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Sustainable Transportation and Communication

Aarushi Chhibber[1,*], S. Ravichandran[2]

Abstract

The concept of sustainability is widely discussed in research worldwide, leading to various interpretations based on different research objectives. This study explores how sustainability principles meet current needs without hindering future generation's ability to fulfil their own needs, ultimately enhancing the quality of life for society. To achieve sustainable living, we must integrate three key areas, known as the triple bottom line: economic equity, environmental protection and social development. Economic equity focuses on interconnected global systems that require collaborative efforts to promote long-term, robust growth and ensure that no community is left behind in the process. Environmental protection emphasizes the sustainable use of natural resources through economically viable solutions, aiming to reduce resource consumption and pollution while preserving natural habitats. Social development involves securing essential services such as employment, food, energy, healthcare, education etc. It also ensures cultural and social diversity, upholds labour rights, and empowers all community members to shape their future. Sustainable transportation involves contributing to the sustainable development of a community through the transportation system they use. Traditionally, transportation infrastructure development focused on minimizing initial operation costs and prioritizing traffic mobility while considering social and environmental needs. This study focuses on modes of sustainable transportation, infrastructure for sustainable transportation, sustainable communication, sustainable communication practice, and innovation in communication technology.

Keywords: Sustainability, triple bottom line, sustainable transportation, transportation and communication, transport system, traffic system

INTRODUCTION

Transport plays a crucial role in enhancing connectivity, facilitating trade, fostering economic growth, and generating employment. Balancing the trade-offs associated with transport is crucial for achieving sustainability in both transportation and overall development.

Transport significantly contributes to greenhouse gas emissions, yet it remains crucial for economic and social progress. Sustainable transport, as outlined in the 2016 report by the Secretary-General's High-level Advisory Group, involves offering services and infrastructure for the movement of people and goods in ways that bolster economic and social development for both present and future generations. This approach emphasizes the need for safety, affordability, accessibility, efficiency, and resilience, while also aiming to lower carbon emissions and other environmental impacts. Thus, sustainable transport is not a goal in itself but a means to attain sustainable development [1]. Sustainability communication is a strategic approach companies use after incorporating sustainability into their operations and strategic plans. It involves sharing information about their sustainability initiatives, objectives, and outcomes with a broad spectrum of stakeholders. However, sustainability communication goes beyond merely

***Author for Correspondence**
Aarushi Chhibber
E-mail: aarushichhibber29@gmail.com

[1]Student, Department of Biotechnology, School of Bio Engineering and Bio sciences, Lovely Professional University, Jalandhar, Punjab, India
[2]Professor, Department of Chemistry, School of Mechanical Engineering, Lovely Professional University, Jalandhar, Punjab, India

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promoting a company's efforts. It involves integrating environmental and social values deeply into the organization and its narrative. This approach ensures that a company's sustainable practices are transparent, comprehensible, and valued by all stakeholders, including employees, consumers, investors, and the broader community. By using sustainability communication, companies can show their dedication to a sustainable future and set themselves apart in a market that increasingly values corporate responsibility [1–6].

METHODS OF SUSTAINABLE TRANSPORTATION

Public transport, which includes systems such as buses, trains, subways, and trams, is a passenger transport option available to everyone. Unlike private transport, it operates on a fixed schedule, follows established routes, and often requires a fare for each journey [3]. There is no strict definition of what constitutes public transport, and air travel is generally not considered part of it. Dictionaries typically describe public transport with terms like "buses, trains, etc.". Examples include city buses, trolleybuses, trams (or light rail), passenger trains, rapid transit systems (such as metros, subways, or undergrounds), and ferries. Intercity public transport is mainly served by airlines, coaches, and intercity rail, with high-speed rail networks being developed in many regions around the world. Most public transport systems operate along established routes with designated stops according to a predetermined schedule. The most frequent services operate on a headway basis, such as "every 15 min", rather than being scheduled for specific times Additionally, most public transport journeys involve multiple modes of travel, such as passengers walking or taking buses to reach train stations [7–9].

In various regions globally, on-demand services are available, which can either compete with or complement fixed public transport routes. These services often transport passengers to interchange points. Paratransit, utilized in areas with limited demand, provides door-to-door services, particularly catering to individuals with specific mobility needs.

A Hybrid Electric Vehicle (HEV) is a car that combines an internal combustion engine with an electric motor for propulsion. By combining these two power sources, the vehicle can achieve improved fuel efficiency and improve overall performance. Depending on the specific hybrid system, the electric powertrain can serve various functions: it can supplement the IC engine to reduce fuel consumption, provide additional power for better acceleration, or, in some cases, operate independently to propel the vehicle using only electric power. This versatility enables HEVs to offer significant benefits in terms of reduced emissions and enhanced efficiency compared to traditional gasoline-powered vehicles [10–12].

INFRASTRUCTURE FOR SUSTAINABLE TRANSPORTATION

Urban planning and design: Urban planning involves the design and regulation of space usage, concentrating on the physical layout, economic functions, and social impacts of urban areas, as well as the placement of various activities within them. This field includes engineering, architecture, and social and political considerations, making it both a technical profession and a political endeavour that necessitates public participation. Urban planning involves the development of new areas (referred to as "greenfield sites") as well as the revitalization of existing urban sections. Urban planning involves several steps: setting goals, collecting and analysing data, forecasting, designing, strategic thinking, and engaging with the public. Geographic information systems (GIS) are commonly used to map urban areas and predict the impact of changes. In the late 20th century, sustainable development became a key goal, defined by the United Nations in 1987 as development that meets current needs without compromising the ability of future generations to meet theirs. Despite general agreement on this goal, planning often involves trade-offs between different objectives, leading to conflicts. Modern urban planning originated in the late 19th century as a response to the disarray of industrial cities [13–15].

Visionaries of that era aimed to create ideal cities, but practical concerns such as sanitation, transportation, and amenities also drove planning efforts. Today, urban planners strive to balance social equity, economic growth, environmental sustainability, and aesthetic considerations. The planning process can lead to the creation of various types of plans, such as a comprehensive master plan for a

city or metropolitan area, a neighbourhood plan, a project plan, or a set of policy alternatives. Successful implementation often requires planners and their sponsors to demonstrate strategic and adaptive capabilities. Entrepreneurship and political savvy, despite attempts to keep planning apolitical. Increasingly, planning involves collaboration with the private sector through public-private partnerships. Urban planning became an established academic discipline in the early 20th century. The University of Liverpool established the first planning program in Great Britain in 1909, and Harvard University followed with the first North American program in 1924. Today, urban planning is mainly taught at the postgraduate level, with curricula differing widely among universities. Some programs focus on traditional aspects of physical design and land use, while others, particularly those offering doctoral degrees, emphasize social sciences. Theoretical issues in urban planning include defining the public interest, determining the characteristics of the ideal city, achieving planned changes, reaching consensus on goals, and balancing the roles of citizens, public officials, and private investors.

The discipline discusses the appropriateness of using quantitative analysis and the "rational model" of decision-making from a methodological standpoint. Most urban planning degree programs include applied courses on topics such as environmental policy, transportation planning, housing, and community economic development.

Green infrastructure addresses the challenges posed by stormwater runoff, which is a major contributor to water pollution in urban areas. It carries various pollutants such as trash, bacteria, heavy metals, and other contaminants through storm sewers into nearby water bodies. Additionally, intense rainstorms can lead to flooding, causing damage to property and infrastructure. Historically, communities have predominantly utilized grey infrastructure, comprising gutters, pipes, and tunnels, to divert stormwater from residential areas to treatment facilities or directly into local waterways. However, much of this grey infrastructure is aging and increasingly unable to handle large volumes of stormwater. To address this issue, many communities are now implementing green infrastructure systems, which enhances their ability to manage stormwater effectively while providing environmental, social, and economic benefits. Green infrastructure works by filtering and absorbing stormwater where it falls. In 2019, Congress enacted the Water Infrastructure Improvement Act, which describes green infrastructure as including methods that use plant or soil systems, permeable pavement, stormwater harvesting and reuse, and landscaping.

These techniques aim to store, infiltrate, or evapotranspire stormwater, thereby reducing flows to sewer systems or surface waters. Green infrastructure can be integrated into communities at various scales. On an urban scale, examples include rain barrels adjacent to houses, rows of trees along major streets, or greening alleyways. At the neighbourhood scale, it could involve creating open park spaces outside city centres, planting rain gardens, or constructing wetlands near residential areas. On a larger landscape or watershed scale, examples include protecting expansive natural areas, riparian zones, wetlands, or greening steep hillsides. When implemented throughout a community, city, or regional watershed, green infrastructure can deliver cleaner air and water, flood protection, diverse habitats, and attractive green spaces, providing significant value to the community.

SUSTAINABLE COMMUNICATION

Digital Infrastructure

Energy efficient data centres: Data centres are central hubs that house the IT infrastructure necessary for running business applications to fully leverage the advantages of data centres; it is crucial to enhance their performance, scalability, energy efficiency, availability, security, and cost-effectiveness. Among these factors, improving energy efficiency stands out as a critical consideration for organizations, given the substantial impact of energy-inefficient data centres [10].

5 G and future networks: 5th-generation wireless (5G) represents the latest advancement in cellular technology, designed to significantly boost the speed and bandwidth of wireless networks while

reducing latency compared to earlier standards. 5G is particularly well-suited for telecommunications, the Internet of Things (IoT), and private networks using dedicated 5G infrastructure. Cellular companies started rolling out 5G networks in 2019, succeeding the 4th-generation wireless (4G) technology. 5G technology offers the capability for wireless broadband connections to attain speeds in the multigigabit range, potentially reaching peak download speeds of up to 20 Gb/sec (Gbps). These speeds surpass those of wired networks and can deliver latency as low as 5 msec (Ms) or even less, which is crucial for applications needing real-time responsiveness. 5G facilitates a substantial increase in data transmission over wireless systems due to greater bandwidth availability and advanced antenna technologies. As 5G technology continues to be deployed, it is expected to drive the development of numerous new applications, use cases, and business opportunities [11].

SUSTAINABLE COMMUNICATION PRACTICES

Remote Work and Virtual Meetings

A virtual meeting allows individuals to communicate and collaborate remotely using digital technology, eliminating the need for physical presence. Participants can join from any location with an internet connection and engage through audio, video, or text, depending on the platform. These meetings are used for various purposes, including business discussions, remote work, online education, and webinars. Their popularity is increasing due to their convenience, cost-effectiveness, and global connectivity. Platforms like Zoom, Skype, Google Meet, and Microsoft Teams facilitate these meetings, which can be accessed via computers, laptops, tablets, or smartphones.

The digital divide highlights the inequality in access to modern telecommunications technology across different demographic groups and regions. This includes differences in access to computers, smartphones, the internet, and digital literacy skills. Initially, when the term “digital divide” emerged in the late 20th century, it specifically highlighted the gap between those who had access to cell phones and those who did not. Over time, the definition has broadened to include the ability, both technical and financial, to utilize available technology and access the internet. As technology continues to evolve, the concept of the “digital divide” also continues to change.

INNOVATION AND COMMUNICATION TECHNOLOGY

The Internet of Things (IoT) involves a network of various physical objects such as devices, vehicles, and appliances, which are integrated with sensors, software, and connectivity features. These objects can collect and exchange data, allowing for increased automation, efficiency, and communication across different systems. This enables these devices to gather and exchange data autonomously. These IoT devices, often called “smart objects”, can vary widely, from basic “smart home” gadgets like smart thermostats to wearable technology like smartwatches and RFID-enabled clothing, and even to complex industrial equipment and transportation systems. There are even ambitious visions of creating entire “smart cities” based on IoT technologies.

Blockchain and decentralized networks: In the context of blockchain, decentralization involves transferring oversight and decision-making authority from a centralized entity (like an individual, corporation, or group) to a distributed network. The goal of decentralized networks is to minimize the level of trust required among participants and to prevent any single entity from exerting undue authority or control in a way that could undermine the network's effectiveness. Decentralization is not a new concept. When designing a technological system, three fundamental network structures are often considered: centralized, decentralized, and distributed. While blockchain technologies often utilize decentralized networks, classifying a blockchain application itself as decentralized or not is not straightforward. Instead, decentralization exists on a spectrum and should be considered in all aspects of a blockchain application. By decentralizing the management and access to resources within an application, it becomes feasible to enhance fairness and improve service delivery. Although decentralization may involve trade-offs, such as lower transaction speeds, these are generally outweighed by the enhanced security and services it provides.

CONCLUSION

Transport is vital for connectivity, trade, economic growth, and job creation, yet it significantly contributes to greenhouse gas emissions, making sustainable transport essential for sustainable development. According to the Secretary-General's High-level Advisory Group, sustainable transport is characterized by its support for economic and social progress. It should be safe, affordable, accessible, efficient, and environmentally friendly. Companies enhance their sustainability efforts through strategic sustainability communication, ensuring transparency and stakeholder engagement. Sustainable transportation includes public transport systems and hybrid electric vehicles, supported by urban planning and green infrastructure. Digital advancements like energy-efficient data centres and 5G networks also play a crucial role. Remote work and virtual meetings provide a cost-effective way to connect globally. However, it is crucial to address the digital divide to ensure equitable access to technology. Innovations like IoT and decentralized blockchain networks further drive sustainable development by improving efficiency, security, and service delivery.

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