From Roads to Rails: Assessing the Sustainability of Road Freight Dependency in Sri Lanka

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Abstract *- Sri Lanka's freight transport system is overwhelmingly dominated by road haulage, with nearly all domestic freight carried by trucks and heavy vehicles. The sector accounts for 96 percent of national transport-related carbon emissions, while rail contributes only about 1 percent of total freight share far below the global average of 24 percent. This road dependence has created persistent sustainability challenges, including severe congestion, frequent road accidents, excessive logistics costs (20–24 percent of GDP), and overreliance on imported fuel. Despite the government's recognition of these issues through the Draft National Transport Policy and sustainability initiatives, implementation of multimodal freight systems remains limited. This study employs a secondary data analysis using multiple international and national databases, including the World Bank's Logistics Performance Index (LPI), the Central Bank of Sri Lanka, the Asian Transport Observatory, and the International Energy Agency (IEA). Comparative benchmarking against regional peers (India, Vietnam, Bangladesh) and global leaders (Germany, the Netherlands) is undertaken to assess modal share disparities and logistics performance gaps. Findings reveal that road freight dominance undermines all three pillars of Sustainable Supply Chain Management (SSCM) environmental (high emissions), economic (inefficiency and high cost), and social (accidents and congestion). Scenario modeling demonstrates that shifting just 1 billion tonne-km from road to rail could reduce* CO_2 *emissions by 35.5 kilotons annually. The paper concludes with strategic recommendations to enhance multimodal infrastructure, incentivize green freight, and strengthen institutional coordination enabling Sri Lanka to transition toward a sustainable, competitive, and resilient freight transport system aligned with international sustainability frameworks.*

Keywords: Emissions, Logistics Performance, Rail Transport, Road Freight, Sri Lanka, Sustainable Supply Chain Management

I. INTRODUCTION

Freight transport is a crucial component of the global trade and economic growth, but it has become one of the most carbon-emitting and ecologically disrupting industries (International Energy Agency [IEA], 2021). The contribution of road freight to greenhouse gas emissions is significant, where among the world transport related CO_2 emissions, approximately a quarter comes from road freight. Excessive utilization of trucks and heavy automobiles contributes to the rapid process of climate change and creates additional issues related to congestion, road safety and inefficiency of logistics (Rodrigue, 2020). The realization of such problems has caused most nations to move towards multimodal transport technologies that trade off roads, rail, and inland waterways to ensure cost-effectiveness and emissions mitigation (European Chemical Transport Association [ECTA], 2011; Organisation for Economic Co-Operation and Development [OECD], 2022).

In Sri Lanka, nevertheless, freight transport is too road based. In the country, trucks and lorries deliver about 99% of the domestic freight, with rail freight consuming almost 1% of the total freight, much less than the international average of about 24 percent (Warnapura, 2024; Asian Development Bank [ADB], 2020). Though the geographical setting of the island has a potential of coastal and inland waterway freights, the system is not well established. The consequences of this modal imbalance are severe sustainability issues such as the growing cost of logistics, traffic, fuel reliance, and the increase in carbon emissions (World Bank, 2020; Central Bank of Sri Lanka [CBSL], 2022). Approximately 9.4 million tonnes of CO_2 are estimated to be produced by the transport sector, and over 96% of it is produced by road vehicles (Asian Transport Observatory, 2023).

Other than being economically inefficient, road freight has far reached social implications. Frequent and severe accidents are closely related to heavy vehicle traffic, which claims thousands of lives and injuries per annum (World Bank, 2021). These consequences underscore the fact that the lack of sustainability of the Sri Lankan freight system is not a mere environmental crisis, but also a socioeconomic problem limiting inclusive development. Even though the government has acknowledged such problems in its Draft National Transport Policy and associated sustainability programs, multimodal and low-carbon freight systems have not been implemented extensively (Ministry of Transport, 2023).

Current studies on freight transport in Sri Lanka have been strongly inclined on infrastructure development and the efficiency of operations but a little on total sustainability. Not much research has been done on the impact of dominance of road freight on the Triple Bottom Line (TBL) aspects of Sustainable Supply Chain Management (SSCM). i.e. environmental responsibility, economic efficiency, and social well-being (Elkington, 1998; Seuring and Muller, 2008). This absence of integrative evidence is a definite research gap in the knowledge on the sustainability consequences of modal imbalance.

In this respect, this paper main objective to review the sustainability of the road freight dependency in Sri Lanka in the SSCM perspective based on secondary data. The researchers rely on the data of the World Bank, ADB, IEA, CBSL, the Asian Transport Observatory, and the Sri Lanka Railways to assess the environmental, economic, and social indicators. It also compares the performance of the logistics sector in Sri Lanka with those of its regional counterparts (India, Vietnam, and Bangladesh) and the best in the world (Germany, Netherlands) in order to determine the gaps and policy interests. The value of this study is probably the evidence-based aspects that can inform the strategic move to the sustainable and multimodal freight systems, the connection of empirical information with the SSCM theory to assist in achieving the national decarbonisation/competitiveness goals.

II. LITERATURE REVIEW

A. Theoretical Sustainable Supply Chain Management (SSCM) Foundations. Sustainable Supply Chain Management (SSCM) incorporates into logistics and operational decision-making the three objectives (environmental, economic, and social) also referred to as the Triple Bottom Line (TBL) (Elkington, 1998; Seuring and Muller, 2008). In the logistics industry, SSCM encourages the use of resource efficiency, emission reduction, and well-being of the stakeholders. Green Supply Chain Management (GSCM) strategy focuses on the operations that are environmentally friendly such as modal shift, cleaner technologies, and energy-efficient infrastructure (Srivastava, 2007; Ahi and Searcy, 2013).In the meantime, the Circular Economy (CE) approach is a complement to SSCM that promotes less waste and resource-optimal loops, which are becoming more and more applicable to the freight systems that are turned into low-carbon operations (Geissdoerfer et al., 2017; Murray et al., 2017).

According to the recent literature, the SSCM lens is applicable to the study of transport sustainability as a way of mapping the logistics activities (freight transport, warehousing and distribution) onto the TBL dimensions (Carter and Rogers, 2008; Mangla et al., 2022). Since this theoretical framing enables the conceptualization of freight transport sustainability not just as a challenge to operational operations, but it is an integrated supply chain issue involving competitiveness and environmental performance**.**

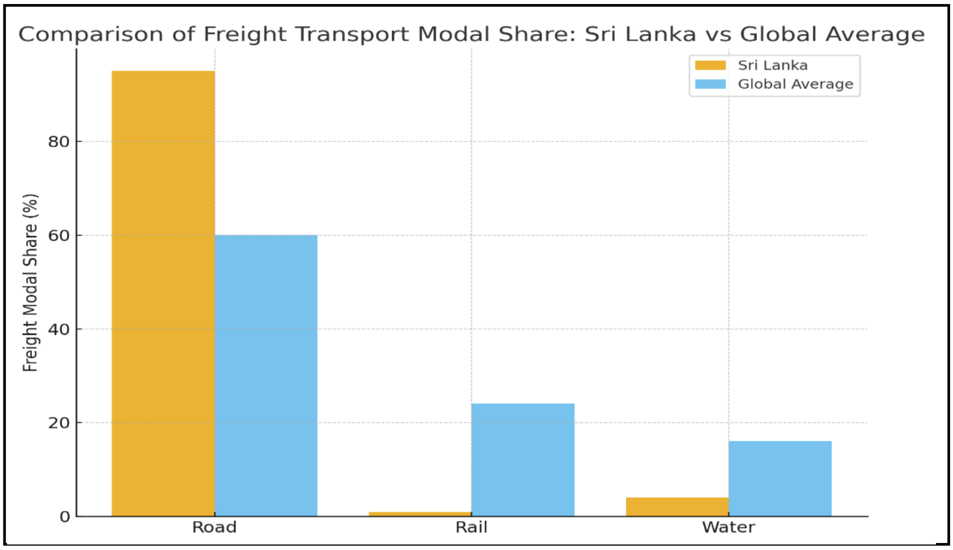
B. Global attitudes towards Modal Imbalance and Freight Sustainability.

All over the world, it is observed that freight transport modes have a tremendous impact on the sustainability results. Road freight is the dominating mode of freight in most developing economies, which increases the carbon emissions, congestion, and logistics expenses (World Bank, 2020). The example of India is when logistics costs are noted as the same as about 14% of GDP, this is mainly because of the excessive use of roads (World Bank, 2023). Likewise, Southeast Asian countries also have similar problems that are related to the inadequate development of rail and inland waterways (Asian Development Bank [ADB], 2020). On the other hand, developed economies like Germany and Netherlands show that balanced multimodal systems enhance the efficiency and sustainability of logistics. Their freight transport systems, which are well spread over road, rail, and water, keep logistics costs at 810 percent of GDP, and have reduced emissions and accidents (Rodrigue, 2020; European Commission, 2022). According to the International Energy Agency (IEA, 2021), road freight, in comparison to rail freight, has the capacity to generate up to 75 times more CO_2 per tonne-kilometre, which proves that rail freight is obviously more environmentally friendly. These results suggest that modal diversification is a necessity both in environmental and economic terms, which is a common cause of the SSCM goal of long-term supply chain resilience (Hilmola & Henttu, 2015).

C. Sri Lankan Background: Road Dependency and Implication.

Sri Lanka is a more extreme manifestation of this international problem. Road freight accounts for the majority of domestic freight movement, nearly 1 %, as compared to a global average of 24% (Warnapura, 2024).

Figure 1. Comparison of freight transport modal share between Sri Lanka and the global average.



Source: Warnapura, 2024; Asian Transport Observatory, 2023; World Bank, 2020

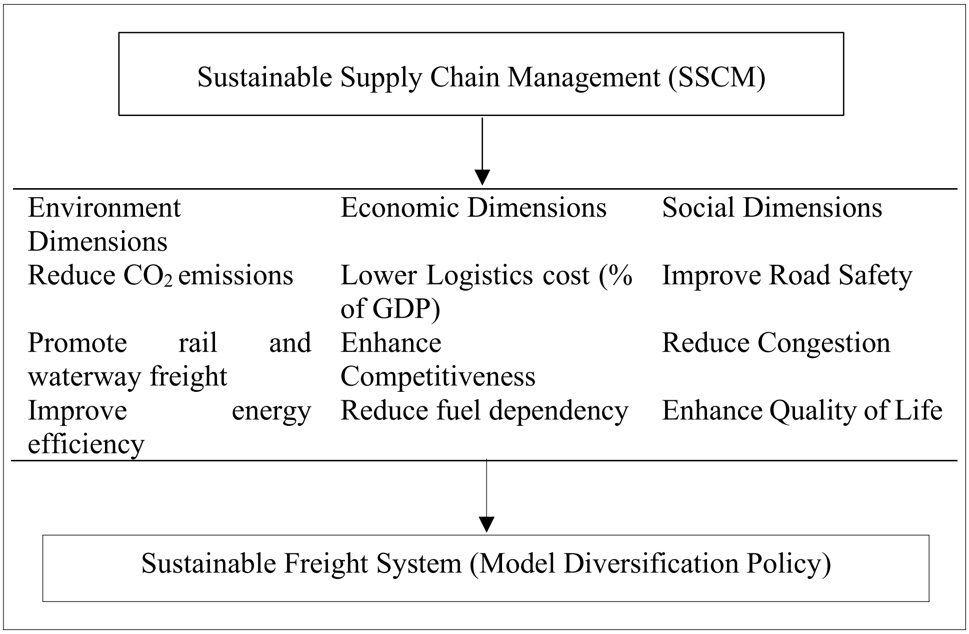
Figure 1 indicates the road dependency has intensified sustainability challenges, including congestion, high logistics costs (20–24% of GDP), and carbon emissions exceeding 9.4 million tonnes annually, of which 96% originates from road vehicles (Asian Transport Observatory, 2023; Central Bank of Sri Lanka [CBSL], 2022).

Dependence on imported fossil fuels has also exposed the supply chain to volatility during fuel crises, such as that experienced in 2022 (CBSL, 2022). From an SSCM perspective, these challenges undermine all three TBL pillars, environmental degradation (emissions), economic inefficiency (high costs), and social harm (accidents and congestion) (World Bank, 2021). Hence, Sri Lanka's freight transport imbalance represents not merely a logistics inefficiency but a national sustainability issue that requires systemic intervention.

D. Research Gaps and Applicability to SSCM.

Most existing Sri Lankan studies on logistics focus on infrastructure and operational efficiency (ADB, 2020; World Bank, 2020), while overlooking sustainability integration through SSCM principles. Few have empirically examined how freight mode imbalance affects environmental, economic, and social outcomes collectively (Warnapura, 2024). To address this research gap, the current study applies the SSCM framework to evaluate freight transport sustainability using secondary data. It builds on global insights to contextualize Sri Lanka's situation and generate evidence-based recommendations for a sustainable, multimodal logistics system.

Figure 2. Conceptual Link between SSCM Dimensions and Modal Shift Sustainability



Source: Author's compilation based on Elkington (1998) and Seuring & Müller (2008)

As shown in Figure 2, this theoretical model aligns modal diversification directly with SSCM's TBL dimensions, providing a structured foundation for analysis and ensuring conceptual coherence with the research objectives.

E. Significance and Contribution

This study contributes to the literature by bridging the gap between SSCM theory and freight transport sustainability in a developing-country context. By employing comparative benchmarking and scenario analysis, it generates policy-relevant insights for achieving sustainable logistics transformation. The findings not only enrich academic discourse on SSCM applications in transport systems but also support policy initiatives toward SDG 9 (Industry, Innovation, and Infrastructure) and SDG 13 (Climate Action).

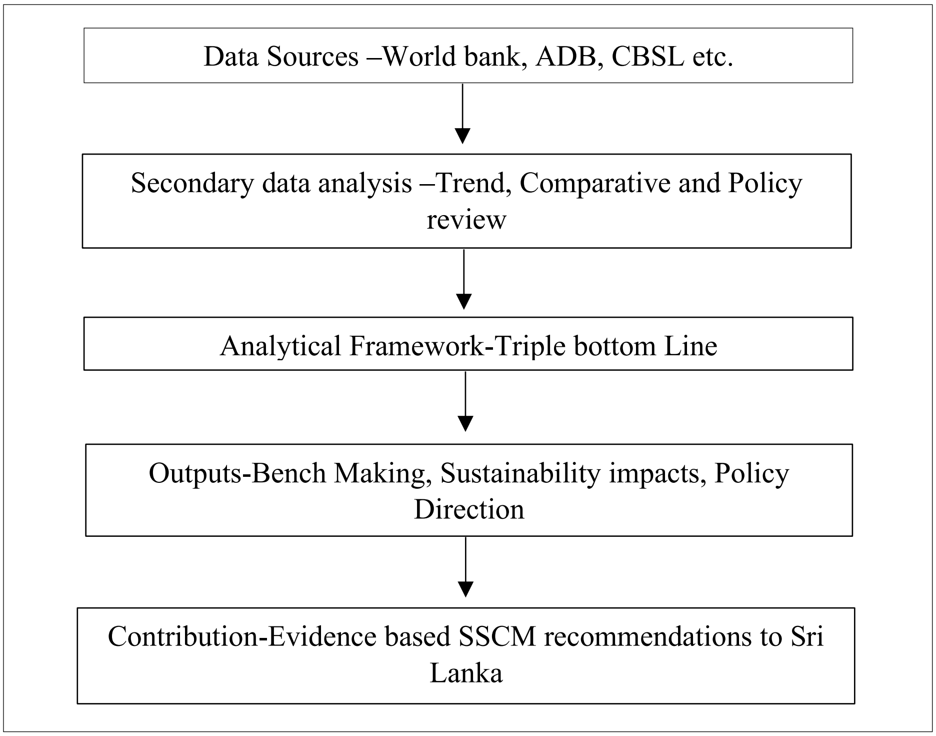
III. METHODOLOGY

A. Research Design

This paper will take a secondary data analytical design to determine the sustainability of the freight transport system in Sri Lanka with a focus on the fact that this country relies on a road freight system highly. Secondary data was chosen because it is reliable, longitudinal and cross-comparable across both global and regional datasets. The case study has utilized a comparative benchmarking case study to compare the performance of Sri Lanka with other countries in the region (India, Bangladesh, Vietnam) and those countries that have been leading in terms of sustainability performance and modal diversification potential (Germany, Netherlands).

The methodological flow of the study (Figure 3) presents how the data sources will be integrated and how the data will be analysed using the Triple Bottom Line (TBL) of Sustainable Supply Chain Management (SSCM) in order to end up with actionable recommendations that can be implemented to facilitate sustainable freight transition.

Figure 3. Research design of the study.



Source: Authors' compilation.

So, the research design is summarized in Figure 3, which outlines the integration of secondary data sources, the analytical framework based on the Triple Bottom Line, and the study's outputs leading to SSCM recommendations.

B. Data Sources and Variables

Data were extracted from multiple credible international and national databases to ensure validity through triangulation. The main sources and their relevant variables are summarized below:

Table 1: Summary of Secondary Data Sources and Variables Used in the Study

Source	Variable Type	Key variable/ Indicators Extracted
Asian Transport Observatory (2023, 2025)	Environmental, Social	CO_2 emissions, vehicle composition, road accident data
World Bank (2020, 2021, 2023)	Economic, Social	Logistics Performance Index (LPI), road safety indicators
Central Bank of Sri Lanka (CBSL, 2022)	Economic	Fuel imports, logistics cost (% of GDP), macroeconomic data
Asian Development Bank (ADB, 2020)	Environmental, Economic	Infrastructure quality, multimodal system efficiency
International Energy Agency (IEA, 2021)	Environmental	Emission factors (road vs rail), energy consumption
Academic Literature (Warnapura, 2024; Rodrigue, 2020)	Theoretical	Modal imbalance context, SSCM integration

Source: Author's Compilation.

Independent Variables (Drivers):

- Transport mode (road, rail, inland waterway)
- CO_2 emission intensity (g/t-km)
- Logistics cost (% of GDP)
- LPI score components (infrastructure, timeliness, customs, logistics competence)
- Road accident frequency

Dependent Variable:

- Sustainability performance of freight transport, represented through SSCM dimensions (environmental, economic, social outcomes).

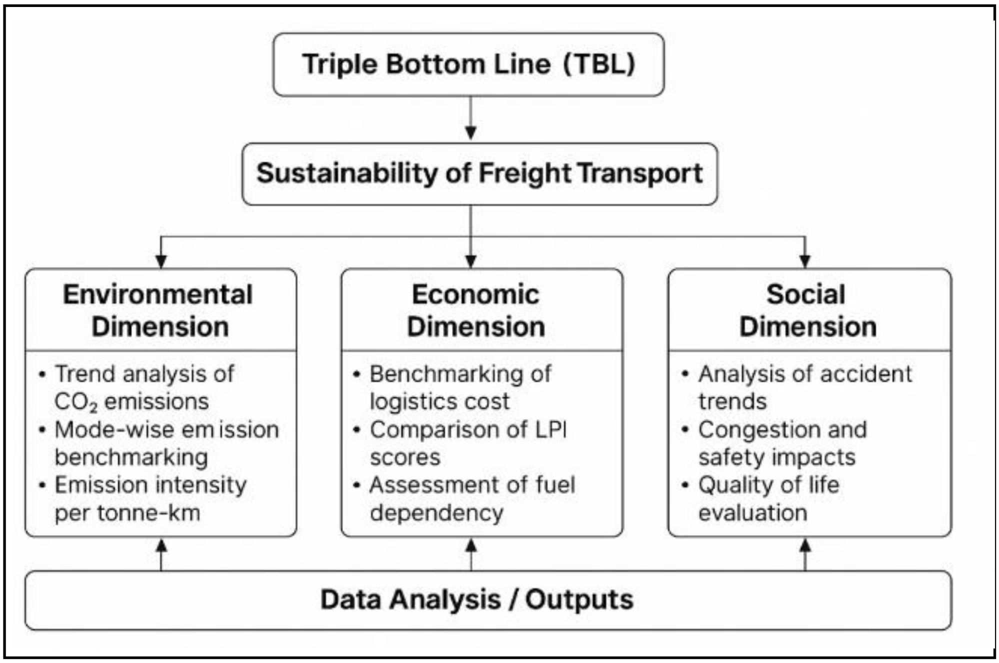
This variable identification enhances transparency and aligns analysis directly with research objectives.

Collectively, these datasets will give information on modal share, emissions, logistics costs, road safety, and policy orientation - all of which are of direct interest to Sustainable Supply Chain Management (SSCM).

C. Analytical Framework

The analytical framework (Figure 4) operationalizes the Triple Bottom Line (TBL) model within the SSCM context. The framework integrates mode-wise, country-wise, and parameter-wise analyses to evaluate sustainability outcomes.

Figure 4. Analytical Framework of the Study



Source: Author's compilation based on Elkington (1998) and Seuring & Müller (2008).

D. Comparative Analysis and Benchmarking.

A two-tier comparative approach was adopted:

1. Mode-wise comparison (road vs rail vs inland waterway) based on emission intensity and efficiency parameters.
2. Country-wise benchmarking between Sri Lanka and selected peers to highlight sustainability gaps in modal share, cost, and safety.

Visual analysis tools (e.g. bar charts, ratio plots) are used to reveal disparities between transport modes and countries, ensuring interpretability and data transparency. Each parameter (CO_2, cost, accident rate, LPI score) is aligned with its corresponding SSCM dimension, reinforcing linkage with study objectives.

E. Data validation and limitations.

Triangulation of data was conducted between ADB, World Bank, and CBSL databases to get internal consistency. The averaged or cross-verified values were used in instances of minor discrepancies (e.g., the accident statistics, the emission coefficients).

Limitations:

- Secondary data does not provide enough operational insights on firms.
- Freight vehicle type is not fully disaggregated with respect to accident data.
- Qualitative analysis of the policy documents was carried out, which does not necessarily indicate the performance of implementation.

Nevertheless, the transparency and strength of the study in terms of methodological transparency and robustness is high because of comparative benchmarking and triangulation of data.

With these shortcomings, the research methodology has a strong and viable evidence base, which facilitates actionable recommendations based on the study.

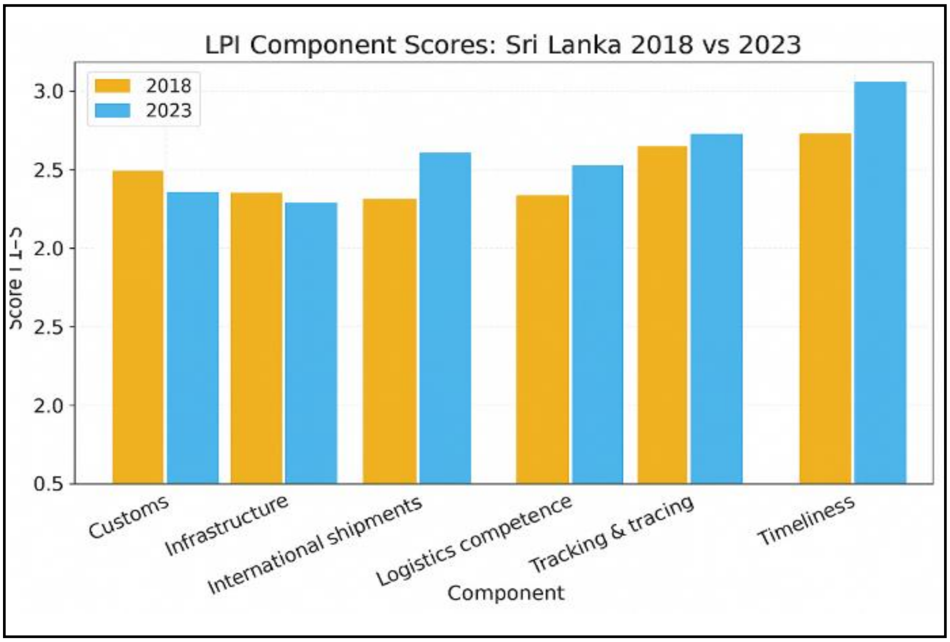
IV. DATA ANALYSIS AND DISCUSSION

A. Logistics Performance: Trends 2018 -2023.

To determine the economic aspect of SSCM, the data of the World Bank Logistics Performance Index (LPI) were evaluated as of 2018 to 2023 with trend analysis and ratio analysis. During 2018-2023, the total LPI score of Sri Lanka rose slightly and changed between 2.6 and 2.8 (World Bank, 2020; 2023). This is a 7.7 percent change in the logistics competitiveness but that still positions Sri Lanka at 73rds among world economies as compared to its regional counterparts like India (38th) and Vietnam (43rd).

Showing on the figure 5 the analysis on a component-by-component basis reveals that there is an increase in international shipments (+0.29), logistics competence (+0.28), tracking and tracing (+0.21) and timeliness (+0.51). On the other hand, the score of customs (-0.08) and infrastructure (-0.09) decreased as indicated in Figure 4.

Figure 5. LPI components score of Sri Lanka 2018 vs 2023



Source: World Bank, 2020; 2023.

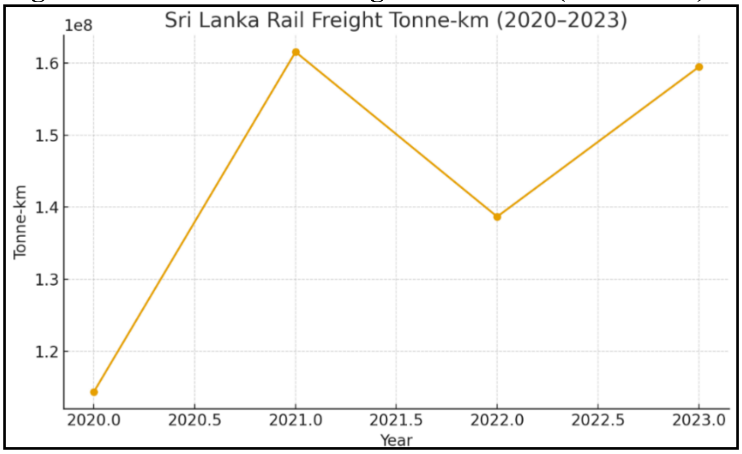
These results indicate that Sri Lanka's logistics system is gradually becoming more reliable but continues to suffer from infrastructure bottlenecks and customs inefficiencies. Within the SSCM framework, this represents a partial strengthening of the economic pillar, improvements in service efficiency are offset by persistent structural weaknesses in trade logistics (Seuring & Müller, 2008).

B. Rail Freight Activity: 2020–2023

Based on the time-series trend analysis of the data in Sri Lanka Railways it was determined that the volumes of cargo increased by 39 percent of pre-pandemic levels after the pandemic, with the 2020-2023 change in volumes being 114 million tonne-km to 159 million tonne-km (Sri Lanka Railways, 2023). Nevertheless, the rail proportion of national freight is extremely low, standing at 1 percent of the world average of 24 percent (Warnapura, 2024).

Figure 6 demonstrates the stagnant trend of rail freight performance, which proves the modal imbalance. The economic resilience is reduced due to the underuse of rail, and carbon dependency is enhanced, which deteriorates the environmental and economic aspects of SSCM.

Figure 6. Sri Lanka Rail Freight Tonne-km (2020–2023)



Source: Sri Lanka Railways, 2023.

Comparisons of benchmarks show that should the Sri Lanka make even a 5% increase in its rail share, the logistics cost might be reduced by up to 3, 4 percent of GDP (using ADB, 2020, elasticity results). This underlines the evident sustainability-based policy reform.

C. Environmental Impacts and Emission-Savings Scenario

The scenario and intensity analysis was used to study the environmental aspect of SSCM.

The road vehicles used in the transport sector in 2022 produced 9.4 million tonnes of CO_2, 96% of this amount was produced by road vehicles (Asian Transport Observatory, 2023). The freight trucks which constituted 5 percent of all vehicles contributed a majority of the emissions because of the tonnage and fuel intensity.

The study was a model of the following scenario using emission factors in ECTA (2011) and ORR (2021):

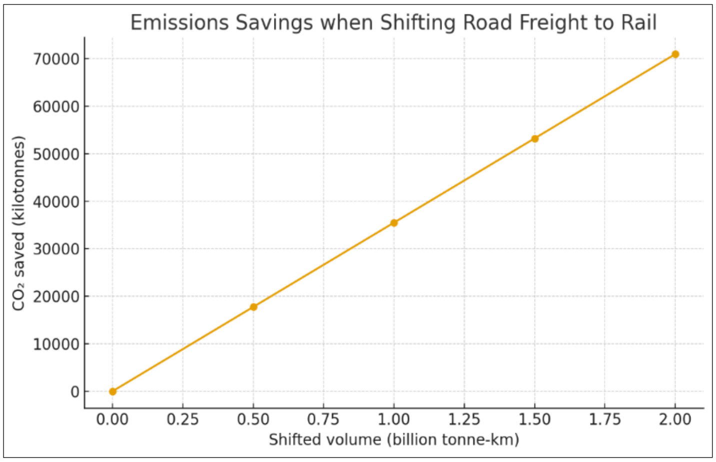
CO_2 Savings= $(E_{road}$-$E_{rail})$ * Q

Where:

E_{road} = 62 g CO_2/t-km (road),
E_{rail}= 26.5 g CO_2/t-km (rail),
Q = tonne-km shifted.

Findings indicate that the transfer of 1 billion tonne-km off-road to the railroad would decrease emissions by 35.5 kilotons/year; 2 billion tonne-km would help cut 71 kilotons/year. This linear saving potential is shown in figure 7. These types of reductions are in line with the environmental pillar of Triple Bottom Line (TBL), which focuses on decarbonisation and eco-efficiency in relation to Green SCM practices (Elkington, 1998; Srivastava, 2007).

Figure 7. Emissions Savings when Shifting Road Freight to Rail



Source: European chemical Transport Association (ECTA, 2011); Office of road and rail (ORR, 2021).

These findings support the environmental pillar of SSCM and align with green logistics research (Srivastava, 2007), proving that even modest modal shifts can substantially enhance national decarbonisation efforts.

D. Social Costs: Safety and Congestion

To get a sense of the social impact, the researcher took a close look at accident data and congestion trends. Every year, Sri Lanka sees about 38,000 traffic crashes, and out of those, 3,000 people lose their lives (World Bank, 2021). In 2024 alone, 2,243 deaths were reported, with freight trucks at the centre of many of these tragedies (Sunday Times, 2025).

Urban freight corridors it thinks of the stretch between Colombo Port and the Katunayake Expressway are hugely faced for gridlock. During peak hours, travel times increased by as much as 40% (ADB, 2020). These numbers paint a clear picture, i.e. when a country leans too heavily on road freight, it puts safety, mobility, and overall social well-being at risk. From an SSCM perspective, this is what it looks like when the social pillar breaks down. Dangerous and inefficient freight operations chip away at community welfare. If Sri Lanka shifts more freight to rail and waterways, it directly cuts accident severity and eases the burdens of congestion.

E. Economic Dimension: High Logistics Costs and Competitiveness Gaps

Economic data reveal that logistics costs in Sri Lanka stand at 20–24% of GDP (World Bank, 2020) more than double the 8–10% global best practice. Using comparative ratio analysis, the cost gap demonstrates a significant inefficiency index of 2.4 relative to benchmark economies.

This inefficiency stems from fuel dependency, congestion, and road maintenance burdens. During the 2022 fuel crisis, road-based supply chains experienced up to 50% logistics downtime, exposing vulnerability in the freight sector (CBSL, 2022).

Within the economic pillar of SSCM, these findings illustrate how modal imbalance limits resilience, disrupts value chains, and reduces competitiveness (Carter & Rogers, 2008). By rebalancing freight toward rail and waterways, Sri Lanka could enhance cost efficiency and align with Circular Economy principles emphasizing resource optimization (Geissdoerfer et al., 2017).

F. Benchmarking Against Regional and Global Peers

A comparative benchmarking analysis was applied using selected countries as reference points.

- Regional peers: India, Vietnam, and Bangladesh (developing multimodal systems).
- Global leaders: Germany and the Netherlands (fully integrated rail–inland waterway systems).

While Germany's rail freight share stands at 18% and the Netherlands at 42%, Sri Lanka's share is only 1% (Warnapura, 2024).

The LPI scores show a similar gap: Sri Lanka (2.8) lags behind India (3.4), Vietnam (3.3), Germany (4.1), while Bangladesh is further behind at 2.6.

This comparison reveals structural constraints in modal infrastructure, governance, and policy execution. Countries with balanced multimodal systems achieve lower emissions, lower logistics costs, and higher SSCM scores, validating the relationship between modal diversity and sustainability performance (Rodrigue, 2020).

G. Synthesis

Synthesizing across dimensions, the results affirm that road freight dominance undermines all three SSCM pillars:

- Environmental: High emissions and energy inefficiency.
- Economic: Elevated logistics costs and reduced competitiveness.
- Social: Safety hazards and urban congestion.

Through comparative and scenario analysis, this study evidence that even partial modal diversification can produce substantial gains in sustainability and resilience.

The findings reinforce the need for evidence-based SSCM policy reforms, focusing on infrastructure investment, multimodal integration, and incentives for green freight operators.

V. CONCLUSION AND RECOMMENDATIONS

This research was an attempt to explore whether the heavy reliance of Sri Lanka on road freight transport can be sustainable based on secondary data on the performance of the logistics, the use of rail freight, and the scenario of emissions, as well as their comparison with the performance of the regional and global counterparts. The results all show that the existing freight setup in the country undermines the three interrelated pillars of the Triple Bottom Line (TBL) model-environmental protection, social well-being, and economic efficiency-at the core of Sustainable Supply Chain Management (SSCM).

This research paper is an addition to both practice and scholarship. Academically, it offers empirical evidence that relates freight vehicle prevalence with sustainability results and fills a gap in the existing literature where efficiency and infrastructure have been examined separately. Practically, it provides policy makers, logistics providers and development partners with tangible areas of intervention, demonstrating that sustainability in freight transport is not only a normative outcome but a quantifiable imperative to national competitiveness.

On the basis of these results, some integrative conclusions and recommendations can be made. First, modernization of rail freight should be considered the key to sustainable logistics. The new or renewed investment in modern locomotives, wagons and freight terminals will increase capacity and enhance reliability and will thus provide a feasible alternative to road haulage. Unless this backbone is upgraded, then Sri Lanka cannot attain any significant modal diversification.

Second, multimodal infrastructure development should be a point of concern. This needs to involve the incorporation of road, rail and waterway into a fluid network by developing multimodal corridors, backed by dry ports, inland container depots and through electronic freight management systems. Not only will such systems maximize cargo flows but will also minimize congestion and inefficiencies in urban freight corridors.

Third, incentives of green freight need to be put into place to help hasten the transition. The changes in behavior can be seen across the logistics industry by policy mechanisms like tax incentives on low-emission fleets, a gradual transition to a carbon price, and subsidies specifically given to companies that transition to green technologies. The incentives will help the logistics companies to streamline their business processes along with the principles of sustainability and thus make SSCM more than an educational concept- it will be an industrial standard.

Fourth, reforms on road safety need to be inculcated within freight policy. Specialized training of heavy vehicle operators, routine maintenance processes of trucks and the construction of special freight lanes along high-density routes can lead to fewer deaths and alleviate traffic jams. Improvements in road safety also increase the social acceptability of freight operations, which is required to support long-term public support of logistics reforms.

Fifth, it is important to improve resilience by decreasing fuel dependency. By electrifying rail, switching to alternative fuels like LNG or biofuels in trucks, and increasing the use of renewable energy in transport infrastructure, the logistics system will be resistant to external shocks, such as a shortage of fuel or the volatility of oil prices on the global market. The diversification of energy will not only stabilize supply chains but will also make Sri Lanka congruent with global decarbonization processes.

Lastly, there should be policy reform and governance convergence. A clear strategic direction would be to revise the Draft National Transport Policy and incorporate measures of sustainability, like emissions reduction targets, safety benchmarks, and logistics cost measures. In addition, the reforms can be coordinated, inclusive, and accountable by organizing a National Multimodal Freight Council comprised of ministries, industry associations, and development partners.

Overall, this paper concludes that the dependency of road freight in Sri Lanka is not only a logistical problem but a structural sustainability issue. To manage it, a multi-pronged strategy is needed: to modernize rail, construct multimodal corridors, to incentivize green practices, to enhance safety, to diversify energy, to enhance governance. By these measures, Sri Lanka will be able to shift to a more environmentally sustainable, more secure, and more affordable freight model that will improve its competitiveness and lead to the achievement of the higher objectives of sustainable development and social welfare.

VI. LIMITATIONS AND FUTURE WORK

Although the current study offers some valuable information regarding the sustainability of the freight transport system in Sri Lanka, a number of limitations have to be considered.

To begin with, the study was completely based on secondary sources of information, such as reports by the World Bank, Asian Development Bank, Central Bank of Sri Lanka, Asian Transport Observatory and Sri Lanka Railways. Despite the credibility of these datasets, there can be delays in reporting, aggregation or methodology differences across sources. Specifically, the accident statistics are often not fully disaggregated by the type of vehicle; therefore, it is hard to isolate the specific rate of crashes involving freight vehicles. Second, the research was based on comparative and scenario analysis instead of using primary data collection. This methodology is useful in offering benchmarking and estimates (e.g., CO_2 reduction through modal shift) but fails to reflect the operational realities of firms, perception of stakeholders and behavioral obstacles that may affect modal shift adoption. Consequently, a few contextual aspects, including issues of governance, the last-mile logistics problem, and the investment behavior of the private sector, fall outside the area of this paper. Third, although the emissions-savings scenario provides a measurable description of how climate could be improved, it is founded on the average international emission factor (62 g CO_2 /t-km road and 26.5 g CO_2/t-km rail). The actual values can change with the vehicle technology, fuel mix and operational efficiency within Sri Lanka.

With these limitations, there are a few paths forward in future research. First, future research must also include primary data using surveys, interviews and case studies of logistics companies, policymakers and freight operators to supplement secondary data and reflect practical challenges associated with modal diversification. Second, scholars might conduct cost benefit analyses of rail and multimodal investments, which would equip policymakers with greater financial support of infrastructure reforms. Third, there is a need to focus on behavioral obstacles to modal shift, including shipper preferences, industry risk perception and institutional inertia, which can often be blamed even with evident sustainability advantages. Fourth, future work may take the form of integrated scenario modelling that only factors in emissions, but also safety and economic effects of various policy interventions, such as carbon taxes, rail subsidies or digital freight optimization. Lastly, researchers need to provide more regional comparisons across more economies in South Asia and Southeast Asia and provide more generalized lessons and comparative standards to the logistics transformation in Sri Lanka.

By filling these gaps, the next round of research can offer a more detailed picture of the processes involved in the transition to sustainable freight systems in Sri Lanka. Not only would such studies contribute to the academic discourse, but they would also provide the country with evidence-based policy guidance to underpin the sustainability agenda.

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