution from oil spills and secondary impacts according to Takayama et al (2020).

2.1 Transportation and Economy

The economy and transportation are inseparable organs of the same body. Economic growth and positive impacts on the local economy may be accelerated by smart planning and enough foresight. The economy and transportation are highly interdependent, with the transport sector significantly influencing growth and population health. Improved market access, more employment, and new investment possibilities are some of the multiplier effects that may arise from efficient transportation infrastructure (Gutiérrez et al., 2022; Hamurcu & Eren, 2020; Ren et al., 2020).

There might be a monetary cost, like lost productivity or missed opportunities, when transportation networks are inadequate in capacity or dependability. Costs are reduced by efficient transportation and increased by inefficient transport. However, transportation also has substantial social and environmental costs that must not be disregarded. Transportation's direct effects on accessibility modify the availability of more markets and the ability to save money, time, and risk (Mahmoudi et al., 2019; Reyes-Rubiano et al., 2021; Serrano-Hernandez et al., 2021).

Effects on the economy as a whole that don't have an indirect effect, such as a reduction in the cost of goods and services and an expansion of available options. Increased transportation needs directly result from developing local businesses and improving agriculture, extension services and products. The community's economic system benefits from the transportation system's efficiency, and vice versa; the two are mutually reinforcing. When analyzing its macroeconomics, investment in the transportation sector is crucial to the growth of a country's gross domestic product, and total value added (Karjalainen & Juhola, 2019; Ren et al., 2020).

2.2 Transportation and Society

Because the purpose of the transportation system is to satisfy human requirements, it must be operated with due care to ensure that all people, regardless of age or socioeconomic status, can benefit from it. Efforts should also be made to ensure that all people, regardless of background or socioeconomic status, are treated fairly (Stokes & Seto, 2019; Tan & Ismail, 2020). Efficient and environmentally friendly transportation options may assist those in the
community with lower incomes to go where they need to go.

The local unemployment rate may be reduced by investing in this industry's infrastructure, which will create new and additional job openings. A shift in the way people shop, the way they socialize, and the way they live may all have a significant impact on the way people go about it according to Ren et al (2020).

### 2.3 Transportation and Environment

An inherent contradiction is at the heart of the transportation and environmental problems we face today. On the one hand, from cities to global commerce, the transportation sector is more vital as rising passenger and freight mobility needs more efficient and effective systems. However, increased congestion and motorization are negative outcomes of transportation activity. That's why much talk about the transportation industry and environmental issues exists (Liu et al., 2021; Takayama et al., 2020; Tan & Ismail, 2020).

Motorization has exacerbated the negative effects of transportation on ecological systems due to the prevalence of hydrocarbons (any chemical compound consisting exclusively of the atoms carbon (C) and hydrogen (H)) combusting technologies, most notably the internal combustion engine. At this moment, transportation-related activities constitute the primary cause of pollution, with repercussions for the natural world. These effects, like all environmental effects, can fall within three categories:

Direct effects: the direct environmental impact of transportation operations, where the cause-and-effect link is commonly believed to exist.

Indirect effects: Environmental systems that suffer from transportation operations but only due to their secondary (or tertiary) effects. Indirect effects may have a more significant overall impact than direct impacts. Still, they are typically harder to identify and demonstrate due to misunderstandings and lack of clarity in the underlying linkages.

Cumulative effects: Transportation actions’ cumulative, additive, and synergistic results. They consider the many, sometimes unpredictable, implications of a change in one factor on an ecosystem (Mahmoudi et al., 2019; Takayama et al., 2020; Tan & Ismail, 2020). Climate change, air quality, noise, water quality, soil pollution, extinction of species, land take, and implications on human health and visibility from ground-level ozone are among the most significant environmental effects of transportation. Climate change is also a primary concern. A rise in atmospheric concentrations of carbon dioxide (CO2) is the primary cause of the current climate crisis (Ghaflar & El Aziz, 2021; Liu et al., 2021; Mahmoudi et al., 2019). The "greenhouse" effect, responsible for global warming, is growing due to climate change. Carbon dioxide, the most major greenhouse gas, behaves like a thick blanket over the globe to maintain moderate surface temperatures. Adding extra carbon dioxide to the air has the same effect as throwing another blanket over the planet, heating the surface even more (Hoonsiri et al., 2021; Karjalainen & Juhola, 2021; Mahmoudi et al., 2019).

Since the turn of the century, the planet's average temperature has increased by nearly half a degree Celsius due to global warming. In the next century, experts project that global temperature will rise by 3 degrees Celsius if the current pattern of growing CO2 emissions continues. In addition to causing some coastal regions to disappear, this temperature rise would also result in a worldwide average increase in sea level of 0.66 m due to the melting the polar icecaps. The loss of arable land to desertification might exacerbate poverty, hunger, and food insecurity in certain regions.

About half of these effects are blamed on CO2 according to Sultana et al (2019). Furthermore, motor vehicles are responsible for around 20% of carbon dioxide emissions in the United States. Promoting public transportation, demand management, operation management, pricing policies, vehicle technology improvement, use of clean fuels, cultural enhancement, integrated land use, and transportation planning are all important components.
of a comprehensive transportation strategy for sustainable development (Sultana et al., 2019).

3 Technological Innovations

Some examples of technological advancements that can be used for sustainable transportation include the Intelligent Transportation System (ITS), alternatives to traditional forms of communication, new vehicle technologies like energy-efficient automobiles, hydraulic hybrid technology for heavy vehicles, and biofuels for cars. Information and communication technology in transportation (ITS) is using such tools to enhance the efficiency of transportation systems. Urban traffic management, computerized toll collection, and the transmission of real-time information on congestion and weather to aid motorists in determining their travel alternatives are just some of the many uses of ITS (Ren et al., 2020; Takayama et al., 2020; Afanasyeva & Uznarodov, 2019).

Rear-end collision avoidance systems, intelligent cruise control, and safeguards against risky manoeuvres are some of the further ITS uses. Telecommuting, teleshopping, teleconferencing, and remote learning are examples of how telecommunication replacements cut down on unnecessary travel. Traditional automobiles run on diesel or gasoline and include internal combustion engines. Hybrids are cars that use an extra power source, usually electricity, to improve the efficiency of the vehicle as a whole. Currently, hybrid cars are available for purchase by the general public.

Unfortunately, the market price of a hybrid car is more than that of a conventional vehicle. Heavy vehicles, propelled by massive diesel engines, are outside the scope of electric hybridization techniques developed for passenger automobiles (Karjalainen & Juhola, 2019). Hydraulics and fluid power must be improved via hybridization to increase the fuel efficiency of large vehicles. Improvements in hydraulic pump/motor efficiency employing swash plate pump/motors and bent axis pumps/motors are being researched and developed, as are improvements in control techniques, noise reduction, and the capacity of components to store larger densities of power. Biofuels are sustainable transportation fuels derived from sources like plants and food scraps (Gutiérrez et al., 2022; Sultana et al., 2019; Tan & Ismail, 2020; Tang et al., 2020).

Ethanol and biodiesel are two of the most common forms of biofuel. Sucrose (from sugarcane) and starch are the primary ingredients in ethanol (from corn) according to Tan & Ismail(2020). Biodiesel is produced from oil-producing plants, including oil palm, coconut, rapeseed (canola), sunflower, and soybean.

3.1 Transportation Systems Management (TSM)

TSM's goal is to improve traffic management and roadway operations to use current street and highway networks. Improving transit service, reducing traffic congestion, and reducing traveler demand are the three primary TSM techniques (as discussed in the preceding section). The goal of making smarter use of roads is to make it easier for drivers, pedestrians, and public transportation riders to go where they need to go with as little hassle as possible according to Mahmoudi et al (2019). Traffic operations and signalization improvements, bicycle and pedestrian improvements, high-occupancy vehicle (HOV) lane priority, residential and congested area traffic restrictions, parking management, work-schedule management, and intermodal coordination are all used to alleviate traffic. Actions taken as part of transportation demand management (TDM) aim to lessen the number of people using the roads. Increased car occupancy via ridesharing, economic disincentives for auto users, encouragement of other modes of transportation (including walking and cycling), and decreased truck traffic in congested locations are all TDM strategies (Sultana et al., 2019; Tang et al., 2020).
3.2 Implementation of Favourable Land-Use Patterns

Changes in land-use patterns may have far-reaching effects on people's commuting habits. New projects that include low population density, hierarchical street designs, ample road and parking capacity, and a focus on the private vehicle can increase reliance on cars according to Ren et al (2020). Growth on the outskirts of cities fuels sprawl because it spreads people out and makes them more reliant on cars (Sultana et al., 2019). Smart growth, new urbanism, and transit-oriented development are all examples of compact, mixed-use, higher-density infill development of the central urban area that are worth considering because they promote bicycling and walking, lessen reliance on automobiles, decrease traffic congestion and pollution caused by cars, and revitalize cities through their use of a variety of land uses (Takayama et al., 2020).

3.3 Elements of Sustainable Urban Policy

Figure 1 depicts the framework and components of a sustainable transportation strategy. To a large extent, sustainable urban transport strategies are determined by the strategic aim, which is an indirect component. Due to its all-encompassing nature and directing influence, it has been placed at the top of this framework. It has an impact on environmental policy and other relevant policies at the national and regional levels. Significant changes to the public transportation network might result from changes in land use. Therefore, land use has an immediate impact on urban transportation plans.

The goals of sustainable urban transport policies are, from one to five, as follows: (1) to issue transportation ideas; (2) to offer the process to the city's mobility plan; (3) to repair urban damages; (4) to regulate environmental effects; (5) to encourage sustainable behaviour. The transmission of novel ideas, like the sustainable notion, is an integral part of issuing transportation concepts, which includes education and publishing. Since humans are the primary focus of urban transportation and the primary focus of transportation systems, this has been prioritized. New transportation ideas need to be well received by the public for politicians to see success. Facilitating urban mobility is the goal of the city's mobility plan.

Restoring urban infrastructure involves several moving parts with the ultimate goal of removing all negative effects on city dwellers, the built environment, and the surrounding suburbs. Transport infrastructures causing visual intrusion in urban areas, particularly in old cities; (1) health problems influenced by the low air quality in urban areas and noise pollution in densely populated areas; (2) cityscape, transport infrastructures causing visual intrusion in urban areas, especially in old cities; (3) suburban areas, since the convenience of urban transport system plays an important role in the urbanization process, the development of urban transportation.

Suburban encroachment due to inevitable urbanization calls for efficient planning of the occupied land. To eliminate the need for fossil fuels, it is necessary to consider environmental issues, energy use, and resource consumption. Long-term sustainability promotion should centre on ensuring transport networks can be kept running in the longterm.
Several sustainability-focused transport goals have been deduced from the framework above by using the eight Sustainability Principles. A transportation strategy will include a number of overarching strategic aims to achieve these goals for sustainable transportation. Vehicle and fuel advancements are not analyzed since they are intrinsically linked to technical progress and beyond this study's scope. Increasing reliance on personal automobiles is the primary concern that needs fixing.

For the environment, the widespread use of private automobiles in the present day results in reliance on fossil fuels, releasing greenhouse gases and other pollutants, and using valuable land. It's also probable that when people drive their cars without any speed restriction, the likelihood of casualties rises, which goes against the societal SP of integrity. In this study, we focus on two key sustainable transport goals: lowering automobile use and developing alternate modes, each of which has the potential to have a direct and unique influence on reducing the reliance on individual car usage.

In our study, we will also look at the viability of non-motorized modes of transportation, such as walking and cycling. The vast majority of studies have shown that a number of different approaches are required, rather than just one, to accomplish sustainability objectives. Environmental, social, and economic goals may be better integrated with the aid of the strategic action plan. More specific measures will be evaluated to ensure they effectively achieve sustainable transportation goals and objectives. Sustainable transportation has been advocated due to several different efforts, such as planning, management, and operational changes. By reducing the number of cars that may be transported along a certain route, for instance, we can assist in lowering the number of people who choose to drive themselves about. Parking regulation is another example of an impact on individual automobile usage that has the added advantage of reducing land use in the city, reducing the danger of accidents and the resulting direct damage to inhabitants.

### 3.4 Transport Strategies for having sustainable transportation in the roadway system

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<th>Strategies</th>
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<td>Vehicle</td>
<td>Improved Efficiency of Conventional Vehicles</td>
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<td>New Vehicle Technologies</td>
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<td>New Fuel (Green Fuel)</td>
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<td>Smart Vehicle</td>
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Sustainable development has significantly benefited from implementing the transportation options outlined in the table above. Depending on the aspect of the transportation network that each tactic seeks to improve, we may classify them into many broad groups.

First, technical advancements in cars and fuels would mitigate the negative impacts of automobile usage on the environment; second, enhancing urban and suburban infrastructure; and third, relying on people to manage the transportation system.

There are a number of different types of human strategy teams. The human strategy may be broken down into several subcategories, including modal switching, telecommunication switching, pricing in response to government regulation and incentives, and proper application of traffic regulations.

## 4 Conclusion

Transportation plays a significant part in sustainable development. Yet, it is also clear that transport is unsustainable, given that it is widely recognized as one of the most crucial pillars of contemporary life. This is due to a number of factors. The primary ones are (1) the scarcity of oil resources, (2) the high toll on human lives exacted by automobiles, (3) the climate-altering effects of emissions from fossil fuels, and (4) the spread of cities. Fifth, traffic congestion is not crucial but also not unimportant.

Public transportation advocacy, demand management, road maintenance, pricing policies, vehicle technology advancement, clean fuel use, cultural enrichment, incentive and disincentive design, and transportation planning are just some of the ideas put forth in this paper to increase transportation's contribution to sustainable development. More research is needed into these methods, and the societal, environmental, and economic implications should all be taken into account as a result of factors, including consumer reactions to sustainability initiatives. These strategies' outcomes must also be factored into sustainable development plans.

Key solutions to develop a sustainable transportation system include enhancing public transportation, managing transportation networks, adopting a favourable land-use pattern, and technological advancements. The current administration's efforts to improve public transportation have the people's complete backing.

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