The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1738-2122.htm

Navigating green transport sustainability model (GTSM) under socio-economic and environmental goals for road-mapping sustainability and mitigating carbon footprints

Received 16 June 2024
Revised 25 July 2024
29 October 2024
6 December 2024
Accepted 11 December 2024

Sri Yogi Kottala
Symbiosis Institute of Business Management, Hyderabad, Symbiosis International University, Pune, India
Ch Shankar
Department of Finance and Business Analytics, GITAM School of Business Hyderabad, GITAM (Deemed to be University), Hyderabad, India, and
Atul Kumar Sahu
Department of Industrial and Production Engineering, Guru Ghasidas Vishwavidyalaya, Bilaspur, India

Abstract

Purpose – This study aims to present an integrated green transport sustainability model (GTSM) to comprehensively understand and explain the multifaceted dynamics of green transport initiatives. The purpose of the study is to evaluate gaps in understanding the interactions between socio-economic and environmental goals in green transport systems using structural equation modelling (SEM) to help in drafting sustainable transportation policy for larger acceptance and true implementation by the stakeholders. The study examines different constructs that collectively influence green transport policy effectiveness (GTPE). Ultimately, the study aims to provide a robust framework for improving the effectiveness of green transport policies and regulations.

Design/methodology/approach – Grounded in empirical evidence, the study utilizes SEM to demonstrate the interplay between policymaking, socio-economic factors, technological consideration and environmental outcomes in green transport. The research framework is developed based on the comprehensive review of the literatures to embrace sustainability in transportation considering stakeholders perceptions. The study navigated a GTSM under socio-economic and environmental goals for road-mapping sustainability and larger acceptance of green transportation.

Findings – It is found that technological advancements in transportation are the most significant determinants of GTPE. This implies the need to develop advancements in technologies to embrace the larger acceptance of green transport. Promotion of environmentally sustainable transportation practices, socio-economic factors and use of eco-friendly transportation modes are also found as significant predictors of GTPE, which suggested that the policies aimed at up-gradation of socio-economic standards and the use of environment friendly modes of transport can help in promoting the active involvement of stakeholders to use green transportation.

Originality/value – The study originally investigated critical constructs to assist in preparing sustainable transportation policy for larger acceptance and true implementation by the stakeholders. The study reciprocated its originality by presenting an integrated model related with green transport sustainability dimensions based on theoretical constructs to examine the interplay between policy effectiveness, technological advancements, socio-economic factors and environmental outcomes. The study addressed the key pillars of green

This paper forms part of a special section “Decarbonizing Logistics and Supply Chains: Sustainable Innovation for Global Impact”, guest edited by Srikanta Routroy, Prasanta Sahu and Prem Chhetri.

Journal of International Logistics and Trade
Vol. 23 No. 1, 2025
pp. 7-37
Emerald Publishing Limited
e-ISSN: 2508-7592
p-ISSN: 1738-2122
DOI 10.1108/JILT-06-2024-0035

transportation and originally highlighted the importance of socio-economic factors and technological advancements in advancing green transport sustainability. It is recommended that the policymaker should make investments in green transport infrastructure and should design a policy for integration of green transportation with a focus on the engagement of all stakeholders for practical implementations.

Keywords Green transport, Sustainability, Structural equation modelling (SEM), Socio-economic factors, Environmental goals, Transportation choices

Paper type Research paper

1. Introduction

The primary activities of the transportation sector endeavour towards one of the most significant contributors to pollutants, emissions and environmental destruction and thus should be considered for sustainability based on the development of modern strategies and policies (Ahmed *et al.*, 2022; Din *et al.*, 2023). Given the current state of environmental decay and climate change, a shift to green transport systems appears essential. Green transport is a broader term that covers numerous concepts and technologies created to reduce the environmental impact of transport and to improve social, economic and personal well-being (Stafford-Smith *et al.*, 2017; Jamil *et al.*, 2024). The global energy-related to CO_2 emissions come from transportation, which thereby makes this sector as one of the primary targets for enduring sustainability and allied development efforts. Conventional modes of transportation based on fossil energy are significant polluters and contributors to air pollution, climate change and resource depletion. Socio-political problems including congestion, air pollution, poor access and so on are unevenly distributed among countries, and health concerns are additional factors that exacerbate environmental problems (Geissdoerfer *et al.*, 2017; Horvath *et al.*, 2019). Green transport initiatives focus on promoting vehicles that can run on electricity or hydrogen and enhancing or expanding existing public transportation systems (Schermelleh-Engel *et al.*, 2003; Miah *et al.*, 2024). This includes numerous congestion charging policies or emissions regulations.

Sustainable transport requires a multi-faceted approach that considers both environmental and socio-economic goals (Bag *et al.*, 2021; Sahu *et al.*, 2024). From an environmental perspective, reducing emissions, promoting quality of air and conserving natural resources are critical. On the other hand, from the perspective of socio-economic goals, improving access, affordability and social equity in transportation are critical and are required for improving people's quality of living (Heidari *et al.*, 2023). Although there has been a growing focus on sustainable transportation, there are still gaps in the existing frameworks to integrate the above goals. Most of the existing research focuses on the environmental and socio-economic goals individually, independently and does not thoroughly investigate the interaction between the two. Given the complexity of these interactions, there is a need for a more coordinated approach (Ur Rehman *et al.*, 2023; Medina-Albaladejo, 2024). This calls for a methodology, which will allow the verification of the interactions between different aspects of the sustainability goals. Structural equation modelling (SEM) is found suitable for such a task as it simultaneously checks the interaction between several variables. Accordingly, in this research SEM is used by the authors to confirm the validation of hypothetical interactions between different aspects of green transportation and allied matches. In this work, SEM is used to establish a framework that explains the interactions of socio-economic and environmental goals in green transport. The study is conducted to report following Research Questions (RQ):

RQ1. What are the perceptions of the stakeholders towards green modes of transportation and how, one can map sustainable policies towards green transportation.

RQ2. Does societal factors influence stakeholders towards using alternative modes of transportation and green sustainability?

RQ3. Does transport policies convince stakeholders to employ green transportation and what should be the constructs for green transportation?

It is ascertained that a balancing nature of assets are nodded to be linked and integrated into the environmental and socio-economic boundaries for retaining sustainability goals (Li *et al.*, 2023; Kottala and Sahu, 2023). Accordingly, the present research is conducted as the same will particularly help the policymakers and interested stakeholders in understanding the complexities of green transportation and for observing the impact of technological advancements, environmentally sustainable practices and investments in green transport infrastructure. The research will give critical insights that shall be used to achieve a balance between the environmental and socio-economic boundaries by applying the SEM technique.

1.1 Purpose of the study

The purpose of the study is to investigate critical constructs to assist in preparing sustainable transportation policy for larger acceptance and true implementation by the stakeholders. The study believes that the development of green transportation policy will lead in reaping environmental benefits by contributing towards the reduction of damaging carbon dioxide emissions, but the same needs exploitation of crucial figures and perceptions of the stakeholders about green transportation, which is done in this study by way of employing SEM to validate crucial constructs considering stakeholders perceptions. The study reciprocated its purpose to develop an integrated green transport sustainability model (GTSM) grounded in theoretical constructs identified from the literature, to examine the interplay between policy effectiveness, technological advancements, socio-economic factors (SOFA) and environmental outcomes. Drawing on prior studies (Hmamed *et al.*, 2023; Heidari *et al.*, 2023; Din *et al.*, 2023), the purpose of the study is to test how different constructs collectively influence green transport policy effectiveness (GTPE). Specifically, the study evaluates gaps in understanding the interactions between socio-economic and environmental goals in green transport systems using SEM to lead in drafting sustainable transportation policy for great acceptance and true implementation by the stakeholders. The theoretical framework developed in this study aims to present a holistic approach to investigate all aspects of the interaction and to subsequently provide a comprehensive theoretical model. The study will explain interactions of SOFA and environmental goals under the surveillance of green transportation.

The study is structured in five sections, where section 2 represents the dimensions of literature review and development of hypotheses, while section 3 outlines the employed research methodology and discusses about research framework. Section 4 embraces results and discussion part. Conclusion section with managerial implications is represented in section 5.

2. Literature review and hypothesis development

2.1 Sustainability in transport

Transport sustainability is a multidimensional issue that entails numerous environmental and social consequences. The authors noted the complexity of the environmental and social problem and analysed various features of sustainable transportation and its implications as a whole under said statistics (Ghisellini *et al.*, 2016; Hysa *et al.*, 2020). Din *et al.* (2023) emphasize the need to prevent the unsustainable effects of transportation, in particular climate change and air pollution. In particular, the authors found that the transportation industry is the contributor to greenhouse gas emissions and global warming. Additionally, it is originated that the transportation is a detrimental factor to human health as "the leading source of outdoor air contamination causing millions of premature respiratory deaths" and risk of cardiac events. The consequences above imply the need for immediate action to reduce the damages and resort to more sustainable alternatives. Building on this foundation, Jelti *et al.* (2023) and Stiebe (2024) referred the need to investigate the social and diverse aspect of sustainable mobility. According to them, making transport more sustainable can help to decrease social costs from the existing transport system. Such costs are "traffic congestion, traffic accidents, and differences in accessibility among population segments." Indeed, these problems are real and urgent for the society and are also faced mainly by marginalized populations. Stiebe (2024) admired that it is impossible to solve these problems without the help of technology and policies. For instance, electric vehicles, ITS solutions and integrated urban policy can substantially increase the sustainability of transport systems.

Taghvaee *et al*. (2022) admired the idea that sustainable transportation is a matter of holistic perception and comprehensive judgement. The latter implies that a mere reduction in emissions or an increase in fuel efficiency is insufficient to induce sustainability. A sustainable transportation system strives to be safe regarding transportation networks and all possible components, socially related to the probability of low-income people to afford transportation and infrastructure, and affordable by being associated with broader economic conditions (Stafford-Smith *et al*., 2017; Pfister *et al*., 2024). Majority of the studies conducted under the extinct of transport sustainability advocated that environmental and social burdens require a comprehensive solution leading to the establishment of sustainable transport. Indeed technological development and benchmarking of technical streams under the distinguish segments of vehicles are required, and policy-making alternatives and social justice are the means to develop a transport form associated with limited environmental destruction and social and economic benefits (Schroeder *et al*., 2019; Walker *et al*., 2021). Thus, one can say that sustainability in transport can be achieved by investigating environmental and social burdens through a comprehensive solution to lead in the establishment of sustainable transport. Thus, it is admired to investigate a linkage between green transport policies attainments by the adoption of eco-friendly transportation modes and to identify that SOFA are responsible for influencing transportation choices.

It is found that operations, process and business-related activities should be keenly and continuously evaluated as the same embraces influence, development and often draw momentous impacts on environmental cost and responsibly creates carbon emissions (Shamsul Bahrin *et al*., 2024; Creazza *et al*., 2024). With ever-increasing attentiveness towards climate change and related unfavourable effects, there is a growing urgency for the operational and service industries to accept and seek sustainable practices particularly in the origins of supply chains, where logistics and green transportation may have favourable impacts in the global as well as economic development. It is admired that to create an inclusive bridge and to integrate global benchmarks, it is indeed necessary to examine and develop logistics and supply chain networks under the roof of digitalization (Wang *et al*., 2024; Li *et al*., 2024), which need the potential investigation of multiple direction of enablers considering both tangible goods and intangibles for transformation. Accordingly, present study is conducted to channelize the adoption of eco-friendly modes of transportation, green transport policies and regulations with definite acceptance of stakeholder engagement. One can assume it significant to seek, develop, recognize and to incorporate logistics activities into a widespread spectrum of global logistics statistics and supply chain integration framework, but that warrants the cross-examinations amongst SOFA, environments goals, green infrastructure and their acceptance by stakeholders.

H1. Investment in green transport infrastructure (IGTI) will positively influence the effectiveness of green transport policies (EGTP), as infrastructure improvements are essential facilitators of sustainable mobility.

2.2 Socio-economic goals

Socio-economic goals can be summarized as ensuring that society is environmentally friendly, socially equitable, vigorous and economically viable (Hmamed *et al*., 2023). Zagonari (2018) state that the proper socio-economic development is the optimal combination of the abovementioned aspects, and respects the most effective and beneficial use of resources, equity and the equal distribution of economic progress benefits among all population groups. In the economic sector, efficiency is normally defined as a rational use of resources to minimize the costs of descents of production programs, services and the productivity of resources and sources (Sauvé *et al*., 2016; Dantas *et al*., 2021). At the same time, efficiency is inextricably linked with the concept of open balance, often defined as equity, which provides the opportunity to spread the effects of efficiency and ideal economic relations, not only in their technical subordination and social context.

It is found that a social system of development relies on socio-economic relations. However, developing a society for altruism requires eliminating the conditions under which all other social forms, including coercion, may arise. It is found that a pro-social approach places people in better conditions, where they can improve their quality of life and contribute to economic growth through equal opportunities for education, health care and work (Aksoy and Bayram Arlı, 2020; Terra dos Santos *et al*., 2023). It is found that the social-value-objectives are interpretive in the form of "richness, harmony, and freedom" and reflects the complexities of socio-economic goals outlined above. Here, richness relates to people's economic status and material possessions; harmony refers to social cohesion and peaceful living of various communities; and freedom is the most crucial as it concerns people's right to be autonomous and make choices that may lead to their and society's fulfilment. In reality, the ultimate social-value-objective must balance out these dimensions of human development by paying equal attention to them (Geissdoerfer *et al*., 2017; Horvath *et al*., 2019). The relationships between equity, welfare and poverty reduction and a balanced mix of policies and their implementation are required to meet society's diverse needs and aspirations (Ghisellini *et al*., 2016; Hysa *et al*., 2020). For example, a green transport policy implemented through investments in new transport infrastructure can increase efficiency and lower traffic and air pollution levels. It can also support equity by ensuring all communities and regions access green transport systems. Secondly, green technology can help in achieving the best socio-economic outcomes, when combined with policy support. For example, an innovative city initiative that uses data and technology to improve public transport efficiency and accessibility levels of different neighbourhoods can inversely benefit people with low incomes. Specifically, social programs and subsidies can be used to ensure that they can afford public transport and benefit from its efficient operation. In conclusion, socio-economic goals in sustainable development and transport policy are diverse and contrastive. Achieving them requires a balanced solution that achieves efficiency, equity, welfare and poverty reduction, while ensuring broader values such as richness, harmony and freedom. Thus, one can say that green transport can lead in nurturing socio-economic goals and accordingly, it can be prominent to investigate the technological advancements impact on the adoption of green transport and their usage under the segment of social-value-objective, which is attempted by the authors in this study.

H2. SOFA, such as income equity and accessibility, will significantly enhance the EGTP, as equitable access promotes adoption and adherence.

2.3 Environmental goals

Environmental goals are crucial in influencing policy and decision-making processes towards sustainability (Nishad *et al*., 2024). According to Fallah Shayan *et al*. (2022), environmental goals are decisive and outline "how to address critical environmental issues such as climate change, the spread of pollution, and biodiversity degradation". Accordingly, a group of criteria's are required to adequately implement the environmental goals and to facilitate the real change. It is highlighted that the environmental goals can be deemed achieved by meeting the criteria's that include precision, evaluability, accessibility, motivation and coherence. Precision ensures that the goals are clearly defined and measurable, allowing the evaluation of the extent of achievements. Evaluability contributes to tracking the progress of achieving the goals over time and adjusting the process, if necessary. Accessibility makes the goals easy to implement and follow and allows the achievement of the majority's participation. Motivation makes individuals and public institutions to identify goals promptly and work purposefully towards achieving them. Coherence makes the goals aligned across the various policies and strategies. Consequently, the concept of Millennium Development Goals (MDGs) is captured to assist in benchmarking the level of activities performed for achieving various development objectives, including environmental sustainability (de Jong and Vijge, 2021). The MDGs are emerged in the form the internationally accepted goals and indicators for poverty alleviation, education, health promotion, gender equality and environmental conservation. Including environmental conservation as one of the MDGs, they ensured that policy-makers and other players should include the environmental conservation initiatives in their development list in priority and preferably. Björnberg (2008) suggested a model for rational target-setting behaviour in environmental policy with the assumption of clear and achievable objectives with focused dimensions that are allied with environmental activities. It is suggested that the selected dimensions have to be ambitious and, at the same time, feasible within the established time frames. It should be consistent with the selected Environmental Policy Initiatives (EPI) components with measurable attributes and should content activities that are indeed touchable realities. The clear and quantifiable dimensions will lead in the attainment of environmental goals and will act as a tool for effective planning, implementation and evaluation of environmental policies and programs (Schroeder *et al*., 2019; Walker *et al*., 2021). With realized objectives, it is easier for decision-makers to adjust their strategies and enhance the chance of reaching them by specifying the indicators and benchmarks.

To sum up, one can understand that the environmental goals are vital decision-making standards for policy formulation to attain sustainability (Ahmed *et al*., 2022). The five criteria of precision, evaluability, accessibility, motivation, and coherence can be used to create a foundation on which action may be predicated for progress towards a sustainable future. Moreover, the inclusion of environmental sustainability into broader development strategies such as MDGs requires rational goal-setting models that will enable an increase in alignment with other policies and efforts (Aksoy and Bayram Arlı, 2020; Terra dos Santos *et al*., 2023). But, here collaboration and stakeholder engagement (CSE) is must for maintaining and achieving environmental goal as a whole. Additionally, one can assume that the concept of green transport can be attained by CSE deliberately and voluntarily. Accordingly, it can be prominent to investigate that the investments in green transport can only be made, if the policy-making framework insists its foundation on assimilating CSE on broader domain, where green transport can be one of the option and that too can support in attaining environmental goals. Thus, it is admired to investigate a linkage between CSE in implementing green transport policies and allied investments in green transport for environmentally sustainable practices.

It is found prominent to check the insights of the inference of green integration and its acceptance by a larger group of users for motivating industries and organization for its inclusions in policy domain and managerial aptitude (Yang and Singhdong, 2024; Kim *et al*., 2024). Accordingly, one can assume it important to investigate the mediating effect of green innovation, its integration on green legitimacy and policy development to understate a positive degree of security and to realize the benefits of green innovation. It is affirmed that the companies should invest in technological infrastructure and before developing any technology, the allied components and hypothesis should be checked and validated in the form of essential component in the business models (Mishrif and Khan, 2023; Helo and Thai, 2024). The same will help in optimizing the costs to be incurred in implementation and adoption issues of technology by the stakeholders. Accordingly, present study is conducted to develop a comprehensive GTSM for understanding and elucidating green transport initiatives' dynamics under socio-economic and environmental goals.

H3. Usage of eco-friendly transportation modes (UETM) will positively impact the EGTP, as the transition towards sustainable modes directly aligns with policy objectives.

2.4 Socio-economic and environmental goals for green transport

It is understood that the green transport can nurture socio-economic goals and thus, it can be beneficial to examine the technological streams, their impact on greenhouse emissions and their importance under the segment of social-value-objective. Hereby, it is fruitful to investigate a linkage between technological advancements impact on the adoption of green transportation and the role of green transportation in inducing sustainability indicators. Moreover, investigations related with the investments in green transportation can be fruitful from the insights of policy-making, assimilating CSE for implementing green transportations for attaining environmental goals. Hereby, it is fruitful to investigate a linkage between CSE in implementing green transport policies and allied investments in green transport for environmentally sustainable practices. Furthermore, it is found that the sustainability in transport can be achieved by investigating environmental and social burdens through a comprehensive solution to lead in the establishment of sustainable transport (Sauvé *et al.*, 2016; Dantas *et al.*, 2021). Hereby, it is fruitful to investigate a linkage between green transport policies as a source of eco-friendly transportation modes and transportation choices. It is understand that the transport sector is one of the largest emitters of greenhouse gases with globally regenerated fossil fuel vehicles. Accordingly, it is admired to carry out innovations related with electric automobile and intelligent transit schemes, which are vital in technology for retaining environmental excellency and to encourage efficient energy utilization by forming effective transport systems (Zhang and Fujimori, 2020). Advanced transport solutions are needed to demonstrate the potential of reducing traffic density and inherent adverse effects on cities (Wu *et al.*, 2023). The necessity of adopting green variants in the form of new vectors for extensive use is explained by researchers as a need to decrease the fossil fuel consumption (Meng *et al.*, 2024) and to increases fuel economy (Tikoudis *et al.*, 2023). But the realization and acceptance of these technologies need a policy call from the side of government and stakeholder support through regulation and capital investment (Zhang and Fujimori, 2020). Thus, it is needed to investigate that the enhancement of technological factors will produce noticeable changes in the efficiency of green transport policies due to the application of technology in sustainable development in transportation.

H4. Technological advancements in transportation (TAT) will strongly drive the EGTP, as innovations such as smart mobility and low-emission vehicles are critical enablers of sustainability.

It is assumed that GHG emissions are critical in the realization of progress and sustainable future for the world especially in the sector that contributes to emissions, where transportation constitutes approximately 25% of the global CO_2 emissions (Fan and Wei, 2022). Thus, transportation plays a significant role in mitigating climate change and meeting targets of ecological maintenance with the development of green transport policies (Boyd *et al.*, 2021). Accordingly, it requires to strike on common elements that include low-emission vehicles, efficient fuels and green transport modes (Meng *et al.*, 2024), green transportation, public investment in electrified rail and green cycling for urban emission reduction. Such efforts are necessary to maintain harmony with international frameworks and agreement that calls for the elimination of carbon within the transport sector (Fan and Wei, 2022). The emission-reducing policies are needed to be strictly involved to define criteria's, measures, emission standards and technologies such as cap-and-trade and carbon taxes, but enforcement is crucial to ensure compliance (Shah *et al.*, 2021; Sobczuk and Borucka (2024). However, the researchers state that socio-economic, public awareness and other barriers counteract the success of these interventions (Boyd *et al.*, 2021).

H5. Reducing greenhouse gas emissions (RGGE) will positively influence GTPE, as emissions reduction is a fundamental objective of sustainable transport systems.

CSE and the use of CSE approaches are vital in development and implementation of policies in transportation sector and in attaining sustainability objectives. Stakeholder management encourages to prepare aligned policies and incentives for facilitating trust and for diverging transport green policies to provide target needs (Nonet *et al.*, 2022). The community participation in mobility planning depends on policy initiatives to increase the acceptance of environmentally friendly practices from the community (Aloui *et al.*, 2021). Hence, collaboration is must and is also needed to minimize tensions and to foster super-execution of large-scale projects (Gergis, 2024). CSE can foster funds from public and private sectors and can be responsible for stimulating green technologies and strengthening communities to take charge of sustainability. Thus, the results that indicate that the quality of CSE engagement and socio-political contexts may affect efficacy and dependability can be prominent for compromising trust towards green transportation are needed to be validated (Walker *et al.*, 2021).

H6. CSE will have a significant positive impact on GTPE, as inclusive and transparent processes enhance trust and adherence.

The green transport policies and regulations (EGTPs) that include articulated and legally tangible policies and regulations can be prominent to be legally implemented to catalyse innovations of sustainable mobility systems and policies, but the same depends on social acceptance based on behavioural changes towards the implementation of environmentally friendly policies (Winkler *et al.*, 2023). Policies based on rewards towards low emission zones; provision of incentives for use of green energy like electric cars and so on can promote sustainable behaviours beneficial for the community by reducing air pollution (Qadir *et al.*, 2024; Das and Bhat (2022). It is however, necessary to establish that the enforceability of these policies as important dimensions; otherwise, the changes will remain trivial. Moreover, policies have to be consistent with practices typical for specific socio-economic environments and they should not trigger resistance in low-income areas (Yadav and Sircar, 2022). Accordingly, the study proposes the hypothesis that GTPE depends on the effectiveness of EGTP and reemphasizes that the formulation of effective green transport policies that are enforceable and contextually relevant is critical towards realizing sustainable transport outcomes.

H7. The EGTP and regulations will significantly influence GTPE, as well-defined and enforceable policies are essential for driving behavioural change and achieving sustainability goals.

The promotion of environment sustainable transport practices (PESP) is crucial to inform the green transport policies and enhanced efficiency of the GTPE, since it entails educational outreach and interventions to community and stakeholder level to influence more sustainable forms of transport. Mobile acceptance interventions, for instance, reward people for choosing environmentally friendly means of transport evidence the goal's suitability (Hsu and Chen, 2021, Verma *et al.*, 2021). Thus, overcoming different forms of resistance like public resistance requires continuous running of awareness campaigns to ensure the public to embrace sustainable mobility. It was found that PESP initiatives depend on socio-economic and cultural environment in different regions, meaning that suitable measures have to be developed for each region (Ghosh *et al.*, 2023). In conclusion, it is required to validate that the government's initiatives outlined under PESP are important for developing the culture of sustainable transport and improving the success rate of green transport schemes.

H8. Promotion of environmentally sustainable transportation practices (PESP) will positively and significantly impact the EGTP, as public awareness campaigns and behavioural interventions encourage adoption.

2.5 Methodology: structural equation modelling (SEM)

SEM presents a robust analytical option to solve complex relationship riddles that maintain sustainability research (Mardani *et al.*, 2017; Rosak-Szyrocka and Tiwari, 2023). Contribution made by Watfa *et al.* (2021) suggested SEM as the branch of the discourse that can be used to provide a framework for answering sustainability questions under high-level view of system architectures. SEM can be useful for attaining sustainability by answering essential hidden patterns from vast datasets (Watfa *et al.*, 2021). It is found that SEM based framework can help to unveil the complexities and core compromises within SME–environmental performance relationships. Accordingly, SEM is used as a methodological asset in present study to establish a framework and to explain the interactions of socio-economic and environmental goals in green transport.

2.6 Research framework

A comprehensive research framework is employed by the authors, and an empirical study was conducted amongst users in urban India underlying green transportation systems. The mall intercept method was employed to select participants and gather their perceptions on constructs related with green transport sustainability derived under SEM framework on sustainable transportation and socio-economic goals.

A research questionnaire was developed to collect primary data, incorporating measurement items for various constructs such as policy effectiveness, socio-economic influences, adoption patterns of eco-friendly transport modes, technological impact and stakeholder engagement strategies exhibited in Table 1. These constructs were adapted from existing literature and tailored to the context of green transport initiatives. The analysis used the SEM technique with AMOS 24 software. Anderson and Gerbing (1988) two-step approach is applied and accordingly at first phase, the measurement model is analysed using confirmatory factor analysis (CFA) to ensure the reliability and validity of the constructs. Secondly, the linkages were investigated using SEM. This study adhered to the model fit criteria recommended by Hair *et al*. (2010).

This study conducted a comprehensive analysis of green transport initiatives through a multicity survey targeting urban populations across India. The sample of 753 respondents was selected using the mall intercept method, ensuring a representative cross-section of users engaged with transport systems. Participants were generally aware of current government policies on green transport, though the extent of their knowledge varied. Critically, the design of survey items raised concerns, particularly regarding the measurement of SOFA like income and employment opportunities, which may require more sophisticated tools than a single-item approach to capture their full impact on transportation choices.

Confirmatory factor analysis (CFA) was used to ensure the validity of constructs, while the SEM framework helped to visualize and test the relationships between GTPE, socio-economic influences and technological advancements. Factor analysis revealed that the first four components explained 50.696% of the variance, with the first factor alone accounting for 16.03%. The study makes a substantial contribution towards understanding the complex dynamics of green transport sustainability, though improvements in survey design and a deeper exploration of latent effects are recommended for future research.

3. Results and discussions

3.1 Demographic characteristics of the respondents

The demographic information of respondents is shown in Table 2. The study included a large sample size, i.e. 753 respondents, with a heterogeneous group of people using green transport systems. The sample was identified using a mall intercept method, which involved selecting participants from various urban locations across India. This approach was adopted to achieve a diverse and representative sample of individuals, who utilize transportation systems. The study sought to encompass a wide range of demographic characteristics, including gender, income, education level, age and travel frequency. To confirm that the respondents engaged with alternatives, the questionnaire is featured under specific screening questions to verify their usage patterns. These inquiries were crafted to establish the frequency and consistency with which respondents employed green transportation modes. For instance, participants were questioned about their primary transportation methods, how often they used these methods and the reasons behind their choice of green options over traditional transportation. The validity and reliability of the respondents' claims were assured through a

Table 1. Tabulation of measurement items for various constructs

Measurement items	Constructs
Green transport policy effectiveness (GTPE)	The current green transport policies effectively promote sustainable modes of transportation (e.g. walking, cycling, public transit) over conventional ones (e.g. private cars) (GTPE1)
	Green transport policies have led to a noticeable reduction in carbon emissions from the transportation sector within my community. (GTPE2)
	Green transport policies adequately address the needs of diverse socio-economic groups, including those with limited access to private transportation. (GTPE3)
	The effectiveness of green transport policies is evident in reducing traffic congestion and associated environmental impacts in my locality. (GTPE4)
Investment in green transport infrastructure (IGTI)	Investments in green transport infrastructure (e.g. bike lanes, electric vehicle charging stations, public transit expansion) are crucial for promoting sustainable mobility. (IGTI1)
	I believe that increased funding for green transport infrastructure will reduce greenhouse gas emissions from the transportation sector. (IGTI2)
	Green transport infrastructure projects, such as pedestrian-friendly streets and improved public transit systems, enhance accessibility for all community members. (IGTI3)
	The government should prioritize allocating resources towards developing and maintaining green transport infrastructure to promote sustainable urban development. (IGTI4)
Socio-economic factors (SOFA)	Socio-economic status significantly influences access to and usage of green transport options (e.g. public transit, electric vehicles). (SOFA1)
	Socio-economic factors, such as income level and employment opportunities, influence individuals' decisions to adopt environmentally friendly modes of transportation. (SOFA2)
	Government subsidies or incentives for green transport initiatives should be targeted towards marginalized communities to address socio-economic disparities in mobility. (SOFA3)
	Improving access to affordable and reliable green transport options can positively impact the socio-economic well-being of communities by reducing transportation costs and increasing mobility opportunities. (SOFA4)
Usage of eco-friendly transportation modes (UETM)	I actively choose eco-friendly transportation modes (such as walking, cycling or public transit) whenever possible. (UETM1)
	The availability of eco-friendly transportation options influences my decision, when planning travel routes or commuting. (UETM2)
	I believe using eco-friendly transportation modes positively reduces my carbon footprint. (UETM3)
	I perceive eco-friendly transportation modes as convenient and reliable alternatives to traditional modes of transportation (e.g. private cars). (UETM4)
	Encouraging eco-friendly transportation modes through incentives or infrastructure improvements is essential for promoting sustainable mobility in my community. (UETM5)

(*continued*)

Table 1. Continued

Measurement items	Constructs
Technological advancements in transportation (TAT)	There is an indeed need to develop technological advancements in transportation from the perspective of embracing green transportation in an economy (TAT1)
	Technological advancements in transportation, such as electric vehicles and autonomous driving systems, have the potential to reduce carbon emissions and improve air quality significantly. (TAT2)
	I believe that investing in research and development for new transportation technologies is crucial for addressing current environmental and sustainability challenges. (TAT3)
	Technological advancements in transportation should prioritize accessibility and inclusivity to ensure that all members of society can benefit from them. (TAT4)
Reduction of greenhouse gas emissions (RGGE)	I believe reducing greenhouse gas emissions from transportation is crucial for mitigating climate change impacts. (RGGE1)
	Efforts to reduce greenhouse gas emissions from transportation should be a priority for government policies and initiatives. (RGGE2)
	Individual actions, such as using public transportation, carpooling or cycling, significantly reduce personal greenhouse gas emissions. (RGGE3)
	Investments in renewable energy sources for transportation, such as electric vehicles and bio-fuels, are effective strategies for reducing greenhouse gas emissions. (RGGE4)
Collaboration and stakeholder engagement (CSE)	Collaboration among stakeholders, including government, industry, and community organizations, is essential for developing effective transportation policies and initiatives. (CSE1)
	Engaging stakeholders in the decision-making process ensures that transportation projects address the needs and concerns of all affected parties. (CSE2)
	Stakeholder engagement should continue throughout transportation projects' planning, implementation, and evaluation stages. (CSE3)
	Effective collaboration and stakeholder engagement lead to greater transparency, accountability and trust in transportation decision-making processes. (CSE4)
Effectiveness of green transport policies and regulations (EGTP)	Green transport policies and regulations effectively incentivize the adoption of sustainable transportation options over conventional ones. (EGTP1)
	I believe that stringent regulations on vehicle emissions and fuel efficiency standards contribute to reducing environmental impacts from the transportation sector. (EGTP2)
	Enforcing green transport policies and regulations is necessary to ensure compliance and achieve desired sustainability outcomes. (EGTP3)
	Public awareness campaigns and education initiatives are crucial in enhancing the effectiveness of green transport policies and regulations. (EGTP4)

(*continued*)

Table 1. Continued

Measurement items	Constructs
Promotion of environmentally sustainable transportation practices (PESP)	Efforts to promote environmentally sustainable transportation practices, such as walking, cycling and public transit, are essential for reducing carbon emissions.(PESP1) I believe that government incentives, such as subsidies for electric vehicles or tax breaks for carpooling, effectively encourage adopting sustainable transportation practices. (PESP2) Public awareness campaigns and educational programs significantly promote environmentally sustainable transportation practices within communities. (PESP3) Investments in infrastructure for sustainable transportation options, such as bike lanes and pedestrian-friendly streets, are crucial for encouraging their use. (PESP4) Collaborative efforts between government, businesses and civil society organizations are necessary to promote and implement environmentally sustainable transportation practices. (PESP5)

Source(s): Authors' calculations

Table 2. Demographic information of respondents

Demographic aspect	Category	Number of respondents	Percentage
Gender	Male	468	62.15
	Female	285	37.85
Income	Above ₹20,000 per month	527	69.99
	Below ₹20,000 per month	226	30.01
Education level	At least a college degree	578	76.75
	Below college degree	175	23.25
Age	21–45 years	596	79.15
	Other ages	157	20.85
Travel frequency	Regular travellers	349	46.35
	Occasional travellers	404	53.65

Source(s): Authors' calculations

survey design and data collection process. The questionnaire was carefully constructed to capture vital details of the respondents' transportation behaviours and preferences, thus ensuring the accuracy and relevance of the data collected in relation to the study's objectives. Table 2 reflects the demographic characteristics of the sample and the gender composition of the sample, which included 468 males, which is 62.15% of the sample. Of the rest, women accounted as 285 in number, which is 37.85% of the sample. The sample drawn in perfect and theoretically generalize across gender lines and appear more structurally accurate to replicate the results and interpretations due to the representational balance of gender. However, the sample's income distribution was skewed, unusually high towards the median, and average income was relatively high in the sample. In the latest study, 69.99% of the people had an income of more than ₹20,000 per month. That is to say, there were a disproportionately large number of relatively well-off people in our sample, a demographic more likely to buy environmentally certified transport. The sample constituted, in its majority, 578 individuals (76.75% of the target population), the highly educated part of the population, i.e. with at-least a college degree. This level of education might also influence respondents' green transport choices because more educated people favour green transport. The sample also concentrated on age and 79.15% i.e. 596 people are from the 21 to 45 age group. Of all age groups, this is one of the most suitable, as the most significant number of respondents fall under the age of 30, the most mobile group of people in the city. There were also 349 regular travellers (46.35%). The sample design incorporated major demographic subgroups, such as sex, income, education, age and travel frequency. The sample structure facilitated the inclusion of the demographic dimensions and ensured a valid evaluation of all the determinants of choosing green transport modes. Secondly, by including a range of demographic characteristics, one can also validate the demographic components against those of effectiveness.

3.2 Reliability and validity analyses of measures

To assess the internal consistency of the items used in the study, the reliability of the scale's sub-dimensions and the entire scale is checked using Cronbach's alpha methodology for each measure and scale overall. The same is shown in Table 3. Cronbach's alpha is an internal consistency measure indicating how closely a set of items is related to the construct, reflecting the scale's reliability. Initially, the authors retained items with Cronbach's alpha coefficients above 0.77 to ensure that only the items with substantial contributions to internal solid consistency were included in the final analysis. The analysis revealed Cronbach's alpha coefficients varying from 0.75 to 0.80 for the nine constructs. Items with low-reliability scores were removed to strengthen the overall consistency of the scale. After eliminating seven items that did not meet the reliability threshold, the authors reassessed the remaining items, which now exceeded the recommended threshold. Due to the meticulous validation process, 38 items remained for the analysis. Each contributed significantly to the rigorous measurement of the constructs under investigation. Using Cronbach's alpha somewhat sceptically ensures that the scale used is valid and reliable. It strengthens the belief that the scale aptly covers and measures the underlying theoretical dimensions in the constructs. Such a validation exercise is crucial in maintaining the rigor and trustworthiness of the findings of studies in intricate multi-dimensional areas like green transport sustainability.

3.3 Results of factor analysis

The total variance is computed for the study from the principal component analysis (PCA), which shows that nine components with Eigenvalues greater than 1 were retained, collectively explaining 84.048% of the variance in the data. The initial Eigenvalues indicate the variance explained by each component, with the first component accounting for 16.03%, and

Table 3. Summary of the reliability assessment using Cronbach's alpha

Aspect	Description	Result
Cronbach's alpha threshold	Retained items with coefficients above 0.77	>0.77
Initial Cronbach's alpha coefficients range	Varying from 0.75 to 0.80 for the nine constructs	0.75–0.80
Number of items removed	Items with low reliability scores were removed	Seven items
The final number of items retained	Items exceeding the recommended threshold	38 items
Final Cronbach's alpha coefficients	Reassessed coefficients exceeded the recommended threshold	>0.77
Importance of Cronbach's alpha	Ensures the scale is valid and reliable	High
Contribution of retained items	Each item significantly contributed to the rigorous measurement of the constructs	Significant
Impact on study findings	Maintains the rigor and trustworthiness of findings in the study of green transport sustainability	Crucial

Source(s): Authors' calculations

subsequent components explaining progressively less variance. After extraction, the variance explained by each component remains the same, but after rotation, the explained variance is redistributed more evenly across the components. The rotation enhances interpretability by spreading the variance, with the first component explaining 11.49%, the second 11.07% and so on, down to the ninth component explaining 7.76%. This even distribution across components suggests that these nine components represent distinct underlying factors that capture most of the data's variability, providing a meaningful summary of the dataset.

To assess the presence of common method bias in the data, Harman's single-factor test was employed, following the procedure outlined in previous studies (Podsakoff *et al.*, 2003). This test is a widely used diagnostic tool for evaluating common method variance, particularly in self-reported data. The approach involves conducting an exploratory factor analysis (EFA) and examining the variance explained by the first unrotated factor. If a single factor accounts for the majority of the variance (generally more than 50%), common method bias is considered a potential concern.

In the current analysis, the total variance (extraction method: PCA) is used, where; the first factor (construct) explained 16.03% of the total variance, which is well below the threshold of 50%. This result suggests that common method bias is unlikely to significantly affect the findings, as no single factor dominates the variance. The relatively low variance explained by the first factor indicates that the variance in the data is distributed across multiple factors, thus minimizing concerns about common method bias. Overall, the findings are consistent with previous recommendations, indicating that the data are not heavily influenced by method bias (Podsakoff *et al.*, 2003; Williams *et al.*, 2010).

The Rotated Component Matrix shown in Table 4 from the PCA with Varimax rotation reveals that each set of variables (UETM, PESP, GTPE, CSE, TAT, SOFA, EGTP, RGGE, and IGTI) loads highly on a distinct component, indicating the presence of nine underlying factors. The UETM variables (UETM1 to UETM5) load strongly on Component 1, the PESP items (PESP1 to PESP5) on Component 2, and the GTPE items (GTPE1 to GTPE4) on Component 3. Similarly, the CSE, TAT, SOFA, EGTP, RGGE and IGTI items load highly on Components 4 through 9, respectively. Each component has high factor loadings for its respective variables, with values generally above 0.8, which suggests that these components represent clear, distinct factors within the dataset. The varimax rotation has effectively enhanced the interpretability of these components by maximizing the variance each account for while reducing overlap between the components, allowing for a clearer understanding of the underlying structure in the data.

Here, component 1 represents "Usage of Eco-Friendly Transportation Modes (UETM)", where all five UETM variables, e.g. "I actively choose eco-friendly transportation modes" and "Availability influences my decisions" exhibit strong factor loadings exceeding 0.919. This component reflects behaviours and attitudes of individuals (stakeholders) regarding the utilization of sustainable transport modes. This component embraces its importance in identifying stakeholder's views under the segments of eco-friendly transportations medium as a key factor for influencing carbon footprints based on user preferences, Component 2 represents "Promotion of Environmentally Sustainable Transportation Practices (PESP)", where all the variables in this component, such as "Public awareness campaigns significantly promote sustainable transportation practices," exhibit high loadings (0.890–0.925). This reflects initiatives to encourage environmentally friendly practices. Component 3 represents "GTPE", where GTPE items, e.g. "Green transport policies effectively promote sustainable modes of transportation" demonstrate high loadings (0.926–0.940), capturing the extent to which policies achieve intended environmental and socio-economic objectives.

Component 4 underlines "Collaboration and Stakeholder Engagement (CSE)", where four CSE items, e.g. "Collaboration among stakeholders is essential for effective policies" exhibit high factor loadings (0.926–0.954). This highlights the role of stakeholder collaboration in achieving green transport outcomes. Component 5 exhibits "Technological Advancements in Transportation (TAT)", where TAT variables like "Technological advancements significantly reduce carbon emissions" demonstrate strong factor loadings (0.888–0.929). This component

Table 4. Rotated component matrix with factor loadings for nine components

Rotated component matrix[a]	Component								
	1	2	3	4	5	6	7	8	9
UETM1	0.937								
UETM3	0.925								
UETM5	0.923								
UETM2	0.920								
UETM4	0.919								
PESP5		0.925							
PESP1		0.919							
PESP3		0.895							
PESP4		0.891							
PESP2		0.890							
GTPE1			0.940						
GTPE3			0.929						
GTPE2			0.929						
GTPE4			0.926						
CSE1				0.954					
CSE2				0.935					
CSE4				0.933					
CSE3				0.926					
TAT1					0.929				
TAT2					0.910				
TAT4					0.898				
TAT3					0.888				
SOFA1						0.916			
SOFA4						0.913			
SOFA2						0.889			
SOFA3						0.887			
EGTP1							0.933		
EGTP2							0.906		
EGTP3							0.864		
EGTP4							0.843		
RGGE1								0.891	
RGGE2								0.873	
RGGE3								0.871	
RGGE4								0.837	
IGTI4									0.879
IGTI3									0.870
IGTI2									0.843
IGTI1									0.776

Note(s): Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
[a]Rotation converged in 6 iterations
Source(s): Authors' calculations

emphasizes the transformative role of technology in shaping sustainable transport systems. Component 6 represents "SOFA", where SOFA variables such as "SOFA influence decisions to adopt eco-friendly transport" exhibit high factor loadings (0.887–0.916). This component reflects the influence of income, subsidies and access on transport choices. Component 7 indicates "Effectiveness of Green Transport Policies and Regulations (EGTP)", where EGTP items, e.g. "Regulations on vehicle emissions contribute to reducing environmental impacts" demonstrates factor loadings ranging from 0.843 to 0.933. This reflects the impact of regulatory measures on policy success. Component 8 indicating "Reduction of Greenhouse Gas Emissions (RGGE)", where RGGE variables such as "Reducing emission is crucial for mitigating climate change" exhibit high factor loadings (0.837–0.891). This underscores the significance of emission reduction strategies in achieving sustainability goals. Component 9 representing "Investment in Green Transport Infrastructure (IGTI)", where IGTI variables, i.e. "Investments in bike lanes and public transit enhance accessibility" demonstrate strong factor loadings (0.776–0.879). This component emphasizes the critical role of infrastructure in enabling sustainable mobility. Thus, one can understand that the authors have considered majority of the aspects to develop and to investigate GTSM for planning sustainable transportation policy for larger acceptance and true implementation by the stakeholders. The classification of components based on factor loadings and their theoretical grounding in literature is considered to draft constructs and to represent decisive facts, to provide robust interpretations and actionable insights in the domain of green transport sustainability and to ensure coherence between the structural model and theoretical framework.

A Scree plot is developed by the authors to help in factor analysis and to understand the status of the factors versus the proportion of variance. The same helps in understanding, when the Eigenvalues start to level-off and where the additional factors have nothing to do with explaining the variance in the data. A Scree plot inspects the Eigenvalues and the number of factors, where Eigenvalues indicate the percentage of variance that each factor exists. The only thing to seek in the Scree plot is the "elbow" or inflection point, i.e. at which point the slope of the plot changes from steep to shallow. When this threshold is reached, factors to the left are only considered for analysis as they explain a large amount of variance that deserves to be kept. The factors at the right of the elbow in Scree plot are not considered because they explain a small percentage of the variance and are typically ignored. The factors preceding the elbow are known as the Eigenvalues and are kept for additional investigation as they capture the underlying structure of the data. The analysis extracted nine components based on the Eigenvalue criterion, and beliefs that the identification of nine factors can capture more data variance than a single original variable.

3.4 Results of the measurement model

CFA is conducted for the constructs using AMOS 24 software to ensure the validity of the constructs used in the study. The summary of the CFA is tabulated in Table 5. Convergent and discriminant validities of the constructs are tested using CFA. Convergent validity is the extent to which the items developed to measure a particular individual assess that construct. Discriminant validity is used to understand the construct that is supposed not to correlate with another

Table 5. Summary of the confirmatory factor analysis (CFA)

Measure	Value	Acceptable limit	Interpretation
Chi-square value (χ^2)	1483.626	–	–
Degrees of freedom (df)	629	–	–
χ^2/df ratio	2.359	<3	Good fit
Goodness-of-fit index (GFI)	0.911	>0.90	Good fit
Root mean square error of approximation (RMSEA)	0.043	<0.05	Good fit
Adjusted goodness-of-fit index (AGFI)	0.895	Close to 0.90	Close to the acceptable limit
Normed fit index (NFI)	0.949	>0.90	Good fit
Incremental fit index (IFI)	0.97	>0.95	Perfect fit
Tucker–Lewis index (TLI)	0.966	>0.90	Good fit
Comparative fit index (CFI)	0.970	>0.95	Perfect fit
Convergent validity	Significant factor loadings	–	Valid constructs
Discriminant validity	There is no correlation with unrelated constructs	–	Valid constructs

Source(s): Authors' calculations

individual would not do so. The guidelines and acceptance limits of various authors including Hu and Bentler (1999), Kline (2005) and Hair *et al*. (2010), are used to judge the model fit indices obtained from the CFA measurement model. The values of the absolute fit measures of the measurement model are found within the acceptable limits. The Chi-square value is found as 1483.626 with a 629 degree of freedom and ratio of 2.359, which also falls within the suggested range for a good fit. The goodness-of-fit index (GFI) was 0.911, and the root mean square error of approximation was 0.043. Both values showed a good model fit with the value of GFI above the threshold value of 0.90, and the RMSEA value is less than the value of 0.05, which means that the model is closely fitted to the data. With the absolute fit measures, incremental fit measures are also computed, i.e. adjusted GFI is found as 0.895, close to 0.90. The normed fit index is found as 0.949, which is above 0.90; the incremental fit index is found as 0.970, which is almost satisfactory, which is above 0.95; the Tucker–Lewis index is found as 0.966, which is above 0.90; and the comparative fit index is found as 0.970, which is above 0.95.

This CFA provided statistical evidence that supports the constructs' convergent and discriminant validity. Factor loadings for convergent validity are found significant for all items. High composite factor loadings indicated that the measures used are good indicators of the latent variables for they are designed to measure. This analysis shows that the model is a good fit for the data and provides the base for the SEM analysis. Results of CFA are shown in Table 6. The CFA performed on the measurement model provided the validation that the structures chosen for the study are reliable and valid, which is very important to make accurate conclusions about the constructs in the context of the study.

3.5 Convergent and discriminant validity

Convergence validity signifies that the objects of a factor under harvest have enough internal consistency and is satisfactorily associated with the compelled item (Hair *et al*., 2010). The same are typically investigated via composite reliability (CR) and average variance extracted (AVE) under convergent validity. Items in a factor show convergence validity, when they fulfil two conditions, i.e. CR should surpass AVE values for each object and CR and AVE must equal or exceed 0.70 and 0.50, correspondingly. In present study, CR values vary from 0.803 to 0.921, and AVE varies from 0.51 to 0.703 among the constructs. Both of these measures surpass their correlations and further require validation of systematic convergence. These concepts may allude to a constant examination of convergence in molecular cholera as a solid theory. The convergent validity scores can be identified from Table 7.

The discriminant validity of the scale is tested through two essential methods, namely the inter-construct correlation matrix approach and the variance-extracted method, developed by Hair *et al*. (2010) and Fornell and Larcker (1981) respectively. Concerning the inter-construct correlation matrix method, both authors suggest that each construct should demonstrate stronger correlations with its items than with items from other constructs. Fornell and Larcker (1981) variance-extracted methods have established two specific criteria, i.e. the Maximum Shared Squared Variance (MSV) between constructs should be less than the corresponding AVE for each construct, and the Average Shared Squared Variance (ASV) should also be lower than AVE for adequate discriminant validity. The overview of the correlation matrix presented in Table 8 demonstrates the satisfaction of the case in the current study. The MSV and ASV values for each construct are found below the AVE, which thus confirming the discriminant validity. In addition to the convergent validity, the detailed examination of discriminant validity proves the reliability of the measurement model in terms of internal solid consistency and the ability of the model to distinguish between the diverse constructs accurately.

3.6 Green transport sustainability model: structural equation modeling

The summary of thorough convergent and discriminant validity assessments suggests the argument that the scale is reliable enough to be further analysed in the framework of green

Table 6. Results of confirmatory factor analysis

Construct	Loadings	*p*-value
Green transport policy effectiveness (GTPE)		
• The current green transport policies effectively promote sustainable modes of transportation (e.g. walking, cycling, public transit) over conventional ones (e.g. private cars) (GTPE1)	0.96	*
• Green transport policies have led to a noticeable reduction in carbon emissions from the transportation sector within my community. (GTPE2)	0.94	*
• Green transport policies adequately address the needs of diverse socio-economic groups, including those with limited access to private transportation. (GTPE3)	0.93	*
• The effectiveness of green transport policies is evident in reducing traffic congestion and associated environmental impacts in my locality. (GTPE4)	0.93	*
Investment in green transport infrastructure		
• Investments in green transport infrastructure (e.g. bike lanes, electric vehicle charging stations, public transit expansion) are crucial for promoting sustainable mobility. (IGTI1)	0.71	*
• I believe that increased funding for green transport infrastructure will reduce greenhouse gas emissions from the transportation sector. (IGTI2)	0.78	*
• Green transport infrastructure projects, such as pedestrian-friendly streets and improved public transit systems, enhance accessibility for all community members. (IGTI3)	0.82	*
• The government should prioritize allocating resources towards developing and maintaining green transport infrastructure to promote sustainable urban development. (IGTI4)	0.88	*
Socio-economic factors (SOFA)		
• Socio-economic status significantly influences access to and usage of green transport options (e.g. public transit, electric vehicles). (SOFA1)	0.92	*
• Socio-economic factors, such as income level and employment opportunities, influence individuals' decisions to adopt environmentally friendly modes of transportation. (SOFA2)	0.86	*
• Government subsidies or incentives for green transport initiatives should be targeted towards marginalized communities to address socio-economic disparities in mobility. (SOFA3)	0.86	*
• Improving access to affordable and reliable green transport options can positively impact the socio-economic well-being of communities by reducing transportation costs and increasing mobility opportunities. (SOFA4)	0.81	*
Usage of eco-friendly transportation modes (UETM)		
• I actively choose eco-friendly transportation modes (such as walking, cycling or public transit) whenever possible. (UETM1)	0.94	*
• The availability of eco-friendly transportation options influences my decision when planning travel routes or commuting. (UETM2)	0.91	*
• I believe using eco-friendly transportation modes positively reduces my carbon footprint. (UETM3)	0.91	*
• I perceive eco-friendly transportation modes as convenient and reliable alternatives to traditional modes of transportation (e.g. private cars). (UETM4)	0.90	*
• Encouraging eco-friendly transportation modes through incentives or infrastructure improvements is essential for promoting sustainable mobility in my community. (UETM5)	0.91	*
Technological advancements in transportation (TAT)		
• There is an indeed need to develop technological advancements in transportation from the perspective of embracing green transportation in an economy (TAT1)	0.98	*
• Technological advancements in transportation, such as electric vehicles and autonomous driving systems, have the potential to reduce carbon emissions and improve air quality significantly. (TAT2)	0.93	*

(*continued*)

Table 6. Continued

Construct	Loadings	*p*-value
• I believe that investing in research and development for new transportation technologies is crucial for addressing current environmental and sustainability challenges. (TAT3)	0.89	*
• Technological advancements in transportation should prioritize accessibility and inclusivity to ensure that all members of society can benefit from them. (TAT4)	0.90	*
Reduction of greenhouse gas emissions (RGGE)		
• I believe reducing greenhouse gas emissions from transportation is crucial for mitigating climate change impacts. (RGGE1)	0.89	*
• Efforts to reduce greenhouse gas emissions from transportation should be a priority for government policies and initiatives. (RGGE2)	0.83	*
• Individual actions, such as using public transportation, carpooling or cycling, significantly reduce personal greenhouse gas emissions. (RGGE3)	0.80	*
• Investments in renewable energy sources for transportation, such as electric vehicles and bio-fuels, are effective strategies for reducing greenhouse gas emissions. (RGGE4)	0.77	*
Collaboration and stakeholder engagement (CSE)		
• Collaboration among stakeholders, including government, industry and community organizations, is essential for developing effective transportation policies and initiatives. (CSE1)	0.96	*
• Engaging stakeholders in the decision-making process ensures that transportation projects address the needs and concerns of all affected parties. (CSE2)	0.92	*
• Stakeholder engagement should continue throughout transportation projects' planning, implementation and evaluation stages. (CSE3)	0.91	*
• Effective collaboration and stakeholder engagement lead to greater transparency, accountability and trust in transportation decision-making processes. (CSE4)	0.92	*
Effectiveness of green transport policies and regulations (EGTP)		
• Green transport policies and regulations effectively incentivize the adoption of sustainable transportation options over conventional ones. (EGTP1)	0.92	*
• I believe that stringent regulations on vehicle emissions and fuel efficiency standards contribute to reducing environmental impacts from the transportation sector. (EGTP2)	0.87	*
• Enforcing green transport policies and regulations is necessary to ensure compliance and achieve desired sustainability outcomes. (EGTP3)	0.83	*
• Public awareness campaigns and education initiatives are crucial in enhancing the effectiveness of green transport policies and regulations. (EGTP4)	0.82	*
Promotion of environmentally sustainable transportation practices (PESP)		
• Efforts to promote environmentally sustainable transportation practices, such as walking, cycling and public transit, are essential for reducing carbon emissions.(PESP1)	0.92	*
• I believe that government incentives, such as subsidies for electric vehicles or tax breaks for carpooling, effectively encourage adopting sustainable transportation practices. (PESP2)	0.87	*
• Public awareness campaigns and educational programs significantly promote environmentally sustainable transportation practices within communities. (PESP3)	0.87	*
• Investments in infrastructure for sustainable transportation options, such as bike lanes and pedestrian-friendly streets, are crucial for encouraging their use. (PESP4)	0.87	*
• Collaborative efforts between government, businesses and civil society organizations are necessary to promote and implement environmentally sustainable transportation practices. (PESP5)	0.93	*

Source(s): Authors' calculations

Table 7. Convergent validity scores

	CR	AVE	MSV	MaxR(H)
PESP	0.909	0.662	0.060	0.954
SOFA	0.861	0.636	0.038	0.940
TAT	0.915	0.703	0.600	0.971
RGGE	0.821	0.543	0.013	0.901
UETM	0.921	0.698	0.038	0.964
EGTP	0.854	0.592	0.069	0.928
CSE	0.895	0.686	0.033	0.965
IGTI	0.803	0.511	0.069	0.891

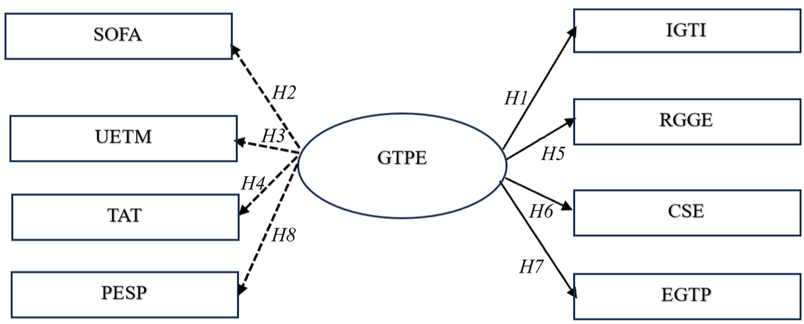
Source(s): Authors' calculations

Table 8. Discriminant validity scores

	PESP	SOFA	TAT	RGGE	UETM	EGTP	CSE	IGTI
PESP	*0.814*							
SOFA	−0.01	*0.797*						
TAT	0.244	−0.18	*0.838*					
RGGE	−0.03	0.071	−0.01	*0.737*				
UETM	0.109	0.196	0.166	0.044	*0.835*			
EGTP	−0.01	−0	−0.01	0.045	0	*0.77*		
CSE	0.147	−0	−0.18	0.01	0.012	−0.014	*0.828*	
IGTI	−0.01	0.059	0.015	−0.112	0.045	−0.262	−0.03	*0.715*

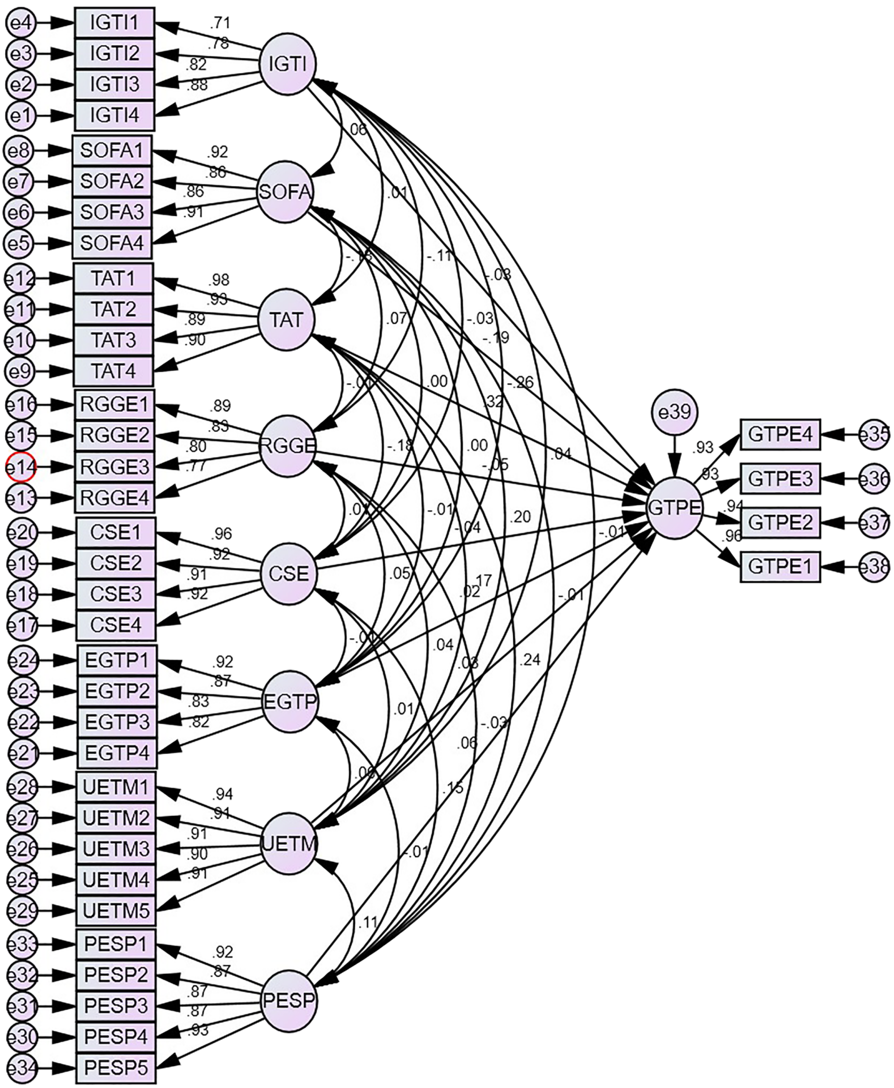
Source(s): Authors' calculations

transport sustainability. The Hypothetical Framework for GTPE can be identify from Figure 1. From Figure 1, one can understand the linkages between various independent variable (IGTI, SOFA, UETM, TAT, RGGE, CSE, EGTP, PESP) and dependent variable (GTPE). The evaluated GTSM and allied multiple indicators, paths and constructs under structural equation model can be identify from Figure 2. The result of the hypothesis testing is shown in Table 9 and Figure 2. The model fit indices and significant factor loadings suggest that the proposed model is robust. The study embraces is existence in generating the GTPE model based on the hypotheses. These relationships are checked or eliminated using the test results, beta values and *p*-values indicated by the types of arrows. The hypothetical framework is conveniently



Source(s): Authors' elaboration

Figure 1. Hypothetical framework for GTPE



Source(s): Authors' compilation

Figure 2. Green transport sustainability model (GTSM)

represented using solid lines for hypotheses rejected, while hypotheses accepted are represented using dotted lines.

The extract picture of the tested hypotheses, related statements, supports and evidences can be understood from Table 9. Here, SEM approach is used to assess the correlation between the independent variables and the dependent variable named as GTPE. The hypotheses are tested and hypothesis, i.e. IGTI → GTPE results in beta value of 0.015 with *p*-values as 0.762. This analysis indicates that investment in green transport infrastructure (IGTI) shows a positive relationship with GTPE; however, this relationship is not statistically significant. The absence of statistical significance indicates that infrastructure investments by themselves might not be

Table 9. Hypothesis results

S.N	Hypothesis	Beta	*p*-value
1	IGTI → GTPE	0.015	0.762
2	SOFA → GTPE	0.094	0.006
3	UETM → GTPE	0.081	0.017
4	TAT → GTPE	0.395	0.000
5	RGGE → GTPE	−0.052	0.114
6	CSE → GTPE	−0.011	0.750
7	EGTP → GTPE	−0.014	0.683
8	PESP → GTPE	0.125	0.000

Source(s): Authors' calculations

adequate to improve GTPE, unless they are combined with additional measures like technological or policy advancements. Quantitative data indicate that IGTI is insufficient to fully explain policy effectiveness on its own; there may be other necessary factors, including raising public awareness or upgrading technologies.

Additionally, hypothesis, i.e. SOFA → GTPE results in beta value of 0.094 with *p*-values as 0.006. Analysis reveals that SOFA have a notable and beneficial influence on GTPE, suggesting that enhanced socio-economic equity and access can lead to greater effectiveness in green transport policies. It is found that the interplay of SOFA, including income distribution and equity, is crucial for achieving inclusive and effective policy outcomes. Moreover, hypothesis, i.e. UETM → GTPE results in beta value of 0.081 with *p*-values as 0.017. The analysis indicates that the use of eco-friendly transportation modes has a statistically significant positive effect on GTPE. The promotion and utilization of eco-friendly modes directly support the objectives of green transport policy, aligning with broader environmental and socio-economic goals.

Furthermore, hypothesis, i.e. TAT → GTPE results in beta value of 0.395 with $p < 0.001$. The analysis suggests that technological advancements in transportation demonstrate a significant and beneficial effect on GTPE, showing the greatest influence compared to all other variables. Thus, one can understand that technology acts as an essential facilitator of green transport policies, promoting emissions reduction, enhancing efficiency and improving accessibility. It is admired that if governments wish to benefit from the enhanced term with technological advancement, they must devote more funds to R&D or else find a way to encourage co-operation between companies. Hypothesis, i.e. RGGE → GTPE results in beta value of −0.052 with *p*-values as 0.114 supports the interpretation and indicates that there is a negative relationship between RGGE and GTPE, which is also statistically insignificant. The effectiveness of emissions reduction initiatives in transportation policy may be compromised by insufficient enforcement mechanisms or the absence of supplementary measures, which could account for the observed negative association.

Additionally, hypothesis, i.e. CSE → GTPE results in beta value of −0.011 with *p*-values as 0.750. The findings indicate that CSE exhibits a minimal and statistically insignificant impact on GTPE. Despite the significance of CSE in inclusive planning, its impact on GTPE, when considered alone is minimal, primarily due to insufficient operational and technical support. Furthermore, hypothesis that EGTP results in GTPE results in beta value of −0.014 with *p*-values as 0.683. The analysis indicates a negative correlation and a lack of statistical significance regarding the EGTP and regulations. The reasoning behind this is that in the absence of adequate investments and stakeholder backing, legislation alone may fall short in driving policy success. Moreover, hypothesis, i.e. PESP → GTPE results in beta value of 0.125 with $p < 0.001$ experiences significant and positive effects from the promotion of ecologically friendly transportation practices. The reasoning for this is that PESP's infrastructure enhancements, awareness initiatives and incentives collectively contribute to the promotion of environmentally sustainable practices. It is demonstrated that Technological Advancements in Transportation (TAT) is the most significant determinant of GTPE. This implies that these policies are primarily needed to be underpinned by advances in transport technology to make the indeed acceptance of green transport policies.

PESP, SOFA and Use of Eco-friendly Transportation Modes (UETM) are also significant predictors of GTPE and thus it is suggested that the policies aimed at up-gradation of socio-economic standards and the use of environment friendly modes of transport can help in better policy result. At the same time, Investment in Green Transport Infrastructure (IGTI), Greenhouse Gas Emission Reduction (RGGE), CSE and EGTP and Regulations do not demonstrate a direct relationship with GTPE. This means that these factors within an environmental sustainability framework are not sufficient stand-alone keys to the success of green transport policies, when lacking complementary technological or socio-economic strategies. The study offers significant insights that can help governments, companies and communities towards improving the EGTP and regulations.

3.6.1 Implications for government. The study discussed crucial aspects, which governments ought to consider towards preparing GTPE. The study suggested insights related with adoption of green transportation and allied boundaries, which can be fruitful for importing dignified polices by the government. The study suggested technological advancement as the most compelling factor to be primarily considered for accepting environmentally friendly transportation mechanism and accelerating green transportation in an economy by the government. The study embraced that the diffusion of innovations theory by the government under the domain of electric cars and smart infrastructure can shape green transport policy. It is therefore important that early government should endorse and support innovative customized technologies for green transportation for embracement. This is required to promote government to self-finance decarbonisation effort and to entail a positive contribution towards the achievement of the SDGs, i.e. SDG7 (the Affordable Clean Energy goal) and SDG11 (the Sustainable Cities and Communities goal). Customized technological innovation promoting enacting of renewable nature systems and green infrastructure development can fast-track transport sustainability. It is affirmed by the study that the integration of SOFA in transport networks can be lead towards harmony by encouraging equal distribution of resources. The study suggested recommendations to the government to subside green modes based on SOFA to enhance the utility of public transport. The study admired its existence by inking stakeholder theory that beliefs in closely linking the public campaigns and local community's involvement based on policy initiatives to retain and maintain involvement of all the stakeholders to enhance their commitment and cooperation for the acceptance of universal rules and policies. The policy initiatives based on socio-economic pillars will stimulate corporations to publish low-carbon technologies and smart transport systems due to the assumption that social acceptance will lead big transport businesses assuming this position can assist to improve transport networks' and revenues sustainability. The main contribution of the study will admire government, business and the community to support TBL (triple bottom line) Framework and Commercial businesses based on CSR to be imposed towards willing to fund environmental programs to offer green products and services in less fortunate communities.

Today, decarbonisation is needed, where transportation is one for the most effective investment areas to the government, which can be done by accelerating the use of EVs, integration of renewable energy and building of smart transport infrastructure to significantly enhance the sustainability of the transportation sector, which demands investigations of certain linkages for appropriate acceleration and employment by the economy. The same is presented in study and linkages amongst diverse hypotheses, related statements, supports and evidences are presented in study to help government in moulding dignified rules and regulations related to green transportation policy for larger acceptance. The study emphasised that transport systems should embrace SOFA to accord the importance and provision of equal or fair access to transport systems. It is suggested that technologies and policies, which can managed income inequality, provision of subsidies for environmentally friendly modes, and increase in the accessibility of public transport can drag stakeholder's attention in green transportation. The study indicates that funding should be allocated on campaigns and interventions for the public by the government, regarding socio-cultural contexts and to enrol community consultation and local community executives to push for green campaigns and to dramatically boost public cooperation.

3.6.2 Implications for companies and communities. The study revealed that GTPE is propelled by innovation especially in the transportation, logistics and technology-based companies. This implies that companies should seek to foster the emergence of low carbon technologies, intelligent transport systems and efficient energy vehicle technologies. Companies should engage in partnerships with government and community and make green logistics solutions to support green transport modes. For example, incentives such as subsidies and special offers can motivate the customers of ride-sharing platforms to order purely electric vehicles. The findings also suggest for Company Social Responsibility (CSR) activities to increase community benefit by offering cheaper green transport solutions in underprovided zones or by sponsoring campaigns for eco-friendly travel. The governments should draft top priorities for equity and public awareness under the line of green transport, while companies should prioritize innovation and CSR to stimulate communities' proactive commitments to sustainability. These efforts supplement strategies for development of civil society with considerations that draw from socio-cultural realities with a view of being sure that strategies in place would be effective and would command the support of the society.

The study underlines that the EGTP not only hinges on reducing emissions but also on improving accessibility to remote and isolated regions. Green transport, particularly through electrification and sustainable public transport solutions, can offer the potential to enhance accessibility in underserved areas. For instance, the introduction of electric buses and solar-powered vehicles could reduce travel costs and improve connectivity, addressing socio-economic disparities in mobility. However, current policies do not adequately address the needs of marginalized groups, making it imperative to develop more inclusive transport policies that prioritize accessibility. There are some encouraging signs that green transport policies are aligning with broader socio-economic and environmental goals, but more focused efforts are required to integrate these development objectives fully. As demonstrated in this study, stakeholder engagement and collaborative efforts between government, businesses, and communities are crucial for the success of green initiatives. Policies that incentivize both the adoption of eco-friendly transport modes and the development of green infrastructure, particularly in remote areas, are vital for achieving sustainability goals.

3.7 Discussions

The study assessed the components towards admiring certain facts associated with the determination of the effectiveness of existing green transport policies, the impact of socio-economic indicators on people's choices regarding the mode of transportation, the patterns of incorporating eco-friendly transport options, technology impact, and greenhouse gas emission reduction to represent the indeed originality of the present manuscript. In corresponding to the EGTP, authors found that many green transport policies are needed to be embraced from the insights of moulding Green transport in an economy, where policies based on electric vehicle adoption quotas, public infrastructure trips, and congestion pricing can be supportive. In conjunction with the impact of SOFA, it is found that the role of other economic sources influences the situation of using green transportation and thus one can say that Green transport is impacted through SOFA. The importance of SOFA is admitted, where; such factors are referred as driver's thorough income and trends, mobility restrictions, and job opportunities. Moreover, under the context of role of technological advancements, it is required that policies should be developed to ensure an equitable approach to all categories and to reduce disparities in mobility. It is found that the role of technological advancements is prominent and advanced models are needed to be developed to foster the incorporation of Green technology and transport. The findings presented in the study will help government and non-government organizations in understanding the behaviours of the stakeholders for matching strategic alliances. The study will act as landmark to help policymakers towards improving transportation policies and to make investments in green transport infrastructures and designs for the development of green transportation universally and collectively with the acceptance of a larger group of any economy. The authors observed that the SOFA can significantly affect transportation choices and the socio-economic people under low and medium groups mainly concentrates on their income as a prime driver, which readily stimulates them to prefer and to adopt transportation means, which are green, competent and can be shareable. The cutting edge solutions related with the development of eco-friendly fuels to preserve biodiversity and ecosystems, development of energy efficiency traits, equipments, renewable and waste reduction practices are found prominent and requires supplementary development for road-mapping green transport sustainability precisely and mitigating carbon footprints. Additionally; design of sustainable engines, development of green framework based on tax incentives, resistance to change towards adherence to traditional transportation practices, adaptation of self-sustainable principles towards greenness and the creation of inspiration model towards consuming locally produced products can reduce the carbon footprint connected with the transportation of that products from long origins are found as few frontiers that can extend the existing literature.

The proportion of electric vehicle (EV) is a critical metric for evaluating the success of green transport initiatives. While specific data on EV usage is lacking and broader trends indicate that EV adoption is gradually increasing, primarily due to favourable policies and incentives aimed at reducing reliance on fossil fuels. Nonetheless, significant gaps remain in promoting EVs, particularly in regions with limited charging infrastructure and lower income levels. This reinforces the importance of continued investment in green infrastructure, such as the expansion of public transit, bike lanes, and EV charging stations, which are critical to supporting green mobility. Current investments in green infrastructure are pivotal, yet the study indicates that they fall short of the required range to transition the entire nation towards green transport. For green policies to fully take effect, substantial and sustained financial commitments are necessary, including government subsidies, public–private partnerships and international collaboration. The study area reflects moderate investment in green infrastructure, but it is essential to scale these efforts to foster widespread EV adoption and integrate public transport networks into greener alternatives.

3.8 Conclusion

This study has presented a comprehensive theoretical GTSM for understanding green transport initiatives' dynamics using SEM. Overall, the proposed GTSM framework demonstrates a robust scenario for evaluating the phenomena of green transport. All constructs are provided by solid convergent and discriminant validity, and the model fit is found acceptable. The results showed that current green transport policies greatly influencing and favouring the implementation of eco-friendly modes of transport. SOFA are found as significant drivers of influencing transport choices, and technological advancements drive and advanced models are needed to be developed to foster the incorporation of green technology and transport. The study indicates that green transport projects can dramatically cut greenhouse gas emissions, but the same demands the engagement and cooperation of all stakeholders as a primitive and vital step for indeed implementation of green transport and to ensure the efficiency of green transport policies. It is admired that the green transportation infrastructure investments support environmentally sustainable practitioners and are a harbinger of regular and proper behaviour among users. In terms of policy implications, the present study indicates that the active stakeholder engagement and considerable spending on green transportation infrastructure are necessary for successful policy implementation. Well-composed policies under comprehensively embed green transportation initiatives, and voluntarily emphasis should be placed on stakeholder engagement to achieve better outcomes. The results have important and practical implications for managers working within both government and for-profit sectors. To improve transportation policies, it is suggested that decision-makers should take seriously the salient facets with the most significant impact, i.e. policy effectiveness, socio-economic influences, technological innovation and emission reductions. This will enable reinforcement of the more eco-friendly transport networks. Today, there is a need of developing integrated green transportation policies to support all stakeholders in realizing long-term environmental and social dividends. In conclusion, the present research grants a critical understanding of green transportation complexities. The research created a solid framework for sustainable transport by first understanding and addressing the complexity of factors that affect sustainable transport. The future research directions of the present study lie in conducting the study with the involvement of varied group of user's, i.e. public transit users, non-motorized travellers and motorized vehicle users, to represent the more specific dimensions and facts with the involvement of different interplay with the considered constructs. The future research directions suggest the potential researchers to conduct more explicit study with the amalgamation of more specific constructs, directions and dimensions under integrated concepts and models with the heterogeneous group of users to suggest more precise outcomes.

3.9 Managerial implications

The research evaluates the need of green transport policies, scrutinizes the influence of SOFA on transportation choices, analyses patterns in the adoption of eco-friendly modes of transportation, assess the impact of technological advancements, provided critical facts on the reduction of greenhouse gas emissions through green transport. The same will help policy-makers in understanding the impact of technological advancements, environmentally sustainable practices and investments in green transport infrastructure. The insights presented can support policymakers in designing relevant policy-making frameworks for ensuring the sustainability delivery of governments and organizations about transport objectives. Moreover, the study explores the importance of CSE strategies in promotes environmentally sustainable practices and presented that the managerial authorities should ponder about green transport investments under green transport infrastructure based on policies and regulations for attaining sustainability. Policymakers should enforce green transport policies to cushion against sustainability challenges. The study recommend to seek drivers and measures that can support to steer eco-friendly transportation modes by promoting high access to transportation resources and offering incentives for technological innovation in the sector. The managerial authorities are suggested to reinforce discounted capillaries to stakeholders for influencing utility and success of green transport. Green transport ventures preliminary demands effective stakeholder engagement and collaboration to succeed and instrumental. It is suggested to engage government entities, businesses, civil society organizations, and affected communities to foster innovations centred on stakeholder needs by the managers for success and sustainability. In large ventures and innovations, public–private partnerships can help in pooling resources and expertise to accomplish adaptation of green projects. Prioritizing supporting projects that amplify public networks, increase pedestrian railways, cycling pathways and investments in green power energy technologies can result in declined greenhouse gases and improved quality of life. Technology is crucial in realizing green transport ambitions. The government's support in offering programs, grants, and tax breaks to companies engaging in green technology or enacting laws that aim to boost green technology prospects may save the day. Agencies should collaborate with academic institutions to develop technology designed for sustainability and offer solutions for sustainability products.

Investment in substantially promoting green transport systems benefits to the environment, economies and societies and is vital, where, the educational programs, publicity and education on the other side will drive miles in ensuring travellers to comply with sustainable transport. In summation, the present study provides vital hints of insight into the policy approach for policymakers, practitioners and everyone interested in integrating sustainability in transport. By enforcing such a policy, employing collaboration, investing in infrastructure, defining technological endeavours and implementing marketing goods; governments can work to realize sustainability situations in the transport sector.

References

Ahmed, K.A., Sahu, A.K., Sahu, A.K. and Sahu, N.K. (2022), "Quantify the behaviour intention of individuals to control SC performance by exploring cloud storage services: an extended UTAUT2 approach", *International Journal of Technology and Human Interaction*, Vol. 18 No. 7, pp. 1-28, doi: 10.4018/ijthi.306227.

Aksoy, F. and Bayram Arlı, N. (2020), "Evaluation of sustainable happiness with the sustainable development goals: structural equation model approach", *Sustainable Development*, Vol. 28 No. 1, pp. 385-392, doi: 10.1002/sd.1985.

Aloui, A., Hamani, N., Derrouiche, R. and Delahoche, L. (2021), "Systematic literature review on collaborative sustainable transportation: overview, analysis, and perspectives", *Transportation Research Interdisciplinary Perspectives*, Vol. 9, pp. 1-15, doi: 10.1016/j.trip.2020.100291.

Anderson, J.C. and Gerbing, D.W. (1988), "Structural equation modeling in practice: a review and recommended two-step approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411-423, doi: 10.1037//0033-2909.103.3.411.

Bag, S., Viktorovich, D.A., Sahu, A.K. and Sahu, A.K. (2021), "Barriers to adoption of blockchain technology in green supply chain management", *Journal of Global Operations and Strategic Sourcing*, Vol. 14 No. 1, pp. 104-133, doi: 10.1108/jgoss-06-2020-0027.

Björnberg, K. (2008), "Rational goal-setting in environmental policy: a model for clear and measurable objectives", *Environmental Planning and Policy Review*, Vol. 15 No. 1, pp. 78-92.

Boyd, D.W., Pathak, M., van Diemen, R. and Skea, J.E. (2021), "Mitigation co-benefits of climate change adaptation: a case-study analysis of eight cities", *Sustainable Cities and Society*, Vol. 77, pp. 1-11, doi: 10.1016/j.scs.2021.103563.

Creazza, A., Colicchia, C. and Evangelista, P. (2024), "Leveraging shippers-logistics providers relationships for better sustainability in logistics: the perspective of SMEs", *International Journal of Logistics Management*, Vol. 35 No. 4, pp. 1009-1039, doi: 10.1108/ijlm-03-2022-0103.

Dantas, T.E., De-Souza, E.D., Destro, I.R., Hammes, G., Rodriguez, C.M.T. and Soares, S.R. (2021), "How the combination of circular economy and industry 4.0 can contribute to achieving the sustainable development goals", *Sustainable Production and Consumption*, Vol. 26, pp. 213-227, doi: 10.1016/j.spc.2020.10.005.

Das, P.K. and Bhat, M.Y. (2022), "Global electric vehicle adoption: implementation and policy implications for India", *Environmental Science and Pollution Research*, Vol. 29 No. 27, pp. 40612-40622, doi: 10.1007/s11356-021-18211-w.

de Jong, E. and Vijge, M.J. (2021), "From millennium to sustainable development goals: evolving discourses and their reflection in policy coherence for development", *Earth System Governance*, Vol. 7, 100087, doi: 10.1016/j.esg.2020.100087.

Din, A.U., Ur Rahman, I., Vega-Muñoz, A., Elahi, E., Salazar-Sepúlveda, G., Contreras-Barraza, N. and Alhrahsheh, R.R. (2023), "How sustainable transportation can utilize climate change technologies to mitigate climate change", *Sustainability*, Vol. 15 No. 12, p. 9710, doi: 10.3390/su15129710.

Fallah Shayan, N., Mohabbati-Kalejahi, N., Alavi, S. and Zahed, M.A. (2022), "Sustainable development goals (SDGs) as a framework for corporate social responsibility (CSR)", *Sustainability*, Vol. 14 No. 3, p. 1222, doi: 10.3390/su14031222.

Fan, Y. and Wei, F. (2022), "Contributions of natural carbon sink capacity and carbon neutrality in the context of net-zero carbon cities: a case study of Hangzhou", *Sustainability*, Vol. 14 No. 5, p. 2680, doi: 10.3390/su14052680.

Fornell, C. and Larcker, D.F. (1981), "Structural equation models with unobservable variables and measurement error: algebra and statistics", *Journal of Marketing Research*, Vol. 18 No. 3, pp. 382-388, doi: 10.2307/3150980.

Geissdoerfer, M., Savaget, P., Bocken, N.M. and Hultink, E.J. (2017), "The circular economy—a new sustainability paradigm?", *Journal of Cleaner Production*, Vol. 143, pp. 757-768, doi: 10.1016/j.jclepro.2016.12.048.

Gergis, F.H. (2024), "Collaborative forms of governance in sustainable urban mobility schemes at the sub-governmental levels: a scoping literature review", *International Journal of Urban Sustainable Development*, Vol. 16 No. 1, pp. 343-359, doi: 10.1080/19463138.2024.2411049.

Ghisellini, P., Cialani, C. and Ulgiati, S. (2016), "A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems", *Journal of Cleaner Production*, Vol. 114, pp. 11-32, doi: 10.1016/j.jclepro.2015.09.007.

Ghosh, T., Kanitkar, T. and Srikanth, R. (2023), "Affordable and sustainable transportation: key drivers and policy choices for a megacity in India", *Case Studies on Transport Policy*, Vol. 13, 101061, doi: 10.1016/j.cstp.2023.101061.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis*, 7th ed., Pearson, New York.

Heidari, I., Toloie Eshlaghy, A. and Seyyed Hoseini, S.M. (2023), "Sustainable transportation: definitions, dimensions, and indicators – case study of importance-performance analysis for the city of Tehran", *Heliyon*, Vol. 9 No. 10, e20457, doi: 10.1016/j.heliyon.2023.e20457.

Helo, P. and Thai, V.V. (2024), "Logistics 4.0 – digital transformation with smart connected tracking and tracing devices", *International Journal of Production Economics*, Vol. 275, 109336, doi: 10.1016/j.ijpe.2024.109336.

Hmamed, H., Benghabrit, A., Cherrafi, A. and Hamani, N. (2023), "Achieving a sustainable transportation system via economic, environmental, and social optimization: a comprehensive AHP-DEA approach from the waste transportation sector", *Sustainability*, Vol. 15 No. 21, 15372, doi: 10.3390/su152115372.

Horvath, B., Bahna, M. and Fogarassy, C. (2019), "The ecological criteria of circular growth and the risk of rebound from closed loops", *Sustainability*, Vol. 11 No. 10, p. 2961, doi: 10.3390/su11102961.

Hsu, C. and Chen, M. (2021), "Advocating recycling and encouraging environmentally friendly habits through gamification: an empirical investigation", *Technology in Society*, Vol. 66, 101621, doi: 10.1016/j.techsoc.2021.101621.

Hu, L.T. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modeling: A Multidisciplinary Journal*, Vol. 6 No. 1, pp. 1-55, doi: 10.1080/10705519909540118.

Hysa, E., Kruja, A., Rehman, N.U. and Laurenti, R. (2020), "Circular economy innovation and environmental sustainability impact on economic growth: an integrated model for sustainable development", *Sustainability*, Vol. 12, p. 4831, doi: 10.3390/su12124831.

Jamil, M.A., Mustofa, R., Ibne Hossain, N.U., Rahman, S.M.A. and Chowdhury, S. (2024), "A structural equation modeling framework for exploring the industry 5.0 and sustainable supply chain determinants", *Supply Chain Analytics*, Vol. 6, 100060, doi: 10.1016/j.sca.2024.100060.

Jelti, F., Allouhi, A. and Tabet Aoul, K.A. (2023), "Transition paths towards a sustainable transportation system: a literature review", *Sustainability*, Vol. 15 No. 21, 15457, doi: 10.3390/su152115457.

Kim, D., Na, J. and Ha, H.K. (2024), "Exploring the impact of green logistics practices and relevant government policy on the financial efficiency of logistics companies", *Heliyon*, Vol. 10 No. 10, e30916, doi: 10.1016/j.heliyon.2024.e30916.

Kline, R.B. (2005), *Principles and Practice of Structural Equation Modeling*, 2nd ed., The Guilford Press, New York, NY.

Kottala, S.Y. and Sahu, A.K. (2023), "Evaluating ergonomics and financial distress in manufacturing organization behavior: resiliency framework from operations and strategic management", *The Learning Organization*, Vol. 31 No. 5, pp. 765-788, doi: 10.1108/TLO-03-2023-0041.

Li, N., Prabhu, M. and Sahu, A.K. (2023), "Investigating economic replacement policy under uncertainty for managerial application based on grey-reliability approach using QCC", *Grey Systems: Theory and Application*, Vol. 13 No. 2, pp. 297-321, doi: 10.1108/gs-07-2022-0075.

Li, Q., Zhang, H., Liu, K., Zhang, Z.J. and Jasimuddin, S.M. (2024), "Linkage between digital supply chain, supply chain innovation and supply chain dynamic capabilities: an empirical study", *International Journal of Logistics Management*, Vol. 35 No. 4, pp. 1200-1223, doi: 10.1108/ijlm-01-2022-0009.

Mardani, A., Streimikiene, D., Zavadskas, E.K., Cavallaro, F., Nilashi, M., Jusoh, A. and Zare, H. (2017), "Application of structural equation modeling (SEM) to solve environmental sustainability problems: a comprehensive review and meta-analysis", *Sustainability*, Vol. 9 No. 10, p. 1814, doi: 10.3390/su9101814.

Medina-Albaladejo, F.J. (2024), "Balancing efficiency and equity: consumer cooperatives in Barcelona (Spain), 1898-1936: an economic and financial-ratio analysis", *Business History*, pp. 1-25, doi: 10.1080/00076791.2024.2387013.

Meng, J., Ye, Z. and Wang, Y. (2024), "Financing and investing in sustainable infrastructure: a review and research agenda", *Sustainable Futures*, Vol. 8, pp. 1-11, doi: 10.1016/j.sftr.2024.100312.

Miah, M.T., Lakner, Z. and Fekete-Farkas, M. (2024), "Addressing poverty through social entrepreneurship for sustainable development: a comprehensive bibliometric analysis", *Administrative Sciences*, Vol. 14 No. 1, p. 16, doi: 10.3390/admsci14010016.

Mishrif, A. and Khan, A. (2023), "Digitization policy design and implementation in the logistics and supply chain sector during the time of Covid-19", *Journal of International Logistics and Trade*, Vol. 21 No. 3, pp. 135-158, doi: 10.1108/jilt-10-2022-0053.

Nishad, S., Sahu, A.K. and Sahu, N.K. (2024), "Advocating lean practices and strategies in decision-making for reinforcing industrial and manufacturing designs", in Sahu, A.K., Raut, R.D., Raja, R., Sahu, A.K. and Sahu, N.K. (Eds), *Industrial and Manufacturing Designs*, Chapter 3, doi: 10.1002/9781394212668.ch3.

Nonet, G.A.H., Gössling, T., Van Tulder, R. and Bryson, J.M. (2022), "Multi-stakeholder engagement for the sustainable development goals: introduction to the special issue", *Journal of Business Ethics*, Vol. 180 No. 4, pp. 945-957, doi: 10.1007/s10551-022-05192-0.

Pfister, J.A., Otley, D., Ahrens, T., Dambrin, C., Darwin, S., Granlund, M., Jack, S.L., Lassila, E.M., Millo, Y., Peda, P., Sherman, Z. and Wilson, D.S. (2024), "Performance management in the prosocial market economy: a new paradigm for economic performance and sustainability", *Qualitative Research in Accounting and Management*, Vol. 21 No. 5, pp. 397-443, doi: 10.1108/QRAM-02-2024-0031.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903, doi: 10.1037/0021-9010.88.5.879.

Qadir, A.S., Ahmad, F., Mohsin, A.B., Al-Wahedi, A., Iqbal, A. and Ali, A. (2024), "Navigating the complex realities of electric vehicle adoption: a comprehensive study of government strategies, policies, and incentives", *Energy Strategy Reviews*, Vol. 53, pp. 1-22, doi: 10.1016/j.esr.2024.101379.

Rosak-Szyrocka, J. and Tiwari, S. (2023), "Structural equation modeling (SEM) to test sustainable development in University 4.0 in the ultra-smart society era", *Sustainability*, Vol. 15 No. 23, 16167, doi: 10.3390/su152316167.

Sahu, A.K., Kottala, S.Y., Narang, H.K. and Rajput, M.S. (2024), "Intertwining green SCM- and agile SCM-based decision-making framework for sustainability using GIVTFNs", *Journal of Global Operations and Strategic Sourcing*, Vol. 17 No. 2, pp. 300-333, doi: 10.1108/jgoss-06-2022-0060.

Sauvé, S., Bernard, S. and Sloan, P. (2016), "Environmental sciences, sustainable development and circular economy: alternative concepts for trans-disciplinary research", *Environment, Development and Sustainability*, Vol. 17, pp. 48-56, doi: 10.1016/j.envdev.2015.09.002.

Schermelleh-Engel, K., Moosbrugger, H. and Müller, H. (2003), "Evaluating the fit of structural equation models: tests of significance and descriptive goodness-of-fit measures", *Methods of Psychological Research Online*, Vol. 8 No. 2, pp. 23-74.

Schroeder, P., Anggraeni, K. and Weber, U. (2019), "The relevance of circular economy practices to the sustainable development goals", *Journal of Industrial Ecology*, Vol. 23 No. 1, pp. 77-95, doi: 10.1111/jiec.12732.

Shah, K.J., Pan, S., Lee, I., Kim, H., You, Z., Zheng, J. and Chiang, P. (2021), "Green transportation for sustainability: review of current barriers, strategies, and innovative technologies", *Journal of Cleaner Production*, Vol. 326, 129392, doi: 10.1016/j.jclepro.2021.129392.

Shamsul Bahrin, A., Mokhtar, A.R.M., Muhamed, A.A. and Kaliani Sundram, V.P. (2024), "The mediating effect of eco-innovation on low-carbon supply chain practices toward manufacturing firm performance in Malaysia", *Journal of International Logistics and Trade*, Vol. 22 No. 3, pp. 110-133, doi: 10.1108/JILT-03-2023-0013.

Sobczuk, S. and Borucka, A. (2024), "Recent advances for the development of sustainable transport and their importance in case of global crises: a literature review", *Applied Sciences*, Vol. 14 No. 22, 10653, doi: 10.3390/app142210653.

Stafford-Smith, M., Griggs, D., Gaffney, O., Ullah, F., Reyers, B., Kanie, N., Stigson, B., Shrivastava, P., Leach, M. and O'Connell, D. (2017), "Integration: the key to implementing the sustainable development goals", *Sustainability Science*, Vol. 12 No. 6, pp. 911-919, doi: 10.1007/s11625-016-0383-3.

Stiebe, M. (2024), "Social big data mining for the sustainable mobility and transport transition: findings from a large-scale cross-platform analysis", *European Transport Research Review*, Vol. 16 No. 1, p. 28, doi: 10.1186/s12544-024-00651-3.

Taghvaee, V.M., Nodehi, M., Mohammadi Saber, R. and Mohebi, M. (2022), "Sustainable development goals and transportation modes: analyzing sustainability pillars of environment, health, and economy", *World Development Sustainability*, Vol. 1, 100018, doi: 10.1016/j.wds.2022.100018.

Terra dos Santos, L.C., Frimaio, A., Giannetti, B.F., Agostinho, F., Liu, G. and Almeida, C.M.V.B. (2023), "Integrating environmental, social, and economic dimensions to monitor sustainability in the G20 countries", *Sustainability*, Vol. 15 No. 8, pp. 1-18, doi: 10.3390/su15086502.

Tikoudis, I., Mebiame, R.M. and Oueslati, W. (2023), "Projecting the fuel efficiency of conventional vehicles: CAFE regulations, gasoline taxes, and autonomous technical change", *Energy Policy*, Vol. 183, pp. 199-216, doi: 10.1016/j.enpol.2023.113778.

Ur Rehman, F., Islam, M.M. and Miao, Q. (2023), "Environmental sustainability via green transportation: a case of the top 10 energy transition nations", *Transport Policy*, Vol. 137, pp. 32-44, doi: 10.1016/j.tranpol.2023.04.013.

Verma, A., Harsha, V. and Subramanian, G.H. (2021), "Evolution of urban transportation policies in India: a review and analysis", *Transportation in Developing Economies*, Vol. 7 No. 2, p. 25, doi: 10.1007/s40890-021-00136-1.

Walker, A.M., Opferkuch, K., Lindgreen, E.R., Simboli, A., Vermeulen, W.J. and Raggi, A. (2021), "Evaluating the social sustainability of circular economy practices: industry perspectives from Italy and The Netherlands", *Sustainable Production and Consumption*, Vol. 27, pp. 831-844.

Wang, M., Childerhouse, P. and Abareshi, A. (2024), "Global logistics and supply chain integration in the digital era: a focus on China's Belt and Road Initiative", *Journal of International Logistics and Trade*, Vol. 22 No. 2, pp. 58-79, doi: 10.1108/jilt-03-2023-0018.

Watfa, M.K., Abdelrehim, A., Shahin, N. and Jaafar, K. (2021), "A structural equation model to assess the impact of sustainability management on the success of construction projects", *International Journal of Construction Management*, Vol. 23 No. 10, pp. 1653-1664, doi: 10.1080/15623599.2021.1998302.

Williams, L.J., Cote, J.A. and Buckley, M.R. (2010), "Lack of method variance in self-reported affect and perceptions at work: reality or artifact?", *Journal of Applied Psychology*, Vol. 95 No. 3, pp. 456-462.

Winkler, L., Pearce, D., Nelson, J. and Babacan, O. (2023), "The effect of sustainable mobility transition policies on cumulative urban transport emissions and energy demand", *Nature Communications*, Vol. 14 No. 1, p. 2357, doi: 10.1038/s41467-023-37728-x.

Wu, Z., Zhao, Z., Gan, W., Zhou, S., Dong, W. and Wang, M. (2023), "Achieving carbon neutrality through urban planning and design", *International Journal of Environmental Research and Public Health*, Vol. 20 No. 3, pp. 1-21, doi: 10.3390/ijerph20032420.

Yadav, K. and Sircar, A. (2022), "A review on electric vehicle transport policy of India with certain recommendations", *MRS Energy and Sustainability*, Vol. 9 No. 2, pp. 469-479, doi: 10.1557/s43581-022-00048-6.

Yang, G. and Singhdong, P. (2024), "A conceptual framework of green supply chain integration toward enterprise performance through ambidextrous green innovation: an organizational capability perspective", *Journal of International Logistics and Trade*, Vol. 22 No. 2, pp. 93-106, doi: 10.1108/jilt-07-2023-0056.

Zagonari, F. (2018), "Responsibility, inequality, efficiency, and equity in four sustainability paradigms: policies for a shared sea from a multi-country analytical model", *Marine Policy*, Vol. 87, pp. 123-134, doi: 10.1016/j.marpol.2017.10.016.

Zhang, R. and Fujimori, S. (2020), "The role of transport electrification in global climate change mitigation scenarios", *Environmental Research Letters*, Vol. 15 No. 3, pp. 1-13, doi: 10.1088/1748-9326/ab6658.

Further reading

George, D. and Mallery, P. (2003), *SPSS for Windows Step by Step: A Simple Guide and Reference, 11.0 Update*, 4th ed., Allyn & Bacon, Boston.

Nunnally, J.C. (1978), *Psychometric Theory*, 2nd ed., McGraw-Hill, New York.

Taber, K.S. (2018), "The use of Cronbach's alpha when developing and reporting research instruments in science education", *Research in Science Education*, Vol. 48 No. 6, pp. 1273-1296, doi: 10.1007/s11165-016-9602-2.

Corresponding author
Atul Kumar Sahu can be contacted at: atul85sahu@gmail.com