

Smart Infrastructure and Green Transportation

Shipra Gupta¹,

¹School of Management,
Graphic Era Hill University,
Dehradun, Uttarakhand, India.

Sweta Bagdwal²

²School of Management,
Graphic Era Hill University,
Dehradun, Uttarakhand, India.

AmalaSuzana³

³AP, J.J. College of Engineering and Technology,
Tiruchirappalli, Tamilnadu, India.

ABSTRACT

The Quick city development and increasing ecological concern, the integration of intelligent infrastructure and clean transportation is vital for creating sustainable building, smart cities. Smart infrastructure offer cutting edge digital tool such as IoT, AI, and data analytics to generate urban systems, make use of services, and enhance standard of life through proper and efficient resource management. Currently, green transportation ambition, including electric vehicles, improved public transit systems, and transit oriented development, address urban transit challenges by reducing emissions and promoting eco-friendly mobility. Together, these initiatives generate a synergy that not only mitigates the environmental impact of urbanization but also fosters improved connectivity, reducing congestion, and optimized public health. But, realizing these systems requires proper collaboration among policymakers, businesses, and residents, as well as good investments and schemes to ensure widespread adoption. This paper explores the combined impact of intelligent infrastructure and green transportation in building sustainable cities and highlights the policy and community engagement strategies essential to advancing these goals.

Keywords- Smart Technology, Green, Transportation, sustainable, Urbanization

I. INTRODUCTION

A new trend of increased change in city growth in the past few decade has highlighted some undesirable and unplanned challenges and aspects associated with urban development. It is leading as a result to several documented concerns about managing local resource use or minimizing environmental impact by changes to traditional methods of city planning and infrastructure. As such, the alleviation of these challenges is trending in the direction of smart infrastructure and green transportation as one of its many core pillars focused on designing efficient and productive urban ecology. Smart infrastructure is a digital technology embedded in the urban fabric to simplify routine services, optimize resource utilization and ultimately improve quality of life. This technology is incorporating the use of IoT (Internet of Things), AI (Artificial Intelligence), and data processing into essential city infrastructures such as power, waste removal, and transportation. Green transportation assists rapidly deployment providing funded with more green transportation option integrated into battery powered researched vehicle and public transit or bike sharing network improvements for better transport synergy. In collectively, these methods aim to decrease greenhouse gas emissions, mitigate traffic congestion, and improve air quality to make the cities more conducive to environmentally friendly living and human health. Connectivity at the core of smart infrastructure this process of connecting urban systems via digital platforms enables cities to collect enormous data in real-time, recognize patterns through analytics, and make informed decisions for continuous improvement on the respective area of urban services. Smart energy grids adapt the energy supply to the actual demand thereby saving wastage & costs or smart water systems gather usage data which are majorly subject to surveillance for monitoring in order to locate and repair leakages quickly. IoT introduced efficiency in waste management, the sensor is fitted in the bins and these only become functional when the bin fills to its last capacity that sends a signal for pickup saving cost in looping through empty bins. Smart technologies are being adopted by transit networks one of the most significant contributors of urban pollution, to route optimization, driving duration and idle time reduction, and better control traffic jams. By leveraging intelligent infrastructure, cities are able to respond proactively to an incident, which minimizes disruptions thereby facilitating a seamless experience for urban operations. These interconnected pathways facilitate the automation of such systems, which can help make public services quicker and more accessible for city dwellers. Equally essential is green transportation which addresses the negative environmental impact of conventional, fossil fuel based transit. One of them is to switch to electric vehicles (EVs), which produce no tailpipe emission and can be powered with renewable energy. In addition, the design of EV charging networks joined to smart grids will guarantee that vehicles are charged sustainably. Improving public transport is also essential, as it motivates citizens to take buses, trains and trams instead of their own cars. It decreases congestion, cuts down on emissions and can be complemented by green infrastructure like bus only lanes and bike share systems. Green

transportation also includes urban design concepts such as transit-oriented development, where a city is organized to be close to public transport and compact city planning, which minimizes the distance travelled by car. Such initiatives reflect a holistic approach to mobility, promoting alignment between funders and climate imperatives. Building smart infrastructure and environmentally friendly transport solutions need joint action by city-planners, policy-makers, businesses and citizens. Large scale, high cost capital investments in things like digital infrastructure, renewables and sustainable public transit networks are essential on the road to long term viability and sustainability. The transition is also being supported through regulatory plan like grants for battery powered, funding for green energy and the development of city based eco zones. Collaborative venture play an essential role in this approach by utilizing innovation and asset from various field, enabling creativity, and expanding solutions successfully. Additionally, public involvement is essential, as resident adoption of smart and green practices notably affects the achievement of this program. Learning and outreach efforts can assist people grasp the advantage of employing eco friendly transit options and accepting conservation practice in their everyday routine.

II. LITERATURE REVIEW

This manuscript states the factors, challenges, and ASI strategy (Avoid, Shift, Improve) for implementing sustainable transportation, highlighting its potential to significantly reduce CO₂ emissions and support urban sustainability. Examples of successful ASI applications underscores its impact on greening public transit [1]. In this paper the author highlights the environmental impact of road transportation, a key infrastructure for economic growth yet a major contributor to CO₂ emissions. It presents the interdisciplinary efforts toward Green Transportation, focusing on the overlooked role of operations research (OR) in optimizing and reducing emissions. The paper aims to bridge this gap by exploring OR's current and potential contributions to sustainable transportation [2]. This paper explores using mobile phones to encourage eco-friendly transportation by tracking users' transit habits and providing feedback via the UbiGreen app. Findings show that visual feedback on mobile devices can effectively motivate greener transportation choices [3]. This manuscript examines the benefits of green transportation in alleviating urban traffic congestion, reducing energy use, and enhancing public health. By analyzing successful strategies from global cities, it identifies challenges in Beijing's green transportation efforts and suggests measures to strengthen its sustainable transit system and promote eco-friendly travel [4]. In this manuscript the author highlights the environmental and economic issues of fossil fuel-based internal combustion vehicles and advocates for hybrid vehicles as a sustainable alternative. It addresses pollution sources, fossil fuel depletion, and oil dependency, along with challenges and solutions for hybrid vehicle adoption. The paper also reviews global initiatives and government policies aimed at reducing fossil fuel reliance and promoting cleaner transportation solutions [5]. This manuscript underscore the critical transportation challenges in developing countries, focusing on traffic congestion, pollution, and inadequate public transit, with a case study on Egypt. It underscores the importance of sustainable urban transport plans as essential as urban planning, emphasizing affordable, eco-friendly, and people-oriented solutions. The paper examines the Egyptian government's interventions and outlines strategies for policymakers and transportation professionals to foster greener mobility systems [6]. This manuscript presents a bi-objective model for green truck transportation scheduling and driver assignment, aiming to minimize transportation costs (TTC) and carbon emissions (TCE). By controlling truck speeds, the model addresses the trade-off between economic and environmental goals, using linearization and the augmented e-constraint method to improve efficiency. A constructive heuristic approach is developed, yielding high-quality solutions quickly, with tests showing better performance than alternative scenarios [7].

This paper reviews smart city technologies such as IoT, big data, and block chain and their applications across civil engineering fields, from transportation to energy systems. The report highlights obstacles in the leveraging of smart infrastructure, while also identifying novel roles civil engineers can play as designers, stewards, innovators, risk managers and leaders guiding the evolution of the smart city. This is reflected in such functions as balancing technical innovations with environmental, societal, and security considerations [8] within urban infrastructure management. This paper deals with the optical technologies for the Internet of Things (IoT), particularly on their opportunities towards advanced sensing and communication applications. It surveys the optical systems that hold promise for satisfying the exacting performance requirements of emerging IoT applications by improving efficiency, precision, and reliability. The paper points out, that these technologies can play their role in making smart infrastructures and systems [9].

This paper presents India's smart city mission which can improve urban sustainability and make citizen safe by integrating advanced technology into infrastructure. While the number of accidents on roads continues to increase due to undesirable conditions AI, IoT, machine learning and cloud computing embrace a need for implementing road safety. Each of these technologies has potential in creating a system for prevention and thus reducing accidents [10] as well as making citizens feel more secure. This paper identifies the framework on how smart city infrastructure should be developed and explains the integration of telecom and IP networks, asset management systems in order to build efficient and cost-effective operations. Clout claims quantifiable and non-quantifiable benefits of the proposed architecture and explores the efficiency in cities such as Dubai, Kochi, Singapore from smart city development. Another

work related to the accurate generic asset location in [11] as well highlights on the part of integrating qualities and economic benefit to build an effective smart city. This paper reviews the paradigm shift from 5G to 6G wireless communications, and summarizes some of the key technologies and applications that enable universal connectivity many new innovations beyond cellular. The ubiquitous connectivity will boost multi-sensory extended reality and digital replicas which are possible by advanced intelligent physical processes. It is focused on many hurdles and how to overcome these hurdles in impact realization of 6G from various aspects such as social, health, commercialization etc., with an introduction of new use cases from agriculture, education and transportation sectors. The paper also examines how 6G can drive global sustainability and transform business practices, along with future research opportunities [12 - 13].

This study explores the potential of smart infrastructure to promote sustainable urban development in Lagos, focusing on the challenges of informal settlements and infrastructure inadequacy. Using data from 460 households in two local government areas, it identifies smart infrastructure as a viable solution to improve socioeconomic conditions, environmental quality, and urban facilities. The findings suggest that smart interventions can address key issues in housing, infrastructure, and services [14]. This study highlight the public support for green transportation within smart cities and highlight a green urban mobility model to optimize intelligent transportation systems[15].

This paper highlights the green transport and smart cities, examining land use, transport systems, and emissions. Key research areas include shared transport, public transit, traffic demand management, and transit-oriented development, all focusing to support sustainable urban growth. This paper highlight strategies to reduce emissions, optimize traffic flow, and enhance public transit through innovative models and real-world applications. Collectively, they offer valuable insights into sustainable urban planning aligned with the dual-carbon goals [16-18].

In this paper the author focuses on advancing green transport and smart cities, examining land use, transport systems, and emissions. Key research areas include shared transport, public transit, traffic demand management, and transit-oriented development, all aiming to support sustainable urban growth. Papers highlight strategies to reduce emissions, optimize traffic flow, and enhance public transit through innovative models and real-world applications. Collectively, they offer valuable insights into sustainable urban planning aligned with the dual-carbon goals [19-20].

III. OBSERVATIONS

TABLE I Various Methods to Implement the Green Transportation

	Focus	Methods/Strategies	Findings	Implications
1	Sustainable transportation using ASI (Avoid, Shift, Improve) strategy	Reviews factors, challenges, and ASI strategy applications	ASI can reduce CO ₂ emissions and support urban sustainability	Demonstrates ASI's potential to improve public transit and urban sustainability
2	Environmental impact of road transportation and operations research	Highlights interdisciplinary operation research approaches for optimizing transportation	Operation research can fill a gap in reducing emissions through transportation efficiency	Encourages using operation research to make transportation greener and economically viable
3	Eco-friendly transportation using mobile tracking	Uses UbiGreen app to track transit habits and provide visual feedback	Visual feedback can motivate greener transportation choices	Emphasizes mobile technology's role in influencing eco-friendly behavior
4	Green transportation benefits and challenges in Beijing	Analyzes global strategies and Beijing's efforts	Green transportation reduces traffic congestion, energy use, and improves health	Provides strategies for improving urban transportation sustainability
5	Hybrid vehicles as sustainable alternatives to fossil fuel vehicles	Reviews environmental issues of fossil fuels and advocates hybrid adoption	Hybrid vehicles can reduce pollution, fossil fuel dependence, and economic costs	Highlights the role of hybrid vehicles and global policies in sustainable transportation
6	Sustainable urban transport challenges in developing countries (Egypt)	Case study on Egypt, assesses traffic and environmental challenges	Egypt's sustainable transport plans are essential but need eco-friendly, affordable solutions	Supports government intervention and green transport policies in developing countries
7	Green truck transportation	Bi-objective model minimizing costs (TTC) and	Efficient scheduling can reduce costs and	Highlights the role of scheduling models in

	scheduling and driver assignment	emissions (TCE), with heuristic and augmented constraints	emissions, with high-quality solutions compared to alternatives	achieving eco-friendly logistics
8	Smart city technology applications in civil engineering	Reviews IoT, big data, block chain, and other technologies in urban infrastructure	Identifies gaps in smart infrastructure and suggests roles for civil engineers	Proposes civil engineers' roles in integrating technology and sustainability in smart city infrastructure
9	Optical technologies in IoT for sensing and communication	Reviews optical technologies for precision and efficiency in IoT applications	Optical technologies can enhance IoT-based smart systems and infrastructure	Shows potential of optical tech in creating efficient, smart urban infrastructures
10	India's Smart City mission and road safety	Examines AI, IoT, machine learning, and cloud applications to reduce accidents	Advanced technology can mitigate road accidents and improve citizen safety	Advocates tech integration for safer, more sustainable infrastructure in India
11	Smart city framework and infrastructure development	Proposes architecture with telecom and IP networks for cost-efficient management	Accurate asset location and integrated systems enhance smart city functionality	Demonstrates the need for advanced frameworks for smart city efficiency
12	6G evolution from 5G with applications in sustainability	Discusses 6G technology advancements, challenges, and use cases across industries	6G promises ubiquitous connectivity, impacting global sustainability and various sectors	Illustrates how 6G will transform communication, with implications for business and sustainability
13	Smart infrastructure for sustainable urban development (Lagos)	Mixed-method study with data from 460 households in Lagos	Smart infrastructure can address informal settlements and infrastructure issues	Recommends smart interventions to improve socioeconomic and environmental conditions in urban areas
14	Smart Bike concept for greener urban mobility	Concept of bike with sensors to reduce physical strain and control electric motor use	Reduces strain and promotes cycling as an accessible, eco-friendly option	Aligns with smart city sustainability by making cycling more viable as a green transport mode

This table 1 captures the primary objectives, methodologies, conclusions, and broader implications of each title providing a structured overview of sustainable transportation, smart infrastructure, and green technology initiatives across various areas.

TABLE II Comparative overview of green transportation and smart infrastructure

Aspect	Green Transportation	Smart Infrastructure
Definition	Eco-friendly transportation methods that reduce emissions and resource use	Integrated systems using advanced technology for efficient urban resource management
Primary Objectives	Minimize environmental impact, reduce CO ₂ emissions, promote sustainable transit	Improve urban services, reduce operational costs, enhance sustainability, and support smart city goals
Key Technologies	Electric and hybrid vehicles, public transit, cycling systems, operations research	IoT, big data, AI, block chain, cloud computing, optical sensors, digital twins
Challenges	High initial costs, infrastructure adaptation, limited EV charging stations, public resistance	High costs, data privacy and security concerns, need for cross-sector integration, technological upkeep
Benefits	Reduces air pollution, enhances public health, lowers traffic congestion, encourages active transit	Increases energy efficiency, improves urban service delivery, supports sustainable growth, reduces costs
Examples	Electric buses, bike-sharing systems, UbiGreen app, green truck scheduling	Smart grids, automated water systems, air quality monitoring, intelligent transportation systems
Interdisciplinary Areas	Environmental science, urban planning, operations research, public policy	Civil engineering, data science, urban planning, environmental management, IT
Global Applications	Copenhagen's bike-sharing program, China's electric buses, California's EV incentives	Singapore's smart city initiatives, Dubai's energy-efficient infrastructure, India's Smart

	Cities Mission
--	----------------

This table 2 provides a comparative overview of green transportation and smart infrastructure, emphasizing their shared goal of urban sustainability through different yet complementary approaches.

IV. RESULT AND DISCUSSION

A. Discussion

An overview of approaches towards sustainable, green transportation and smart infrastructure development is given in table 1. This table represents the uses of avoid shift improve (ASI) model to technological fields, smart city developments and climate-change mitigating projects. The avoid shift improve strategy purpose is to reduce auto dependence, promote a shift toward less polluting transport modes, and better vehicle operation in an effort to mitigate environmental impacts. Synthesizes interdisciplinary strategies to improve transportation efficiency and mitigate emissions are presenting complementary insights of operation research for sustainable transport. The UbiGreen app illustrated how visual feedback can lead to greener transport behaviour through simple tracking of user behaviour. The success of green transportation strategies by improved mobility, lower congestion and energy usage reduction can have much broader benefits as illustrated by efforts in Beijing. Green truck scheduling models can reduce emissions and costs for greener logistics. Civil engineering, smart city technology, IoT, big data and block chain provides smart infrastructures. These sustainable recent evolutions are emphasising considerations for mobilizing urban solutions to encourage climate action easily incorporating such technologies and involving civil engineers in integrating these smart solutions. Tech powered improvements in public safety is deploying AI, IoT & ML for road safety in India Smart City Mission. Smart working city frameworks can also be supported through the integration of telecom and IP networks for centralized management of efficient infrastructures. 6G can offer benefits by transforming the domain of communication and enabling exponential advancements in key industry sectors with positive implications on sustainability. Smart infrastructure can cater to the challenges of housing and service delivery, resulting in socio-economic and environmental boosts to resident lives. Smart Bike aims to alleviate physical discomfort and increase biking, it contributes to sustainable urban mobility consistent with the objectives of sustainable cities.

Table 2 shows the comparison of green transportation and smart infrastructure. Green Transportation is an eco-friendly approach to reducing emissions and resource consumption using electric vehicles, hybrid vehicles, public transport system, and bike-sharing. Smart Infrastructure is concerned with the sustainable management of urban resources using technologies ranging from Internet-of-Things, big data, and AI to digital twin concepts for efficient delivery of urban services.

While all the approaches have some hurdles such as costs, infrastructure adaptations needs, data privacy and technology maintenance, but also offer high benefits by reducing pollution and concomitantly improving health, energy efficiency and urban services.

B. Result

The result from the above tables reveals a clear interaction effect, identifying green transportation and smart infrastructure as vital and complementary strategies for sustainable urban building. Green transportation is sustainable because it tries to minimize environmental harm with eco-friendly transit systems, and smart infrastructure helps to use technology solutions to make urban services and resource management work better. Both approaches depend on technology, interdisciplinary work, and regional solutions adapted to specific needs. While they face challenges like costs and adoption hurdles, the benefits they offer, such as lower emissions, greater efficiency and better quality of life, highlight their important role in achieving urban sustainability.

V. FUTURE SCOPE

The future is uncertain and very advance and connected mobility and sustainable future is an expansive topic, with continuous progress in innovation and a growing emphasis on eco-friendly city planning. For connected mobility, the combination of autonomous vehicles improved AI-driven traffic control and diversification of electric mobility infrastructure promise even greater cuts in pollution and improved traffic movement. Developing tech, such as vehicle-to-roadways system communication, can enable more reactive and adaptive urban transit systems, further reducing traffic jams and power consumptions. In green infrastructure, upcoming advancement could include more optimized, economical structure materials, enhanced water management systems, and creative designs that expand green areas by balancing growth requirement. Integrating sustainable power sources such as solar energy systems on building tops and wind electricity in public locations also reduces ecological footprint of cities. Integrating intelligent transportation and green infrastructure with integrated data analytics and near real-time monitoring creates a natural progression to action that is proactive rather than reactive in making these cities CO2 neutral footprints by identifying and addressing ecological issues in an iterative, dynamic way. Sustained focus on inclusive urban planning, cross-sector partnerships and enabling policies will be needed to realize the full potential of these innovations while ensuring that future advancements benefit all citizens equitably and contribute to healthy, resilient cityscapes.

VI. CONCLUSION

This manuscript is concluded about the smart transportation with green infrastructure. It is a combination of movement of human beings, goods and all other materials in an urban area with environment-friendly buildings, parks, roads etc. These two are very important components of sustainable cities and their cordial interrelationship will help transform them to a new level by overcoming existent environmental, economic and social challenges. Such systems not only improve efficiency and quality of life by reducing congestion, emissions, and energy consumption but also boost urban biodiversity and resilience. The upfront implementation costs, policy adaptation, and corrupted data privacy found to some extent in the sustainable development simulation screen is actually a hurdle to initiate such initiatives on the practical side but its combined impact analysis tells it is one of the strongest pathways towards sustainability goals. By encouraging continued innovation while ensuring equitable access and supportive regulatory frameworks, cities can utilize the strengths of smart transportation and green infrastructure to maximize the benefits for more resilient, inclusive, and livable urban environments.

REFERENCES

- [1] K. J. Shah, S. Y. Pan, I. Lee, H. Kim, Z. You, J. M. Zheng and P. C. Chiang, "Green transportation for sustainability: Review of current barriers, strategies, and innovative technologies," *Journal of Cleaner Production*, vol. 326, pp. 129392, 2021.
- [2] M. M. Abdel Wahed Ahmed and N. Abd El Monem, "Sustainable and green transportation for better quality of life case study greater Cairo–Egypt," *Hbrc Journal*, vol. 16(1), pp. 17-37, 2020.
- [3] E. Z. Berglund, J. G. Monroe, I. Ahmed, M. Noghabaei, J. Do, J. E. Pesantez and J. Levis, "Smart infrastructure: A vision for the role of the civil engineering profession in smart cities," *Journal of Infrastructure Systems*, vol. 26(2), pp. 03120001, 2020.
- [4] S. Aleksic, "A survey on optical technologies for IoT, smart industry, and smart infrastructures," *Journal of Sensor and Actuator networks*, vol. 8(3), pp. 47, 2019.
- [5] S. D. Bhogaraju and V. R. K. Korupalli, "Design of smart roads-a vision on Indian smart infrastructure development," In *2020 International conference on communication systems & networks (COMSNETS)* pp. 773-778, IEEE, 2020.
- [6] A. L. Imoize, O. Adedeji, N. Tandiya and S. Shetty, "6G enabled smart infrastructure for sustainable society: Opportunities, challenges, and research roadmap," *Sensors*, vol. 21(5), pp. 1709, 2021.
- [7] I. Makarova, A. Boyko, I. Giniyatullin and A. Ahmadeeva, "Development of transport infrastructure in smart cities," In *IOP Conference Series: Materials Science and Engineering*, vol. 786(1), pp. 012073, IOP Publishing, 2020.
- [8] J. Mao, Q. Sun, X. Wang, B. Muthu and S. Krishnamoorthy, "The importance of public support in the implementation of green transportation in the smart cities," *Computational Intelligence*, vol. 40(1), e12326, 2024.
- [9] Z. Yang and J. Li, "Towards Green and Smart Cities: Urban Transport and Land Use," *Sustainability*, vol. 16(2), pp. 595, 2024.
- [10] M.M. Mahmoud, H. S. Salama, M. Bajaj, M. M. Aly, I. Vokony, S. S. H. Bukhari, and A. M. M. Abdel-Rahim, "Integration of wind systems with SVC and STATCOM during various events to achieve FRT capability and voltage stability: Towards the reliability of modern power systems," *International Journal of Energy Research*, vol. 1, pp. 8738460, 2023.
- [11] M. V. Kumar, A. V. Babu, C. R. Reddy, A. Pandian, M. Bajaj, H. M. Zawbaa, and S. Kamel, "Investigation of the combustion of exhaust gas recirculation in diesel engines with a particulate filter and selective catalytic reactor technologies for environmental gas reduction," *Case Studies in Thermal Engineering*, vol. 40, pp. 102557, 2022.
- [12] K. Kakouche, T. Rekioua, S. Mezani, A. Oubelaid, D. Rekioua, V. Blazek, and S. S. Ghoneim, "Model predictive direct torque control and fuzzy logic energy management for multi power source electric vehicles," *Sensors*, vol. 22(15), pp. 5669, 2022.
- [13] S. B. Hamed, M. B., Hamed, L. Sbita, M. Bajaj, V. Blazek, L. Prokop, and S. S. Ghoneim, "Robust optimization and power management of a triple junction photovoltaic electric vehicle with battery storage," *Sensors*, vol. 22(16), pp. 6123, 2022.
- [14] S. Tajjour, S. S. Chandel, M. A. Alotaibi, H. Malik, F. P. G. Márquez, and A. Afthanorhan, "Short-term solar irradiance forecasting using deep learning techniques: a comprehensive case study," *IEEE Access*, vol. 11, pp.119851-119861, 2023.
- [15] B. R. Lingampalli, S. R. Kotamraju, M. K. Kumar, Ch. R. Reddy, M. Pushkarna, M. Bajaj, H. Kotb, S. Alphonse, "Integrated Microgrid Islanding Detection with Phase Angle Difference for Reduced Nondetection Zone," *INTERNATIONAL JOURNAL OF ENERGY RESEARCH*, vol. (1), pp. 2275191, 2023.

- [16] R. Pansare, G. Yadav, J. A. Garza-Reyes, and M. Raosaheb Nagare, "Assessment of Sustainable Development Goals through Industry 4.0 and reconfigurable manufacturing system practices," *J. Manuf. Technol. Manag.*, 2023.
- [17] M. Sharma, S. Luthra, S. Joshi, and A. Kumar, "Analysing the impact of sustainable human resource management practices and industry 4.0 technologies adoption on employability skills," *Int. J. Manpow.*, 2022.
- [18] S. Joshi and M. Sharma, "Sustainable Performance through Digital Supply Chains in Industry 4.0 Era: Amidst the Pandemic Experience," *Sustain.*, 2022.
- [19] Shabbiruddin et al., "Industry Challenge to Pro-Environmental Manufacturing of Goods Replacing Single-Use Plastic by Indian Industry: A Study Toward Failing Ban on Single-Use Plastic Access," *IEEE Access*, 2023.
- [20] M. S. Kaswan, R. Rathi, J. Cross, J. A. Garza-Reyes, J. Antony, and V. Yadav, "Integrating Green Lean Six Sigma and industry 4.0: a conceptual framework," *J. Manuf. Technol. Manag.*, 2023.