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IDENTIFYING FACTORS THAT AFFECT PRICE DETERMINATION FOR FUEL AND VEHICLES IN SRI LANKA: A SYSTEM DYNAMICS APPROACH

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ABSTRACT

Transportation is crucial for the progress of a nation, and sustainable transportation policies are necessary for long-term development. Among these policies, fuel and vehicle pricing strategies significantly impact the economy, society, and environment. To effectively formulate transportation policies, policymakers must understand the factors influencing policy implementation and explore different approaches to fuel pricing, vehicle pricing, and sustainable transportation. This study aims to develop a comprehensive causal loop diagram (CLD) using the System Dynamics (SD) approach to identify factors and interrelationships within the transportation system. The CLD provides a holistic overview of the complexities and feedback loops inherent to fuel and vehicle pricing policies. The findings contribute to evidence-based decision-making and facilitate the formulation of effective and sustainable transportation policies in the country.

Keywords: *fuel pricing, vehicle pricing, transportation, Causal loop diagram, System Dynamic*

1. INTRODUCTION

The progress of any nation heavily relies on transportation. Adopting sustainable transportation policies is essential to achieve long-term sustainable development. Fuel and vehicle pricing policies play a central role in transportation policies because they significantly impact the economy, society, and environment. To establish efficient procedures, it is important to understand the factors that influence the implementation of transportation policies. The Government of Sri Lanka (GOSL) has adopted several fuel and vehicle pricing measures, including the introduction of Euro IV standard fuel, implementation of the Sri Lanka Vehicle Emissions Test (SLVET) program, and the provision of tax concessions for the import of electric vehicles [1]. However, the issue is the effectiveness of such efforts in achieving sustainable transportation.

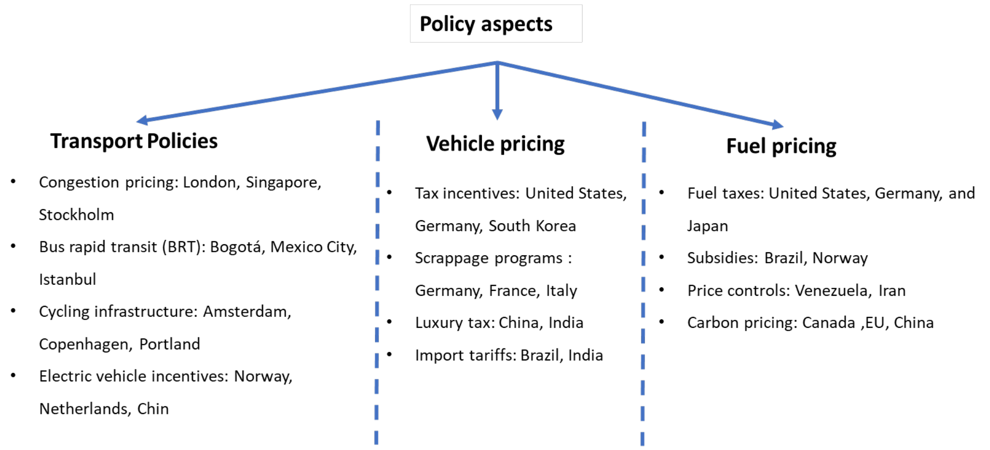

Figure 1: Current policy aspects of the world

Figure 1 illustrates the complexity of fuel prices and vehicle price determination in different contexts. A transport policy like incentivising electric vehicles cannot be implemented alone. Fuel and vehicle pricing will play an integral role in the succession of transport policy. Implementing such incentives requires amendments to the taxation and related tariff systems within the framework of vehicle pricing. Moreover, thorough attention must be given to the price increments for gasoline and diesel. Formulating policy decisions of this nature calls for a comprehensive and holistic overview. Consequently, this study aims to identify factors related to developing a complete causal loop diagram using the System Dynamic approach, specifically focusing on elucidating the interrelationships and feedback loops pervasive within the system.

2. LITERATURE REVIEW

2.1. Introduction

Fuel and vehicles occupy a crucial position in human life as they are essential to meet transportation needs. Fuel emerged as the most extensively consumed primary energy fuel worldwide by 2021 [2]. Approximately 80% of global transportation relies on fossil fuels [3]. Among fossil fuels, petroleum stands as the predominant choice for transportation purposes. In the United States, petroleum products accounted for 90% of the total energy consumption within the transportation sector in 2021 [4].

In addition to emissions, traffic congestion can also give rise to some socioeconomic issues. Policy intervention is required to reduce traffic congestion. The main reason for traffic congestion is the excessive use of private vehicles. The ideal solution to this issue is improving public transportation, another effective solution to the above-discussed problems in achieving sustainable transportation. Traffic congestion leads to an increase in road accidents, too. Fuel pricing, vehicle pricing, and road user charging or congestion charging can be identified as effective policy interventions reducing traffic congestion [5], [6], [7]. These three solutions, fuel pricing, vehicle pricing, and road user charging, can be relied on by transportation policies to reduce congestion and emissions.

Most of the issues associated with traffic congestion prevail in Sri Lanka. There is also an economic impact because both fuel and vehicles are imported. Several types of transportation policies can be identified in the history of Sri Lanka. As per the [8], policy objectives have included adopting accessible transport systems, improving energy efficiency, environmental protection, increasing safety and security, and positively contributing to the economy. On the other hand, Sri Lanka spends more than Rs: one trillion annually on road transportation. More than 50% is spent on fuel, vehicle, and spare part imports [9]. Though the government had planned to adopt a sustainable vehicle or fuel pricing strategy to assist transport policies, it has yet to adopt them. There were some attempts to subsidise electric and hybrid vehicles, but their effectiveness in achieving transport policy goals is unclear. There are indeed procedures to decide on fuel and vehicle pricing, but the question is their effectiveness in terms of congestion reduction or achieving sustainable transportation.

2.2. Current context of the fuel and vehicle pricing

In Sri Lanka, the pricing mechanisms for fuel and vehicles are crucial components of the transportation landscape. Fuel prices are determined by the Ceylon Petroleum Corporation (CPC), a state-owned enterprise, which considers factors such as international market prices, taxes, distribution costs, and government interventions

[10]. The government has introduced a pricing formula for fuel, which is applied regularly based on different criteria. A committee comprising officials from other entities, including the Ministry of Power and Energy, the Ministry of Finance, and the Central Bank of Sri Lanka, determines fuel prices [11].

On the other hand, vehicle pricing involves a complex interplay of factors such as import taxes, manufacturing costs, distribution expenses, and government subsidies or incentives. The largest automobile marketplace in Sri Lanka, Riyasewana, plays a significant role in facilitating vehicle transactions and collaborates with leading finance institutes to provide competitive leasing offers [12].

Government policies and regulations are pivotal in shaping fuel and vehicle pricing strategies. For instance, the government has implemented a cost-reflective fuel pricing formula to alleviate the burden on the state-owned CPC and to establish a more balanced subsidy regime [13].

The current fuel and vehicle pricing methods in Sri Lanka have certain advantages. The fuel pricing formula introduced by the government has contributed to reducing the burden on the CPC and ensuring a more equitable subsidy system. Additionally, these pricing methods generate revenue for the government and contribute to economic stability. In vehicle pricing, government subsidies and incentives have played a key role in making electric vehicles more accessible to the public [13]. However, challenges persist. The lack of transparency in the fuel pricing mechanism has been a significant concern, raising questions about market distortions and potential adverse effects on consumers and the environment. High import taxes have also made vehicles more expensive in Sri Lanka compared to other countries. Comparing Sri Lanka's current fuel and vehicle pricing methods with international practices reveals similarities and differences. While the fuel pricing formula aligns with approaches seen in other countries, the high import taxes in Sri Lanka contribute to a notable discrepancy in vehicle pricing [14].

The Sri Lankan government's attempt to promote transport sustainability is reflected in the 2018 budget. Following are some highlights[15].

- Import taxes on Diesel three-wheelers have been increased by Rs 50,000.
- Taxes on import of Electric Three wheelers, buses & other vehicles reduced.
- Import taxes on vehicles have been revised based on engine capacity.
- Taxes on the import of luxury vehicles increased. The price has been increased by Rs 2.5 million. The luxury tax was imposed on luxury vehicles with engine capacity > 2500cc.
- It has been proposed to revise the loan-to-value ratio for electric buses, three-wheelers, and domestically assembled cars to 90/10.

2.3. System Dynamics

System Dynamics (SD) is a simulation and modelling approach that can be used to understand complex systems. SD focuses on studying the relationships in different components of a system. It helps to identify underlying causes of system behaviour and predict the impact of particular decisions[16]. The System Dynamic approach helps to get a holistic understanding of the complex system by considering the interactions among different components. It helps in decision-making [17]. Some other advantages of SD are that the approach provides insights into the nonlinear behaviours concerning minor changes in the system and predictive ability.

Further, SD helps with the design and evaluation of policies because simulation helps to identify the effects before implementation [18]. On the other hand, developing a proper model takes considerable time and resources. Further, it is a complex process that requires more qualitative data. Another major disadvantage is the uncertainty associated with SD, which affects the reliability of the relationship that is developed[19]. In a study evaluating fuel and vehicle pricing, the SD method can be used to model the interactions between fuel prices, vehicle demand, and market dynamics. The model can incorporate consumer behaviour, economic conditions, government policies, and technological advancements.

2.4. Application of System Dynamics in Transportation Analysis

SD has emerged as a widely applied analytical approach in pricing analysis, particularly in the automotive and energy sectors. Researchers recognise the value of integrating SD principles into pricing models to gain a comprehensive understanding of the intricate dynamics and feedback loops that shape pricing decisions. In this section, the practical application of SD in pricing analysis, drawing insights from relevant studies in the field, will be discussed.

The System dynamic approach has been utilised in determining car pricing and its energy efficiency level versus governmental sustainability goals in South Korea [20]. Here, the focus is on the impact of environmental policies on car manufacturers. The major challenge that car manufacturers face involves determining car prices based on factors such as energy efficiency, energy saving, revenue generation, and advancements in social welfare. A causal loop diagram (CLD) was developed to reflect factors that affect fuel demand and vehicle demand, and which finally relates to the price of the vehicle. Here, a game theoretic approach has been used with SD. In supply chains, the method has been used to decide pricing in a closed-loop supply chain, considering a product exchange program and a full-refund return policy [21].

Several studies have been conducted on the Congestion Pricing Policy (CPP), focusing on the benefits associated with the economic congestion of CPP [22]. A system dynamic simulation model was used to identify and explore the pattern of pedestrian injuries and the impact of CPP. It was determined that the trend of pedestrian injuries has varied based on the changes made regarding the CPP [22]. Further, it has been identified that additional congestion pricing increases will lead to reduced pedestrian accidents. Before implementing regulations, SD models provide a significant tool for extensively assessing both intended and unintentional effects across multiple outcomes.

Further, an SD model is used to analyse the effectiveness of an area-based congestion pricing scheme in reducing traffic congestion. Individual behaviour, driving expenses, and metro transport supply and demand are all factored into the model. It also considers user perceptions and uses fuzzy set theory to analyse travel mode selection and switching behaviour. The study investigates the possible benefits of congestion pricing on alternate modes of transport and congestion reduction. It also recognises the short-term constraints of congestion pricing due to material and information delays. The study attempts to discover the best way to implement the area-based pricing scheme by assessing various policies and important parameter values [23].

Sustainable transportation is another sector where SD is used abundantly [24]. Despite efforts to promote alternative fuels and alleviate environmental repercussions, the transportation sector remains strongly reliant on oil. Existing policies have failed to achieve sustainable mobility goals, with petrol and diesel dominating the market. On the other hand, policymakers and energy corporations can build effective strategies to solve these difficulties using an SD model of the automobile sector. This model can assist energy businesses in adjusting to market transitions and inform the creation of policies that support sustainable mobility. The findings indicate the potential of such a strategy in dynamic industries undergoing significant transformations.

Further, a novel evaluation approach is proposed to address the inadequacies of the traditional benefit-cost paradigm in sustainable transport[25]. The proposed method uses SD, which examines the cause-and-effect interactions in an integrated system. Unlike conventional techniques, which concentrate on marginal alterations, this methodology considers structural and marginal transformations. It includes the economy, society, and environment as interrelated system components. Vertical linkages are reflected in an aggregate sustainability criterion, whereas horizontal links are captured through interactions with inherent dynamics. The methodology includes feedback loops based on changeable limitations and sustainability objectives. This technique allows for a complete evaluation of sustainable transport possibilities.

Finally, using SD in pricing analysis has given valuable insights into the automobile and energy sectors. The influence of environmental policies on car pricing, the effectiveness of congestion pricing in minimising pedestrian injuries, and the benefits of congestion pricing in alleviating traffic congestion have all been studied. Furthermore, SD models have been critical in tackling the sustainability concerns of the transportation sector. Overall, SD provides a comprehensive framework for comprehending and assessing pricing decisions in many industries.

2.5. Importance of CLDs

CLDs are a valuable tool used in various fields to understand and analyse complex systems [26]. CLDs show the causal relationships between different variables, which helps get an in-depth insight into the entire context. One critical feature of CLDs is their ability to uncover feedback loops within a system. Feedback loops can be either reinforcing (positive feedback) or balancing (negative feedback) [27]. By identifying these loops, researchers can better comprehend the underlying mechanisms that drive system behaviour and anticipate potential consequences or unintended outcomes.

Another crucial aspect is that CLDs promote a holistic approach to problem-solving and decision-making[28]. They enable researchers to consider multiple factors simultaneously, visualising the intricate relationships between variables. This comprehensive view assists in avoiding the pitfall of oversimplification and encourages a more nuanced understanding of complex phenomena. Moreover, CLDs encourage interdisciplinary collaboration [27]. Complex systems often involve multiple disciplines, and these diagrams serve as a common language to communicate and integrate diverse perspectives[29]. They facilitate knowledge sharing, encourage exchanging ideas, and foster a more comprehensive analysis by incorporating insights from different fields.

In summary, CLDs play a vital role in literature reviews by enhancing understanding of complex systems and their behaviour. CLDs help identify the holistic approach to understanding the context. Correctly visualising a presentation in CLD helps to get an overall context for a single image. Here, the SD has been selected because they assist in identifying the whole story behind the fuel and vehicle pricing context of Sri Lanka by developing a CLD.

3. METHODOLOGY

3.1. System Dynamic Approach

The importance of this is discussed in the literature review section, along with its pros and cons. As per [30], this study requires the following steps in SD modelling.

3.1.1. Identifying and defining the problem

Identifying and defining the problem or research question is essential in the initial stage of applying SD. This involves developing a clear problem statement, determining the scope and boundaries of the system being studied, and establishing the objectives of the modelling endeavour. This initial step lays the foundation for an effective and focused SD analysis. This step ensures that the modelling efforts are relevant, align with the desired outcomes, and provide a common understanding of the issue to be addressed among stakeholders. [30]

3.1.2. Conceptualization of the system

After identifying the problem and system elements, the next step in the conceptualisation process is to define and map interrelationships between these elements. This step involves graphical representation to establish the study's boundaries and depict the system's causal behaviour. Various visual tools such as CLDs, model boundary diagrams, stock and flow diagrams, and subsystem diagrams can be used for this purpose.

In this case, CLDs have been selected as the method for conceptualisation. CLDs provide a clear understanding of how variables are related within the system. While other ways, like model boundary diagrams and subsystem diagrams, primarily focus on illustrating the system's boundaries and architecture, CLDs emphasise the dynamic relationships and feedback structures of the problem. CLDs visually illustrate the causal influences among variables by connecting them with arrows. Variables are first identified, then the connections between each variable are determined and represented in the diagram.

Overall, CLDs serve as maps showing the system's cause-and-effect relationships. They help construct conceptual models, highlight the dynamic hypotheses of the problem, and provide insights into the behaviour and feedback loops of the system. The software called Venism PLE is used to develop the CLDs.

4. SYSTEM DYNAMICS APPROACH

The primary reason for using SD in this context is to identify the factors associated with fuel and vehicle pricing in the Sri Lankan context. Therefore, the focus is on process modelling using CLD.

The following steps have been developed to identify the factors associated with fuel and vehicle pricing in Sri Lanka.

1. **Defining the problem-** This is the first step of the SD process. In the fuel and vehicle pricing context of Sri Lanka, many associated issues can be defined from the systems perspective to gain entirely sustainable solutions.
2. **Process Modelling-** SD can identify the variables and relationships affecting a particular system. The problems associated with transportation in Sri Lanka can also be considered a process that is iteratively continuing. Therefore, that can be modelled in SD.

4.1. Identifying the problem

Around 2014, the world started to move towards green concepts. GOSL decided to provide low-interest loans for government officers to buy motorbikes. Motorbikes accounted for the highest number of road accidents by that time [31].

The decision to restrict vehicle imports in 2019 was another abrupt decision due to the dollar crisis. There was no proper plan for that. Therefore, the entire industry has been left away while goals are set to be sustainable by 2040[32].

Regarding public transportation, the government introduced the bus lane concept in 2015. However, in 2024, GOSL can still not utilise it properly to reduce traffic congestion even after nine years. The question is whether the Makumbura Multi-Modal Centre has taken advantage of the optimal benefits.

Land transportation, from bus transportation to privately owned cars, in Sri Lanka faces many issues due to a lack of proper policy implementation. Among these, the lack of proper policies to address traffic congestion is a key challenge. Traffic congestion has become a significant problem due to rapid urbanisation and economic expansion. Limited road infrastructure capacity, higher population density, inefficient public transportation system, and inefficient traffic management are some reasons for traffic congestion in Sri Lanka. However, an in-depth study was conducted based on the literature.

Centralising the problem of traffic congestion, CLDs have been developed to identify how fuel and vehicle pricing can be used to overcome the issue sustainably in terms of policy development.

4.2. System Conceptualization

In the methodology section, a CLD was developed to conceptualise the factors affecting fuel and vehicle pricing and their interrelationships relating to traffic congestion. The factors identified during the problem definition stage were used to construct the CLD. Vensim PLE software was employed to create the CLD, facilitating the visualisation and analysis of the complex relationships among the identified variables.

Using a CLD, a visual representation of the feedback loops and causal connections between the different factors was established. This diagram provided a comprehensive understanding of how the variables influenced and interacted with one another within the system. The CLD helped to uncover the underlying dynamics and complexities associated with the problem, allowing for a deeper exploration of the relationships and potential leverage points within the system.

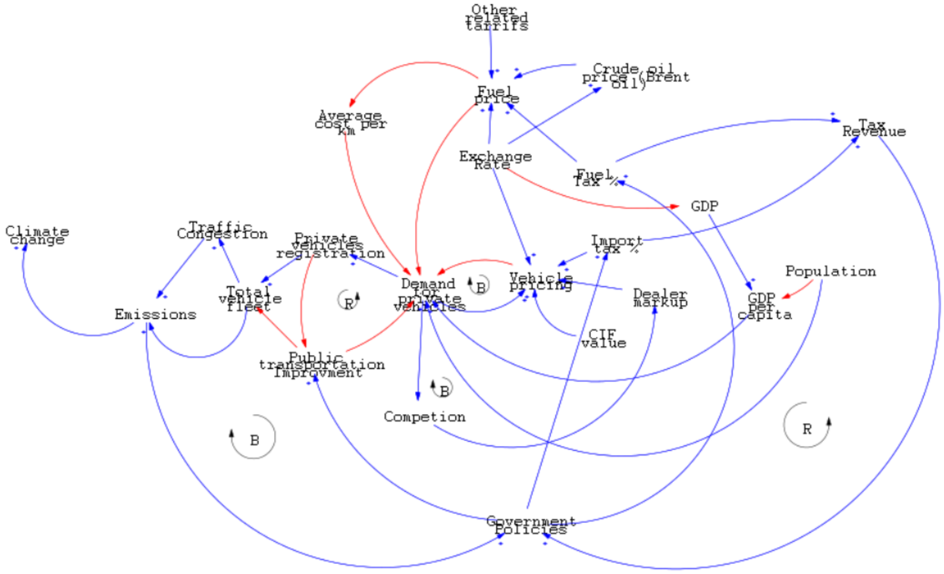

Figure 2: Detailed Causal loop diagram which relates all the variables

The CLD in Figure 2 reveals the presence of five feedback loops within the system under consideration. These loops represent interconnected variables and exhibit looping behaviour, influencing the system's dynamics. Two of the five loops are reinforcement loops, while the remaining three are balancing loops.

The loop that connects emissions, government policies, public transportation, and total vehicle fleet is a balancing loop (Emissions $\xrightarrow{+}$ Government policies $\xrightarrow{+}$ public transportation improvement $\xrightarrow{-}$ Vehicle fleet $\xrightarrow{+}$ emissions). If we start with emissions, when they are increasing, the government will take action to reduce them. Improving public transportation will be such an action. As a result, the total vehicle fleet will be reduced. When the vehicle fleet increases, the emission levels will increase.

A balancing loop connects Demand for private vehicles, market competition, dealer markup, and vehicle pricing. (Demand for private vehicles $\xrightarrow{+}$ market competition $\xrightarrow{-}$ Dealer markup $\xrightarrow{+}$ Vehicle pricing $\xrightarrow{-}$ Demand for private vehicles). If we start with the Demand for private vehicles, when it is increasing, market competition will increase. When market competition is increasing, the dealer markup will be reduced. When the dealer markup increases, the vehicle pricing also increases. Lastly, when vehicle pricing increases, the demand for private vehicles will be reduced.

The loop that connects the Demand for vehicles and vehicle pricing is a balancing loop. (Vehicle pricing $\xrightarrow{-}$ Demand for private vehicles $\xrightarrow{+}$ vehicle pricing). If it starts with vehicle pricing, the demand for private vehicles will be reduced when it increases. When the Demand for personal vehicles increases, the price of the vehicles will increase.

A reinforcing loop connects public transportation infrastructure, demand for private vehicles, and private vehicle registration (Public transport improvement $\xrightarrow{-}$ Demand for $\xrightarrow{-}$ private vehicle registration $\xrightarrow{-}$ Public transport improvement). When public transport improves, the Demand for private vehicles will be reduced. The increasing demand for personal vehicles leads to increased private vehicle registrations. An increase in private vehicle registration leads to a lack of improvements in public transportation.

The loop that connects government policies, import tax percentage, and tax revenue is reinforcing. (Government policies $\xrightarrow{+}$ import tax percentage $\xrightarrow{+}$ Tax revenue $\xrightarrow{+}$ Government policies). Think of the government deciding to increase the revenue; it will lead to an increase in the import tax percentage, an increase in import tax percentage will increase the tax revenue will be increased, and finally, it will lead to an increase in government revenue.

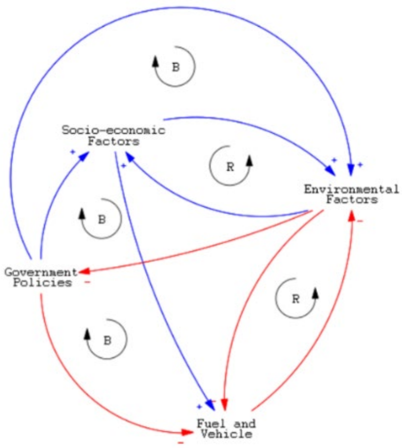

Figure 3: Causal Loop Diagram of Sub Models

This CLD helps to identify the impact of the decision of a particular variable on other variables. It will help policymakers to test the effects of other related variables.

Following is the CLD for sub-models developed by grouping the factors correctly. It will give a macro idea about the whole scenario.

The context is set through four sub-models, including relevant variables. The selected submodels cover Socioeconomic, Environmental, Fuel and Vehicle Factors, and Government policy. Socioeconomic factors include GDP, GDP per capita, population growth rates, import taxes and duties, exchange rates, employment rates, income distribution, education, and urbanisation rates. Environmental factors include environmental regulations, carbon emissions, air pollution, and climate change. Fuel and Vehicle factors consist of variables like crude oil prices, refining and distribution costs, government subsidies, demand for fuel, local manufacturing and assembly costs, cost of raw materials, availability of supply, competition in the market, and overall consumer demand for vehicles. Finally, Government Policies include the stability of government, government regulations and taxes, and energy policies.

As per Figure 3, the system has five loop behaviours with the considered boundary. In this diagram, three balancing loops and two reinforcing loops can be identified.

The loop that connects government policies, fuel and vehicle factors, and environmental factors is a balancing loop (government policies $\xrightarrow{-}$ fuel and vehicle factors $\xrightarrow{-}$ environmental factors $\xrightarrow{-}$ government policies). If we start from government policy factors, the demand for energy and vehicles will be reduced when the government increases the import tariffs and taxes on fuel and vehicles. When there is an increase in fuel and vehicle consumption, it adversely affects environmental factors. When environmental factors are badly affected by the government, the government must protect nature by employing rules and regulations; therefore, the government needs to revise its policy decisions.

The loop that connects government policies, socioeconomic factors, and environmental factors is a balancing loop (government policies, $\xrightarrow{+}$ socioeconomic factors, $\xrightarrow{+}$ environmental factors $\xrightarrow{-}$, government factors). A better increment in socioeconomic factors leads to an increase in sustainability concerns, reducing adverse environmental factors. An increase in destructive impacts on the environment leads to changes in governmental policies. Therefore, the effect is balanced within the loop. The other three loops are associated with two factors.

There is a balancing loop between government and environmental factors (government policies $\xrightarrow{+}$ environmental factors $\xrightarrow{-}$ government policies). When government policies are implemented to align with sustainability, it leads to the betterment of environmental factors. On the other hand, when an adverse impact happens to the environment, there might be stress in revamping policy implementations.

There is a reinforcing loop between socioeconomic and environmental factors (socioeconomic factors, $\xrightarrow{+}$ environmental factors $\xrightarrow{+}$, socioeconomic factors). When there is an improvement in environmental well-being, it improves socioeconomic conditions. Conversely, better socioeconomic conditions will lead to more sustainable activities that serve environmental factors.

There is another reinforcing loop connecting environmental factors and fuel and vehicle factors (environmental factors $\xrightarrow{-}$ fuel and vehicle factors $\xrightarrow{-}$ environmental factors). An increase in fuel and vehicle consumption adversely impacts environmental well-being and increments in environmental regulation might adversely affect demand for fuel and vehicles.

5. IMPLEMENTATION

When it comes to real-world implementation, first, it is necessary to focus on the significant policy decision and how that decision might impact others, as shown in the fishbone diagram in Figure 4.

Think of a policy to reduce the number of fossil fuel-powered vehicles by 20% by 2040. Fuel and vehicle pricing can play an important role there. First, develop a fishbone diagram considering this context's associated areas and variables. Then, based on that, develop CLDs. This stage of CLD development is crucial as it requires brainstorming of experts to get optimal output. The adequately developed CLD will cover all the aspects that require focus and provide how a change of one variable will affect others. Thus, it will provide an overview of the policy's results before implementation.

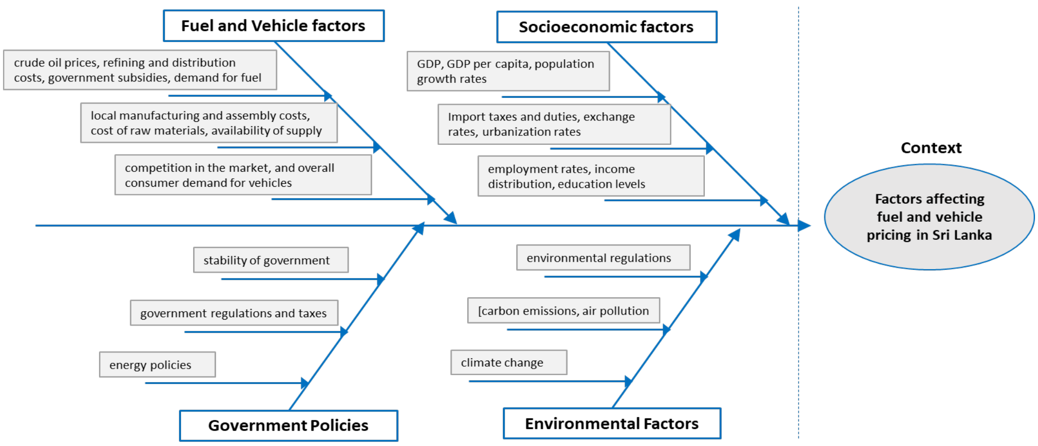

Figure 4: Fishbone diagram of associated aspects of Fuel and vehicle pricing

The final aim of this study is to provide a base for sustainable policy development. Following is an instance where SD can be used in policy development.

Here, a schematic or a design for a policy tool has been suggested based on the findings and learnings of SD. Policy Design can be described as the systematic process of developing effective methods to address complex societal, environmental, and economic challenges. In that process, clear objectives must be established, the environment must be assessed, key change levers must be identified, potential impacts must be quantified, policy options must be considered, cost-benefit analyses must be performed, stakeholders must be involved, the policy tool must be implemented, and its effectiveness must be monitored and evaluated. This systematic approach aids in creating and applying policies that can lead to the intended results and enhance the creation and application of policies that can lead to the intended results and improve well-being.

1	Define the Policy Objective	Total removal of vehicle import restriction and let to go as before 2019					
2	Assess Current Situation						
3	Identify Key Levers	fuel prices, taxes, incentives, vehicle standards, or infrastructure development					
4	Quantify Impact			other relevant parameters			
		fuel consumption	CO2 emissions	Congestion	accidents	travel time	Govt expenditure/ Revenue
5	Consider Policy Options						
6	Conduct Cost-Benefit Analysis	Fuel Saving	CO2 emission reduction	Other relavant parameters			
				congestion redcution	accidents reduction	Travel time saving	Govt net gain

Figure 5: Draft for a policy tool

Following is a demonstration of how to use the policy tool.

Assume the following objective:

- Total removal of vehicle import restriction from 2024 and let to go as before 2019

5.1. Current situation of Sri Lanka

- Going through an economic recession.
- Vehicle importation is banned.
- Fuel for transportation is issued under rationing (QR method)
- Fuel prices
    - LAD-310 (LKR)
    - LSD- 340 (LKR)
    - LP-92- 318 (LKR)
    - LP-95- 385 (LKR)
- The inflation rate is 25.2% as of May 2023
- Current car population-901,070 (11% of the total population)

- Sri Lanka - CO_2 emissions from transport (% of total fuel combustion) will be 47.73 % by 2014 (Assumed to be 50% by now). Assuming the Current car fleet accounts for 10% of CO2 emissions from transportation.

5.1.1. Identify Key Levers

Generally, key levers have been selected as follows. However, in the real context, an in-depth examination is necessary to identify all the key levers.

Table 1: Key levers of the policy tool

Key Levers	Description
Legislative Amendments	Review and modify relevant laws, regulations, and policies to eliminate vehicle import restrictions.
Tariff and Customs Policies	Adjust import tariffs, customs duties, and fees related to vehicle imports.
Trade Agreements	Negotiate and establish trade agreements or alliances that promote open trade-in vehicles.
Administrative Procedures	Streamline administrative procedures and bureaucratic processes related to vehicle imports.
Market Access and Competition	Enhance market access for foreign vehicle manufacturers and promote healthy competition.
Consumer Education and Awareness	Conduct awareness campaigns to educate consumers about the benefits of unrestricted vehicle imports.
Infrastructure Development	Invest in infrastructure to support increased vehicle imports.
Environmental and Safety Standards	Ensure imported vehicles meet required standards for environmental and safety compliance.
Market Monitoring and Regulation	Implement mechanisms to monitor and regulate the vehicle market.

5.1.2. Quantify Impact

In this context, environmental and social impacts should be considered, and the effect should be adequately measured. A few factors have been considered for demonstration purposes covering all the aspects. A few factors have been considered for demonstration aspects. A few factors have been considered, covering all aspects.

- Fuel consumption
- CO_2 emission
- Congestion
- Accidents
- Travel time
- Government Expenditure/ Revenue

5.2. Demonstration of policy tool

The objective: Total removal of vehicle import restriction from 2024 and let to go as before 2019

Assess Current Situation: Current Situation of Sri Lanka is generally described in the section "Current situation of Sri Lanka."

Identify Key Levers: Generally discussed in the section Identify Key Levers".

5.2.1. Quantifying the impact

- Fuel consumption will be increased by 20%
- CO_2 emission will be increased by 12-15%
- Congestion in major cities will be increased by 25-30%
- Travel time will be increased by 35-40%
- Government expenditure for transportation sectors will be increased by 2-3% while the tax revenues are going to be increased by 10-15%

5.2.2. Available policy options

- Fuel pricing formula
- Incentives for electric and hybrid vehicles
- Import restrictions on three-wheeler import

5.2.3. Conduct Cost-Benefit Analysis

When assessing cost, the benefit associated with the "total removal of vehicle import restriction from 2024 and go as before 2019" can be considered a considerable drawback except for the increase in government tax revenue. On the other hand, there is a net disadvantage in all the social, environmental, and economic aspects.

Therefore, revisiting the policy objective again and again is required, and the decision must be made on whether it must be implemented or go back to a worse situation.

6. SUMMARY AND CONCLUSION

This study employs an SD approach to reveal the complex factors shaping fuel and vehicle pricing policies in Sri Lanka, primarily focusing on constructing CLD. These diagrams, offering a holistic view of SD, reveal the interplay among variables, contributing to a nuanced understanding of evidence-based decision-making.

The analysis identifies five feedback loops within the transportation system, encompassing reinforcing and balancing mechanisms. Among these, balancing loops illuminate how government policies respond to environmental impacts and maintain equilibrium, while demand for private vehicles and vehicle pricing showcase balancing interactions influenced by market competition and dealer markups.

In contrast, reinforcing loops highlight the positive feedback from public transportation improvements, reducing demand for private vehicles and increasing government revenue as import tax percentages rise.

These findings support the policy recommendations. First, it emphasizes the integration of sustainability goals into economic growth policies, advocating for stringent emissions standards and incentivizing public transportation enhancements. Second, it underscores the need for fair competition measures, pricing transparency, and adaptable regulations. The manuscript also calls for developing a comprehensive transportation plan balancing private and public transport, prioritizing socioeconomic inclusivity. Dynamic taxation policies promoting eco-friendly vehicle adoption and regular review of tax structures are suggested, along with establishing a robust environmental monitoring system for prompt policy adjustments. Lastly, the study recommends prioritizing sustainable infrastructure investment, particularly in public transport, and collaborating with urban planners for innovative, eco-friendly solutions.

The SD approach, particularly using CLD, helped identify the factors associated with fuel and vehicle pricing in Sri Lanka. The CLDs revealed various feedback loops within the system, including balancing and reinforcing loops, showing the relationships and interdependencies between different variables. These CLDs visually represent the complex dynamics and help policymakers understand the impact of decisions on related variables. The research also proposed a policy tool schematic based on the findings and learnings from the previous objectives. The schematic outlines the systematic process, including defining objectives, assessing the current situation, identifying key levers, quantifying impacts, involving stakeholders, implementing the policy tool, and monitoring and evaluating its effectiveness. This methodical approach aims to develop effective policies that address complex challenges and enhance societal, environmental, and economic well-being. In conclusion, the research findings contribute to a comprehensive understanding of global transportation, vehicle, and fuel pricing policies. The insights gained from analysing the fuel and vehicle landscape in Sri Lanka and using SD approaches can inform the development of strategies and policies to promote sustainable fuel usage, manage fuel prices, regulate vehicle imports, and mitigate environmental impact.

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