



UTILISING GLOBAL STRATEGIC MODELS TO FORMULATE A RAIL FREIGHT STRATEGY FOR SRI LANKA

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ABSTRACT

Rail freight in Sri Lanka is declining substantially in all respects of volume, mode share, financial performance, and service quality, which are severely lag far behind international standards. This dire situation calls for a complete reformation of the rail freight system from its inception. Moreover, the issue of overcrowded roads increases the urgency for an improved alternate mode of freight transportation. Accordingly, this research investigates a rail freight strategy for Sri Lanka, using a global strategic model to align the Sri Lankan railway with international standards. The strategy formulation model is a pre-designed multiplicative regression framework, crafted through insights gleaned from a comprehensive global analysis of strategies employed by different nations for revitalising the sector. This model was selected following a rigorous examination of available frameworks identified through a thorough literature survey. Finally, our application of the model to the Sri Lankan context suggests various strategic measures that could be taken to optimise the performance of the Sri Lanka Rail freight industry and its ability to conform to global standards. These measures span policy, business operating structure and operations of Sri Lanka rail.

Keywords: Freight Railway; Strategic Model; Global Learning; Revitalize; Policy

1. INTRODUCTION

Rail transportation is widely used globally and domestically for freight, particularly in North America, Europe, Russia, East Asia, and Australia. In certain European nations such as Lithuania and Latvia, railways handle over 60% of freight traffic [1]. However, Sri Lanka's rail freight sector significantly trails the global average. Despite being a dominant mode of freight transport for its first eight decades since its establishment in 1862, Sri Lanka's rail freight has seen a significant decline in mode share, volume, financial stability, and service quality in recent years. Currently, rail freight accounts for only one percent of total freight in Sri Lanka, compared to the global average of twenty-four percent [2].

In contrast to the United States, Australia, China, Russia, South Africa, and several European nations, Sri Lanka's rail freight industry has been consistently unprofitable since 1946 [3], [4]. Frequent train cancellations and delays make service unreliable. Customer service is subpar, given outdated infrastructure, incompatible wagons, and a less-accessible railway network [5].

In recent years, the deterioration of the Sri Lankan rail freight system has accelerated due to a lack of corrective measures, signalling neglect and failure to mitigate escalating losses. This situation underscores the imperative for a significant overhaul of the rail freight infrastructure. Meanwhile, road

transport has emerged as the predominant mode for freight transportation, driven by increased demand resulting from economic expansion [6]. However, this surge in demand has strained the road network, leading to bottlenecks. Researchers such as Gunaruwan and Jayasekara (2012) have raised concerns regarding the transport sector's capacity to support the country's economic growth and have advocated for increased investment in transportation infrastructure [7]. Over the past decade, a notable uptick in freight movement, spurred by rising exports, imports, and GDP growth in agriculture and industry, has further exacerbated the strain on the transportation system. The road transport system, characterised by limited carrying capacity per vehicle and mounting congestion, is currently inadequate to meet the growing demand. Additionally, the absence of a competitive and efficient public transportation system has resulted in fragmented arrangements for transportation, leading to increased costs and extended travel times [6].

Given the challenges within the existing freight transportation system, revitalising rail freight in the country is imperative to encouraging a shift from road to rail. Rail freight has demonstrated cost-effectiveness, reliability, speed, and environmental friendliness globally, leading to its growing adoption [8]. Shifting heavy vehicle traffic from road to rail alleviates congestion and enhances roadway space for

passenger transportation. However, to realise these benefits, it is crucial to establish a robust railway system geared to meet the current logistical and transportation requirements [9].

Furthermore, our literature review indicates that there is a lack of extensive research investigating the root causes of the factors hindering rail freight development in Sri Lanka. Existing research predominantly addresses surface-level issues without probing into their deeper origins. These studies overlook the integration of international recommendations into the solution formulation process, which is essential for attaining competitiveness and necessary advancement [5].

Therefore, the objective of this research is to reform the rail freight system in Sri Lanka by developing a strategy that is grounded in a predetermined global rail freight model, but which also considers the root causes of the problem. Accordingly, the following research objectives have been established:

1. To examine the revival strategies implemented globally by various nations in the advancement of rail freight systems.
2. To examine the challenges confronting Sri Lanka's current rail freight system and recognise their underlying causes.
3. To construct a systematic approach for formulating a strategy tailored to the Sri Lankan context.
4. To devise a comprehensive strategy aimed at revitalising the rail freight system in Sri Lanka.

The rail freight strategy was developed by an examination of the present global rail freight landscape, facilitating an evaluation of successful approaches adopted by various nations. The need for the development of rail freight in Sri Lanka was evaluated based on the deficiencies inherent to the country's freight transportation system. An in-depth analysis was then conducted to identify the root causes of challenges prevailing in the domain of rail freight. The aim of this analysis was to pinpoint issues that necessitated targeted strategic intervention.

To formulate a tailored strategy for Sri Lanka, a pre-established model was selected. This selection was based on a comprehensive evaluation of diverse strategic models proposed within academic literature. The strategy development process entailed the systematic application of the chosen model to the unique socio-economic context of Sri Lanka, yielding strategic recommendations spanning policy, operational, and business dimensions. These recommendations are anticipated to serve as catalysts for revitalising Sri Lanka's freight railway system, thereby fostering enhanced efficiency and sustainability within the nation's broader transportation network.

2. LITERATURE REVIEW

Rail transport presents considerable potential for facilitating the nationwide movement of freight, particularly given constraints within road transport systems. This prospect has yet to be realised due to problems affecting the entire railway system. It is futile to attempt to resolve these issues with solutions that provide temporary relief. Therefore, the identification of underlying causes must come before the formulation of a solution. Moreover, it is vital to identify how various nations have optimised the advantages of rail transportation by establishing the right railway system. Hence, global learning serves as a pivotal aspect in the formulation of an effective rail freight strategy.

2.1. Limitations in the Road Transport System

Colombo serves as Sri Lanka's logistical hub, and a majority of truck journeys take place within the Western Province, where the country's international air and seaports are located. Port traffic accounts for around 35,000 truck trips each week, of which 60% are container trucks. These significantly exacerbate road congestion in Colombo and the wider Western Province [11]. Other major cities also experience congestion due to the inflow and outflow of heavy vehicles transporting bulk freight; this may be overcome by shifting bulk freight from road to rail [12].

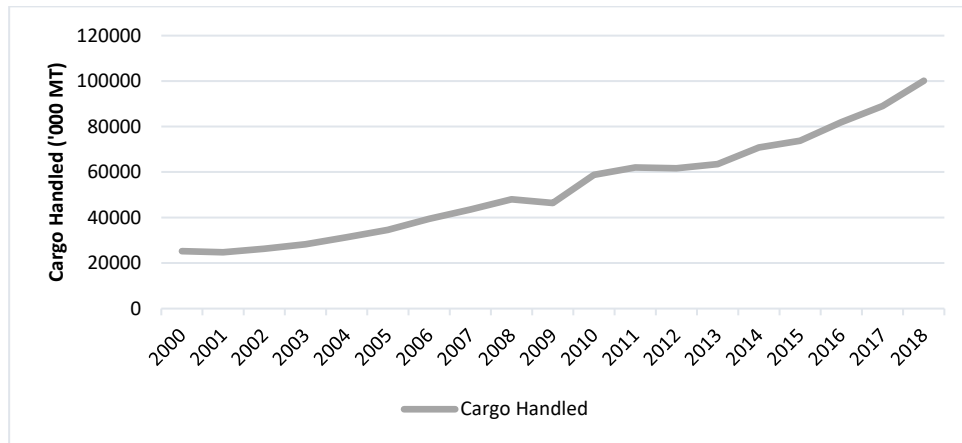


Figure 1: Cargo handled by Colombo Port

Source: [10]

The growth in freight-related activities at Katunayake Airport and Colombo Port is a strong indicator of congestion expansion in the city and suburbs of Colombo. Colombo Port, the principal and busiest port in Sri Lanka, handles an increasing volume of imports and exports of cargo, as seen in Figure 1. Moreover, the railway

is regarded as the most economically efficient and expeditious means of transporting import and export containers to and from the Colombo Port [10].

Bandaranaike International Airport (BIA), the primary international airport in Sri Lanka, witnessed a substantial increase in cargo flows during the last decade. This is a result of the increased volume of cargo movements surrounding the airport. The airport serves as a critical hub for industries and businesses that necessitate faster cargo transportation. The delivery of time-sensitive commodities via air requires the development of a more rapid method for goods to and from warehouses, manufacturers, and retail locations [11].

2.2. The Current Problem and the Analysis of Root Cause

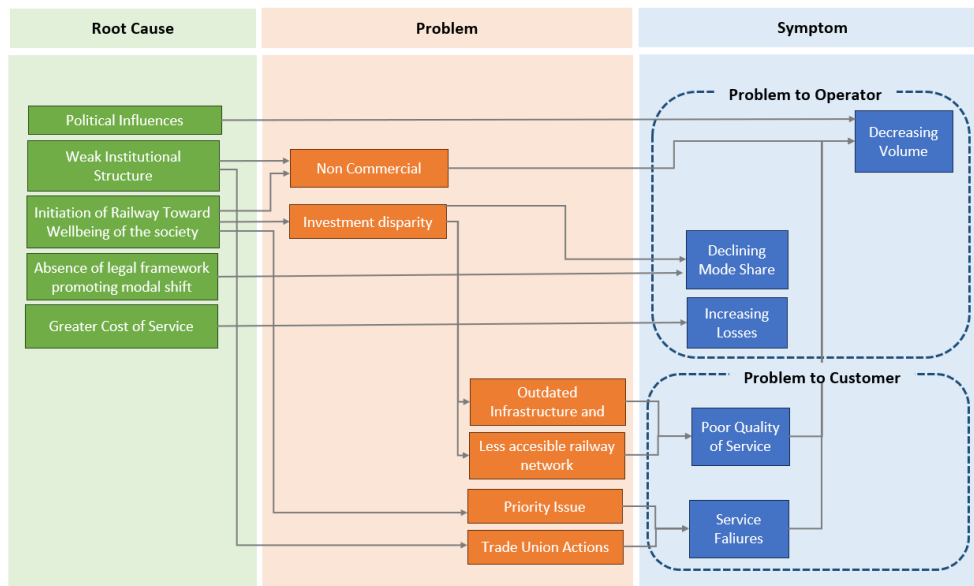


Figure 2: Root cause analysis of rail freight in Sri Lanka

A comprehensive knowledge of the problem at hand and the factors that contributed to its emergence is important before formulating a solution. As a result, a root cause analysis was conducted to ascertain the true cause of the problem. The symptoms of the rail freight system in Sri Lanka are illustrated in Figure 2. Then, it determines which potential issue is mostly responsible for the emergence of the specified symptoms. Ultimately, the underlying cause is identified by doing a historical analysis of railway data spanning its inception. Subsequently, the root cause analysis is comprehensively discussed in the following subheadings.

2.2.1. Declining volume and mode share

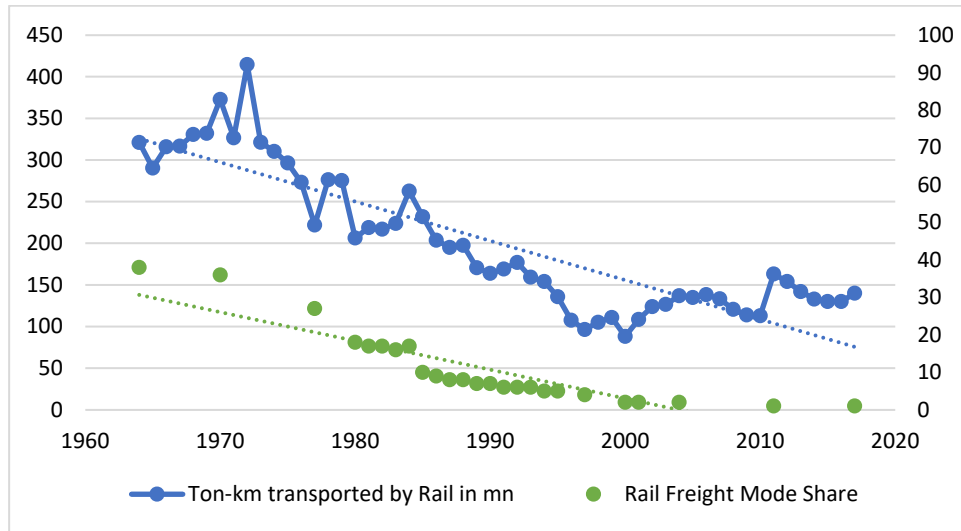


Figure 3: Rail freight mode share and ton-km transported by rail

Source: [3], [4], [12], [3], [11]

Sri Lanka Railway's mode share and volume have decreased substantially over time. As seen in Figure 3, there was a threefold decline in the ton-kilometers transported by rail in 2017 compared to its peak in 1972. The greatest rail freight mode share of 38 percent in 1964 is comparable to the rail freight mode share of 41 percent in the market-leading nation, the United States, in 1967. However, Sri Lanka Railway was unable to sustain its freight share at that level [4], [3], [12].

The substantial expansion of road transport infrastructure during the 1970s and 1980s exerted a considerable influence on rail transport, notably by capturing a significant portion of freight transportation formerly handled by railways. The removal of import restrictions on motor vehicles consequent to the implementation of an open economic policy in 1977 exacerbated this trend, posing a considerable threat to the rail freight industry and precipitating a subsequent decline in its cargo volume [4], [13]. Political interests hastened the downfall by diverting significant rail traffic to the road for their own personal gain. The railway could not compete to at least hold its position given the rise of vehicle freight. The inability to commercialise in accordance with industrial demands leads to a rapid loss of its volume (figure 3). The Sri Lanka Railway, as the sole operator in the industry, is wholly accountable for train operation and infrastructure management as a government entity. This institutional framework fails to afford the necessary autonomy for the commercial operation of the railway industry [3].

Moreover, a loss in mode share has been brought about by the wider difference in railway investment. Currently, government neglect of the railway sector is evident in the fact that rail investments make up only 15% of road investments. The government allocates most of the limited capital designated for railways to passenger transport, as it provides greater public benefit than freight. Additionally, the 1958 deregulation of automobiles eliminated the legal safeguard against railroads, encouraging the transfer of freight from rail to road [14].

2.2.2. Increasing financial losses

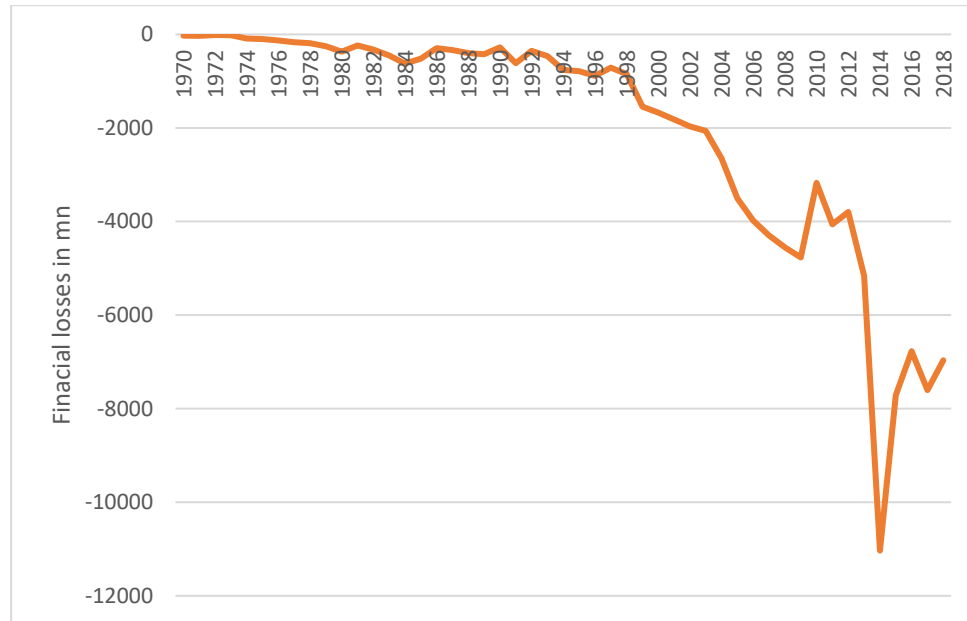


Figure 4: Financial losses and the ton-km transported by railway

Source: [3], [15], [16]

Figure 4 illustrates a noticeable rising trend in financial loss, which has escalated significantly since 2004 and peaked in its highest point in 2014. The increased cost of service is one of the factors contributing to the reported losses, with human resource expenses recognised as the primary driver. The revenue generated is inadequate to even offset the cost of personnel. In 2018 and 2019, revenue was able to cover nearly 80% of the personal emoluments (table 1). Furthermore, as per the table 1, personal emoluments account more than 60% of total recurrent expenditure. The annual revenue per employee is LKR 497,986 (1536 USD) in 2018 which is significantly less valuable compared with freight railway in South Africa. Transnet Freight Rail, the rail freight operator in South Africa earned 108, 264 USD per employee in 2018 which is 70 times greater than the value of the Sri Lanka Railway [17], [18].

Table 1: Selected railway financial performance criteria

Financial Performance Criteria Sri Lanka Railway	2018	2019
Freight Revenue (LKR)	418,221,298	435,021,225
Passenger Revenue (LKR)	5,933,282,780	6,394,844,929
Revenue from parcels, mail and miscellaneous	1,061,011,699	1,071,459,513
Total Revenue (LKR)	7,412,515,777	7,901,325,667
Freight Revenue as % of Total Revenue	6%	6%
Passenger Revenue as % of Total Revenue	80%	81%
Revenue per operated freight train (LKR)	61,099	65,328
Revenue per operated passenger train (LKR)	50,630	55,495
Personal Emoluments (LKR)	9,078,028,510	9,887,549,759
Total Recurrent Expenditure (LKR)	14,380,549,167	15,463,534,602
Personal Emoluments as % of Total cost	63%	64%
% of Personal Emoluments covered by the revenue	82%	80%
No of Employees	14,885	13,590
Revenue per employee (LKR)	497,986	581,407

Source: [15]

Even though railway was initiated in the country primarily focusing freight transportation, at present freight railway has been overtaken by passenger transportation. According to the financial analysis presented in Table 1, freight railway was the least income producer in recent years, accounting for only 6 percent of total revenue. In comparison passenger railway has contributed over 80 percent. However, freight railway has generated more income per operating train than passenger railway, highlighting the fact that freight railway is more efficient at generating revenue [15].

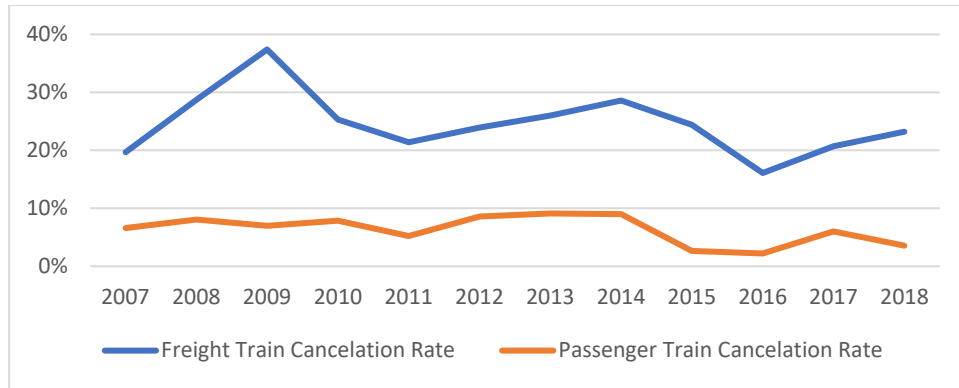


Figure 5: Train cancellation rate

Source: [15], [16]

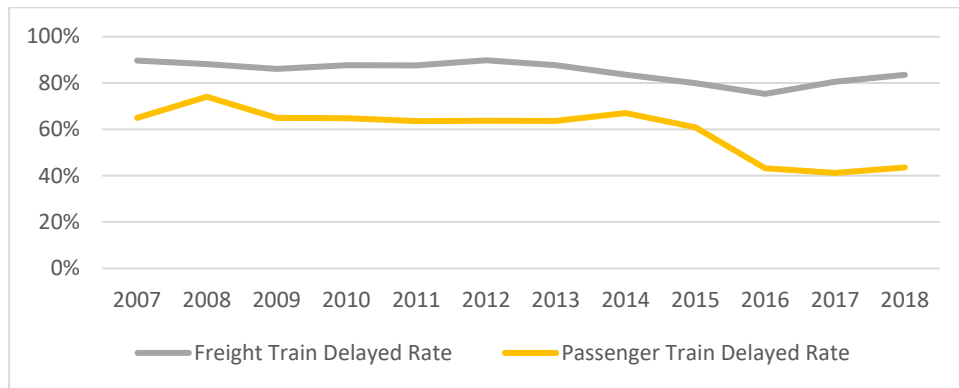


Figure 6: Train delayed rate

Source: [15], [16]

2.2.3. Poor quality of service and service failures

Freight trains have a markedly higher incidence of train cancellations and delays, as seen in Figures 5 and 6 [15], [16]. The performance that is observed was attributed primarily to obsolete infrastructure, trains, and equipment. Trains are suddenly cancelled due to unanticipated trade union actions. Additionally, freight trains exhibit the lowest performance in terms of train cancellation and delay rates, which differ significantly from passenger trains. Four times as many freight trains are cancelled as passenger trains. Approximately ninety percent of freight trains are delayed, showing that on-time arrivals are quite uncommon. The analysis presented above reveals a rising disregard for freight railways. Being the only services provider for both passenger and freight trains, Sri Lanka Railway has placed a higher priority on passenger trains than freight trains, emphasising social welfare over business considerations [3], [5].

Moreover, inadequacies in the accessibility of the rail network contribute to an extended distance that requires a combination of travel by both road and rail within a single journey. This, in turn, increases cost and time taken. The transition between rail and road is further hindered by the lack of seamlessness, attributed to outdated infrastructure and equipment. This inefficiency in the intermodal transition process adds to the overall time and cost [3].

2.3. Global Rail Freight Revival

In recent years, the railway has experienced a surge in freight transportation demand because of its distinctive characteristics that enable more efficient and effective movement of freight than alternative modes. It has been proven that the railroad can move heavy cargo in greater volume, at a lower cost, and with more safety than road transport [8]. Many nations across the world have realised these benefits. China, the United States, Russia, India, Australia, and Canada have all achieved greater volumes by rail. China alone has recorded 3.59 trillion ton-km. European countries, on average, have a higher freight rail mode share. In 2021, twelve countries in Europe surpassed the global average of 24 percent in freight rail mode share [19]. Numerous nations, including the United States, Canada, South Africa, Australia, Russia, and India, as well as many European countries, find the industry to be the most profitable in the world: in the United States, it generates an average annual profit of fifty percent. Freight railways are highly reliable throughout Europe. Its punctuality is similar to passenger railway; nevertheless, the punctuality of international freight by rail has grown by 60% in 2020 [20].

As previously shown, there is a global resurgence in rail freight. Nevertheless, mere possession of a railway system does not deliver these benefits. The establishment of a well-functioning railway system, which is recognized globally, necessitates careful attention to every essential aspect. Understanding the distinct strategic approaches adopted by various nations to achieve the desired performance level is therefore of the utmost importance.

The development of an effective railway policy and a legislative framework are critical to the success of the industry, as is shown globally. While several passenger trains are established with the purpose of providing public value, freight railways in very profitable nations as the United States, South Africa, Australia, Russia, and India were founded with the objective of generating profits. Passenger railways in India are subsidised by the freight railway due to the former's high-profit margin [21]. The 1980 Staggers Act, which was enacted in the United States, created a conducive environment for the rail freight industry to operate, allowing for greater pricing and asset management flexibility. In 1930, road freight laws in South Africa reduced

competition for railway services, hence enhancing the efficiency of the rail freight sector [22].

The railway's ownership is an additional crucial element that influences the performance of rail freight. Compared to public railways, privatized railways promote commercialization through greater autonomy in decision-making. Privately-owned railway operators, like those in the United States, Canada, Australia, and several European countries, operate in highly commercialized industries with large volumes and profit margins. In addition to private ownership, state-owned railway companies in countries like Russia, China, and Ukraine have demonstrated superior performance. A number of public railway systems in Asia and Africa, including those in Vietnam, Malaysia, and Nigeria, have not experienced substantial development in rail freight operations, except few geographically vast countries like India [1].

The majority of freight railroads in Europe are vertically separated. Therefore, the management of railway operations and infrastructure is delegated to two distinct business organisations, relieving the operator from the responsibility of infrastructure management and allowing them to focus on providing superior customer service [23]. Freight and passenger railroads typically utilize the same railway track, unless dedicated tracks are accessible. Hence, for the purpose of improving freight reliability, an optimal distribution of tracks is necessary, as is the case in Europe, where the performance of passenger and freight railways is equivalent [24], [25].

Dedicated freight railways, which alleviate the traffic caused by passenger trains on railway tracks, are prevalent in the United States, India, Australia, and Canada [26]. At present, freight railways in Italy, China, Russia, and Japan are operating at higher speed through the utilisation of High-Speed Rail Tracks that were formerly designated for passenger railways [27]. Geographically confined nations, including Denmark, New Zealand, and the United Kingdom, have implemented train ferries, tunnels, and bridges to span the land separation by sea. This has ultimately facilitated the improvement of their rail operations to neighbouring countries and to connect distant domestic islands [28].

3. METHODOLOGY

The sequential procedure employed in formulating the rail freight strategy for Sri Lanka is illustrated in Figure 7, incorporating the analysis technique utilized at each stage. An extensive review of the literature has been undertaken in order to ascertain the potential for the development of rail freight in Sri Lanka. Such opportunities emerge as a result of challenges within the freight transportation sector. Road transport has been the subject of extensive research for this purpose, as it is the

predominant mode of domestic freight transit in Sri Lanka. After the opportunity has been identified, it is necessary to determine the industry's existing problem and the underlying cause that the solution must address. In order to ascertain patterns, quantitative data obtained from literature review was subjected to descriptive analytic technique. The acquired qualitative data were subjected to thematic analysis in order to uncover problems by identifying recurring themes. Following this, a root cause analysis was performed to determine the cause of the apparent problem. It was then necessary to identify worldwide revival plans. Secondary data were gathered for this objective from a variety of worldwide sources, including annual reports, journal articles, transport reviews, and etc. The resurgence of rail freight in numerous countries and the strategies they have used are examined in depth through the application of thematic analysis.

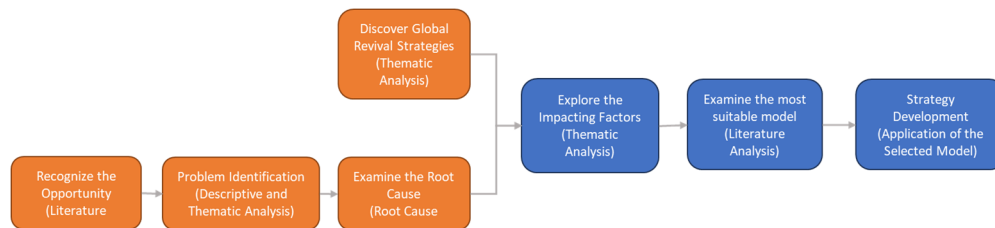


Figure 5: The methodology

Given the substantial disparity between the performance of Sri Lanka's rail freight sector and the global standards, there is a need to formulate a corrective strategy derived from a model developed based on global best practices. This aims to elevate Sri Lanka's rail freight industry to conform with global benchmarks.

As the first step for strategic model selection, the elements that influence the development of rail freight were identified through a global investigation and root cause analysis. These considerations then served as the foundation for model selection. The model best suited to Sri Lanka was selected after a comprehensive analysis of several models designed to evaluate the performance of rail freight. Once this was selected, it was applied in-context.

4. DATA ANALYSIS

4.1. Identify the Target Variables

As input for strategy formulation, the literature review has detailed the global freight railway revival strategies, the opportunity for freight railway revival in Sri Lanka, the problem, and its core cause. An analysis of the global rail freight industry and its revival revealed the diverse approaches adopted by various nations to develop rail freight. Furthermore, problem and root cause analysis identified deficiencies within

the Sri Lankan industry that required attention in the formulation of strategic initiatives. Based on global strategies and local industry weaknesses, key considerations for the formulation of local strategies have been suggested.

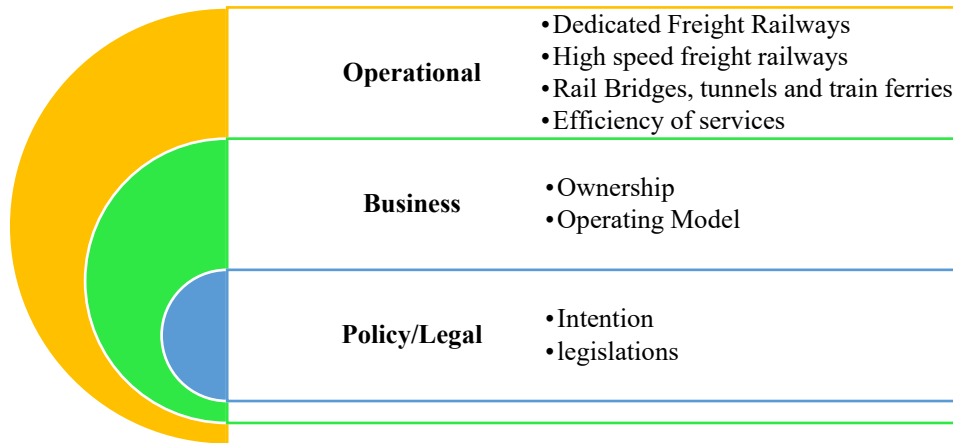


Figure 6: Factors impacts rail freight performance

As depicted in figure 8, policy and legal factors are core elements that must be incorporated while formulating a strategy. The literature review revealed that nations endowed with favourable policy and legislative frameworks concerning rail transportation exhibit higher performance. Furthermore, the root cause analysis highlighted that the current problems arise from policy and legal factors. The primary objective of establishing a railway system is to either generate profits for commercial purposes or to provide public benefit by means of government subsidies. Freight railroads that have acquired a commercial focus have demonstrated strong financial health. A supportive legislative framework is another requirement that fosters a supportive environment for operations through regulation of competition. The absence of effective regulatory framework in Sri Lanka to safe guard rail share let road transport, the primary competitor, to function at its maximum capacity [29].

Business-related variables exert the second-most influence on the development of rail freight. Proper establishment of the railway ownership and operating model are necessary to offer the required freedom for the operation of its business activities. According to a review of the relevant literature, privately owned and railways with state-owned companies have demonstrated superior performance compared to public railways. Vertically separated business structures, in which two distinct organisations are established for infrastructure management and train operation, have resulted in higher performance compared to those that have adopted vertically integrated business models [23], [25].

Thirdly, operational factors influence railway development. The implementation of dedicated railways has been shown to facilitate service development by designing the railway system exclusively for freight transportation. Additionally, it contributes to the expansion of the system's capacity. The increased delivery speed of freight facilitated by high-speed freight railways is advantageous for the transportation of time-sensitive items. Several nations that are geographically isolated have implemented rail connections via tunnels, bridges, and ferries in order to reach neighbouring nations and domestic islands devoid of land borders; this has increased the volume of transport. Enhanced rail efficiency results in increased volume as a consequence of enhanced customer satisfaction [26].

4.2. Examination of Available Models

Research on modelling the performance of rail freight is limited in scope. Zhang and Li (2019) have introduced an optimization model that centres on carbon emissions, pricing, service queuing, and operational planning, that is among the few research that have addressed these topics. The researchers have directed their attention towards container transportation as opposed to the entire operation of the railway [30]. Several others, including Dong (1997) and Fernandez and Joaquin (2004), have proposed operational optimization models as opposed to a strategic model that can improve the industry's overall performance. Implementing tactical actions to improve operating performance within a well-established railway system is the fundamental objective of each of these models. Policies, laws, and business related initiatives at the macro level, which are crucial for the reconstruction of Sri Lanka's railway network, cannot be recognised in these researches [31], [32].

The global strategic rail freight model proposed by Warnapura (2024) provides a comprehensive analysis of macro-level factors aimed at evaluating the performance of rail freight within a given country, a feature not found in other research models. In formulating strategies tailored to Sri Lanka, it becomes imperative to comprehend both the limitations constraining its rail freight system and its potential for revitalization, particularly given its comparatively rudimentary status vis-à-vis global benchmarks, as explicated in the literature review. Furthermore, an understanding of the strategies adopted by other nations to revitalise their rail freight sectors is essential. In this context, the global strategic rail freight model proves particularly relevant, as it comprehensively considers constraining factors, determinants of performance potential, and global best practices. In contrast, other models often focus solely on short-term improvement initiatives rather than addressing the need for revitalizing an entire system. As such, the global strategic rail freight model aligns closely with the requisite considerations in the development of strategies specific to Sri Lanka [33].

4.3. Strategy Development

4.3.1. The global strategic rail freight model

The strategy for Sri Lanka has been developed using the pre-designed global strategic rail freight model. A multiplicative regression model has been created by Warnapura (2024) to evaluate a nation's rail freight performance. The model underwent rigorous examination to assess for heteroscedasticity and multicollinearity, with findings indicating their absence. Additionally, validation procedures were conducted using varied sets of sample countries, including those with contextual similarities to Sri Lanka. These robust analyses affirm the precision and reliability of the model's output [33].

The author has identified several numeric and dummy independent variables spanning various controllable and uncontrolled aspects in accordance with the basic formula stated in Equation 1 to quantify the performance of a railway represented as ton-km transported by rail. Geographical location, the socioeconomic composition of the nation, the state of the freight-related sectors, and the rivalry from alternative modes of transportation are examples of uncontrollable factors. These factors are uncontrollable within the manageable scope of railways. As a result, those have been viewed as fixed variables as opposed to the flexible nature of strategic factors. The author accessed various sources to gather data pertaining to the identified factors. These sources encompassed databases such as Knoema, Statista, Eurostat, CEIC data, OECD data, World Bank data, as well as annual reports, performance reports from individual operators, and governmental sources.

The author identifies the ton-kilometre distance travelled by train in border nations as a crucial factor in determining how a nation can expand its railway to improve operations; this metric is incorporated as a strategic variable in the model. Being a land-locked continent, European nations can take this opportunity without further strategic intervention. International transport and transit account for 87% of the amount of rail freight in Latvia, where rail freight is reliant on cross-border activity. Despite possessing vast land borders, several African countries have unable to capitalize on cross-border activity due to the limited extent of rail freight operations in those regions. Hence, to optimize operations, it is critical to establish strong partnerships with neighbouring countries that engage in substantial rail freight operations.

$$Y = aX_1^b \times X_2^c \times X_3^d \times X_4^e \times X_5^f \times X_6^g \times X_7^h \times X_8^i \times X_9^j \times 10^{l \times D1} \times 10^{m \times D2} \times 10^{n \times D3} \times 10^{o \times D4} \times 10^{p \times D5} \times 10^{q \times D7} \text{ ----- (1)}$$

Where,

Y : Ton-km by rail

X₁ - X₇ : Uncontrollable Discrete Variables

D₁ - D₃ : Uncontrollable Dummy Variables

X₈ : Ton-km transported by rail in border countries. (Mn ton-km)

X₉ : Efficiency of train services*

D₄ : Dedicated Freight Railways (Dummy Variables)

D₅ : Privatized Railways (Dummy Variable)

D₆ : Vertically separated railways and vertically integrated freight railways (Dummy Variable)

D₇ : Profit oriented railways (Dummy Variable)

*Global Competitiveness Index published annually by the World Economic Forum (WEF).

The model also designates profit-driven railway as a strategic variable. This represents the number of profitable railways after excluding subsidies. Generally, profitable railroads are highly commercialized and customer-centric, which ultimately results in increased rail freight operations. The privatized railway has been incorporated as another variable in the model used to assess strategic initiatives. Here, ownership of the operation is taken to account. This analysis encompasses both privately operated and railways operated by state-owned companies. Private rail systems, in contrast to public railways, prioritize the needs and interests of its customers, hence enhancing overall operational efficiencies.

Incorporating vertically integrated and vertically separated railways into the model allowed for the evaluation of how freight railways gain access to the track over passenger railways, hence facilitating freedom of operation. A variable used to evaluate strategic measure of dedicated railway which refers to a railway system that is specifically designed for the transportation of freight. This type of system offers expedited service, hence improving the overall performance of the freight operation. As another variable in the model, railway efficiency influences to enhance overall performance of the railway. It measures the cost, frequency, punctuality, and velocity of a railway system.

4.3.2. The strategy based on model application.

The model that was previously mentioned was used on the Sri Lanka Railway System to assess the effects of various strategic interventions on the country's rail freight

performance. Data were gathered from local sources, including performance reports from Sri Lanka Railway, statistical reports published by government institutes, reviews of Sri Lanka Railway by various authors, and other pertinent materials. These inputs were utilized within the model to generate outputs. [3], [4], [10], [13], [15], [16]. Based on the findings shown in Table 2, the predicted ton-km in the absence of any intervention amounts to 102.8 million.

Table 2: Model output in different scenarios

Description	Predicted ton-km (MN)	% of Improvement
Without intervention	103	
If Rail efficiency is enhanced by 20%	114	10%
If Privatized	118	14%
If Business Operating Model is Improved	187	81%
If connect with India	253	145%
If focused for profit	261	154%
If all these strategies were implemented	1,673	1,526%

Currently, Sri Lanka Railway operates primarily as a public service entity rather than a profit-oriented organization aimed at generating additional revenue for the nation, a model commonly observed in both freight and passenger transportation sectors. This implies that the railway system prioritizes fulfilling the transportation needs of the public over maximizing financial gains.

However, as evidenced by the model outcomes detailed in Table 2, prioritizing profitability yields a considerable surge in rail freight volume, amounting to a noteworthy 154 percent increase. This indicates that if the focus were shifted towards maximizing profits, there would be a significant boost in the amount of freight transported via rail.

Unlike passenger railways, which directly serve a substantial segment of the populace, freight-oriented rail services primarily cater to enterprises reliant on freight transportation for commercial purposes. This suggests that while passenger travel serves a broader public interest, the imperative for profit-oriented operation is more pronounced in freight transport, as it largely serves the needs of businesses and industries.

Consequently, while passenger travel holds a superior capacity to deliver public benefits, the imperative for profit-oriented operation is more pronounced in freight

transport. Given the current fiscal instability exacerbated by escalating inflation rates, transitioning the entire freight rail infrastructure into a profit-driven enterprise stands to fortify the government's financial position. This means that by commercializing the freight rail system and focusing on profitability, the government could enhance its revenue streams and mitigate financial challenges stemming from economic uncertainties.

The model results underscore the considerable impact of rail connectivity with India on volume growth, revealing a remarkable 145 percent enhancement. Given Sri Lanka's geographical isolation as an island nation, it lacks the inherent advantage of land borders with neighbouring countries to facilitate the expansion of its rail freight operations. However, this limitation presents an opportunity that could be realized through the establishment of a rail bridge, rail tunnel, or train ferry connecting Sri Lanka and India. Such infrastructure would serve to bridge the geographical gap and unlock access to India, the fourth largest volume generator globally. Consequently, the establishment of this connection would exert a substantial influence on the enhancement of rail freight operations within Sri Lanka. Notably, it would position the railway as a more viable solution for freight transportation not only within the country but also with other nations across the Asian continent. This strategic link would not only foster greater trade and economic cooperation between Sri Lanka and India but also facilitate seamless connectivity with key markets in the broader Asian region, thereby amplifying the role of the railway as a pivotal conduit for regional transportation networks and economic growth.

The model suggests an 81 percent increase in performance with an upgraded business operating model. There are two potential approaches to improving the system: infrastructure ownership and management being separated from both passenger and freight operations, or infrastructure being owned by the freight railway. Due to the fact that passenger rail traffic in Sri Lanka outweighs freight railway traffic, it is extremely difficult to implement infrastructure owned by the freight rail.

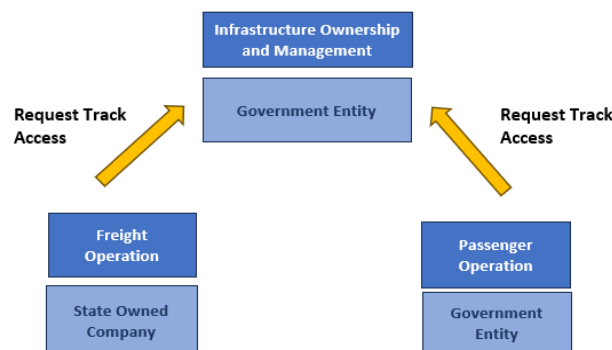


Figure 7: Proposed organizational reform

Hence, the most practical approach would be to segregate infrastructure ownership and management from operations, granting equal access to track and other facilities to both passenger and freight trains as shown in the proposed organizational structure in figure 9.

Railway privatization gives a 14% improvement to freight volume. As internationally practiced, both government and privately owned companies are two possible ways of privatizing railway. As per the current structure of Sri Lanka Railway, which is fully government department, it is suggested to establish government owned railway company to operate the freight operation as a smooth transition. Privatizing freight railway fosters the proposed purpose of profit gain through commercialization. As illustrated in figure 8, passenger railway can continue similar as a direct government entity. When comes to the infrastructure ownership, in many cases infrastructure is held by the government as in Europe and Asia except few market leaders like USA, Canada and Australia. Further the track is laid spanning significant regions of the country, and it has national influence with extensive assert involvement. Therefore, primary network and other superstructures are suggested to be government owned. In this scenario, the infrastructure owner will assume the role of an autonomous governmental entity, requiring freight and passenger operators to remit track access charges to the infrastructure manager for the utilization of the railway track.

In the absence of any additional interventions, a ten percent enhancement in rail freight performance results from a mere twenty percent improvement in rail efficiency. This approach yields a performance enhancement more rapidly than other strategic initiatives. Optimizing punctuality, frequency, time, and cost ultimately increases freight transport volume via the shift from road to rail.

The execution of the strategies is a sequential procedure that concludes once every strategy has been executed. The volume of transport increases by a factor of sixteen, to 1673-ton kilometre, when each of these strategies were implemented. Therefore, the collective execution of these strategies yields superior outcomes compared to their individual implementations.

5. CONCLUSION

The resurgence of rail freight in Sri Lanka presents a substantial opportunity for meeting the growing demand for freight transport, particularly given the congestion challenges faced by road transport. The congestion of roadways in Colombo is primarily attributed to the increased vehicular traffic associated with the heightened movement of freight vehicles concentrated around the Port. Given the globally established cost-effectiveness, reliability, and safety of railway transportation, it

emerges as the most pragmatic alternative to address the prevailing challenges encountered by road users.

Nevertheless, rail freight in Sri Lanka has been in decline, lagging considerably behind global benchmarks. This is attributable to a number of factors, including political interventions, governmental prioritization of public welfare over freight considerations, a frail institutional framework, and the absence of a robust legal structure. The escalation of cost of service, notably due to elevated personnel remuneration, has substantially contributed to mounting financial losses. The prevalence of inadequate punctuality and service failures has primarily stemmed from neglecting freight services in favour of passenger railway operations. Greater end-to-end delivery times and costs have ensued due to the inadequacies of the poorly connected rail network, necessitating a greater reliance on road transport over considerable distances. Moreover, it imposes additional time and cost in the process of transferring freight between road and rail, both from road to rail and vice versa.

Substantial degradation within the industry, falling significantly below global standards, mandates comprehensive modifications from its inception. This imperative underscore the need for detailed consideration of global best practices to elevate the Sri Lanka rail freight industry to international standards. Following a thorough examination of various models devised for assessing rail freight performances, the global strategic rail freight model presented by Warnapura (2024) has emerged as the most fitting for rail freight development [33]. This model has been meticulously crafted, incorporating diverse revival strategies observed worldwide across the realms of policy, law, business and operations.

The approach for revitalizing rail freight operations in Sri Lanka has been formulated by adapting a global model to the specific context of the country. The model recommends a shift in the government's objective for the freight railway system, from a focus on delivering public value to an emphasis on profit generation. This adjustment has the most substantial impact on rail freight performance in Sri Lanka. Aligning with international practices, where freight railways are predominantly commercially oriented with a primary aim of financial gain rather than public service, underlines the inclination for Sri Lanka's railway system to be commercialized, with a strategic focus on profit-oriented objectives.

Moreover, the establishment of rail connectivity with India, characterized by a strong rail freight system, significantly facilitates Sri Lanka's expansion of rail freight activities to an international scale, transcending current domestic limitations. Prospective measures for overcoming the geographical separation between the two nations include the construction of rail bridges, tunnels or having train ferries. Substantive organizational changes within Sri Lanka Railway are essential to allow

the required freedom for independent and commercial operations. In line with the model's recommendations, it is proposed that infrastructure ownership be dissociated from train operations, thereby fostering operational autonomy. Additionally, the privatization of the freight service into a state-owned company is advocated, emphasizing a commercial orientation and an enhancement of customer service. The model further suggests that enhancing service efficiency is crucial for furthering the development of rail freight activities within the country. The model finally recommends that the implementation of all these strategies is important to gain more extensive improvement in rail freight operation in the country.

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