UNIVERSITÀ DEGLI STUDI DI PALERMO
Modelli per il miglioramento della performance nel settore pubblico
Doctoral Program in Model-Based Public Planning, Policy Design, and Management
Department of Political Science and International Relations (DEMS)
SECS-P/07

A DYNAMIC PERFORMANCE GOVERNANCE APPROACH TO IMPROVING THE ENVIRONMENTAL PERFORMANCE IN THE FREIGHT TRANSPORT SECTOR

IL DOTTORE
GAETANO SAPORITO

IL COORDINATORE
Chiar.mo Prof. SALVATORE MANCUSO

IL TUTOR
Chiar.mo Prof. FEDERICO COSENZ

CICLO XXXVI
ANNO CONSEGUIMENTO TITOLO 2023

A Dynamic Performance Governance approach to improving the environmental performance in the freight transport sector

Index:

Chapter 3: Designing Dynamic Performance Governance Systems in the freight transport sector

Chapter 4: Applying Dynamic Performance Governance in the French freight transport sector: a case study

Introduction

This thesis highlights that the transport sector is a major source of CO2 emissions by pointing out its effects which could range from negative to disastrous (Intergovernmental Panel on Climate Change, IPCC, 2014). According to recent data from the International Energy Agency (IEA), transportation continues to depend on oil products for 91% of its final energy, a decrease of only 3.5 percentage points since the early 1970s[1]. Over time, CO2 emissions from the transport sector have continued to be generated mainly by road transport. The freight transport sector can be defined as a complex system and a wicked problem. The freight transport sector is a complex system because of the continuous changes in the impacts on the environment mainly caused by CO2 emissions and the complexity on the government of this sector because of the many entanglements between several actors at the organizational level and inter-organizational level. The freight transport sector is also defined as a wicked problem. Wicked problems are contrary to their tame counterparts, which are simple to define and formulate and have a high potential for standard or routine solutions (Head & Alford, 2015). Here it is important to note that the word "wicked" does not necessarily indicate "evil" but rather refers to issues that are challenging to define and manage (Australian Public Service Commission, 2007; Head & Alford, 2015). Because the freight transport sector can be classified as a complex system and a wicked problem, it presents several challenges to reduce its impact on the environment. In order to reduce the environmental consequences, nowadays, public agencies and national governments are trying to promote sustainable development. Here, Sustainable Development Goals (SDGs) are among the most important tools to reach sustainable development. The Voluntary Environmental Programs (VEPs) represent a policy lever to reduce the CO2 emissions in the freight transport sector and are, therefore, crucial to reach the SDGs.

Despite their many benefits, VEPs have limitations. The complexity of the transport and logistics sectors, as well as the involvement of various private and public actors, increases the risk of dysfunctions. These dysfunctions hinder the attainment of the

[1]https://www.iea.org/energy-system/transport

desired VEPs outcomes and generate short-term interests of the organizations involved (Bivona & Bilek 2021). This thesis will highlight the lack of the adoption of the collaborative governance approach in VEPs which can lead to failure in achieving the predetermined results as the main limitation. A collaborative governance approach, which can help to overcome the limits of VEPs and support more effective implementation in the freight transport sector, could therefore foster the reduction of CO_2 emissions. Moreover, the Dynamic Performance Governance (DPG) approach as a systemic methodological approach will be suggested. Hereby, the underlying idea is to support decision-makers at the policy and management levels in formulating and implementing more effective policies/strategies in reducing the environmental impact of the transportation sector, as well as being able to improve the coordination of each actor being involved and to support collaborative governance. Moreover, the DPG method using System Dynamics (SD) models - which have successfully supported a descriptive perspective in policy evaluation and performance management - facilitates communication and sharing of comprehension of the reasons and effects behind the observed governance structure between network members (Bianchi et al., 2019).

In the empirical part, the thesis focuses on a case study in France which gives an overview of a voluntary program in France: the EVE program "Engagements Volontaires pour l'Environnement" (Voluntary Commitment to the Environment) which aims at increasing transportation operator efficiency and decreasing greenhouse gas (GHG) emissions. In a next step, the main motivations and barriers to promote VEP in the transport industry that emerged from field research conducted with a sample of logistics service providers engaged in the EVE program in France will be identified. The result is then used to build a DPG chart and a Causal Loop Diagram (CLD), including the feedback mechanisms that impact the performance of VEP in France. Finally, an SD model is used to investigate alternative policies to increase the performance of the EVE program in France (Bivona et al., 2023).

The advantages of the DPG and SD approaches, the limits and further research on this relevant topic are mentioned in the conclusions.

Chapter 1: The transport sector

1.1 Introduction

This chapter, first of all, provides an overview of the transport sector, highlighting transportation as a major source of CO_2 emissions (Intergovernmental Panel on Climate Change, IPCC, 2014).

Secondly, different scenarios about the future of the transport sector related to fuel demands and CO_2 emissions are highlighted.

Moreover, this chapter focuses on the freight transport sector to understand its impact on the environment, analyzing, in particular, the environmental impacts of international freight transport. An overview is illustrated by analyzing the different impacts of several freight transport methods: shipping, air transport, trucking, and rail.

In addition, the freight transport sector is defined as a complex system mainly because of its multitude of actors and the variations in the structure over time. For these reasons, how these characteristics contribute to defining the freight transport as a wicked problem will be highlighted.

Furthermore, the Sustainable Development Goals (SDGs) followed by the national governments and public agencies are also introduced. This chapter illustrates also how the transport sector plays a relevant role in achieving sustainable development. Although there is no specific SDG for transportation, it is represented in several SDG targets and acknowledged as a prerequisite and enabler for attaining many SDGs (United Nations. Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference, 2021). As a result, how the RFT (Road Freight Transport) sector is an important industry in achieving the SDGs will be underlined.

Furthermore, the research objectives, the thesis's process design, and the conclusions are highlighted.

1.2 An overview of the transport sector: inter-organizational attributes, structures, trends, and policy issues

The recorded increase in the Earth's average temperature is referred to as "global warming" and is well-documented. This is due to the accumulation of major greenhouse gases in the atmosphere brought on by the continuous burning of fossil fuels and changes in land use over the 20th century (Weubles & Jain, 2001).

Transport is a major source of CO_2 emissions, the most significant Greenhouse gas (GHG), and its effects could range from negative to disastrous if global warming exceeds the 2 C safety threshold. GHG concentrations in the atmosphere must be stabilized to keep global warming below 2 C, eventually necessitating net zero annual emissions (Intergovernmental Panel on Climate Change, IPCC, 2014).

The amount of CO_2 emitted globally has increased since the United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994 (UNEP, 2016), with some regions of the world, such as China and India, experiencing significant increases in their overall emissions, and others, such as Europe, experiencing decreases (Olivier & Muntean, 2014). Transport-related CO_2 emissions have persisted, even in areas where other sectors' emissions are largely down (European Commission, 2015). For instance, total GHG emissions in Europe declined by approximately 18% between 1990 and 2012, whereas transportation-related emissions increased by about 14% during the same period (Eurostat Statistics, 2015).

According to the IPCC (Intergovernmental Panel on Climate Change) past research, CO_2 levels are expected to rise over the next century from 369 parts per million to between 540 and 970 parts per million (Nakicenovic & Swart, 2000). According to Watson (2001) past research, this amounts to an increase in world average temperatures of 1.4 to 5.8 °C, and as a result, there will be more extreme weather occurrences and a rise in sea levels.

As previous research has shown, transport has long been one of the largest sectors in terms of energy use and CO_2 emissions. Road transport accounts for 81% of all energy use by the transportation industry (Figure 1b), with oil as the primary fuel source (Figure 1a). Due to its reliance on fossil fuels, transportation is one of the few industrial sectors with rising emissions and contributes significantly to greenhouse gas emissions (WBCSD, 2001).

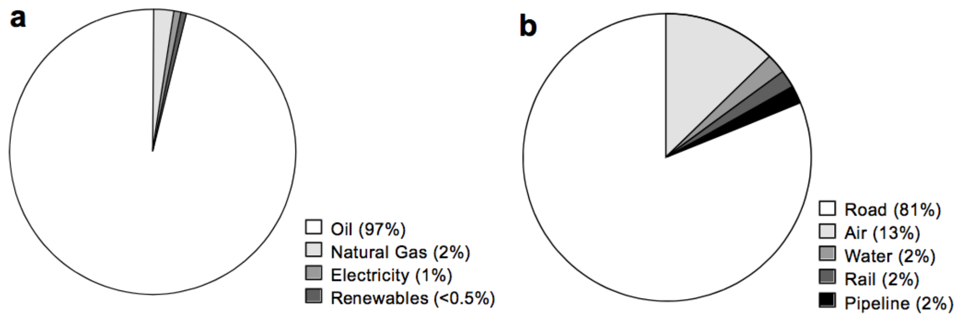

Figure 1. *"(a) Fuel use in the transportation sector in OECD (Organization for Economic Cooperation and Development) countries and (b) shares of transport modes in OECD countries."* Source: IEA, 2002. Adapted from (Chapman, L. (2007).

Transportation was one of the primary areas that the 1997 Kyoto protocol aimed to address. By 2012, it was intended to cut global greenhouse gas emissions by 5.2% from 1990 levels. Therefore, since the agreement's signing in 1997, transportation has taken a prominent place on the political agendas of the 38 developed nations (Chapman, 2007).

Figure 2 (a) demonstrates that the transportation industry is responsible for 26% of worldwide CO2 emissions (IEA, 2000), with about two-thirds of those emissions coming from the wealthier 10% of nations (Lenzen et al., 2003). Although the motor car is not completely to blame for all these emissions, road transport is the largest emitter of greenhouse gases in the transportation industry (Figure 2b). Although buses, taxis, and intercity coaches contribute significantly to road transport, road freight normally makes up slightly under half the total (Chapman, 2007).

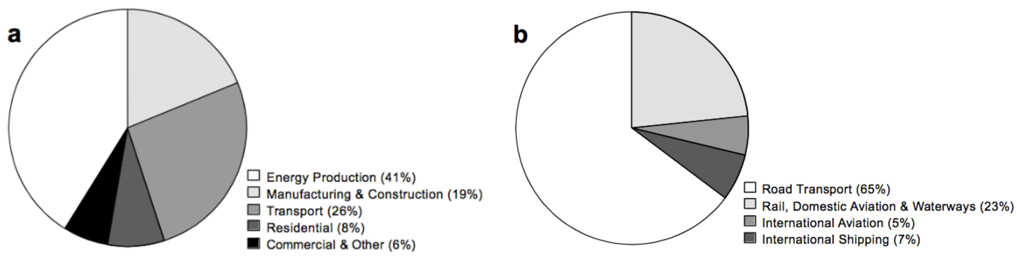

Figure 2. *"(a) Carbon dioxide emissions per sector and (b) carbon dioxide emissions per transports sector."* Source: IEA, 2000. Adapted from (Chapman, L. (2007).

As shown in the figure 3 (a) and (b), all transportation sectors are growing, and sadly, there is a general tendency that the modes with the greatest growth are also the most polluting.

(a)
Modal split of passenger transport energy consumption in OECD countries with projected annual growth rates in parentheses (*Source:* Lenzen et al., 2003)

Mode	North America	European OECD	Pacific OECD
Cars	57 (+1.4)	54 (+1.7)	57 (+1.2)
Railways	1 (+0.4)	1 (+1.0)	3 (+0.9)
Buses	1 (+1.5)	3 (+1.3)	1 (+0.8)
Aviation	8 (+2.3)	8 (+4.5)	5 (+3.3)

(b)
Modal split of freight transport energy consumption in OECD countries with projected annual growth rates in parentheses (*Source:* Lenzen et al., 2003)

Mode	North America	European OECD	Pacific OECD
Trucks	24 (+2.0)	30 (+2.2)	25 (+1.9)
Railways	7 (+1.6)	3 (+0.1)	3 (+1.8)
Shipping	2 (−0.7)	1 (+0.1)	5 (+0.2)

Figure 3. *(a) Modal split of passenger transport and (b) Modal split of freight transport*. Adapted from (Chapman (2007).

The motor car is a major obsession in the developed world. The car is the second-largest source of greenhouse gas emissions in the transportation sector (after road freight). While technological advancements could eventually result in lower fuel consumption and emissions, these gains will be in the short term mitigated by rising ownership and use of cars (WBCSD, 2001). Congestion is a growing issue in many towns and cities worldwide, since the existing infrastructure cannot handle significant growth in the number of motor vehicles. Moreover, the increase in number of motor vehicles contribute to a growth in air pollution and CO2 emissions (Chapman, 2007).

In particular, an ongoing environmental burden is an increase in road freight. 43% of all transportation energy is used to move freight, and slowly moving vehicles significantly increase highway traffic congestion (WBCSD, 2001). Figure 3 (b) reveals that trucks are not only the most common method of transportation but also the one with the quickest growth rate in energy consumption. Trucks do, in fact, account for the majority of CO2 emissions from freight relative to GDP, especially in small countries where trucks are a more practical alternative than other means of transportation (Schipper & Fulton, 2003).

Additionally, aviation pollution is a problem for the environment since it affects local and regional ecosystems and the global environment due to its massive emissions of pollutants that affect global climate change. Commercial aviation has expanded dramatically despite having a brief history. Since 1960, passenger traffic has increased by around 9% per year, though this growth slowed in 1997 as the sector started to mature, to approximately 5% (IPCC, 1999).

According to Somerville (2003), aviation is a crucial component of the global economic system. However, increasing the number of aircraft will cause landing delays, reducing fuel efficiency, increase greenhouse gas emissions, and ultimately result in institutional failure and an unsustainable airport expansion program. These increases have a variety of reasons. For example, travel is made simpler by cheaper and more frequent flights (Chapman, 2007).

To reduce the negative environmental effects of short-haul aviation and road transportation, a modal shift to rail has been suggested (Shaw et al., 2003). Wheels on rails are recognized as an environmentally conscious mode of transportation because it is twice as effective for moving freight and four times as efficient as using the road for people (Bonnafous & Raux, 2003). However, to make rail an attractive and practical alternative for travelers, it must be completely integrated with other forms of transportation, such as buses, and capable of handling challenging routes, such as interstate travel (Chapman, 2007).

In addition, in low-income communities, people frequently use buses because they are the only option besides driving a car locally (WBCSD, 2001). Unlike railways, buses do not require specialized infrastructure and can be easily deployed in response to changing demand (DfT, 2004a).

Other transport solutions with zero CO2 emissions are walking and cycling. However, during the past 20 years, both cycling and walking have considerably decreased (DfT, 2004b). Several psychological and sociological reasons, including a general lack of fitness, fear of criminality, and unfavorable weather, impact this modal choice. This decline closely matches the rise and affordability of motor vehicles (Black et al., 2001).

More in detail, as mentioned above, road transport represents the largest producer of CO2 in the transport sector (Chapman, 2007).

Since they were the first major emitters, as indicated in Figure 4, ships and rail continue to have relatively higher relevance in accumulated CO2 than in current emissions (Uherek et al. l., 2010).

	2000		Cumulative 1900–2000	
	Emissions Tg CO_2	Share [%]	Emissions Tg CO_2	Share [%]
Road	4282	72.3	114,494	55.1
Rail	124	2.1	20,913	10.1
Maritime shipping	626	10.6	31,940	15.4
Aviation	688	11.6	16,890	8.1

Figure 4. *"Emissions of CO2 from transport in 2000 and cumulative emissions 1900e2000. Derived from calculations condensed in Fuglestvedt et al. (2008)."* Adapted from (Uherek et al. l., 2010).

However, after 1910, road traffic quickly surpassed all other forms of transportation in importance. Road vehicles have significantly increased, as shown in Figure 5 (Uherek et al. l., 2010).

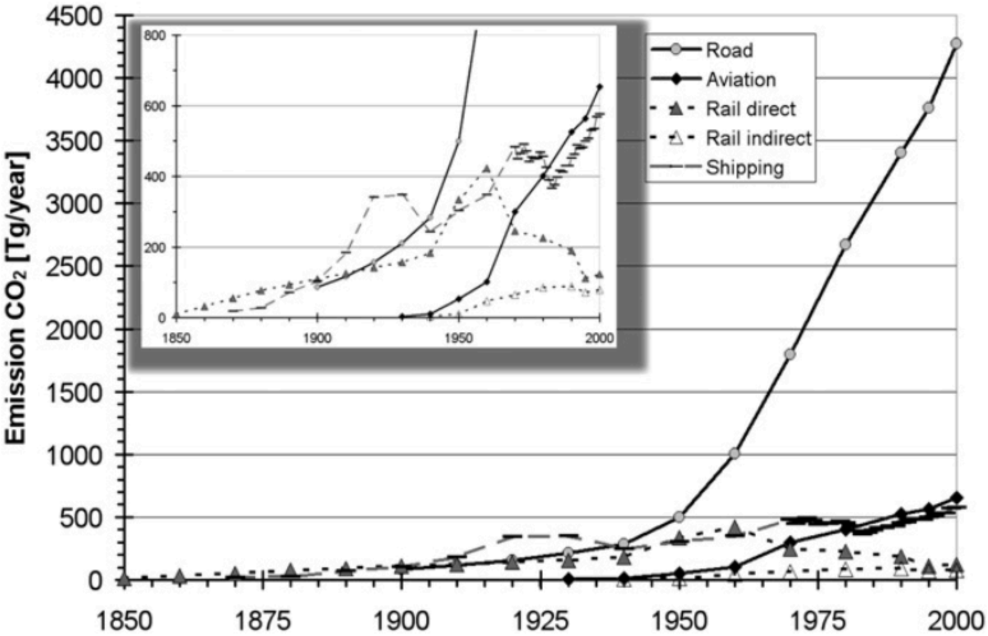

Figure 5. *"CO2 emissions from the transport sector 1900e2000 (from Fuglestvedt et al., 2008). The inset shows the lower values with a higher resolution of the y-axis."* Adapted from (Uherek et al. l. 2010).

In 1907, there were approximately 140,000 cars on American roads. By 1927, there were more than 20 million. After the Second World War, and with a delay of nearly 30 years, a similar process occurred in Europe. There were fewer than ten automobiles per 1000 inhabitants in the United Kingdom in 1960. Within 40 years, this number increased to 400 or more, increasing the country's oil consumption. A similar process begins in East Asia with a shift of another 30 years. So, as mentioned above, the fastest-growing end-user industry for CO2 is transportation. The increase in the transport sector over time has had several impacts. In particular, the Arctic regions are most affected, which alters the terrain's suitability for land transportation. Higher latitudes may experience better winter road conditions, which could impact business operations (ACIA, 2004)[2]. On the other hand, increased temperatures may negatively affect permafrost zones, reducing the winter driving season (Instanes et al., 2005).

Until the end of the century, sea levels are predicted to increase by 18 to 59 cm, with the possibility of an extra rise driven on by the rapid melting of glaciers, particularly in the Arctic, which would damage coastal settlements and transportation infrastructure. The snow cover is projected to decrease, as well as the sea ice. The waters are warming, favoring stronger tropical cyclones that cause more damage along the coast. Some areas will experience more severe droughts due to uneven rainfall distribution. Extreme precipitation and storms may produce, among other things, traffic restrictions, highway and railroad closures, train delays, and train cancellations (O'Brien et al., 2004).

Different methods are used to make scenarios about the transport sector's future. On a worldwide or supranational scale, road transportation scenarios have primarily concentrated on fuel use and associated CO2 emissions. As highlighted by (Uherek et al., 2010), the following categories can be used to categorize significant road transport emission scenarios:

1. Occasionally referred to as frozen policy, current legislation, or do-nothing scenarios, these scenarios examine the effects of policies that have been in place up until a given point in time. They might be used as examples of what happens when autonomous advances occur without any additional (external) action, measure, or policy;
2. Some scenarios presuppose the continuing of specific historical tendencies, as well as high probability policies or measures that will be introduced shortly in addition to all existing policies or measures. These kinds of situations are often known as trend, forecast, or business as usual scenarios;

[2]www.acia.uaf.edu

3. Other scenarios aim to examine the effects of certain policies that are not necessarily scheduled for adoption yet, of technologies that are still in development, or of other developments that have yet to be observed. These situations, which typically call for an active shift from precedent, might be referred to as policy scenarios;

These three hypothetical situations all involve forecasting: the analysis starts with a given (historical) year and generates, in our example, estimations of future fuel consumption and emissions that are likely, plausible, or practicable. Future outcomes are uncertain and not necessarily predetermined (Uherek et al. l., 2010).

4. In contrast, in backcasting scenarios, the future state is prescribed, such as in terms of energy consumption or emissions, then the developments are determined inversely. These hypothetical situations are used to examine potential pathways and the necessary adjustments to structures, behavior, and technology, which often go much beyond the assumptions of business as usual in order to reach a desired target state.

It is critical to remember that scenarios are not predictions of the future. Scenarios summarize what is known today and what is expected to happen (Uherek et al. l., 2010).

Every year, the US Energy Information Administration releases its International Energy Outlook. Under the "frozen policy" assumption, the future supply and demand of fuels are projected. Unenacted policies are not considered for version 2006 (US-DoE, 2006). It is not assumed that there will be autonomous trends; rather, new technologies are only considered if regulated[3]. According to these assumptions, the transport sector's global fuel demand is anticipated to rise by nearly 50% between 2000 and 2030 (Uherek et al. l., 2010).

This prognosis has hardly changed for the most recent 2009 version (US-DoE, 2009). Given the different absolute consumption levels, non-OECD countries represent approximately two-thirds of the total increase in demand. In 2030, they will account for more than 40% of the total global fuel demand in the transport

[3]John Maples, US-EIA, pers. comm. 6 May 2009

sector. Average growth rates in non-OECD countries are projected at about 2.3% per year, almost a factor 3 higher than in OECD countries (0.8% p.a.). The EIA does not expect an increase in the use of biofuels in the transportation industry. As a result, worldwide CO_2 emissions from transportation are anticipated to increase at the same rate as fuel demand (Uherek et al. l., 2010).

Fulton and Eads (2004) estimated fuel consumption and exhaust emissions from transportation globally for a group of manufacturers, suppliers, and oil firms. Future improvements in vehicle mileage, fuel economy, and exhaust pollution management are predicted using historical patterns. It is expected that developing nations will eventually adopt exhaust emission regulations that are equally strict as those in industrialized nations. For OECD nations, data quality is seen as good; for developing nations, it is often considered inadequate. Actuality, the so-called "Reference Case," makes the same assumptions for all developing regions collectively and without distinction, such as for vehicle mileage, emission factors, fuel and vehicle shares, change rates, etc. The "Reference Scenario" can be categorized as a "business as usual" scenario. According to these assumptions, global road passenger travel is expected to expand by 40% and 90% in 2030 and 2050, respectively, while road freight transport is projected to increase by 125% and 240% within the same time frame. The OECD areas experience growth and stability in transport volumes, whereas developing nations are predicted to experience the fastest growth rates. Fuel consumption and CO_2 emissions from road transportation are predicted to rise from the year 2000 by 64% and 118% until 2030 and 2050, respectively, under the assumption of improved autonomous vehicle efficiency.

The Energy Technology Perspectives 2050 (ETP) was also created by the International Energy Agency (IEA, 2006, 2008b). A "business as usual" scenario is created for 2050 based on the World Energy Outlook published by the agency (IEA, 2008a). The aim is to examine this "Reference Scenario" to understand two current policy options. These current policy options are intended to analyze the potential fuel usage and CO_2 emissions reductions under rosy technological and policy assumptions. Data are only provided for the entire transportation industry; approximately 80% of overall demand was fulfilled by road transport. The 2008 version of Energy Technology Perspectives 2050 (IEA, 2008b) reflects an increased governmental focus on carbon emissions reduction, fuel efficiency improvements, and the eventual electrification of road transportation. In comparison to the level in the year 2000, it is predicted that the global demand for transportation fuel will rise by more than 60% and approximately 140% by 2030 and 2050, respectively.

Compared to the previous estimation (IEA, 2006), the projected increase in the business-as-usual case is around 5% higher. It is slightly higher than Fulton and Eads' projection (2004) (Uherek et al. l., 2010).

According to recent data from the International Energy Agency (IEA), transportation continues to depend on oil products for 91% of its final energy, a decrease of only 3.5 percentage points since the early 1970s[4].

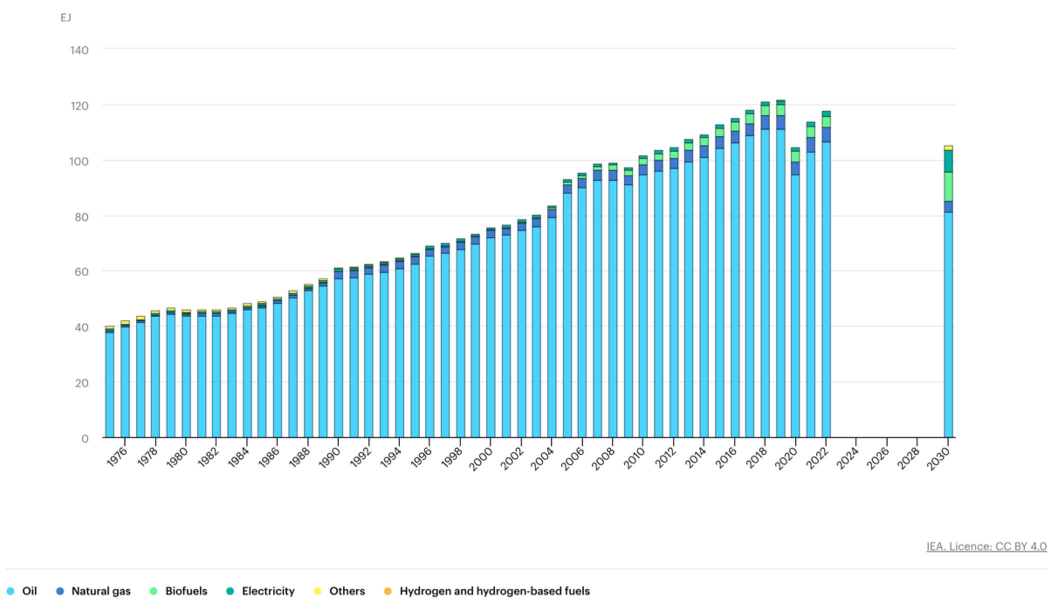

Figure 6. "Energy consumption in transport". Source: IEA (2023), World Energy Balances[5]

As can be seen from Figure 6 above, energy consumption in transport remained mainly dominated by oil products over time[6].

[4]https://www.iea.org/energy-system/transport
[5]https://www.iea.org/data-and-statistics/data-product/world-energy-balances.
[6]https://www.iea.org/energy-system/transport

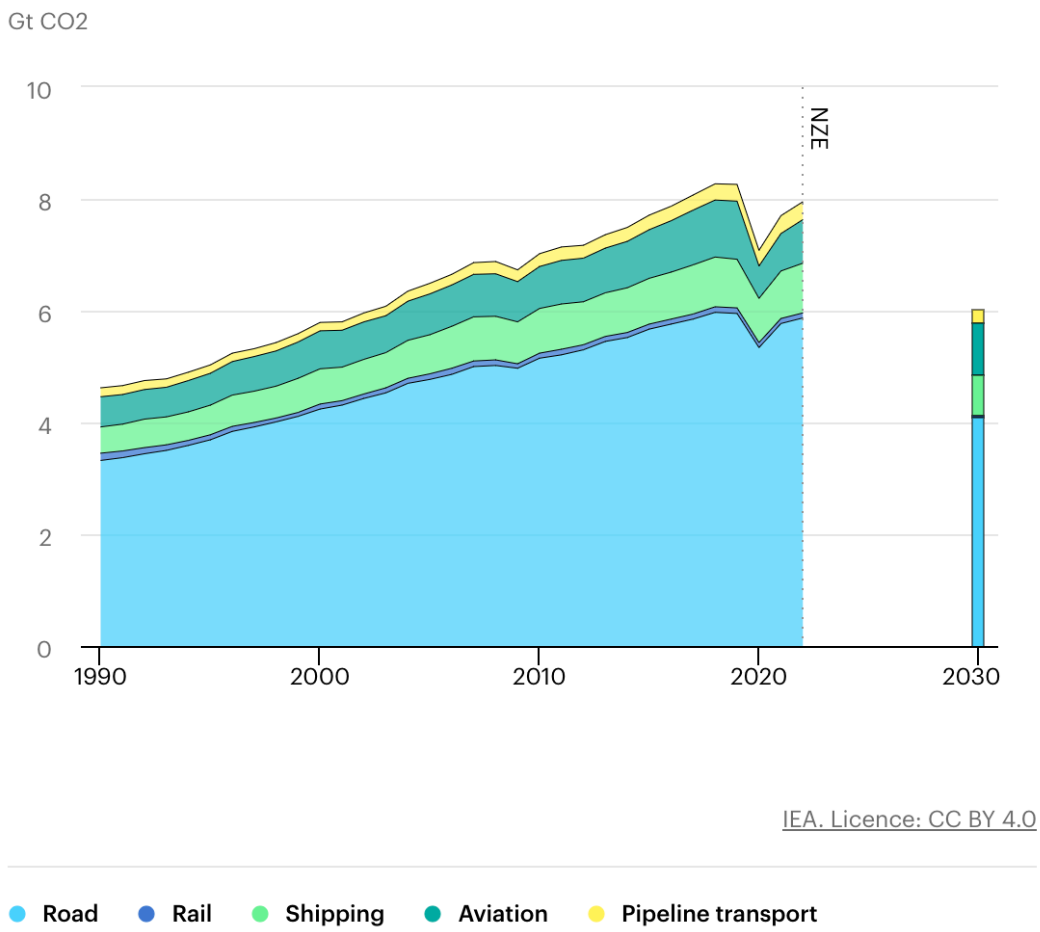

Figure 7. “Global CO2 emissions from transport by sub-sector”. Source IEA (2023), Greenhouse Gas Emissions from Energy[7].

As can be seen from the figure 7 above, the CO2 emissions in the transport sector remained over time produced mainly by road transport. More in detail, global CO2 emissions from the transportation industry increased by more than 250 Mt CO2 in 2022, reaching over 8 Gt CO2, 3% more than in 2021. Aviation accounted for the majority of the rise, as air traffic recovered from pandemic lows to almost 70% of 2019 levels. EVs continued to gather speed in 2022, with over 10 million cars sold worldwide, accounting for 14% of total car sales. Emissions are still lower than in 2019, reflecting the pandemic's ongoing effects on passenger and cargo activities. Keeping on track according to the Net Zero Emissions (NZE) Scenario would necessitate a 25% reduction in transportation emissions to about 6 Gt by 2030,

[7]https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy.

despite expected increases in demand. The rapid electrification of road vehicles, operational and technical energy efficiency measures, commercialization and scale-up of low-emissions fuels, particularly in the maritime and aviation sub-sectors, and policies to encourage modal shift to less carbon-intensive travel will be required to achieve this reduction[8].

In detail, the Net Zero Emissions by 2050 Scenario (NZE) is an IEA normative scenario that depicts a path for the global energy industry to reach net zero CO2 emissions by 2050. This scenario also satisfies important energy-related United Nations Sustainable Development Goals (SDGs), including universal energy access by 2030 and significant improvements in air quality. It is consistent with limiting global temperature rise to 1.5 degrees Celsius.[9]

The next paragraph will focus on the freight transport sector and its impact on the environment.

1.3 The freight transport sector and its impact on the environment

The previous section makes an overview of the transport sector, highlighting in detail the structure and different scenarios for the future regarding fuel demand and CO2 emissions.

As mentioned briefly in the previous section, the environment is impacted by transportation in several ways. Emissions contribute to air pollution and climate change, noise generates health concerns and nuisances, and infrastructure significantly and negatively impacts the environment and ecosystems. The combined effects of the many freight and passenger transportation modes constitute the transportation industry's overall effects (Van Essen, 2008).

This paragraph focuses on the freight transport sector and its environmental impact. The freight transportation market comprises several submarkets that interact but do not actually compete with one another. Distribution of goods occurs at the regional level, primarily using small and medium-sized vehicles. The long-distance global flows between the various continents, where maritime shipping is the primary means of transportation, are on the other side of the spectrum. The international

[8] https://www.iea.org/energy-system/transport
[9] https://www.iea.org/reports/global-energy-and-climate-model/net-zero-emissions-by-2050-scenario-nze

transportation market, which may be defined as the transport chain between the shipment of goods among the continents and the regional distribution networks, is located in the middle. Road and rail transportation are the most significant modes in this intra-continental international freight transport sector. However, inland and short-sea shipping are also significant in some regions of the world (Van Essen, 2008). In particular, the environmental impacts of international freight transport will be analyzed. A major concern of modern society is climate change. More and more data has emerged over the past few decades to support the idea that greenhouse gas emissions are a factor in the effects of global warming. A significant component is the emission of carbon dioxide (CO_2) from the combustion of fossil fuels. The CO_2 emissions from burning fossil fuels account for most greenhouse gas emissions in the transportation industry. These have a close connection to energy use in transportation.

Moreover, air pollution from transportation affects people, the biosphere, soil, water, buildings, and materials. Additionally, noise presents several negative impacts on human health. Community noise, particularly road noise, has been identified by the World Health Organization (WHO) as a severe public health issue (Van Essen, 2008). There are several adverse effects of traffic noise. In particular, people are most disturbed by the effect of annoyance. Furthermore, there is strong evidence that the noise from traffic contributes to significant health issues. The main issue is sleep pattern disturbance, which impacts cognitive function (particularly in children) and increases the risk of developing certain cardiovascular diseases. Additionally, there is growing evidence that noise might affect blood pressure (Den Boer & Schroten, 2007).

Currently, transport volumes for freight are rapidly increasing. Economic growth is what drives this expansion. Eliminating internal borders and other market barriers also helps boost growth in various parts of the world, most notably in the European Union (Van Essen, 2008).

Azar et al. 2003 evaluated the expansion of freight transportation globally between 1990 and 2100. The same study also provides estimations for energy use in 2100. Figure 8 presents the findings of this evaluation (Azar et al., 2003; IRF, 2007).

	Transport volume in Ttkm/year		Energy demand (EJ/year)	
	1990	**2100**	**1990**	**2100**
Road	6.4	40	23	72
Rail	6.1	13	3.1	4.3
Domestic water	2.6	5.0	1.2	1.6
Ocean	29	126	5.8	16
Air	0.07	0.28	0.32	0.62
Total	*44*	*184*	*33*	*95*

Figure 8. *"Growth in global freight transport volumes."* Source: (Azar et al., 2003)

The predicted growth in the volume of freight transportation is most substantial for road transportation, as shown in Figure 8. The global energy demand for freight transportation is projected to triple despite anticipated improvements in fuel efficiency. This demonstrates that the growth in transportation is the primary factor contributing to the rising energy demand for freight transport (Van Essen, 2008). A similar picture emerges from evaluations of the EEA (European Economic Area). In Europe, freight transport volume growth is rapid and outpaces economic expansion (EEA, 2008a).

As mentioned before, the leading cause of the rising energy consumption for freight transportation is increased transport volume, particularly for road freight. Between 2000 and 2030, the amount of road freight transport in the European Union is expected to rise by 78%. This denotes growth that is even more robust than in the previous 20 years (Smokers *et al.*, 2007).

The modal split varies greatly between nations. Both China and Russia have substantially higher rail than road share. In Russia, the volume of freight transported by rail is several times greater than that transported by road. While the shares of the two modes of transportation are more or less equivalent in the United States, only a small portion of the inland freight market in Europe is controlled by rail transportation. Figure 8 and other estimates show that the share of road transport is likely to rise sharply globally. Both the number of vehicles and vehicle kilometers increase with the growth in the volume of road freight transport. A global estimation of the number of trucks used for the transport of freight is shown in Figure 9. Over the following decades, the number of trucks is projected to increase further (Van Essen, 2008).

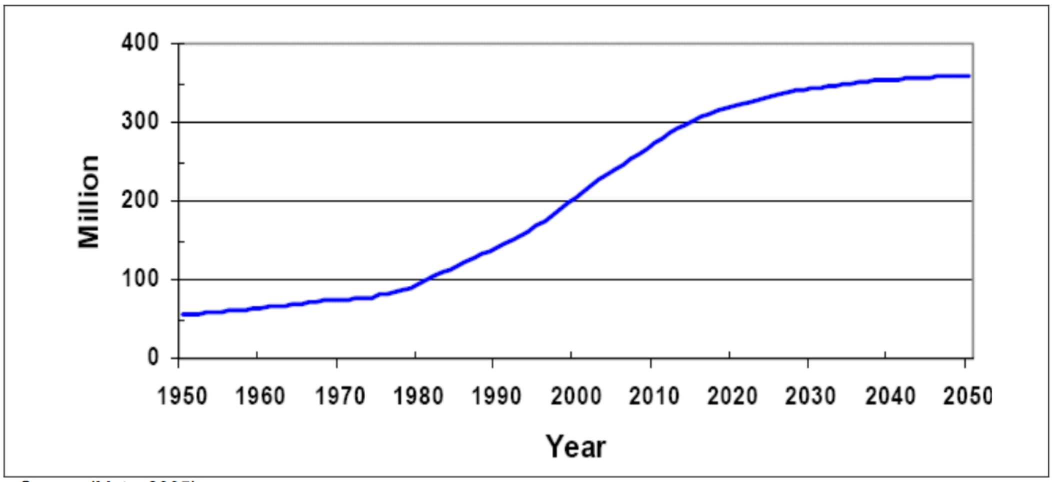

Figure 9. *"Estimated trend of the worldwide number of freight vehicles."* Source (Metz, 2005)

Only a small portion of freight transportation is global. Each continent has a different percentage of its overall freight volume that crosses international borders (Van Essen, 2008).

Switzerland, Norway, and the Russian Federation account for three-quarters of all international road transport with non-EU nations. In the European Union, international road freight transportation volume increased by 25% compared to 12% between 2000 and 2005 (EC, 2007). In North America, international transport accounts for only around 8% of all road freight transport (US Department of Transportation, 2006; IRF, 2007). Only 5% of all freight rail transport in North America is conducted internationally. The few (extremely large) countries involved help to explain these tiny shares: the only international surface transportation in North America is that which connects Canada, the United States, and Mexico (Van Essen, 2008).

The international transport of goods generates different environmental impacts. An overview will be illustrated, analyzing the diverse impacts of the varying freight transport methods. It will be analyzed, particularly the impact of shipping, air transport, trucking, and rail.

Both on interior waterways and in the ocean, shipping is hazardous to the environment. When filled with freight, ships are made to navigate the ocean safely. They fill their tanks with ballast water while the ships are empty to stabilize and weigh them down as they cross the ocean. They discharge the ballast water, whose weight will be replaced with freight, before they arrive at the port where they will load up. The water discharged is often mixed with oil and probably other contaminants in the ballast tanks. As a result, its discharge contributes to water pollution. A related source of pollution is bilge water, seepage that builds up in a ship's hold and needs to be routinely discharged (Hecht, J. (1997).

Moreover, given that plastics are buoyant and durable, their dumping at sea poses a severe threat to the environment. These plastics materials are used to pack break bulk freight to prevent the freight from shifting as the boat travels (GESAMP, 1990).

Aquatic species can be shipped successfully from one planet region to another. Most of the time, these so-called "exotic" species are transported via ballast water, although they can also attach to boat hulls or penetrate freight. Most exotic invaders do not survive in their new environment, so they do not significantly impact the ecology or the economy. Their most expensive effect has been to block water intake pipelines and valves in power plants, necessitating costly repairs and technological upgrades to avoid future issues (National Ocean Pollution Program, 1991).

Air transport is another means of transport for freight that impacts the environment. Less than 1% of all freight worldwide is carried by air, although this number is rising quickly. Furthermore, concerns about aviation emissions have increased with growing global warming concerns. Consequently, beyond its current importance as a method of transportation, air freight merits examination (Hecht, J. (1997). In particular, takeoff and landing aircraft emissions contribute to traditional air pollution and global warming. Global warming is a result of airplane emissions. Around airports, there are significant problems with noise, pollution, traffic, and other land-use issues. However, drawing a connection between these effects and air freight is challenging. Two-thirds of air freight is reportedly transported on commercial passenger aircraft, and it is anticipated that future increases in air freight will be handled similarly (Snape & Metcalfe, 1991; (Hecht, J. (1997). Assigning the expenses of air pollution and noise for one-third of air freight transported by cargo planes is simple. It is challenging to determine which externalities to attribute to passenger travel and which to assign to cargo for the two-thirds carried in passenger craft (Hecht, J. (1997).

Nitrogen oxides, carbon monoxide, and hydrocarbons are among the low-altitude airplane emissions. They are transformed into ozone and other pollutant substances. Aircraft emissions are small compared to road traffic and other transportation methods but are growing faster than other emission sources (Vedantham & Oppenheimer, 1994). High-altitude aircraft emissions are a substantial source of greenhouse gases. However, the precise amount and impact are still the subject of intense scientific discussion (Vedantham & Oppenheimer, 1994; Crayston, personal communication).

Moreover, people who live or work close to airports find them a major nuisance. Noise from airplane takeoffs and landings is the main issue. The air pollution is produced by aircraft and the cars used to transport passengers and freight to the airport. In some cases, the associated industrial development that may be built near the airport is a second issue (Hecht, J. (1997).

Another means to transport freight is represented by trucking. Trucking's environmental effects have gotten much attention, especially compared to rail. Air pollution and noise are the two main quantified environmental risks of trucking. Additionally, the use of trucks contributes to environmental stressors associated with land use and the environmental effects of accidents. Truck air pollution emissions have been estimated in various ways based on factors such as miles driven, the weight of the freight being transported, the amount of energy used, and more. They differ greatly even when calibrated in the same units. However, they provide a general understanding of the significance of the air pollution caused by trucks. Trucks may be a more critical contributor to road noise compared to other freight transportation. (Hecht, J. (1997).

Also, rail is another means of transportation for freight. Compared to trucking, railway transportation is considered less damaging to the environment. Without a doubt, this is supported by data on air pollution. Although less evident in noise, the rail may also be less damaging. Compared to trucks, rail is typically thought to cause less noise pollution. This is mostly because highway noise, which includes truck noise, tends to be relatively constant in contrast to train noise, which is intermittent (Hecht, J. (1997).

Trucks are considerably more polluting than trains or boats, as figure 10 below demonstrates, despite a significant range in estimates within each mode of transportation.

Pollutant	Truck	Rail	Marine
CO	0.25 - 2.40	0.02 - 0.15	0.018 - 0.20
CO_2	127 - 451	41 - 102	30 - 40
HC	0.30 - 1.57	0.01 - 0.07	0.04 - 0.08
NO_x	1.85 - 5.65	0.20 - 1.01	0.26 - 0.58
SO_2	0.10 - 0.43	0.07 - 0.18	0.02 - 0.05
Particulates	0.04 - 0.90	0.01 - 0.08	0.02 - 0.04
VOC	1.10	0.08	0.04 - 0.11

Figure 10. *"Air Emission Factor Ranges for Truck, Rail, and marine, in grams/tonne-Km."* Source: (Hecht, J. (1997).

1.4 Framing the freight transport sector as a complex system: wicked problems and related challenges

The freight transport sector can be defined as a complex system. For example, according to Goldenfeld and Kadanoff, complexity denotes variations in a structure (Goldenfeld & Kadanoff, 1999). Moreover, as mentioned by Whitesides and Ismagilov, a complex system is one whose evolution is very sensitive to initial conditions or to tiny perturbations, one in which there are numerous independent interacting components or one in which the system can evolve along a variety of different ways (Whitesides & Ismagilov, 1999). Rind states that a complex system has numerous interactions between diverse components (Rind, 1999).

The freight transport sector is a complex system - because of the continuous changes in the impacts on the environment mainly generated by the CO2 emissions, the complexity on the government of this sector, both at an organizational level and inter-organizational level related to the several actors involved in it - and can be defined as a wicked problem.

Wicked problems are contrary to their tame counterparts, which are simple to define and formulate and have a high potential for standard or routine solutions (Head & Alford, 2015). Since the environment they affect is so complicated, the word "wicked" does not necessarily indicate "evil" but rather refers to issues that are challenging to define and manage (Australian Public Service Commission, 2007; Head & Alford, 2015).

Rittel and Webber (1973) proposed ten features that are reported and summarized as follows in order to characterize "wicked" problems in a better way:

1. There are no criteria for framing issues in complex contexts because they arise in open systems. Hence there is no conclusive formulation. The formulation of a wicked problem is a problem of its own. This is since the knowledge we require to comprehend wicked problems depends on the approach we choose to solve them and the biases we bring to the discussion.
2. The difficulty of addressing a wicked problem is identical to the process of understanding it. Hence there is no stopping rule for them. The first claim states that the causal chains connecting the steps reached in understanding them in open systems, have no endings.
3. The evaluation of the solutions offered to handle wicked problems is influenced by the interests, the value set, and the ideological predilections of who is judging. Solutions are not true or false but good or bad. Since social facts cannot be categorized as absolutely true or untrue, it is preferable to convey their evaluation as "good or bad," "better or worse," "satisfying," or "good enough."
4. A solution cannot be tested because, if implemented, a wave of unintended consequences will result, making it impossible to isolate the solution. For instance, short-term solutions could seem to work in complex systems, but their real effects will not be evident until significantly later.
5. Trial and error learning are not an option when dealing with wicked problems because every implemented solution has consequences and cannot be removed. Suppose we invest the necessary funds to create a new road to relieve congestion. In that case, we cannot easily return those funds if the road's performance is unsatisfactory, and its effects will have a long-term influence on the lives of those affected. Therefore, every trial counts when the acts' repercussions have extended half-lives and are irrevocable.
6. They do not have an innumerable list of options. Often several solutions may be found for a wicked problem, but another set of options is never

considered. When problems are not clearly defined, the range of potential solutions depends on realistic assessment and the feasibility and validity of the suggested actions.

7. There are no classes of wicked problems; each problem is distinct. Even though several wicked problems may appear similar, we can never be sure that a problem's unique characteristics do not override its similarities to other problems already solved.
8. Every problem is a symptom of another problem because problems are the difference between "what is" and "what should be." We must first comprehend the cause of the discrepancy to find solutions. Removing the identified cause creates a new problem: the first plan was a symptom. The new problem can therefore be seen as the symptom of another problem that is "at a higher level," and so on. In wicked contexts, this is what takes place. Because "every try counts," addressing the symptoms may make it more challenging to solve the root problem (see proposition 5). Fragmented governances are an example of this, where symptoms are experienced by single players who address them at their level without addressing the underlying cause.
9. There are several ways to explain the existence of a discrepancy that poses a wicked problem. The nature of the problem's resolution depends on the explanation chosen: because wicked problems are unique (see statement 7) and there are not many opportunities for rigorous experimentation, we cannot deal with them using a linear reasoning model and test a hypothesis (see proposition 5). People frequently select explanations based only on their own goals and believability.
10. There is no tolerance for failed experiments. Thus decision-makers have no right to make mistakes. Decision-makers are made responsible for the results of the decisions they make. Their proposed solutions are further complicated by a second set of problems brought on by the public's increasing plurality.

Because the freight transport sector can be classified as a wicked problem, it presents several challenges to reducing the environmental impact. Nowadays, to reduce the environmental impact, public agencies and national governments are trying to promote sustainable development. In this regard, among the most important tools to reach sustainable development, there are the Sustainable Development Goals (SDGs).

1.5 An introduction to SDGs applied to the freight transport

As mentioned in the previous paragraph, national government and public agencies focus on promoting sustainable development. In this regard, sustainable development is characterized as the *‘‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’’*. This definition is now widely used to characterize sustainability, as defined in the 1987 United Nations publication "Our Common Future," better known as the Brundtland Report (WCED, 1987). According to these definitions, sustainable development prioritizes environmental protection while fostering the current and the next generation's economic and social progress and welfare (Hansmann et al., 2012). As a result, social, economic, and environmental sustainability are the three interconnected concepts of sustainable development, or the three major pillars (Purvis et al., 2018). It is acknowledged that to achieve responsible and sustainable development, environmental, human, and economic capital should be considered in every action or decision (Hansmann et al., 2012). The United Nations Millennium Declaration, which aimed to develop an international alliance to reduce levels of extreme poverty worldwide, was adopted following the Millennium Summit in New York City in 2000. The 8 Millennium Development Goals (MDGs) are a series of eight objectives that address various social, economic, and environmental issues. These eight Millennium Development Goals are highlighted in figure 11. Member states and other organizations took a variety of initiatives to assist the 8 Goals to be achieved by 2015 (Halkos & Gkampoura, 2021). According to the 2015 MDG evaluation report (United Nations, 2015a), significant progress has been made over the past 15 years (Halkos & Gkampoura, 2021).

Figure 11. *"Millenium Development Goals."* Source: United Nations (2015c)

So far, the world continues to face significant problems and challenges. The core of the 2030 Agenda for Sustainable Development, which the United Nations Member States adopted in 2015, comprises the 17 SDGs. In order to solve social, economic, and environmental problems and promote sustainable development, this agenda aims to create a global partnership. To develop a more sustainable world by 2030, deliberate strategies regarding the issues of individuals and prosperity, the planet and partnership, and peace will need to be undertaken and put into action (United Nations, 2015b). Figure 12 illustrates the 17 Sustainable Development Goals (SDGs).

Figure 12. *"Sustainable Development Goals."* Source: United Nations (2015b)

The MDGs were replaced with the SDGs, which addressed all unfinished goals and considered new problems while incorporating lessons learned from the MDGs' execution (Kumar et al., 2016).

The SDGs differ from the MDGs in terms of purpose, conception, and politics, according to Fukuda-Parr (2016). The MDGs primarily addressed poverty and underdeveloped nations, but the SDGs are a worldwide project emphasizing sustainable development. The SDGs, which include additional goals and targets, cover a wider range of topics and more aspects of sustainable development (Fukuda-Parr, 2016) while emphasizing the human development and human rights components that the MDGs did not include (Kumar et al., 2016). The SDGs are also thought to integrate the three pillars of sustainable development more effectively, which results in systemic reforms that set the stage for a more sustainable future (Costanza et al., 2016).

In particular, sustainable development depends on sustainable transportation. In global discussions and international forums, sustainable transportation has become increasingly important. The 1992 Rio de Janeiro, Brazil, United Nations Earth Summit recognized the importance of transportation for sustainable development and strongly emphasized it in its outcome document, Agenda 21. After that, during the 2002 World Summit on Sustainable Development in Johannesburg, South

Africa, the significance of transportation was once again reflected in the document that served as its conclusion, the Johannesburg Plan of Implementation (JPoI). Transportation and mobility are crucial to sustainable development, according to The Future We Want, the final document of the 2012 United Nations Conference on Sustainable Development (Rio + 20). The 2030 Agenda for Sustainable Development, which contains 17 SDGs and calls for bold and ambitious action for the well-being of people and the planet, was endorsed by world leaders in New York in 2015, establishing the route for building a sustainable future. Although there is no specific SDG for transportation, it is represented in several SDG targets and acknowledged as a prerequisite and enabler for attaining many SDGs. Thus, the SDGs provide fundamental building blocks that can be used, such as universal access to safe, affordable, and sustainable transportation systems, energy efficiency, road safety, the creation of resilient infrastructure, the promotion of health, and the combating of climate change. The 17 SDGs of the 2030 Agenda for Sustainable Development have been considered integral and indivisible since its conception. Some SDGs, such as SDG target 3.6 on road safety, SDG target 9.1 on infrastructure, and SDG target 11.2 on providing access to safe, affordable, accessible, and sustainable transport systems for all and expanding public transportation, are directly related to sustainable transport through specific targets and indicators. Due to sustainable transportation's importance in facilitating other SDGs, many more are indirectly related. Achieving other SDGs and associated goals can also make creating and accessing sustainable transportation systems easier. To accelerate progress towards achieving the SDGs and climate objectives, various stakeholders must consider the interconnections between sustainable transport and various SDGs and targets, as well as the interdependencies among nations and stakeholders. The involvement and interaction of various stakeholders, including policymakers, transport engineers and economists, social scientists, health professionals, urban and regional planners, and the private sector, is also necessary to ensure that transportation infrastructure and services are inclusive and sustainable (United nations. Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference, 2021).

In this regard, since the road freight transport (RFT) sector is associated with significant environmental concerns due to the usage of petroleum-based fuels to power vehicles, it is crucial to the achievement of a sustainable future. More in detail, according to Sharma and Strezov (2017), the road freight transport (RFT) sector is the primary contributor to global pollution emissions and the primary source of greenhouse gases (GHG) (Sharma & Strezov, 2017). Moreover, RFT is a significant industry in the global economy and directly impacts the effectiveness of national economies (Nowakowska-Grunt & Strzelczyk, 2019). As a result, the RFT sector plays a key role in achieving the SDGs.

1.6 Research objectives and process design

The thesis has several research objectives. First of all, as illustrated above, the first chapter is oriented to highlight the transport sector, focusing on the freight transport sector and its impact on the environment. The second chapter aims to introduce Voluntary Environmental Programs (VEPs) to reduce CO2 emissions in the freight transport sector and pursue the Sustainable Development Goals (SDGs). The third chapter will suggest a systemic methodological approach, the Dynamic Performance Governance (DPG) approach, to support decision makers at the policy and management levels in formulating and implementing more effective policies/strategies in reducing the environmental impact of the transportation sector, as well as better coordinating the actions of each actor involved. The fourth chapter of the thesis is oriented on applying a Dynamic performance Governance (DPG) approach to the French freight transport sector.

1.7 Concluding remarks

This chapter has given an overview of the transport sector, highlighting how transportation represents the largest sector concerning CO2 emissions. Future trends in the transport industry were provided. It illustrated how freight transport is increasing over time and how it has various environmental impacts. It has also highlighted that national governments and public agencies are focusing on promoting sustainable development and following the SDGs. Moreover, it was illustrated that the transport sector plays a key role in achieving sustainable development and achieving Sustainable Development Goals (SDGs). The next chapter is oriented toward explaining the SDGs related to the freight transport sector in more detail. Moreover, it illustrates the Voluntary Environmental Programs (VEPs) as a tool to reduce the CO_2 emissions in the freight transport sector and, as a result, pursue the Sustainable Development Goals (SDGs).

References:

ACIA, 2004. Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press.

AUSTRALIAN PUBLIC SERVICE COMMISSION (2007). Tackling wicked problems: A public policy perspective. Commonwealth of Australia, Barton.

AZAR, C., LINDGREN, K., & ANDERSSON, B. A. (2003). Global energy scenarios meeting stringent CO2 constraints—cost-effective fuel choices in the transportation sector. Energy Policy, 31(10), 961-976.

BLACK, W.R., 2001. An unpopular essay on transportation. Journal of Transport Geography 9, 1–11.

BONNAFOUS, A., RAUX, C., 2003. Transport energy and emissions: rail. In: Hensher, D.A., Button, K.J. (Eds.), Handbooks in Transport 4: Handbook of Transport and the Environment. Elsevier, pp. 293–308.

CHAPMAN, L. (2007). Transport and climate change: a review. Journal of transport geography, 15(5), 354-367.

COSTANZA, R., DALY, L., FIORAMONTI, L., GIOVANNINI, E., KUBISZEWSKI, I., MORTENSEN, L.F., PICKETT, K.E., RAGNARSDOTTIR, K.V., DE VOGLI, R., WILKINSON, R., 2016. Modelling and measuring sustainable wellbeing in connection with the UN sustainable development goals. Ecol. Econom. 130, 350–355.

DEN BOER, L.C., AND A. SCHROTEN (2007), Traffic noise reduction in Europe - Health effects, social costs and technical and policy options to reduce road and rail traffic noise, CE Delft, Delft, the Netherlands, 2007.

DFT, 2004A. The Future of Transport, A Network For 2030. UK Department for Transport, Crown Copyright 2004, 140pp.

DFT, 2004B. Walking and Cycling: An Action Plan. UK Department for Transport, Crown Copyright 2004, 68pp.

EC (2007), *EU Energy and transport figures – Statistical pocketbook 2006*, European Commission, Brussels, 2007.

EEA (2008A), *Climate for a transport change*- TERM 2007: indicators tracking transport and environment in the European Union, EEA, Copenhagen, Denmark, 2008.

EUROPEAN COMMISSION, 2015. Climate Action: Reducing Emissions from Transport. http://ec.europa.eu/clima/policies/transport/index_en.htm.

EUROSTAT STATISTICS, 2015. Greenhouse Gas Emission Statistics. http://ec.europa.eu/eurostat/statisticsxplained/index.php/Greenhouse_gas_emission_statistics.

FUKUDA-PARR, S., 2016. From the millennium development goals to the sustainable development goals: shifts in purpose, concept, and politics of global goal setting for development. Gend. Dev. 24 (1), 43–52.

FULTON, L., EADS, G., 2004. IEA/SMP Model Documentation and Reference Case Projections. International Energy Agency (IEA)/World Business Council for Sustainable Development (WBCSD). pp. 1e92.

GESAMP, the IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (1990), The State of the Marine Environment. (Oxford:Blackwell Scientific Publications)

GOLDENFELD, N., & KADANOFF, L. P. (1999). Simple lessons from complexity. *Science, 284*, 87–89.

HALKOS, G., & GKAMPOURA, E. C. (2021). Where do we stand on the 17 Sustainable Development Goals? An overview on progress. *Economic Analysis and* Policy, 70, 94-122.

HANSMANN, R., MIEG, H.A., FRISCHKNECHT, P., 2012. Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability. Int. J. Sustain. Dev. World Ecol. 19 (5), 451–459.

HEAD, B. W., & ALFORD, J. (2015). Wicked problems: Implications for public policy and management. *Administration and Society, 47*(6), 711–739.

HECHT, J. (1997). The Environmental Effects of Freight, Organization for Economic Co-operation and Development.

IEA, 2000. International Energy Agency. CO_2 Emissions From Fuel Combustions 1971–1998. 2000 Edition. OECD, Paris

IEA, 2008a. World Energy Outlook 2008. International Energy Agency, Paris/France.

IEA, 2008b. Energy Technology Perspectives 2008 e Scenarios & Strategies to 2050.

IEA/OECD, 2006. Energy Technology Perspectives 2006 e Scenarios & Strategies to 2050.International Energy Agency (IEA).

INSTANES, A., ET AL., 2005. Infrastructure: Buildings, Support Systems, and Industrial Facilities. ACIA. Arctic Climate Impact Assessment Cambridge University Press, 934 pp.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Core Writing Team: R.K. Pachauri and L.A. Meyer (eds.)], IPCC, Geneva, Switzerland. http://ar5-syr.ipcc.ch/.

INTERNATIONAL ENERGY AGENCY, 2006. Energy Technology Perspectives 2006: Scenarios and Strategies to 2050: In Support of the G8 Plan of Action. Organisation for Economic Co-operation and Development, 479 pp.

IPCC, 1999. IPCC Special Report: Aviation and The Global Atmosphere. Intergovernmental Panel on Climate Change, 12pp.

IRF (2007), *World road statistics 2007 – Data 2000 to 2005*, International Road Federation (IRF), Geneva, Switzerland.

KUMAR, S., KUMAR, N., VIVEKADHISH, S., 2016. Millennium development goals (MDGS) to sustainable development goals (SDGS): Addressing unfinished agenda and strengthening sustainable development and partnership. Indian j. community med. off. publ. Indian Assoc. Prev. Soc. Med. 41 (1), 1.

LENZEN, M., DEY, C., HAMILTON, C., 2003. Climate change. In: Hensher, D.A., Button, K.J. (Eds.), Handbooks in Transport 4: Handbook of Transport and the Environment. Elsevier, pp. 37–60.

METZ (2005), World Wide Emission Trend 1950 to 2050 Road Transport and all Sources, Eurochamp Workshop in Andechs, Chemistry, Transport and Impacts of Atmospheric Pollutants With Focus on Fine Particulates, 10. -12.

October 2005, www.eurochamp.org/datapool/page/28/Metz.pdf, site visit: 21 March 2008.

NAKICENOVIC, N., SWART, R., 2000. IPCC Special Report: Emissions Scenarios. Cambridge University Press, UK, pp. 570.

NATIONAL OCEAN POLLUTION PROGRAM (1991), "Federal Plan for Ocean Pollution Research, Development and Monitoring: Fiscal Years 1992-1996" Prepared by the National Ocean Pollution Program Office (National Oceanic and Atmospheric Administration, US Department of Commerce) for the National Ocean Pollution

NOWAKOWSKA-GRUNT, J., & STRZELCZYK, M. (2019). The current situation and the directions of changes in road freight transport in the European Union. *Transportation Research Procedia*, *39*, 350-359.

O'BRIEN, K., SYGNA, L., HAUGEN, J.E., 2004. Vulnerable or resilient? A multi-scale assessment of climate impacts and vulnerability in Norway. Climatic Change 64, 193e225.

OLIVIER, J.G.J., MUNTEAN, M., 2014. Trends in Global CO2 Emissions: 2014 Report. PBL Netherlands Environmental Assessment Agency and Institute for Environment and Sustainability of the European Commission's Joint Research Centre, The Hague. http://edgar.jrc.ec.europa.eu/news_docs/jrc-2014-trends-in-global-co2-emissions-2014-report93171.pdf.

RIND, D. (1999). Complexity and climate. *Science, 284*, 105–107.

RITTEL, H. W., & WEBBER, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155–169.

SCHIPPER, L.J., FULTON, L., 2003. Carbon dioxide emissions from transportation: trends, driving forces and forces for change. In: Hensher, D.A., Button, K.J. (Eds.), Handbooks in Transport 4: Handbook of Transport and the Environment. Elsevier, pp. 203–226.

SHARMA, A., & STREZOV, V. (2017). Life cycle environmental and economic impact assessment of alternative transport fuels and power-train technologies. *Energy*, *133*, 1132-1141.

SHAW, J., WALTON, W., FARRINGTON, J., 2003. Assessing the potential for a 'railway renaissance' in Great Britain. Geoforum 34, 141–156.

SMOKERS, R. ET AL., (2007), *State-of-the-Art CO_2 en Mobiliteit*, CE Delft, Delft, 2007.

SNAPE, D.M. AND M.T. METCALFE (1991), "Emissions from Aircraft: Standards and Potential for Improvement" In Kroon et al, eds.

SOMERVILLE, H., 2003. Transport energy and emissions: aviation. In: Hensher, D.A., Button, K.J. (Eds.), Handbooks in Transport 4: Handbook of Transport and the Environment. Elsevier, pp. 263–278.

UHEREK, E., HALENKA, T., BORKEN-KLEEFELD, J., BALKANSKI, Y., BERNTSEN, T., BORREGO, C., ... & SCHMID, S. (2010). Transport impacts on atmosphere and climate: Land transport. *Atmospheric environment*, *44*(37), 4772-4816.

UNEP (2016). The Emissions Gap Report 2016. United Na ons Environment Programme (UNEP), Nairobi

UNITED NATIONS, 2015A. Millennium development goals UNDP. Availableonline:https://www.undp.org/content/undp/en/home/sdgoverview/mdg_ goals. Html

UNITED NATIONS, 2015B. The 17 goals. Available online: https://sdgs.un.org/goals

UNITED NATIONS, 2015C. United nations millennium development goals. Available online: https://www.un.org/millenniumgoals/

UNITED NATIONS. Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference. 2021.

US DEPARTMENT OF TRANSPORTATION (2006), *North American Freight Transportation – U.S. trade with Canada and Mexico*, US Department of Transportation, Washington, USA, 2006.

US-DOE, 2006. International Energy Outlook 2006. U.S. Department of Energy, Energy Information Administration, Washington, DC, USA, 192þX pp.

US-DOE, 2009. International Energy Outlook 2009. U.S. Department of Energy, Energy Information Administration, Washington, DC, USA, 127þX pp.

VAN ESSEN, H. (2008, November). The environmental impacts of increased international road and rail freight transport–past trends and future perspectives. In Global Forum on Transport and Environment in a Globalising World, Guadalajara, Mexico.

VEDANTHAM, ANU AND MICHAEL OPPENHEIMER (1994), Aircraft Emissions and the Global Atmosphere: Long-term Scenarios. (New York: Environmental Defense Fund, 1994)

WATSON, R.T., 2001. IPCC Special Report: Climate Change 200: Synthesis Report. Cambridge University Press, UK, pp. 398.

WBCSD, M. (2001). World Mobility at the End of the Twentieth Century and Its Sustainability. World Business Council for Sustainable Development, Switzerland.

WEUBLES, D.J., JAIN, A.K., 2001. Concerns about climate change and the role of fossil fuel use. Fuel Processing Technology 71, 99–119.

WHITESIDES, G. M., & ISMAGILOV, R. F. (1999). Complexity in chemistry. Science, 284, 89–92. WCED, 1987. Our Common Future. Oxford: Oxford University Press.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, 1987. Our Common Future. Brundtland Report. Oxford University Press, Oxford.

Chapter 2: Pursuing SDGs in the freight transport sector through the implementation of VEPs

2.1 Introduction

First, this chapter analyzes the Sustainable Development Goals (SDGs) the transport sector organizations are expected to contribute to. In particular, the freight transport sector contributes to the achievement of several SDGs: SDG 3 (good health and well-being), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), SDG 11 (sustainable cities and communities), SDG 12 (sustainable consumption and production), and SDG 13 (climate change)[10] (Fulzele & Shankar, 2022).
Secondly, this chapter introduces the Voluntary Environmental Programs (VEPs), representing a policy lever to reduce CO2 emissions in the freight transport sector and, consequently, reach the SDGs. In particular, it highlights that since the 1980s, research has observed that restrictive, expensive, and competitive regulation denies organizations flexibility and keeps them from developing less expensive and alternative approaches to achieve environmental goals (Portney & Stavins 2000). Also, at the same time, since the 1980s, VEPs have become an attractive means for governments to persuade companies to decrease pollution and preserve natural resources. VEPs aim to bring out companies' attitudes towards complex societal and ecological issues and create awareness. More than that, VEPs can encourage businesses to internalize this awareness and act according to socially desirable standards – without strict governmental supervision (Thaler & Sunstein 2008).

---

[10]SDGs-UN.org. Available at: https://www.un.org/sustainabledevelopment/sustainabledevelopment-goals/.

In addition, in this chapter, the several advantages but also limitations that characterize VEPs are analyzed.

2.2 The SDGs in the freight transport sector

As mentioned in the previous chapter, the transport sector, particularly the freight transport sector, plays a key role in achieving sustainable development. Based on the present demand trajectory, the demand for freight is anticipated to triple by 2050 (ITF, 2019). As shown in the previous chapter, road freight transportation (RFT) is one of the major contributors to global pollution emissions among all modes of transportation (ITF, 2019; IEA, 2018). The negative externalities of freight operations could rise quicker if robust and strong sustainable policies are not implemented (Fulzele & Shankar, 2022). To help the world gain sustainable development on a global scale, the United Nations (UN) established 17 sustainable development goals (SDGs) in 2015. Transport organizations are expected to contribute to these seventeen goals, particularly towards SDG 3 (good health and well-being), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), SDG 11 (sustainable cities and communities), SDG 12 (sustainable consumption and production) and SDG 13 (climate change) for the accomplishment of the UN's climate protection agendas[11] (Fulzele & Shankar, 2022).

In particular, the transport sector contributes to achieving SDG 3 (good health and well-being). SDG 3 aspires to provide health and well-being for all people, regardless of age. It includes discussing important health topics, such as maternal, neonatal, and child health and mortality, epidemics, illnesses, non-communicable diseases, and mental health. The goal also emphasizes the prevention of drug misuse, injuries, and fatalities from road accidents, as well as diseases and deaths from exposure to dangerous substances, pollution, or contamination (Halkos & Gkampoura, 2021). In detail, the freight transport sector may contribute to the achievement of this SDG, particularly to the decrease of diseases and deaths from

[11]SDGs-UN.org. Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.

exposure to dangerous substances and pollution. This is possible if the CO_2 emissions from the freight transport sector decrease.

Moreover, the transport sector may contribute to achieving SDG 7 (affordable and clean energy). Energy is essential to a population's health, economic growth, and the functioning and development of societies (Brand-Correa & Steinberger, 2017; Smil, 2019). Given that it is necessary to create all goods and services, energy plays a significant role in daily life (Lambert et al., 2014). To meet its energy demands, the globe now depends on fossil fuels. Carbon-based fuels have been the dominant driver behind global economic and social development since the early 1800s (Höök & Tang, 2013). The importance of switching to renewable energy sources has grown significantly over the past few years due to the numerous disadvantages of using fossil fuels, including their high greenhouse gas emissions and contribution to global warming (Abas et al., 2015). The 7th SDG aims to ensure everyone has access to modern, sustainable, affordable energy. This is primarily done by guaranteeing everyone can access electricity, clean fuels, and technology. Additionally, it aims to increase the percentage of renewable energy sources in the world's energy mix, boost energy efficiency, and support clean energy research and technology (Halkos & Gkampoura, 2021). In detail, according to World Bank statistics, 89.6% of the world's population had access to electricity in 2018 - a 12% increase compared to 2000, when the percentage was 78.3%. Sub-Saharan Africa had the lowest percentages of people with access to electricity, with only 26% in 2000 and 47.7% in 2018. In the early years of the twenty-first century, South Asia experienced low percentages, but by 2018, when it reached 91.6%, it had significantly increased. In every other part of the world, high access rates to electricity were observed (World Bank, 2020). The following figure 13 illustrates what is mentioned above.

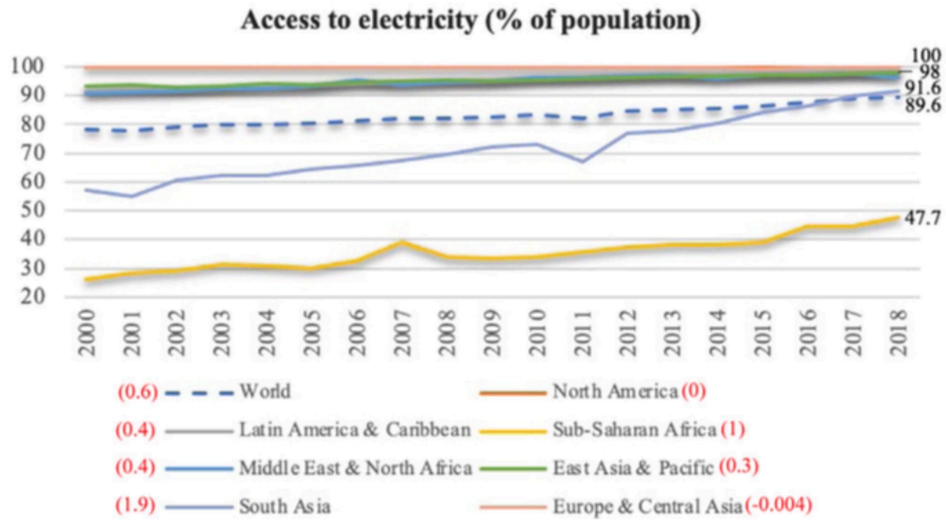

Figure 13. *"Access to electricity (% of the population)".* Adapted from (Halkos & Gkampoura, 2021)

Based on the World Bank database, the percentage of renewables in final worldwide usage was 18.1% in 2015, which has been retained at approximately the same rates since 2000. Since 2000, similar high percentages have been reported, making Sub-Saharan Africa the region with the largest share of renewables in overall power consumption. In 2015, renewable sources provided 70.1% of the region's energy needs. However, the Middle East and North Africa saw the lowest percentages, with renewables accounting for just 1.6% of their region's final energy consumption in 2015 (World Bank, 2020). These numbers are shown in Figure 14.

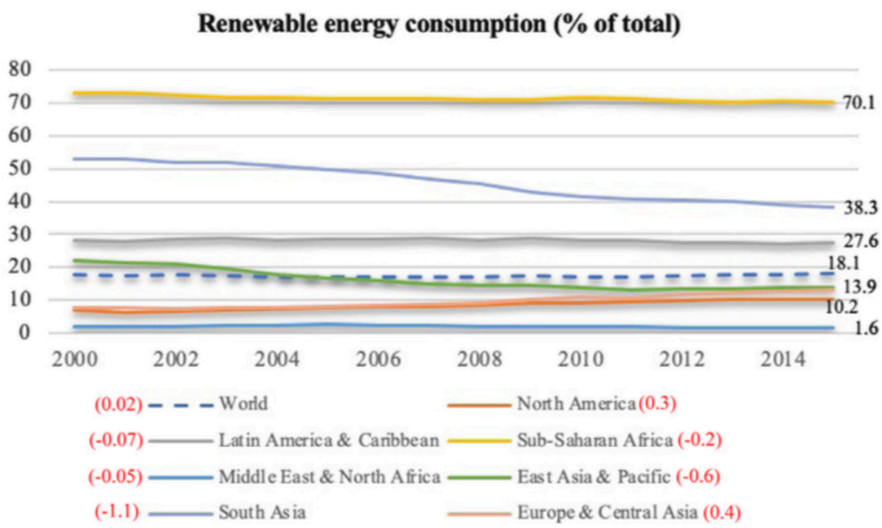

Figure 14. *"Renewable energy consumption (% of total final energy consumption)".* Adapted from (Halkos & Gkampoura, 2021)

The freight transport sector plays a key role in achieving this SDG because a considerable percentage of energy used in the freight transport sector is fossil fuel. Hence, a decrease in fossil fuel energy and an increase in renewable energy in the freight transport sector contributes to an increase in the percentage of renewable energy consumption and, therefore, may foster the achievement of this SDG.

SDG 8 (decent work and economic growth) aims to promote employment and decent work for all and inclusive and sustainable economic growth. The goal is to boost productivity and growth while promoting policies that foster entrepreneurship, innovation, and the creation of jobs. To prevent environmental deterioration brought on by economic expansion, it also encourages sustainable production and consumption with increased resource efficiency (Halkos & Gkampoura, 2021). The freight transport sector may also contribute to achieving this SDG if there is a shift from fossil fuel energy to more sustainable energy. This may reduce CO2 emissions and generate more sustainable economic growth.

Moreover, communities and regions have repeatedly experienced severe losses and damages from several hazard events (Lounis & McAllister, 2016). This is especially true regarding the effects of climate change, which include changing weather events, increasing sea levels, and pressure on infrastructure due to extreme weather events and temperature changes (Vallejo & Mullan, 2017). To limit the amount of damage done, infrastructure resilience is now more critical than ever (Lounis & McAllister, 2016). Moreover, sustainable industrialization is crucial to sustainable development (Halkos & Gkampoura, 2021). For this reason, SDG 9 (industry, innovation, and infrastructure) emphasizes research and innovation, sustainable industrialization, and resilient infrastructures. More specifically, it encourages the creation of resilient and sustainable infrastructure that will contribute to inclusive industrialization, human well-being, and economic growth. Additionally, it promotes upgrading industry and infrastructure to make them cleaner, resource-efficient, and ecologically friendly (Halkos & Gkampoura, 2021). The freight transport sector may contribute to the achievement of SDG 9 through the use of more efficient and environmentally friendly resources instead of fossil fuel energy.

In addition, the global population is rapidly urbanizing (Devisscher et al., 2020). According to the World Bank (2020), 55.7% of the world's population resided in cities in 2019, which is anticipated to continue rising by 2050, resulting in unprecedented levels of urban expansion (Van der Berg, 2018). Cities already have huge ecological footprints because they use such a large portion of the world's energy and resources, which results in significant carbon emissions and water and air pollution. In this regard, cities negatively affect biodiversity, local climate, environmental degradation, public safety, and human health (Devisscher et al., 2020; Bibri & Krogstie, 2017; Halkos & Gkampoura, 2021). As stated by Joss (2015), a sustainable city is one that ‘‘reduces energy consumption, protects the environment, promotes urban density, decreases traffic congestion, recycles waste, provides clean water, expands parkland, creates ‘walkable’ neighborhoods, generates local employment, supports human health and well-being, celebrates civic engagement and enhances efficient information management’’.

For this reason, making cities inclusive, secure, resilient, and sustainable is the goal of the 11 SDGs (sustainable cities and communities). The goal's core is inclusive and sustainable urbanization and everyone's access to appropriate, safe, affordable housing. Promoting affordable, accessible, and sustainable transportation systems go hand in hand. SDG 11 also aims to decrease the environmental effects on cities and the number of people impacted by disasters (Halkos & Gkampoura, 2021).

Based on information gathered from the World Bank database, the average yearly exposure to fine particulate matter (PM2.5 and PM10) for the entire world was 45.5 micrograms per cubic meter in 2017. Figure 15 shows the following regional trends: North Americans had the lowest exposure (7.3 in 2017), whereas South Asia had a significantly higher amount (82.9 in 2017). The exposure level was maintained at its 2010 level globally, with East Asia and the Pacific (from 51.9 to 39.8) and South Asia (from 89.2 to 82.9) showing only substantial improvements (World Bank, 2020).

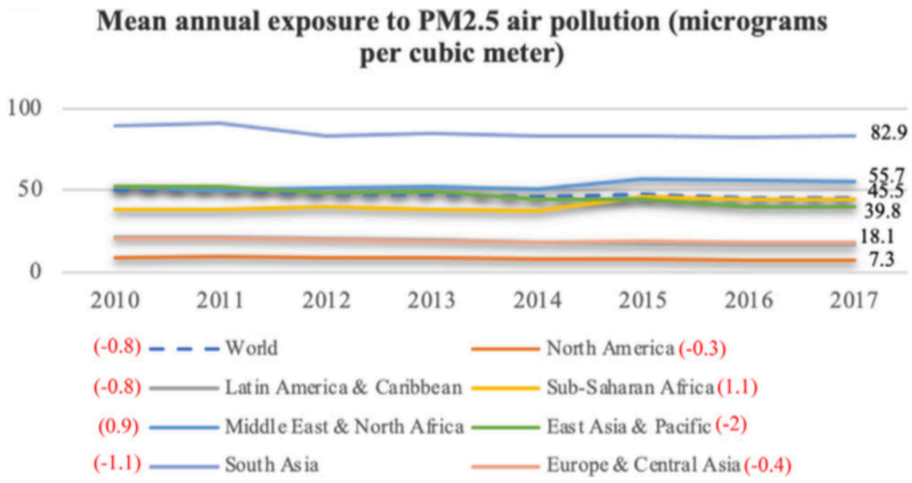

Figure 15. *"PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)"*. Adapted from (Halkos & Gkampoura, 2021).

The freight transport sector can contribute to reducing the mean annual air pollution exposure. It may support the achievement of this SDG if there is a reduction in fossil fuel energy used in freight transport in order to make the transportation system more sustainable and, consequently, make the cities more sustainable.

Unsustainable production and consumption significantly negatively influence the environment. The industrial sector is a major cause of water, air, and land pollution. Environmental problems also result from final consumption practices connected to the food, energy, and transportation sectors (Tseng et al., 2013; Tukker et al., 2008). The Oslo Symposium on Sustainable Consumption defined sustainable consumption and production in 1994: ''the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations'' (Norwegian Ministry of Environment, 1994).

Among the others, SDG 12 (sustainable consumption and production) also aims to decrease food waste and waste in general, promote environmentally friendly management of chemicals and waste, and promote the adoption of sustainable practices by organizations. The freight transport sector may contribute to the achievement of this SDG by introducing sustainable practices.

Climate change is characterized as ‘‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods’’ (United Nations, 1992). By taking immediate action and promoting the integration of climate change measures into all national policies and strategies, SDG 13 aims to tackle climate change and its effects. The goal also intends to increase each nation's ability for resilience and adaptation to hazards and natural disasters related to the climate. This includes, among other things, promoting education and raising awareness of the need to mitigate and adapt to climate change (Halkos & Gkampoura, 2021). The freight transport sector may contribute to the achievement of this SDG by implementing measures to reduce the impact of climate change.

As highlighted above, the transport sector and in particular the freight transport sector, contribute to the achievement of several SDGs: SDG 3 (good health and well-being), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), SDG 11(sustainable cities and communities), SDG 12 (sustainable consumption and production), and SDG 13 (climate change)[12] (Fulzele & Shankar, 2022).

In this regard, Voluntary Environmental Programs (VEPs) represent a useful policy lever to reduce CO2 emissions and contribute to reaching the SDGs in the freight transport sector. In the next paragraph, there will be illustrated VEPs and their advantages and limitations will be analyzed.

2.3 The VEPs as a policy lever to reduce the CO2 emissions in the freight transport sector

The Voluntary Environmental Programs (VEPs) represent a policy lever to reduce the CO2 emissions in the freight transport sector and are, therefore, crucial to reach the SDGs. As it was highlighted in the previous chapter and according to Environmental News (2013) and Liimatainen et al. (2015), the transportation sector

[12]SDGs-UN.org. Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.

has one of the worst environmental impacts of any industry, coming in second only to the production of electricity in terms of greenhouse gas (GHG) emissions. According to research, only a relatively small number of businesses are trying to lower the carbon footprint of their freight transportation (Ellram & Golicic, 2015; Golicic et al., 2010; Lun et al., 2011). Despite the knowledge that freight transport emissions negatively impact human health and the environment (U.S. EPA, 2015), emissions remain high (Marks, 2015). Customers are becoming more aware of environmental issues and more inclined to support businesses that adopt improved environmental practices (PLS, 2016). Although more and more companies claim to enhance their environmentally responsible transportation practices (ERTP), action still lags behind good intentions in decreasing transportation emissions (Large et al., 2013).

Due to the perceived cost of improving truck fuel efficiency and the business practice of outsourcing the majority of transportation needs to logistics service providers, firms frequently see the emissions as someone else's responsibility (Diesel Technology Forum, 2015; Golicic et al., 2010; Lun et al., 2011).

Nevertheless, shippers and carriers are beginning to adopt practices beyond legal requirements in anticipation of potentially tougher restrictions and other reasons (Ellram & Golicic (2016)).

While prior studies have established that stakeholder pressure is one aspect that firms consider when pursuing socially responsible corporate operations (Ellram & Golicic, 2015), societal legitimacy is another, maybe more powerful, path (Chen & Roberts, 2010). Meeting these expectations becomes crucial in improving, sustaining, and gaining legitimacy as society and individuals demand more from organizations regarding general environmental performance and ERTP (Ellram & Golicic (2016). By considering external and internal influences on company behavior, legitimacy explains why ERTP is pursued. While companies may strive for legitimacy by backing up their words with actual actions (Alrazi et al., 2015), the concept of legitimacy is something that is given from the outside; it is a "social evaluation" of people on a micro level and institutions on a macro level (Bitektine & Haack, 2015). Research from the past suggests that companies may report GHG emissions and other environmental actions to demonstrate or enhance their perceived legitimacy among stakeholders (Bansal & Clelland, 2004; Liesen et al., 2015). Businesses must follow several policies and laws to achieve legitimacy (Berrone et al. 2013), like mandatory environmental regulations (MERs). The corporate environmental standard may rise due to MERs (Jiang et al. 2018) for reducing pollution under the strict MERs requirements. As a result, some scholars think that MERs could help to enhance environmental performance (Wu et al. 2020; Ma et al. 2018). But MERs are also one of the instant and dangerous pressures on companies (Darnall & Carmin 2005; Teeter and Sandberg 2017; Zhang et al. 2018; Lian et al. 2016). According to Ghisetti (2017) and Porter and van der (1995), only flexible regulations could encourage green corporate innovation and boost competitive advantage. The major characteristic of MERs is that polluters have little flexibility and are forced to adhere to the rules and regulations mechanically to avoid facing severe penalties that could harm the efficiency of businesses (Popp et al. 2011; Zizzo & Fleming 2011). Although regulations form the core of environmental governance initiatives, their effectiveness has been limited by various factors, including political opposition, the cost of monitoring, and the absence of globally recognized authorities (Aragon-Correa et al., 2020; Hoffman, 2011). Since the 1980s, research has observed that restrictive, expensive, and competitive regulation denies organizations flexibility and keeps them from developing less expensive and alternative approaches to achieve environmental goals (Portney & Stavins, 2000). The government's attempts to enforce compliance with these standards often ended in blockades between regulators and regulated actors, preventing mutually acceptable solutions to environmental issues (Portney & Stavins 2000; Bardach & Kagan 1982; Aspen Inst 1996; Enterprise Environ 1998; Mayer 1999).

At the same time, since the 1980s, Voluntary Environmental Programs (VEPs) have become an attractive means for governments to persuade companies to decrease pollution and preserve natural resources. VEPs aim to bring out companies' attitudes towards complex societal and ecological issues and create awareness.

More than that, VEPs can encourage businesses to internalize this awareness and act according to socially desirable standards – without strict governmental supervision (Thaler & Sunstein 2008).

Thus, VEPs are a policy tools addressing the supposed weaknesses in command and control. The main goal is to encourage organizations to produce environmental public goods beyond what is required by applicable legislation by giving them a valid, affordable tool to demonstrate their commitment to environmental stewardship (Gunningham et al., 2003; Lundgren, 2003). Governments, trade associations, and nongovernmental organizations may sponsor them (Darnall et al., 2017). By encouraging rather than forcing their participants to adopt better practices, VEPs aim to enhance environmental results. If they spread widely, they may also create normative and mimetic pressure on other companies to imitate companies already participating in VEPs (Prakash & Potoski, 2012). It is assumed that stakeholders of businesses will reward companies for their "beyond compliance" environmental initiatives by awarding benefits, including larger market shares, consumer loyalty, and higher product prices (Gunningham et al., 2003; Lundgren, 2003). A VEP thus offers an excludable "club good" to participating organizations (Buchanan, 1965; Cornes & Sandler, 1996) in that only organizations that take part in the program can profit from its exclusive branding or awarding benefits (Prakash & Potoski, 2006a; Borck & Coglianese, 2009; Kotchen & van't Veld, 2009). Companies join VEPs to receive their certification, which they may use to demonstrate their environmental attention to stakeholders (such as communities, customers, and regulators) (Berchicci & King, 2007). This helps stakeholders to make sense of companies' environmental performance because they frequently lack evaluative knowledge or the capacity to investigate and monitor business practices that produce negative environmental impacts (Darnall, 2006). Due to this information gap, skeptic stakeholders frequently misjudge companies' environmental performance and assign them to incorrect stereotypes. By guaranteeing companies' efforts, VEPs help stakeholders to reduce these problems (Barnett & King, 2008; Berchicci & King, 2007). More in detail, the branding of a program also enables external stakeholders to distinguish between participants and non-participants (Spence, 1973).

In practice, VEPs can develop a new market for corporate environmental reputation (Prakash & Potoski, 2012).

Because of their intrinsic and voluntary features, VEPs differ from command and control systems. While in a command and control system, government regulators are often in charge, VEPs enable wider participation of stakeholders in evaluating, rewarding, and sanctioning organizations' environmental management. There are several programs from which organizations can choose which one to participate in. With this wide range, VEPs are more likely to permit various levels of stringency between programs, enabling companies to choose among several programs (Prakash & Potoski, 2012).

Nevertheless, it is not always easy for businesses to decide whether or not to join VEPs. In particular, an organization is more likely to join a VEP if the associated expenses are less than the anticipated cost of compliance with (current or expected) governmental laws or other regulations, such as ecotaxes (Segerson & Miceli, 1998). Certain VEPs have high adoption costs, which exceed any potential advantages in terms of competition (Ahmed, 2012). Others with less expensive adoption costs are perceived as greenwashing tools (Castka & Corbett, 2016).

Both issues are connected to VEP stringency, which provide the ideal combination of rewards and penalties to the organizations for enhancing environmental performance and legitimizing themselves with important stakeholders (Darnall et al., 2017).

The stringency of the VEPs depends on their governance design (Berchicci & King, 2007; Darnall & Carmin, 2005; Prakash & Potoski, 2012). The set of criteria and regulations that VEPs implement to persuade participating companies to achieve their goals is called governance design (Borck & Coglianese, 2009).

The success of VEPs is significantly influenced by three distinct rules: the nature of environmental standards, the nature of monitoring criteria, and the presence of sanctions for participating companies that do not adhere to a program's standards (Darnall & Carmin, 2005; Darnall et al., 2017; King & Lenox, 2000).

The three rules are analyzed individually below:

- The environmental outcomes that members of VEPs must achieve are called environmental performance standards (Carmin et al., 2003). They can be environmental management systems, where companies must adopt procedures aiming at minimizing environmental impacts; codes of conduct intended to normalize sustainable values in companies; written commitments by companies to enhance their environmental practices or persuade others to do the same; and environmental performance targets, which demand companies to achieve measurable results for safeguarding ecosystems, decreasing natural resource usage, or decreasing pollution (Berchicci & King, 2007; Darnall & Carmin, 2005; Darnall et al., 2017).

- Monitoring criteria describe how programs track whether a company complies with the VEP environmental performance standards (King & Lenox, 2000). On the one hand, strict monitoring, which incorporates third-party oversight by authorized agencies, prevents companies from claiming compliance without providing evidence. On the other hand, lenient monitoring includes self-monitoring, absence of oversight, or companies or trade associations providing oversight (for industry-sponsored VEPs). The only way to prevent moral hazard, which encourages shirking and symbolic engagement, is to control companies independently (Berchicci & King, 2007).
- Last but not least, sanctions refer to a VEP's capacity to sanction companies that fail to meet its environmental performance standards. The most severe punishment is expulsion from the VEP, which authorizes a program to stop providing benefits to participating firms (Koehler, 2007).

After examining the characteristics of VEPs and the main differences with laws and regulations, a more detailed analysis of the primary determinants of participation below will follow.

According to empirical evidence, several factors, including regulatory pressure, environmental performance, market pressure, competitive pressure, and financial performance, might affect a participant's decision to participate. These factors are outlined in Figures 16 and 17. The VEPs and associated paper(s), the majority of which have been published, where these characteristics have been found to affect participation, are also included in Figures 16 and 17. Both figures analyze several VEPs, including those that the EPA and Department of Energy (DOE) started (33/50, Green Lights, WasteWise, and Climate Challenge). Those operating by business (such as ISO 14001 EMS, Responsible Care [RC], Responsible

Distribution Processes, Sustainable Slopes, Sustainable Forestry Initiative, and Encouraging Environmental Excellence) reveals a striking consistency of influential factors (Koehler, 2007).

Influential Factors		VEP	Reference
Environmental performance/ regulatory pressure	High toxic chemical emissions	33/50, Green Lights, WasteWise, Responsible Care, Responsible Distribution Processes, Sustainable Forestry Initiative, Encouraging Environmental Excellence, ISO 14K	Arora & Cason, 1995, 1996; Videras & Alberini, 2000; King & Lenox, 2000; Khanna & Damon, 1999; Potoski & Prakash, 2005a; Gamper-Rabindran, 2006; Lenox, 2006; Lenox & Nash, 2003; King et al., 2005; Toffel, 2006
	High hazardous air pollutant emissions	33/50, EMS	Khanna & Damon, 1999; Khanna & Anton, 2002; Gamper-Rabindran, 2006
	Low toxic chemical emissions per output	ISO 14K	Toffel, 2006
	Poor air quality (NAAQS criteria pollutants)	Climate Challenge, 1605(b)	Karamanos, 1999; Lyon & Kim, 2006
	High inspections	ISO 14K, 33/50	Potoski & Prakash, 2005a; Gamper-Rabindran, 2006
	More Superfund sites	33/50, WasteWise, EMS	Khanna & Damon, 1999; Videras & Alberini, 2000; Khanna & Anton, 2002
	High pollution abatement costs (proxy for regulation)	EMS, Climate Challenge	Khanna & Anton, 2002; Delmas & Montes-Sancho, 2007
	Carbon emissions per unit output	Climate Challenge, 1605(b)	Karamanos, 1999; Lyon & Kim, 2006
	High environmental group membership	Climate Challenge	Karamanos, 1999; Welch et al., 2000
	Perceived regulatory pressures	EMS, 33/50, ISO 14K, Sustainable Slopes	Henriques & Sardorsky, 1996; Dasgupta, Hettige, & Wheeler, 2000; Khanna & Damon, 1999; Potoski & Prakash, 2005b; Rivera et al., 2006; King et al., 2005; Coglianese & Nash, 2006
Market pressure/PR	Perceived pressures from shareholders, lobby groups, neighborhood and community groups, trade associations, educated employees, and management	33/50, EMS, ISO 14K	Henriques & Sardorsky, 1996; Khanna & Damon, 1999; Dasgupta et al., 2000; Potoski & Prakash, 2005b; Gamper-Rabindran, 2006; Coglianese & Nash, 2006
	Final goods producers and consumer pressures	33/50, Green Lights, WasteWise, EMS	Khanna & Damon, 1999; Henriques & Sardorsky, 1996; Arora & Cason, 1995, 1996
	More visible, concern with public image	33/50, Responsible Care	Celdran et al., 1996; King & Lenox, 2000; Coglianese & Nash, 2006

Figure 16. *"Factors Influencing Participation in VEPs"* Adapted from (Koehler, 2007).

Influential Factors		VEP	Reference
	Higher advertising expenditures per unit sales	33/50, Green Lights, WasteWise	Arora & Cason, 1996; Videras & Alberini, 2000;
	Publish environmental report	WasteWi$e, Green Lights	Videras & Alberini, 2000;
	Industry association membership	33/50, Climate Challenge	Khanna & Damon, 1999; Delmas & Montes-Sancho, 2007
	Participation in Green Lights	33/50	Arora & Cason, 1996
Competition/ competitiveness	Less concentrated industries subject to more competition	33/50	Arora & Cason, 1995
	Older equipment	33/50, EMS	Khanna & Damon, 1999; Khanna & Anton, 2002; Videras & Alberini, 2000
	More innovative, high R&D expenditure	EMS, 33/50, Green Lights, WasteWi$e, ISO 14K	Khanna & Anton, 2002; Arora & Cason, 1996; DeCanio & Watkins, 1998; Videras & Alberini, 2000; King & Lenox, 2001a
	More foreign presence and subject to greater global competition	EMS	Khanna & Anton, 2002
	Foreign-owned	Responsible Care, Responsible Distribution Processes, Sustainable Forestry Initiative, Encouraging Environment Excellence, ISO 14K	Lenox & Nash, 2003; King & Lenox, 2001a
	Greater distance to buyers, foreign buyers, ongoing relationships with buyers	ISO 14K	King et al., 2005
	Certification to ISO 9000	ISO 14K	King & Lenox, 2001b
	Existing EMS	ISO 14K	King et al., 2005
Financial performance	Large firms (by sales, output or employees or property)	33/50, Green Lights, Responsible Care, Responsible Distribution Processes, Sustainable Forestry Initiative, Encouraging Environmental Excellence, ISO 14001, Climate Challenge, WasteWi$e, Sustainable Slopes	Arora & Cason, 1995, 1996; Khanna & Damon, 1999; DeCanio & Watkins, 1998; Karamanos, 1999; Videras & Alberini, 2000; King & Lenox, 2000, 2001a; Dasgupta et al., 2000; Karamanos, 1999; Welch et al., 2000; Lenox, 2006; Lenox & Nash, 2003; Rivera et al., 2006; Coglianese & Nash, 2006
	High ratio of capital asset to sales and more dependent on capital markets	EMS	Khanna & Anton, 2002
	High earnings per share, growth in earnings per share	Green Lights	DeCanio & Watkins, 1998

Figure 17. "Continued" Adapted from (Koehler, 2007).

As theoretical work suggested, the research demonstrates that a combination of market and nonmarket forces influences the decision to participate in a VEP. These factors are statistically significant despite variations in the sample, sampling period, and econometric analysis across studies (Koehler, 2007).

The observation that VEP participants typically come from sectors that create final goods which are more visible and focused on sustaining a strong brand or public image suggests that perceived pressures from various external stakeholders are significant motivators (Henriques & Sardorsky, 1996). According to Alberini and Segerson (2002), these perceived pressures may also signify a rise in demand for green products or an issue with marketing that receives more attention. Similar to this, it seems that participants typically face more competition from abroad or are more likely to be foreign-owned, and they utilize their involvement in the VEP (such as their ISO 14001 certification) to promote their environmental excellence to their distant business partners (Koehler, 2007).

According to Khanna and Anton (2002) and Khanna & Damon (1999), organizations with older equipment and under more investor scrutiny are more inclined to participate. These characteristics don't have to be mutually exclusive. Participating companies trying to stand out in highly competitive consumer product markets where profit margins are tight, and investor perception is closely linked to preserving a strong brand image and reputation. The probability of participation is also higher for organizations that compete on the global market and are subject to larger supply chain challenges (Koehler, 2007).

After examining the characteristics of VEPs, the main differences between laws and regulations, and provided a detailed analysis of the primary determinants of participation, the main advantages and limitations of VEPs are now analyzed.

2.3.1 Advantages

As VEPs benefit both the environment and the organizations involved, they generate win-win approaches to environmental sustainability. Organizations are attracted to participate in government-sponsored environmental programs for several reasons voluntarily.

First to name is the factor of reputation and external perception. Some stakeholder groups encourage businesses to report their environmental management practices. Businesses that follow ecological/green standards and voluntarily reveal these efforts can show their behavior to the outside world (Tate et al. 2010). Furthermore, the willingness to reveal their environmental ratings and improve environmental performance will be appreciated by stakeholder groups, who are likelier to perceive these kinds of businesses favorably (Hofer et al. 2012).

It stands to reason that voluntary participation in voluntary environmental programs might raise the company's reputation (Scott et al., 2022).

Hence, revealing environmental ratings and participating in government-sponsored environmental programs can lead to advantages on the market and more competitiveness (Chen & Miller 2012).

Speaking about competitiveness, some analysts claim that voluntary environmental programs might stimulate creativity in companies that want to compete on an ecological and sustainable level. One scenario could be managers considering innovative methods to enhance their environmental performance. This, again, could lead to the already mentioned win-win approach (Fiorino 1999; Orts 1994; Esty & Winston 2006). Managers from the business world could also bring their in-depth expertise regarding the best or most affordable environmental improvements outlook for voluntary programs (Coglianese & Nash 2010). In this way, VEPs help to foster information exchange between businesses and governments, assisting them in spreading excellent environmental practices (Coglianese & Nash 2014).

Another incentive to participate in a voluntary environmental program is the so-called labeling system that some VEPs include. This system identifies and certifies those organizations which reach predefined standards. Some VEPs linked to reducing CO2 emissions in the transport sector already use labels. The label system is extremely effective in this industry because there is already evidence of increased competition among businesses, particularly in those market segments characterized by end-users with great value environmental concerns. Labeled businesses can also benefit from accessing more funds at a lower cost (Barnea et al. 2004).

In the following section, the limitations of VEPs will be analyzed.

2.3.2 Limitations

The previous section noted how Voluntary Environmental Programs (VEPs) provide many benefits. Now, this section highlights some inefficiencies of VEPs.

Despite the many benefits of the VEPs, the following limitations can be pointed out.

The involvement of multiple private and public actors and the transport and logistics sectors' complexity go hand in hand with an increasing risk of dysfunctionalities. Those dysfunctionalities prevent achieving the desired VEPs outcomes and generate short-term interest on the side of the involved organizations (Bivona & Bilek 2021).

The main danger lies in "greenwashing" which can emerge if VEPs are not adequately planned and implemented and instead inadvertently identify and reward the incorrect companies, placing the government in the position of encouraging corporate "greenwashing" (Delmas and Keller 2005). Based on wrong planning and implementation, it could happen that organizations participating in the VEPs often achieve results that are not in line with the goals that were predetermined in the first place.

Another challenge is holding the balance: if organizations see that the costs of participating in the VEP exceed the benefits, some will choose to leave the program (Scott et al., 2022). According to some studies, certain organizations have already drawn negative conclusions regarding participating in a voluntary program. For them, neither a considerable boost in their environmental reputation was achieved (Ehrgott et al. 2013) nor did it lead to new clientele or other commercial opportunities (Klassen & McLaughlin 1996).

These and other factors clarify why an organization can prematurely stop participating in a voluntary environmental program. But many factors could support an organization's participation in a voluntary environmental program (Scott et al., 2022). Support from a company's top management team is one factor that helps an organization to continue its voluntary engagement over time. This phenomenon has been mentioned by Cantor et al. 2012 and Sarkis et al. 2010. According to them, if an organization doesn't have formal leadership, then people who work in it won't participate in its environmental management programs (Cantor et al. 2012; Sarkis et al. 2010). The ability of the organization to learn from peers is another factor. Interfirm learning occurs when two organizations interact often, and one organization gains knowledge from the other (Haunschild & Sullivan 2002).

Regular interactions include issues like attending government-sponsored events, business affiliations, or attending informal meetings (Leung et al. 2019). Exchanges between organizations which participate in the program and those that sponsor the environmental program can provide the necessary support to resolve potential environmental policy difficulties (Delmas & Montes-Sancho 2010). These discussions could encourage the organization to continue participating in the environmental initiative (Scott et al., 2022).

In the next step, some practical applications of programs to highlight the programs' effectiveness will be analyzed. In particular, Morgenstern and Pizer decided to adopt a new strategy, using case studies of representative programs, because the existing research on voluntary programs generally focuses on why enterprises choose to participate rather than on the outcomes. Descriptions of the various programs, the authors of the case study's primary conclusions and observations are provided below (Morgenstern & Pizer, 2007).

In 1997, before the Kyoto Protocol negotiations, the industry launched Japan's Keidanren Voluntary Action Plan on the Environment. Large businesses from 58 business associations, including those in the industrial, electrical, construction, commercial, and transportation sectors, constitute this group. The industry initially supported the plan to support the government's efforts to reduce greenhouse gas emissions without being subject to regulations. The nonbinding targets are currently commonly acknowledged as commitments that industries must fulfill. The cooperative connection between the Keidanren and businesses, the prospect of mandatory measures like taxes or cap-and-trade programs, and awareness of private enterprises' social responsibilities all appear to drive the industry to comply with the plan. These notions might be specific to how business and government interact in Japan, in part or full. Keidanren members have committed to stabilizing their total greenhouse gas emissions at 1990 levels by 2010; they are now on track to meet this commitment. Is there a discernible difference between this and business as usual? This is the crucial question, complicated by a recession during the program's early years (Morgenstern & Pizer, 2007).

Furthermore, the United Kingdom has taken an active approach to climate change domestically and globally and was one of the first and strongest supporters of the

Kyoto Protocol. As part of a complicated policy mix that included an energy tax, a climate change tax, and an emissions trading scheme, the UK government developed voluntary climate change agreements (CCAs) with 48 sectoral organizations in the industrial, commercial, and public sectors in 2001. Virtually all eligible sites are covered by CCAs, which collectively account for around 12,000 individual sites and over 44% of all industrial emissions in the UK. Energy use reductions or the purchase of emissions permits through the recently formed pilot emissions trading program are two ways to achieve compliance. The total emissions during the first two years of implementation were far below the target. Even though a government-sponsored study indicated high compliance, CCAs seem to have only little success in promoting reductions beyond the norm (Morgenstern & Pizer, 2007).

Also, the Danish Energy Agency established voluntary agreements on energy efficiency in 1996 through green taxes imposed on the industrial, commercial, and service sectors. Energy-intensive businesses and those most susceptible to international competition were charged lower rates. If energy-intensive companies signed a voluntary agreement on energy efficiency with the energy agency, they would receive nearly 100% refunds. Thus, the voluntary agreements were viewed as supplements to the tax system. Companies were explicitly required to repay the rebate in full as punishment if they disregarded their agreement. Although there were no quantifiable targets in the voluntary agreements, completing the execution of all measures expected to have a payback that met certain standards within three years was the initial reimbursement requirements. Energy-saving projects, specialized analyses, and energy-management systems were among the actions to be implemented. Analysis of the consequences of these agreements revealed decreases of 2–8%, with the top end being somewhat questionable given the study's small sample size. Analysts also discovered that most savings were realized in the early years, limiting opportunities for the future (Morgenstern & Pizer, 2007).

In addition to the UK and Denmark, VEPs were also promoted in Germany: in 1995, the "Declaration of German Industry on Global Warming Prevention" (GGWP), which was voluntarily issued by the Federation of German Industries, a group of 16 industrial associations representing important sectors of German industry, called for voluntary reductions in fuel consumption of up to 20% below 1987 levels by the year 2005. Government-provided incentives and threats of future regulation were absent from the initial industry commitments. Most of the obligations had already been met by 2000, five years before the target date, showing that the goals weren't excessive. The GGWP targets were modified due to government and industry pressure to avoid mandatory regulations. The cement industry was the only one of the 19 currently included in the German Federation for which there was sufficient historical data to compare the CO2 emissions of the sector to emissions in years previously. This comparison was made to assess the GGWP declaration's efficacy. According to the authors ' calculations, the annual fuel efficiency gains made while the voluntary commitment was in force were roughly equal to the average for the previous two decades. They conclude that the industry has not achieved well-intentioned efforts (Morgenstern & Pizer, 2007).

Moreover, a voluntary EPA program called Climate Wise aims to promote CO2 and other greenhouse gas reduction in the nonutility industrial sector. It was founded in 1993 and ran until 1999–2000, when it had a name change and was incorporated into the organization's Energy Star program. A participating company was required to create baseline emissions estimates, self-designate activities to reduce emissions in the future and submit regular progress reports. Firms were strongly advised to choose at least part of their planned improvements from the EPA's list of key initiatives, including specified boiler upgrades and waste-heat recovery systems. The EPA also provided a guide to industrial energy efficiency, a variety of government publications on energy efficiency, free phone consultations with government and private-sector energy specialists, and other forms of technical support. The main finding is that Climate Wise appears to have had little to no effect on fuel use while slightly boosting electricity demand—a paradoxical result—when program participants are compared with identical, non-participating enterprises. There are numerous reasons why this might have occurred. For instance, businesses might have used additional electricity to cut direct CO2 emissions. After two years it has been observed that any consequences of the program are only transitory (Morgenstern & Pizer, 2007).

Examining different programs, it is accurate to say that the least effective programs—Climate Wise and the German GWP declaration—had the fewest incentives. The UK, Danish, and Japanese Keidanren programs had the most significant effects since they offered the biggest incentives. The impact of all energy-related programs on emissions is less than 10%, and more often than not, it is closer to 5%. Thus, the difference is negligible. As Morgenstern and Pizer state, a 5% decrease in energy use or CO2 emissions is not insignificant. Initial efforts made by several countries under the Kyoto Protocol are roughly of that size. It could result in savings of several billions of dollars. However, it illustrates what seems to be the greater limit of what such types of programs can accomplish. In contrast, incentives considerably impacted the degree of involvement, with some programs having nearly universal enrollment due to higher incentives and fewer participation obstacles (Morgenstern & Pizer, 2007).

2.4 Conclusions

This chapter highlighted the SDGs that transport organizations are expected to contribute to. Moreover, a policy lever was introduced to reduce the CO2 emissions in the freight transport sector and facilitate ecological transitions: the Voluntary Environmental Programs (VEPs). Also, the several advantages and limitations of the latter were highlighted. The VEPs lacking the adoption of a collaborative governance approach (Ansell & Gash 2008; Bianchi 2015; Cepiku 2017; Bianchi et al. 2017) may lead to failure to reach the predetermined results. In this regard, the following chapter will explain how a collaborative governance approach can go beyond the limitations of the VEPs and boost the decrease of CO2 emissions in transportation. More in detail, the aim of the next chapter is also to highlight the two effects of the collaborative governance approach, which would prevent the development of dysfunctional practices on the one hand and support more effective implementation of VEPs in the transport sector and thus fostering the reduction of CO2 emissions on the other.

Additionally, the next chapter will suggest a systemic methodological approach, the Dynamic Performance Governance (DPG) approach, to support decision-makers at the policy and management levels in formulating and implementing more effective policies/strategies in reducing the environmental impact of the transportation sector, as well as better coordinating the actions of each actor involved.

References

ABAS, N., KALAIR, A., KHAN, N., 2015. Review of fossil fuels and future energy technologies. Futures 69, 31–49.

AHMED, R. (2012). The design of voluntary environmental programs: Competition and incentives to participate. Strategic Behavior and the Environment, 2(3), 217-238. https://doi.org/10.1561/102.00000016

ALBERINI, A., AND K. SEGERSON. 2002. "Assessing Voluntary Programs to Improve Environmental Quality." Environmental and Resource Economics 22 (1/2): 157–84.

ALRAZI, B., DE VILLIERS, C., VAN STADEN, C.J., 2015. A comprehensive literature review on and the construction of a framework for environmental legitimacy, accountability and proactivity. J. Clean. Prod. 102, 44e57. http://dx.doi.org/ 10.1016/j.jclepro.2015.05.022.

ANSELL, C., & GASH, A. (2008). Collaborative governance in theory and practice. *Journal of public administration research and theory*, *18*(4), 543-571.

ARAGON-CORREA, J. A., MARCUS, A. A., & VOGEL, D. (2020). The effects of mandatory and voluntary regulatory pressures on firms' environmental strategies: A review and recommendations for future research. *Academy of Management Annals*, *14*(1), 339-365. https://doi.org/10.5465/annals.2018.0014

ASPEN INST. (1996). *The Alternative Path: A Cleaner, Cheaper Way to Protect and Enhance the Environment*. Washington, DC: Aspen Inst.

BANSAL, P., CLELLAND, I., 2004. Talking trash: legitimacy, impression management, and unsystematic risk in the context of the natural environment. Acad. Manag. J. 47 (No. 1), 93e103. http://dx.doi.org/10.2307/20159562.

BARDACH E, KAGAN RA. (1982). *Going by the Book: The Problem of Regulatory Unreasonableness*. Philadelphia: Temple Univ. Press

BARNEA A, HEINKEL R, KRAUS A. 2004. Green investors and corporate investment. *Struct. Change Econ.Dyn.* 16:332–46

BARNETT, M., & KING, A. (2008). Good fences make good neighbors: A longitudinal analysis of an industry self-regulatory institution. *Academy of Management Journal*,*51*(6),11501170.https://doi.org/10.5465/amj.2008.35732609

BERCHICCI, L., & KING, A. (2007). 11 Postcards from the edge: A review of the business and environment literature. *Academy of Management Annals*, *1*(1), 513-547. https://doi.org/10.5465/078559816

BERRONE P, FOSFURI A, GELABERT L, GOMEZ-MEJIA LR (2013) Necessity as the mother of "green" inventions: Institutional pressures and environmental innovations. Strateg Manag J 34(8):891–909

BIANCHI, C. (2015). "Enhancing Joined-Up Government and Outcome-Based Performance Management through System Dynamics Modelling to Deal with Wicked Problems: The Case of Societal Ageing." *Systems Research and Behavioral Science* 32 (4): 502–505.doi:10.1002/sres.2341.

BIANCHI, C., BOVAIRD, T., & LOEFFLER, E. (2017). Applying a dynamic performance management framework to wicked issues: How coproduction helps to transform young people's services in Surrey County Council, UK. *International Journal of Public Administration*, 40, 833– 846.

BIBRI, S.E., KROGSTIE, J., 2017. Smart sustainable cities of the future: An extensive interdisciplinary literature review. Sustainable cities and society 31, 183–212.

BITEKTINE, A., HAACK, P., 2015. The 'macro' and the 'micro' of legitimacy: toward a multilevel theory of the legitimacy process. Acad. Manag. Rev. 40 (No. 1), 49e75. http://dx.doi.org/10.5465/amr.2013.0318.

BIVONA, E., & BILEK G. M. (2021). Using System Dynamics modelling to frame environmental voluntary commitment programs: the French experience. In *38th International Conference of the System Dynamics Society* (Vol. 1, pp. 71-82). Curran Associates, Inc.

BORCK, J. C., & COGLIANESE, C. (2009). Voluntary environmental programs: Assessing their effectiveness. *Annual Review of Environment and Resources*, *34*, 305-324. https://doi.org/10.1146/annurev.envi- ron.032908.091450

BRAND-CORREA, L.I., STEINBERGER, J.K., 2017. A framework for decoupling human need satisfaction from energy use. Ecol. Econom. 141, 43–52.

BUCHANAN, J. (1965). An economic theory of clubs. Economica, 32, 1–14.

CANTOR, D. E., MORROW P. C., & MONTABON, F. (2012). Engagement in environmental behaviors among supply chain management employees: An organizational support theoretical perspective. Journal of Supply Chain Management, 48(3), 33–51.

CARMIN, J., DARNALL, N., & MIL-HOMENS, J. (2003). Stakeholder involvement in the design of US voluntary environmental programs: Does sponsorship matter? *Policy Studies Journal*, *31*(4), 527-543. https://doi. org/10.1111/1541-0072.00041

CASTKA, P., & CORBETT, C. J. (2016). Adoption and diffusion of environmental and social standards. *International Journal of Operations & Production Management*, *36*(11), 1504-1529. https://doi. org/10.1108/IJOPM-01-2015-0037

CEPIKU, D. (2017). *Collaborative Governance*. In: Klassen T., Cepiku D. and Lah T.J. (eds), Routledge Handbook of Global Public Policy and Administration. London: Routledge, pp.141-156.

CHEN, J.C., ROBERTS, R.W., 2010. Toward a more coherent understanding of the organization society relationship: a theoretical consideration for social and environmental accounting research. J. Bus. Eth. 97 (No. 1), 651e665. http:// dx.doi.org/10.1007/s10551-010-0531-0.

CHEN, M. J., & MILLER, D. (2012). Competitive dynamics: Themes, trends, and a prospective research platform. *Academy of Management Annals*, 6(1), 135–210.

COGLIANESE, C., & NASH, J. (2010). Environmental management systems and the new policy agenda. In Regulating from the Inside (pp. 19-44). Routledge.

COGLIANESE, C., & NASH, J. (2014). Performance Track's Postmortem: Lessons from the Rise and Fall of EPA's Flagship Voluntary Program. Harv. Envtl. L. Rev., 38, 1.

CORNES, R., & SANDLER, T. (1996). The theory of externalities, public goods, and club goods, 2nd ed. New York: Cambridge University Press.

DARNALL, N. (2006). Why firms mandate ISO 14001 certification. *Business & Society*, *45*(3), 354-381. https://doi.org/10.1177/0007650306289387

DARNALL, N., & CARMIN, J. (2005). Greener and cleaner? The signaling accuracy of US voluntary environmental programs. *Policy Sciences*, *38*(2-3), 71-90. https://doi.org/10.1007/s11077-005-6591-9

DARNALL, N., JI, H., & POTOSKI, M. (2017). Institutional design of ecolabels: Sponsorship signals rule strength. *Regulation & Governance*, *11*(4), 438-450. https://doi.org/10.1111/rego.12166

DELMAS, M. A., & MONTES-SANCHO, M. J. (2010). Voluntary agreements to improve environmental quality: Symbolic and substantive cooperation. *Strategic Management Journal,* 31(6), 575–601.

DELMAS, M., & KELLER, A. (2005). Free riding in voluntary environmental programs: The case of the US EPA WasteWise program. *Policy Sciences*, *38*(2), 91-106.

DEVISSCHER, T., KONIJNENDIJK, C., NESBITT, L., LENHART, J., SALBITANO, F., CHENG, Z.C., LWASA, S., VAN DEN BOSCH, M., 2020. SDG 11: Sustainable cities and communities–impacts on forests and forest-based livelihoods. In: Sustainable Development Goals: Their Impacts on Forests and People, Vol. 349. Cambridge University Press.

DIESEL TECHNOLOGY FORUM, 2015. Diesel at Work Emissions Reduction. http://www.dieselforum.org/diesel-at-work/delivering-for-america.

EHRGOTT, M., REIMANN, F., KAUFMANN, L., & CARTER, C. R. (2013). Environmental development of emerging economy suppliers: Antecedents and outcomes. *Journal of Business Logistics*, 34(2), 131–147.

ELLRAM, L. M., & GOLICIC, S. L. (2016). The role of legitimacy in pursuing environmentally responsible transportation practices. *Journal of Cleaner Production*, *139*, 597-611.

ELLRAM, L.M., GOLICIC, S., 2015. Adopting environmental transportationpractices.Transp.J.54(No.1),55e88.http://dx.doi.org/10.5325/transportationj.54.1.0055.

ENTERPRISE ENVIRON. (1998). The Environmental Protection System in Transition: Toward a More Desirable Future. Washington, DC: Cent. Strateg. Int. Stud.

ENVIRONMENTAL NEWS SERVICE, 2013. Downshifting North America'sFreightTransportEmissions.February25,2013.http://www.ensnewswire.com/ens/apr2011/2011-04-04-02.html

ESTY DC AND WINSTON AS, (2006) *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Building* Competitive Advantage (Yale University Press)

FIORINO, D. J. (1999). Rethinking environmental regulation: perspectives on law and governance. Harv. Envtl. L. Rev., 23, 441

FULZELE, V., & SHANKAR, R. (2022). Improving freight transportation performance through sustainability best practices. Transportation Research Part A: Policy and Practice, 165, 285-299.

GHISETTI C (2017) Demand-pull and environmental innovations: Estimating the effects of innovative public procurement. Technol Forecast Soc Chang 125:178–187

GOLICIC, S.L., BOERSTLER, C.N., ELLRAM, L.M., 2010. Greening the transportation in your supply chain. Sloan Manag. Rev. 51 (No. 2), 47e55.

GUNNINGHAM, N., KAGAN, R., & THORNTON, D. (2003). Shades of green. Stanford, CA: Stanford University Press.

HALKOS, G., & GKAMPOURA, E. C. (2021). Where do we stand on the 17 Sustainable Development Goals? An overview on progress. *Economic Analysis and* Policy, 70, 94-122.

HAUNSCHILD, P. R., & SULLIVAN, B. N. (2002). Learning from complexity: Effects of prior accidents and incidents on airlines' learning. Administrative Science Quarterly, 47(4), 609–643

HENRIQUES, I., AND P. SARDORSKY. 1996. "The Determinants of an Environmentally Responsive Firm: An Empirical Approach." Journal of Environmental Economics and Management 30 (3): 381–95.

HOFER, C., CANTOR, D. E., & DAI, J. (2012). The competitive determinants of a firm's environmental management activities: Evidence from US manufacturing industries. Journal of Operations Management, 30(1–2), 69–84.

HOFFMAN, A. (2011). Talking past each other? Cultural framing of skeptical and convinced logics in the climate change debate. *Organization & Environment*, *24*(1), 3-33. https://doi.org/10.1177/1086026611404336

HÖÖK, M., TANG, X., 2013. Depletion of fossil fuels and anthropogenic climate change—A review. Energy Policy 52, 797–809.

IEA, 2018. Improving the sustainability of passenger and freight transport. Retrieved 11 11, 2020, from https://www.iea.org/topics/transport.

ITF, 2019. ITF Transport Outlook 2019. OECD Library. https://www.oecd-ilibrary.org/sites/transp_outlooken2019en/index.html?itemId=/content/publication/transp_outlook-en-2019-en#countryli_container2.

JIANG Z, WANG Z, LI Z (2018) The effect of mandatory environmental regulation on innovation performance: evidence from China. J Clean Prod 203:482–491

JOSS, S., 2015. Sustainable Cities: Governing for Urban Innovation. Macmillan International Higher Education.

KHANNA, MADHU, AND LISA A. DAMON. 1999. “EPA’s Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms.” Journal of Environmental Economics and Management 37: 1–25.

KHANNA, MADHU, AND WILLIAM R. Q. ANTON. 2002. “Corporate Environmental Management: Regulatory and Market-Based Incentives.” Land Economics 78 (4): 539–58.

KING, A., & LENOX, M. (2000). Industry self-regulation without sanctions: The chemical industry’s respon- sible care program. *Academy of Management Journal*, *43*(4), 698-716. https://doi.org/10.2307/1556362

KLASSEN, R. D., & MCLAUGHLIN, C. P. (1996). The impact of environmental management on firm performance. *Management Science*, 42(8), 1199–1214.

KOEHLER, D. A. (2007). The effectiveness of voluntary environmental programs: A policy at a crossroads? Policy Studies Journal, 35(4), 689-722. https://doi.org/10.1111/j.1541-0072.2007.00244.x

KOTCHEN, M., & VAN’T VELD, K. (2009). An economics perspective on treating voluntary pro- grams as clubs. In M. Potoski & A. Prakash (Eds.), Voluntary programs: A club theory per- spective (pp. 67–86). Cambridge, MA: MIT Press.

LAMBERT, J.G., HALL, C.A., BALOGH, S., GUPTA, A., ARNOLD, M., 2014. Energy, EROI and quality of life. Energy Policy 64, 153–167.

LARGE, R.O., KRAMER, N., HARTMANN, R.K., 2013. Procurement of logistics services and sustainable development in Europe: fields of activity and empirical results. J. Purch. Supply Manag. 19 (No. 3), 122e133. http://dx.doi.org/10.1016/ j.pursup.2013.05.002.

LEUNG, A., XU, H., WU, G. J., & LUTHANS, K. W. (2019). Industry peer networks (IPNs): Cooperative and competitive interorganizational learning and network outcomes. *Management Research Review*, 42(1), 122–140.

LIAN T, MA T, CAO J, WU Y (2016) The effects of environmental regulation on the industrial location of China’s manufacturing. Nat Hazards 80(2):1381–1403

LIESEN, A., HOEPNER, A.G., PATTEN, D.M., FIGGE, F., 2015. Does stakeholder pressure influence corporate GHG emissions reporting? Empirical evidence from Europe. Acc. Audit. Acc. J. 28 (No 7), 1047e1074. http://dx.doi.org/10.1108/AAAJ-12- 2013-1547.

LIIMATAINEN, H., INGER, I.B., ARVIDSSON, N., NYKA€NEN, L., 2015. Driving forces of road freight CO2 in 2030. Int. J. Phys. Distrib. Logist. Manag. 45 (No. 3), 260e285. http://dx.doi.org/10.1108/IJPDLM-10-2013-0255.

LOUNIS, Z., MCALLISTER, T.P., 2016. Risk-based decision making for sustainable and resilient infrastructure systems. J. Struct. Eng. 142 (9), F4016005.

LUN, Y.H.V., LAI, K.H., NG, C.T., WONG, C.W.Y., CHENG, T.C.E., 2011. Research in shipping and transport logistics. Int. J. Shipp. Transp. Logist. 3 (No. 1), 1e5. URI: hdl.handle.net/10397/12028.

LUNDGREN, T. (2003). A real options approach to abatement investments and green goodwill. Environmental and Resource Economics, 25, 17–31.

MA D, FEI R, YU Y (2018) How government regulation impacts on energy and CO2 emissions performance in China’s mining industry. Resource Policy. https://doi.org/10.1016/j.resourpol.2018.11.013

MARKS, H., 2015. How a greener trucking industry could save $40 billion per year. GreenBiz. http://www.greenbiz.com/article/how-trucking-industry-could- reduce-ghg-emissions

MAYER GE. (1999). A green tier for greater environmental protection. Wis. Dep. Nat. Resour. Rep., Madison, WI

MORGENSTERN, R. D., & PIZER, W. A. (2007). How well do voluntary environmental programs really work?. RESOURCES-WASHINGTON DC-, 164, 23.

NORWEGIAN MINISTRY OF ENVIRONMENT, 1994. Report of the Sustainable Consumption Symposium. Oslo.

ORTS, E. W. (1994). Reflexive environmental law. Nw. UL Rev., 89, 1227.

PLS LOGISTICS SERVICES, 2016. 5 Ways Shippers Are Affected by Green Transportation Regulations (March 24) retrieved from. http://info.plslogistics.com/blog/5-waysshippersareaffectedbygreentransportation-regulations

POPP D, HAFNER T, JOHNSTONE N (2011) Environmental policy vs public pressure: innovation and diffusion of alternative bleaching technologies in the pulp industry. Res Policy 40(9):1253–1268

PORTER ME, VAN DER LINDE C (1995) Toward a new conception of the environment-competitiveness relationship. J Econ Perspect 9(4):97–118

PORTNEY PR, STAVINS RN. (2000). Public Policies for Environmental Protection. Washington, DC: Resour. Future

PRAKASH, A., & POTOSKI, M. (2006a). The voluntary environmentalists. Cambridge: Cambridge University Press.

PRAKASH, A., & POTOSKI, M. (2012). Voluntary environmental programs: A comparative perspective. Journal of Policy Analysis and Management, 31(1), 123-138.

SARKIS, J., GONZALEZ-TORRE, P., & ADENSO-DIAZ, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. Journal of Operations Management, 28(2), 163–176.

SCOTT, A., LI, M., CANTOR, D. E., & CORSI, T. M. (2022). Do voluntary environmental programs matter? Evidence from the EPA SmartWay program. Journal of Operations Management.

SEGERSON, K., AND T. J. MICELI. 1998. "Voluntary Environmental Agreements: Good or Bad News for Environmental Protection?" Journal of Environmental Economics and Management 36 (2): 109–30.

SMIL, V., 2019. Energy in World History. Routledge.

SPENCE, M. (1973). Job market signaling. Quarterly Journal of Economics 88, 355–374.

TATE, W. L., ELLRAM, L. M., & KIRCHOFF, J. F. (2010). Corporate social responsibility reports: A thematic analysis related to supply chain management. Journal of Supply Chain Management, 46(1), 19–44

TEETER, P., & SANDBERG, J. (2017). Constraining or enabling green capability development? How policy uncertainty affects organizational responses to flexible environmental regulations. British Journal of Management, 28(4), 649-665.

THALER, R. H., & SUNSTEIN, C. R. (2008). Nudge: Improving decisions about health, wealth and happiness. In Amsterdam Law Forum (Vol. 1).

TSENG, M.L., TAN, R.R., SIRIBAN-MANALANG, A.B., 2013. Sustainable consumption and production for Asia: sustainability through green design and practice. J. Cleaner Prod. 40, 1–5.

TUKKER, A., EMMERT, S., CHARTER, M., VEZZOLI, C., STO, E., ANDERSEN, M.M., GEERKEN, T., TISCHNER, U., LAHLOU, S., 2008. Fostering change to sustainable consumption and production: an evidence based view. J. Cleaner Prod. 16 (11), 1218–1225.

U.S. ENVIRONMENTAL PROTECTION AGENCY, 2015. About SmartWay. http://www3.epa. gov/smartway/about/index.htm (accessed 05.10.15.).

UNITED NATIONS, 1992. United Nations Framework Convention on Climate Change. United Nations, New York.

VALLEJO, L., MULLAN, M., 2017. Climate-resilient infrastructure: Getting the policies right.

VAN DER BERG, A. (2018). The Pursuit of SDG 11 Through the Lens of Integrated Development Planning. In The Globalisation of Urban Governance (pp. 208-226). Routledge.

WORLD BANK, 2020. Retrieved from The World Bank Data. Available Online: Https://Data.Worldbank.Org/

WU W, LIU Y, WU CH, TSAI SB (2020) An empirical study on government direct environmental regulation and heterogeneous innovation investment. J Clean Prod 254:120079

ZHANG H, ZHU Z, FAN Y (2018) The impact of environmental regulation on the coordinated development of environment and economy in China. Nat Hazards 91(2):473–489

ZIZZO DJ, FLEMING P (2011) Can experimental measures of sensitivity to social pressure predict public good contribution? Econ Lett 111(3):239–242

Chapter 3: Designing Dynamic Performance Governance Systems in the freight transport sector

3.1 Introduction

The previous chapter analyzed the Sustainable Development Goals (SDGs) to which the transportation sector contributes. It also introduced Voluntary Environmental Programs (VEPs), a policy lever to reduce CO2 emissions in the freight transport sector and achieve the SDGs. Aside from the many benefits, the VEPs are limited because they lack the adoption of a collaborative governance approach, which can lead to failure in achieving the predetermined results.

Based on the limitations regarding VEPs highlighted in the previous chapter, this chapter introduces the collaborative governance approach, which can help overcome the limits of VEPs and support more effective implementation in the freight transport sector, thus fostering the reduction of CO2 emissions. Moreover, this chapter suggests a systemic methodological approach, the Dynamic Performance Governance (DPG) approach, to support decision-makers at the policy and management levels in formulating and implementing more effective policies/strategies in reducing the environmental impact of the transportation sector, as well as better coordinating the actions of each actor involved and to support collaborative governance.

In detail, the Dynamic Performance Management (DPM) approach is introduced, centered on a continual learning process that aims to improve the mental models of organizational key-actors (Bianchi, 2016). Then, the Dynamic Performance Governance (DPG) approach (Bianchi, 2016; Bianchi et al., 2019; Bianchi & Vignieri, 2020) is introduced as a method for investigating and managing the freight transport sector, offering an interorganizational perspective in setting policy coordination and collaborative governance. This approach promotes sustainable socioeconomic development and improved community outcomes (Bovaird, 2007; Torfing & Ansell, 2017; Bianchi & Vignieri, 2020).

Lastly, the System Dynamic (SD) methodology and how it can support performance management in the freight transport sector, characterized by complexity and dynamism, is introduced.

3.2 A collaborative governance approach to implement VEPs

As highlighted in the previous chapter, VEPs show several limitations. A collaborative governance approach can be helpful to overcome the limits of VEPs and to support more effective implementation of them in the freight transport sector, thus fostering the reduction of CO_2 emissions.

As pointed out in the first chapter, the freight transport sector is a complex system - because of the continuous changes in the impacts on the environment mainly generated by the CO_2 emissions and the complexity on the government of this sector both at an organizational and inter-organizational level related to the several actors involved in it - and can be defined as a wicked problem.

As mentioned previously, wicked problems are contrary to their tame counterparts, which are simple to define and formulate and have a high potential for standard or routine solutions (Head & Alford, 2015). Since the environment they affect is so complicated, the word "wicked" does not necessarily indicate "evil" but rather refers to issues that are challenging to define and manage (Australian Public Service Commission, 2007; Head & Alford, 2015).

Because of both their dynamic and complex character and the reason that they engage multi-level, multi-actor and multi-sectoral issues, “wicked” problems cannot be grouped inside the confines of a single organization (Head and Alford 2013; Lægreid and Rykkja 2014; Bianchi 2015).

When wicked problems emerge, the collaborative governance approach is intended to decrease policymaking divisions and coordinate different actors. Moreover, the collaborative governance approach encourages actors to participate in roundtable discussions with public institutions (Bianchi 2016; Bianchi et al. 2017).

In this approach, a public agency deliberately and directly engages non-state actors in a formal, consensual, and collective decision-making process to implement programs and to come up with solutions to issues that no organization can solve alone (Ansell and Gash 2008; Agranoff and McGuire 2003).

Bretschneider et al. (2012) identify three different reasons for understanding incentives to collaborate:

- the organizational behaviour theories,
- the public value theory, and
- the accessibility of performance data.

The basic concept of organization theories is the resource dependency theory, in which single organizations do not have complete access to all the resources they need to achieve their goals (Pfeffer and Salancik 1978).

Public value theory states that if public managers believe that a collaborative governance approach can facilitate and increase public value creation, they will be willing to give up some of their authority.

Sharing resources between different actors can also be encouraged by the accessibility of performance data (Lah 2017).

Ansell and Gash (2008) point out, among others, several elements that characterize the collaborative process:

- Face-to-face dialogue;
- Trust building;
- Commitment to the process;
- Shared understanding and
- Intermediate outcomes.

They state that open and continuous communication between the different actors is essential to understand how they can benefit from each other. The face-to-face dialogue between the different actors aims to eliminate prejudices and barriers to communication that can inhibit open and continuous dialogue (Bentrup 2001). In addition, there must be mutual respect among the actors, trust, understanding and dedication to the procedures (Gilliam et al. 2002; Lasker and Weiss 2003; Plummer and Fitzgibbon 2004; Schneider et al. 2003; Tompkins and Adger 2004; Warner 2006).

Moreover, Ansell and Gash (2008) show that the degree of commitment of the actors to collaborate is a critical variable in explaining the success or failure of the collaboration. A prerequisite of the commitment is trust in the other actors' concerns. Furthermore, commitment requires clear, impartial, transparent procedures (Gilliam et al. 2002).

In addition, the collaborative governance approach shifts ''ownership'' of decision-making from the single actor to the actors acting collectively (El Ansari 2003; Geoghegan and Renard 2002; Weech-Maldonado and Merrill 2000). In this regard, actors must understand what they can achieve through collaboration (Tett et al. 2003).

A further element that Ansell and Gash (2008) highlight in a collaborative governance process is the importance of obtaining intermediate outcomes. Numerous case studies show that collaboration is more likely to occur when "little wins" can be obtained and potential goals and benefits are clear and achievable (Chrislip and Larson 1994; Roussos and Fawcett 2000; Warner 2006; Weech-Maldonado and Merrill 2000). More precisely, "little wins" can strengthen the collaborative process and promote commitment and trust building (Rogers et al. 1993; Vangen and Huxham 2003; Cepiku 2017).

Figure 18 explains the collaboration process and how this can foster a decrease in CO_2 emissions by creating co-value through the engagement of different actors (Saporito et al., 2022).

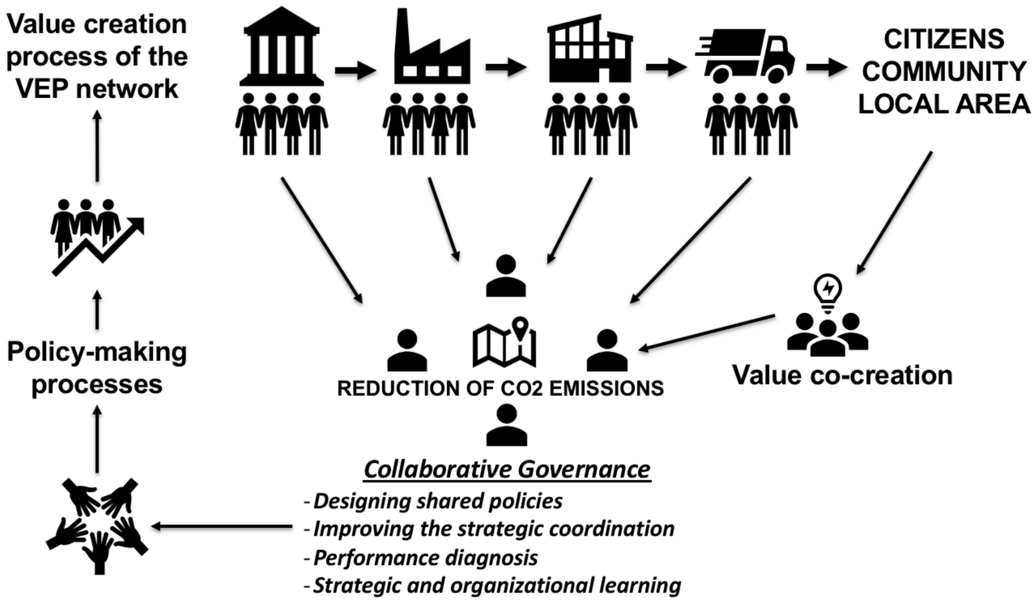

Figure 18. *"The collaborative governance process."* Adapted from Saporito et al. (2022) article in press.

More precisely, the implementation of a collaborative governance approach in the freight transportation sector can foster the effectiveness of VEPs in terms of the number of participants in the program and in the results achieved by the organizations that participate in the program regarding the reduction in CO2 emission. In particular, a collaborative governance approach increases communication among all the actors involved in the program (e.g., public agencies, shippers, carriers, and freight forwarders). It increases awareness of the potential benefits of VEPs. It can also foster value co-creation by stimulating a shared vision of the goals to be achieved.

Due to the above reasons, a collaborative governance approach can also overcome a limited individual perspective and utilize shared resources more effectively to achieve expected CO2 targets (Saporito et al. 2022).

The next paragraph will suggest a systemic methodological approach, the Dynamic Performance Governance (DPG) approach, to support decision-makers at the policy and management levels in formulating and implementing more effective policies to reduce the environmental impact of the transportation sector, as well as better coordination of each actor's action, and to support collaborative governance.

3.3 The DPM and DPG approach: purposes, design principles, and practical examples

3.3.1 The DPM approach

Often, decisions may be influenced by a conservative approach resulting in a "single loop" learning process when an organization operates in complex dynamic systems and mental models are only supported by accounting or statistical data (Argyris and Schon 1978). Furthermore, it is assumed that decision makers refrain from evaluating organizational procedures over a reasonably long time when learning in a single loop. The change primarily occurs through discrete occurrences predetermined exclusively by formal plans in this situation. According to this perspective, strategic management is simply characterized by making long-term decisions, and the line between strategic design and implementation is emphasized clearly.

The dangers of single-loop learning are associated with the rigidity of decision-making processes, particularly when businesses work in complex and unpredictable systems (Bianchi, 2016).

Implementing a "double-loop" (Argyris and Schon 1978) learning process that enables decision-makers to evaluate consistency in their mindsets, i.e., the way they frame problems and strategic concerns, is important to overcome the limitations of accounting and mental models (Bianchi, 2016).

The System Dynamics (SD) technique can promote double-loop learning to:

- make mental models explicit;
- evaluate the consistency of mental models;
- improve mental models.

Via simulating, SD modeling tests mental models. After the model has been verified, decision-makers can evaluate the consistency of their own decisions in a "protected" context with a modeler/learning facilitator (Bianchi, 2016).

Therefore, the idea of performance management as a mechanical or bureaucratic duty should be avoided. On the contrary, an SD methodology can improve

performance management, particularly for organizations operating in dynamic and complex environments (Bianchi, 2016).
Organizational decision-makers can benefit from the SD model by receiving the right "lenses" to view dynamic complexity and improve conventional performance management techniques (Bianchi, 2016).
On the one hand, the formal quantitative-mathematic approach to finding the best possible solutions to company problems and, on the other hand, the practical management world - which necessitates a better understanding of complex systems and managing unpredictability - are two large domains that have traditionally been kept apart. The SD approach is a "bridge" between these two broad domains (Bianchi, 2016).
Often, decision-makers may be prevented by their mental models from quickly recognizing subtle changes in the relevant system's structure and comprehending the underlying causes of organizational phenomena, especially when an organization functions in complex dynamic systems. Even though experience, intuition, intelligence and entrepreneurial abilities can be significantly helpful in decision-making, human cognitive limits are frequently a consequence of misunderstandings about feedback loops and non-linear correlations between pertinent factors (Bianchi, 2016).
For this reason, the Dynamic Performance Management (DPM) approach is centered on a continual learning process that aims to improve the mental models of organizational key-actors (Bianchi, 2016).
Such an objective may be attained through an ongoing activity supported by an SD modeler/learning facilitator and designed to foster a circular process defined along a series of interconnected steps: (1) observation; (2) reflection, knowledge elicitation and communication; (3) diagnosis and sharing of a common understanding of reality; and (4) decision-making and action (Kolb 1984).
To adopt a "double-loop learning" method, as Argyris (2002) defined, decision-makers must first cross all of these stages using SD models. Double-loop learning is revising goals or standards for making decisions based on the knowledge gained by testing and modeling organizational performance (Cosenz, 2022).

The following stages of the performance management cycle can be supported by the SD modeling process, which encourages double-loop learning:
1) mapping (framing the system);
2) planning;
3) putting decisions or operations into action;
4) measuring/evaluating results; and
5) taking remedial action (Figure 19) (Bianchi, 2016).

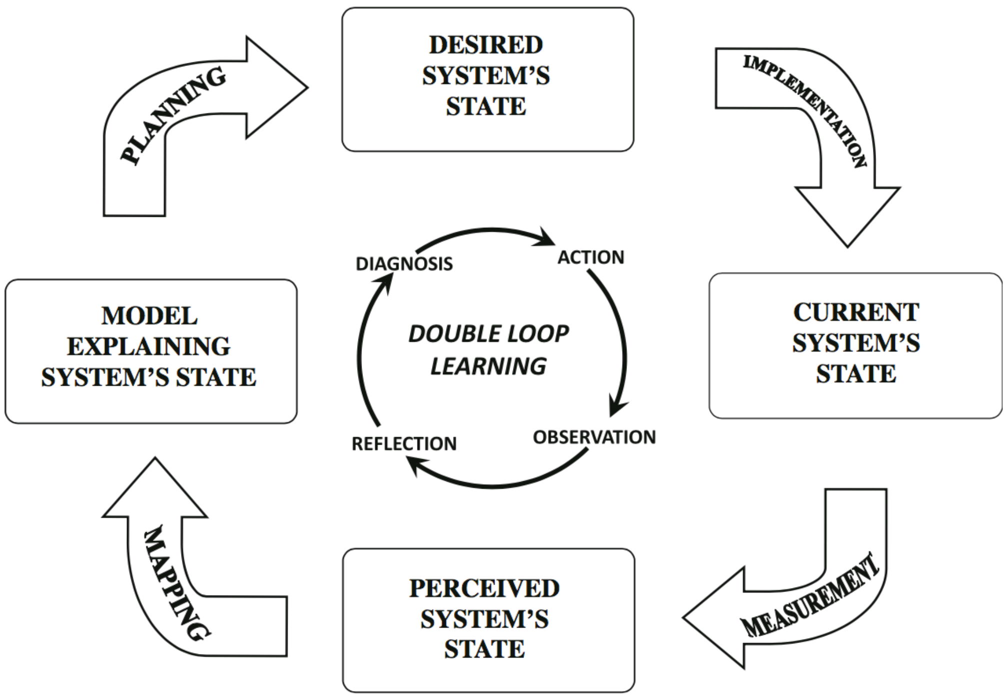

Figure 19. "*Dynamic performance management and double loop learning*" adapted from Bianchi, 2016.

In reality, developing an SD model starts with identifying a dynamic pattern of behavior linked to reported results (data collection/measurement). These results are a product of the organizational system's current status.
Dynamic Performance Management aims to:
1) recognize such a state;
2) sketch, through system mapping, a model that might explain the hidden feedback structure underpinning detected behavior;
3) define a desired systems state through planning;

4) implement the plan and take corrective action through feedback and feedforward control (Bianchi, 2016).

In detail, the ability of decision makers to identify a dynamic issue underlying observed reference behavior across time, with the support of the SD modeler, enables them to create a picture of the perceived system's state. Such a picture, which involves creating and sharing impact diagrams among decision-makers, first frames the system through qualitative feedback analysis. Quantitative analysis of stock and flow is created in the second stage of SD modeling to support planning (Bianchi, 2016).

Decision-makers can examine the model's behavior during simulation to reevaluate their initial hypotheses. This activity allows the creation of dynamic plans and the formulation of decisions. Double-loop learning is improved through the aforementioned processes (Bianchi, 2016).

Moreover, decision-makers in organizations can frame the causal processes driving organizational outcomes throughout time using the DPM approach. As mentioned, Performance Management and SD modeling are two convergent research methodologies that constitute the foundation of this field of study and application. DPM bases its arguments on research showing the ineffectiveness of traditional P&C systems with a financial focus. It highlights that such systems no longer support the management of dynamic complexity, measurement of intangibles, delay detection, comprehension of linkages between short and long-term, and determining appropriate boundaries in strategic planning (Bianchi, 2016).

According to Bianchi (2010, 2012, 2016), applying SD modeling to PM defines Dynamic Performance Management (DPM) as a more reliable methodological approach for facilitating strategic planning and performance monitoring in complex organizational systems (Cosenz, 2022).

Performance Management (PM) can be presented and described differently depending on the perspective. Bianchi (2010, 2012, 2016) established three complementing perspectives of PM: instrumental, subjective, and objective (Noto, 2020).

Defining goals and objectives within a PM environment, according to Bianchi (2016), especially calls for the implementation of a "subjective" perspective regarding performance (figure 20) (Cosenz, 2022).

Figure 20. *"The "subjective" view of performance management (Bianchi, 2016, pp. 136)"*.

This perspective reveals the connections between results and goals in terms of actions. As a result, goals and objectives are established by considering both the connected processes and activities to be carried out and the anticipated results (i.e., performance drivers and end results). Consequently, goals can be established for the organization as a whole (macro processes) and each organizational unit, a particular process or activity (micro-processes). To enhance strategic planning and decision-making processes, this perspective on PM – taken from Bianchi's work (2010, 2012, 2016) - is very helpful (Cosenz, 2022).

Concerning the organization, the objective view employs a hybridized exterior and inside perspective. It must first identify the clients, users, or, more generally, the stakeholders with whom it interacts. It also calls for the description of the products or services. The processes and activities required to supply the product or service can be designed once it has been established (Figure 21) (Bianchi, 2016; Noto, 2020)

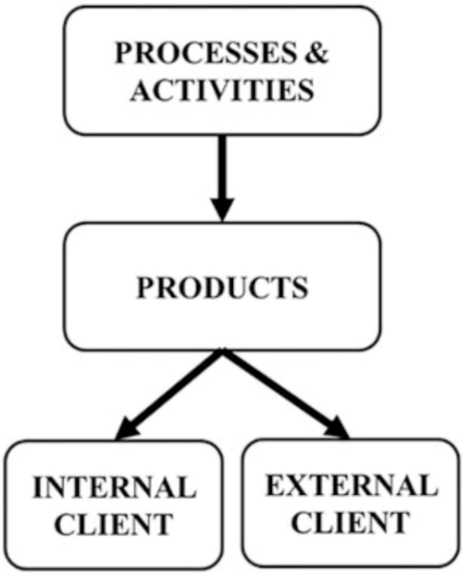

Figure 21. *“The “objective” view of performance management (Bianchi, 2016, pp. 121)”.*

The instrumental perspective of performance uses three important building components to create PM frameworks:

- strategic resources,
- performance drivers and
- end results

Strategic resources are the system’s assets, such as information or physical assets, that can be used to achieve targeted results. These often constitute the system's inputs for analysis.

Performance drivers are intermediate results that evaluate a system's state by contrasting it to a benchmark or a goal value. They are frequently referred to as performance indicators. They frequently refer to output measurements.

End results are results attained by the organization or system evoked by the management cycle (producing process). Depending on who benefits from them, these can be outputs or outcomes. The notion of "outputs" refers to the quantitative results that are immediately attainable. The long-term effects of such outputs on a wider context are referred to as outcomes (Figure 22) (Bianchi et al., 2019; Cosenz, 2022; Noto, 2020)

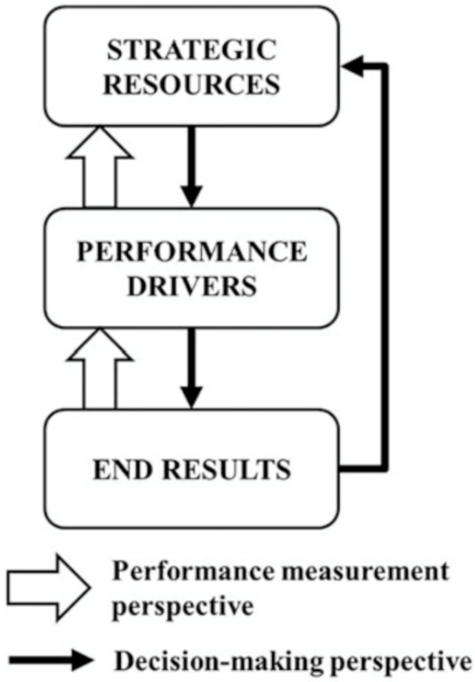

Figure 22. “The “instrumental” view of performance management (Bianchi, 2016, p. 73)”.

Performance drivers can change the end result. A DPM system requires both end results and performance drivers because, although an end result may be altered over the medium to long term, a performance driver can be influenced over the short term. They give decision-makers measurements of potential weak symptoms of potential future change in the end results, enabling an organization to recognize, quantify, and maybe mitigate the consequences of discontinuity on performance. To anticipate potential changes in the financial, competitive, or societal end results, measures like these can be helpful (Bianchi, 2016).

It is important to distinguish between the performance index and the performance driver. Synthetic measurements of a system's status or quality are called performance indexes. They are often stated as ratios, just like performance drivers. Indexes have no impact on any particular performance measure, whereas drivers have an impact on end results or other performance drivers. Performance drivers, thus, are appropriate measurements for performance management, whereas performance indexes may simply be pertinent for measuring performance (Bianchi, 2016).

In a DPM system, the three performance views—instrumental, objective, and subjective—play complementary roles. The objective view identifies what the object of performance management is. The defined object(s)' potential effects are revealed through the instrumental view. The subjective perspective concentrates on who is in charge of tasks intended to develop and coordinate strategic resources, influence performance drivers and results, and estimate the volume and quality of products/services to effectively and efficiently meet target customers’ needs. As a result, the interaction of the three performance perspectives might promote a P&C that is responsive and learning-oriented (Figure 23) (Bianchi, 2016).

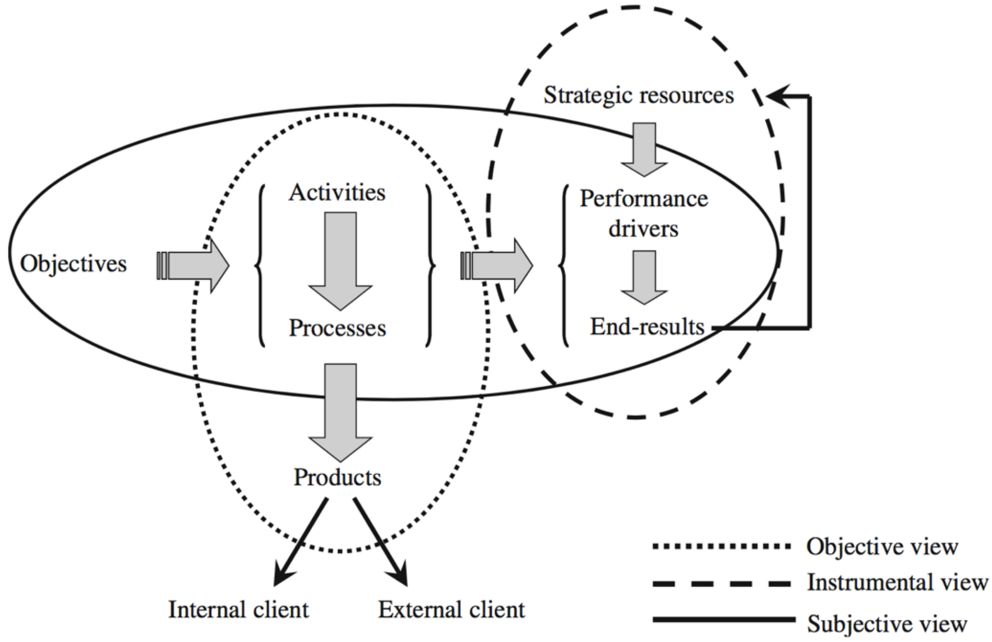

Figure 23. “Synergies among the three views of dynamic performance management” adapted from Bianchi, 2016.

This is especially important for organizations operating in complex dynamic systems because it has been shown that a formalistic, static, non-systemic, and incremental approach to planning can create the illusion of control that results in uncontrollable development and crises (Brews and Hunt 1999; De Geus 1988; Mintzberg 1993, 1994a, b; Bianchi, 2016).

As mentioned above, the methodological approach known as Dynamic Performance Management (DPM) is based on combining the three perspectives of performance management (i.e., "subjective," "objective," and "instrumental") with SD modeling (Bianchi, 2010, 2012, 2016; Cosenz, 2022). DPM specifically uses SD models to improve the effectiveness of PM systems to better frame the dynamic complexity that characterizes today's organizational settings and promote long-term sustainability. In this way, the "instrumental view" of PM is translated into terms of SD methodology to define the relationship between PM and SD models. The conversion of strategic resources, performance drivers, and end results into SD variables is shown in Figure 24 (Cosenz, 2022).

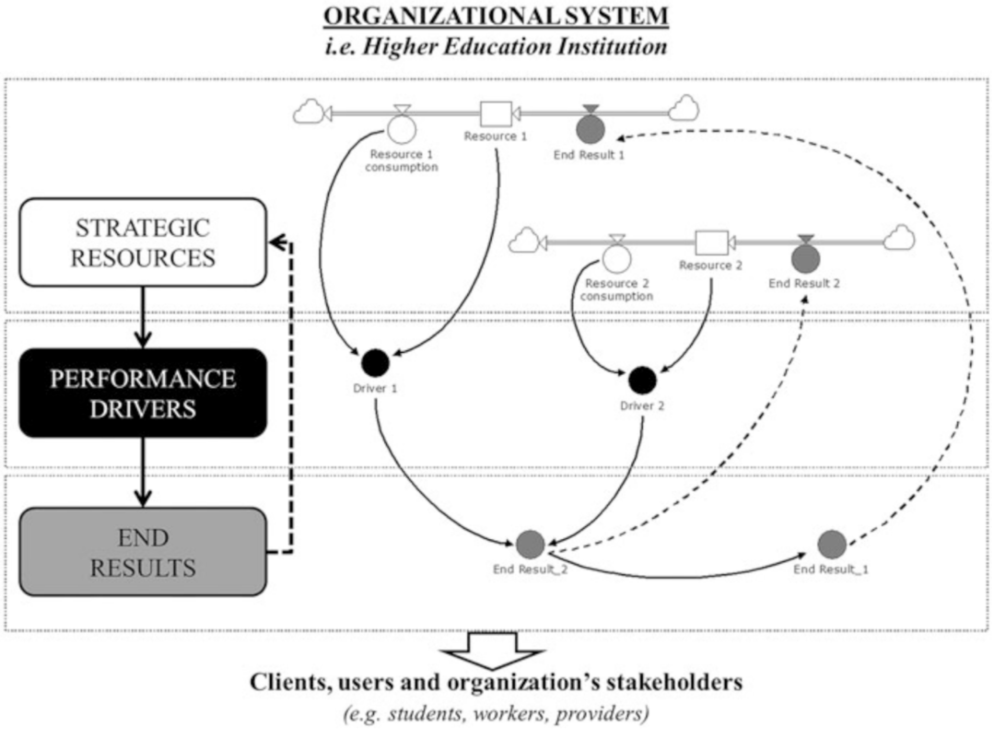

Figure 24. *"Modeling the "instrumental view" of PM through SD methodology (Bianchi, 2016, p. 73)"*

Resources are specifically treated as stock variables, with inflows and outflows controlling the processes of accumulation and depletion, respectively. Flow variables measure the value created (or destroyed) by management and operations processes since they represent the end results attained over time. Critical success factors are influenced by operations and activities used to distribute and use strategic resources. These factors are quantified as performance drivers and modeled as auxiliary variables.

As mentioned above, the DPM methodology uses SD to improve comprehension of how time delays affect strategic resources and results across value creation processes. This methodological support is crucial for controlling performance in complex dynamic systems (Cosenz, 2022).

To sum up, SD modelling is used to help the comprehension of:

- How performance drivers can influence end results;
- How performance drivers can be influenced by the implementation of policy levers intended to condition the processes of strategic resource growth and depletion; and
- How end results can influence the flow of strategic resources (Bianchi, 2016).

3.3.2 Relevance of DPG in the freight transport sector

The design of a performance management system for the freight transport sector suggests the implementation of a broader perspective, including the collaborative governance and related performance resulting from the combined effort of multiple actors (e.g., public, private, and nonprofit organizations, agencies, local authorities) (Bianchi et al., 2019; Bianchi & Vignieri, 2020, Cosenz, 2022).

The Dynamic Performance Governance (DPG) approach (Bianchi, 2016; Bianchi et al., 2019; Bianchi & Vignieri, 2020) will therefore be introduced as a method for investigating and managing the freight transport sector, offering an interorganizational point of view to foster policy coordination and collaborative governance to promote sustainable socioeconomic development and improved community outcomes (Bovaird, 2007; Torfing & Ansell, 2017; Bianchi & Vignieri, 2020).

As mentioned by Bianchi et al., 2019, Dynamic Performance Governance (DPG) is a method "able to support policy networks to pursue sustainable community outcomes" (Bianchi et al., 2019, p. 2).

To foster coherence and to learn in the development, implementation and interorganizational coordination of policies at a policy network level, this approach employs the methodological perspective of Dynamic Performance Management (DPM) (Bianchi, 2010; Bianchi, 2016), extending the organizational boundaries of a single institution (Bianchi & Tomaselli, 2015; Bianchi et al., 2017, 2019).

This perspective is intended to highlight the strategic communication between the many stakeholders that operate in the same area for collaboratively generating public value through products and services based on a sustainable development perspective, as noted by Bianchi et al. (2019, p. 4).

As mentioned above, the DPG approach utilizes the Dynamic Performance Management (DPM) perspective to help in the formulation of policies and, as a consequence, enhance performance governance by adopting interpretative lenses for analyzing how and why performance measurements change over time as a result of implemented policies, activities of the stakeholders, and external circumstances (Bianchi, 2016; Bianchi et al., 2019).

As with the DPM approach, creating feedback structures - used in the system dynamics model (Morecroft, 2015; Sterman, 2000) - is how the emerging DPG models are created. These feedback structures can define the causal interdependences between the variables (strategic resources, performance drivers, and end results) of the governance structure in analysis (Bianchi, 2016). Moreover, policy levers are highlighted to change the system's current status (Bianchi, 2016; Sterman, 2000). DPG models, thus, are used as cognitive tools to investigate the value creation processes impacting community outcomes and to clarify how the stakeholders respond to applied policies in the context of performance governance, similar to alternative modeling methods that support decision-making (Bianchi, 2016). As mentioned above, the DPG method uses System Dynamics (SD) models, which have successfully supported a descriptive perspective in policy evaluation and performance management. This facilitates communication and sharing of comprehension of the reasons and effects behind the observed governance structure between network members (Bianchi et al., 2019).

Hence, the Dynamic Performance Governance (DPG) approach (Bianchi, 2016; Bianchi et al., 2019; Bianchi & Vignieri, 2020) could be a valid tool for the freight transport sector because it offers a method to investigate and manage it. The DPG approach ensures the performance evaluation at an inter-institutional level regarding results achieved by decision-makers within the larger system, including numerous transport sector organizations (Bianchi 2016). It is important to specify that the performance of the inter-institutional system can be described as "the net relationships and synergies among the different institutions linked to each other" rather than simply being the sum of the performances of all the individual institutions. This enables the analyst to comprehend that each organization involved in the system will contribute to creating public value for the entire transportation system (Noto, 2020). In particular, the DPG approach matches well with the freight transport sector because it can deal with the complexity of this special domain through a systemic view of the freight transport sector, highlighting all the actors involved in it and the interaction between them (Bianchi 2016).

The next section introduces the system dynamic methodology and how it can support performance management in the freight transport sector, characterized by complexity and dynamism.

3.4 System dynamics modelling

A scientific method called system dynamics (SD) was created in the 1950s, principally by J. W. Forrester. It may be characterized as a method and group of conceptual tools that help us comprehend the dynamics and structure of complex, non-linear, multi-loop feedback systems (Forrester 1961; Meadows 1980; Sterman 2000).

Concepts from several disciplines, including control engineering, cybernetics, and organizational theory, were combined to create SD (Meadows 1980; Vennix 1990). It was initially used to address industrial enterprises' issues (such as inventory management, declining market share, labor force instability, etc.). However, a larger range of social systems, including those related to engineering, environmental sciences, economics, and strategic management, has gradually and effectively incorporated it (Cosenz and Noto 2016).

By testing and challenging their mental models and strategic choices, decision makers can use SD modeling to theorize the potential effects of various scenarios (Cosenz and Noto 2018). SD focuses on the connection between the system's behavior and the complex structure that causes it. This allows the entire system's structure and the individual parameters to be examined (Noto, 2020).

Causal Loop Diagrams (CLD) and Stock and Flow Diagrams (SFD) are two of the representational types offered by SD. In the first, qualitative, the main focus is the causal connections between the variables. The second option, which emphasizes the structural characteristics of the system under study, is quantitative (Noto, 2020). The feedback systems thinker can use a Causal Loop Diagram (CLD) as a visual support. Such visual representations depict links between cause and effect and feedback mechanisms. The core building blocks of a Causal Loop Diagram (CLD) are always words, phrases, links, and loops, with special requirements for identifying variables and showing the polarity of connections and loops. A polarity—either positive or negative—is given to each connection. A positive pointing "+" indicates that if the cause rises, the effect will be the same. If there is a negative "-" relationship, the cause and effect are inversely correlated. Thus, with a negative relationship, if the cause grows, the effect diminishes (Morecroft, J. D. (2015).

In general, a feedback loop might be reinforcing or balancing. The names provide information about how the feedback process works. When the consequences of a change in a variable's condition are traced through a balancing loop, the result is a counteracting or balancing change. A balancing loop may support either a draining or an adjusting process (Bianchi, 2016). A reinforcing loop, in contrast, amplifies or reinforces change. Behavior over time in a realistic multi-loop system results from the interaction of balancing and reinforcing loops (Morecroft, J. D. (2015).

Figure 25 below shows an example of reinforcing and balancing feedback loops through Causal Loop Diagrams (CLDs).

On the one hand, the reinforcing loop (R) in the figure below highlights how "Shipper program advertising" increases the rate of "Shippers enrolled in the program." The more shippers enrolled in the program, the more "Shippers' internal environmental awareness," generating greater "Shippers' Environmental & Operating Performance" and "Shippers' reputation". An increase in "Shippers' reputation" generates an increase in "Shippers enrolled in the program".

On the other hand, the balancing loop (B) in the figure below shows how an increase of "Shippers enrolled in the program" increases the percentage of enrolled shippers relative to all shippers. Shippers' enrollment rate growth would decline as the percentage of shippers enrolled increased over the total shippers. This generates a balancing effect on the number of shippers enrolled in the program.

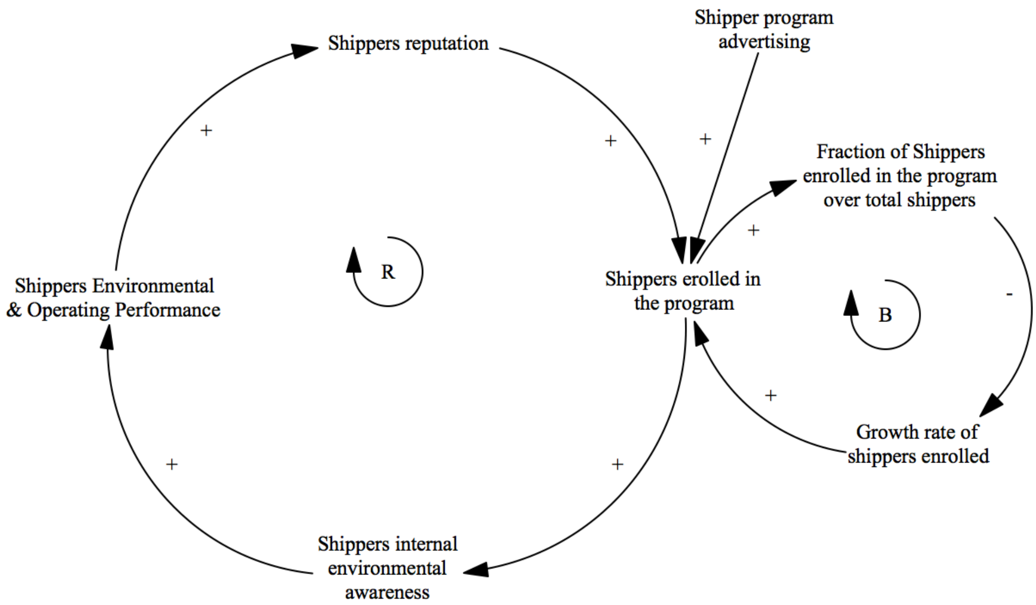

Figure 25. The Causal Loop Diagram

Figure 26 below shows that the reinforcing loop generates an exponential growth behavior of the shippers enrolled in the program.

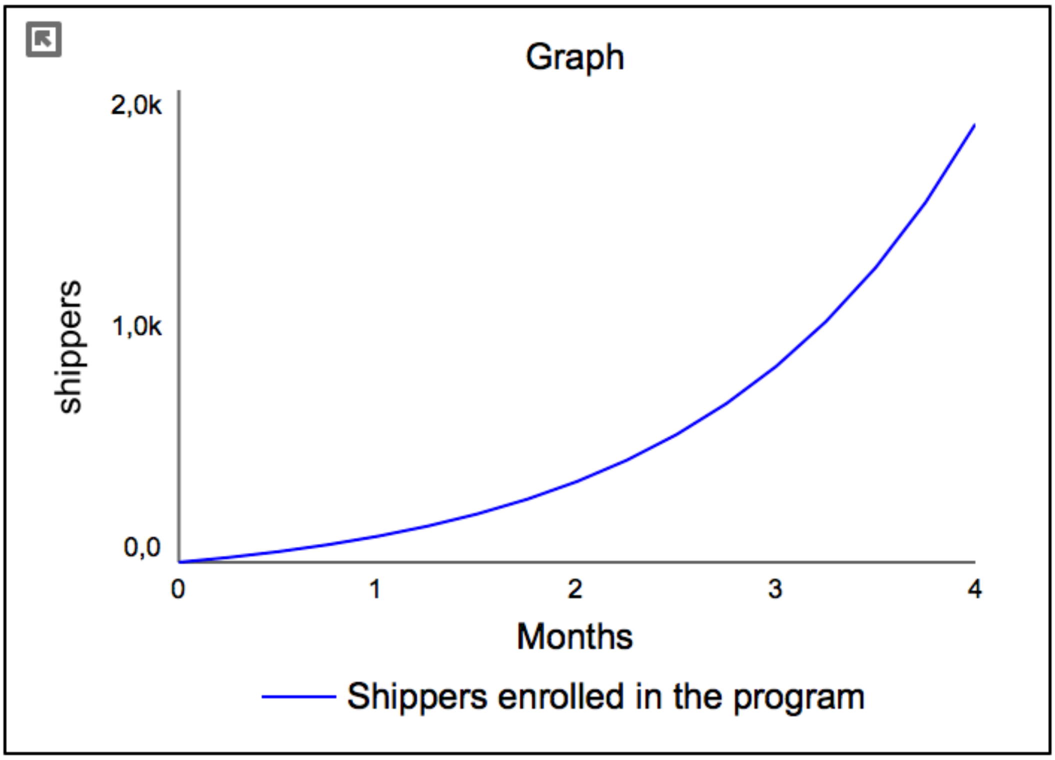

Figure 26. Exponential growth behavior of shippers

Figure 27 below shows an exponential decay behavior of the balancing loop depicted in the CLD of the shippers enrolled in the program caused by the achievement of the maximum number of the shippers that can be enrolled in the program because, over time, almost all the shippers are enrolled in the program.

As mentioned before, according to Meadows (1980), "balancing" feedback loops have an odd number of negative interactions and tend to counterbalance a behavior by guiding the system toward equilibrium.

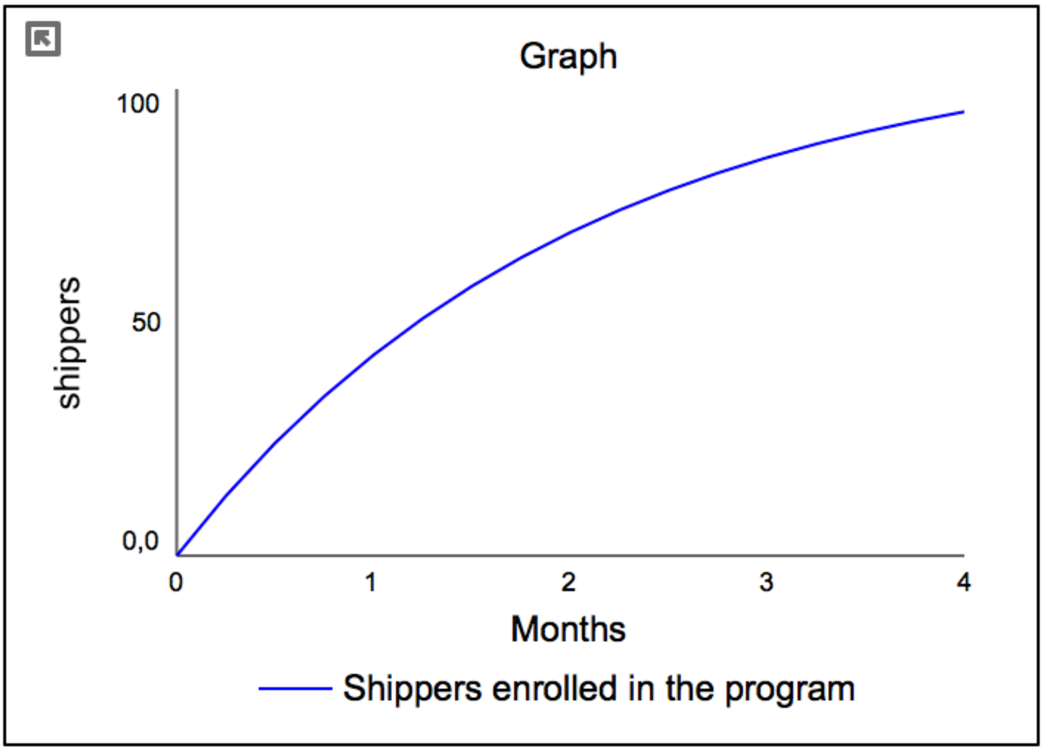

Figure 27. Exponential decay behavior of shippers

To replicate a system's behavior over time, stock-and-flow simulation models attempt to quantify the causal relationships among its variables (Größler et al., 2008).

While the idea behind a Causal Loop Diagram (CLD) is clear and simple, the Stock and Flow Diagram (SFD) needs a brief explanation of the components: stocks, flows, auxiliary variables and constant variables (Noto, 2020).

- Stocks (square variables) accumulate material or information resources at a certain period. They can alter through accumulation and depletion processes (Cosenz, 2022; Noto, 2020).

- Flows (arrows with valves): these variables represent the end result that the organization has attained. They are regular flows of information or materials to or from a stock. These variables define how a stock changes (increases or decreases) from one time period to the next due to strategies put into place. They can be represented as inflows or outflows influencing a particular stock (Cosenz, 2022; Noto, 2020).
- Constant variables are input variables. Their value stays unchanged during simulation (Cosenz, 2022; Noto, 2020).
- Auxiliaries variables are elements that help in calculating. The model includes these variables to incorporate additional intermediate calculations that enhance system comprehension. Auxiliary variables are used to model performance drivers (Cosenz, 2022; Noto, 2020).

Figure 28 below represents the translation of the CLD illustrated above according to the stock and flow simulation model.

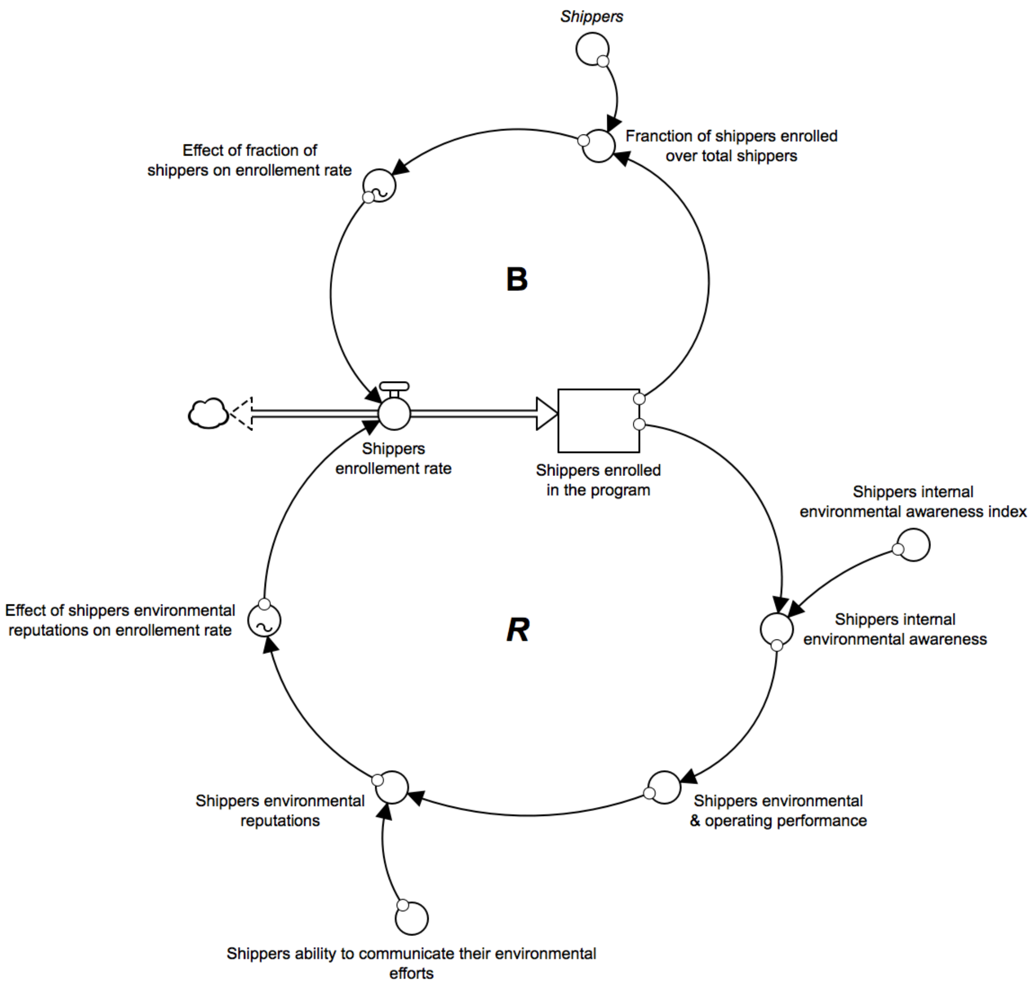

Figure 28. The stock and flow diagram

Simulation is a main characteristic that makes SD appropriate for complex social systems. Three basic characteristics make simulation valuable as a scientific approach (Axelrod, 1997):

- Prediction
- Existence proof
- Discovery (of unusual structures)

However, this value also comes from its educational and training aspects in social sciences like management (Sterman 2014; Cosenz and Noto 2018).
Sterman (2014) believes that simulation is a useful tool that helps us learn how complex systems function when real testing is too slow, too expensive, immoral, or just not practical (Noto, 2020).

According to Noto and Bianchi (2015), SD is a suitable tool for examining governance issues in a complex setting like urban transportation. At the same time, SD represents a valuable resource for analyzing the freight transport sector, characterized as a complex system with many interacting players. In detail, SD represents a useful method that helps the development of transportation strategies. This idea originates from the fact, as mentioned above, that SD enables us to analyze a system's structure while also including the features of its fragmented environment (Noto, 2020).

As mentioned in Noto's 2020 book, numerous scholars have applied SD methodology in the transportation sector. The section below briefly overviews several scholarly contributions promoting SD methodology use in the transportation sector.

Abbas and Bell (1994) were among the first researchers to suggest using SD for transportation modeling. Specifically, they stated that SD is well suited to strategic challenges and might offer a practical instrument to enhance policy analysis and decision-making in the transport sector. Transportation systems, according to Abbas and Bell (1994), involve a variety of different stakeholders, are complex, and produce feedback with various time lags between each type of user's response. Thus, SD models provide a systemic approach to transport planning which can help policymakers to understand the significance of these feedbacks and lags (Shepherd 2014).

Haghshenas et al. (2015) also dealt with SD models. They used them to examine the possibility of alternative transportation strategies based on relevant data and worldwide urban dynamic models.

Noto (2017) created an SD model focused on Buenos Aires, Argentina, in a northern urban area. The model aimed to identify the main performance drivers affecting the urban system's performance and use those drivers as indicators to analyze different policy options (Noto, 2020). Moreover, with their contribution to research about SD, Bivona and Montemaggiore (2010), Liu et al. (2010), and Noto and Bianchi (2015) delivered three interesting scientific publications that highlight the benefits of SD in assisting urban transportation planning and management (Noto, 2020).

According to several studies, the SD approach is useful for providing a comprehensive view of urban transport systems and managing feedback, delays, and non-linear causal relationships between the resources of the stakeholders involved (Haghshenas et al. 2015; Noto and Bianchi 2015; Noto 2017; Shepherd 2014). As a result, the application of SD in the field of transportation research may present a chance to create models which provide strategic analysis and inform a wide range of stakeholders about the dynamic interactions of the urban transportation system (Pfaffenbichler et al. 2010). As stated by Shepherd (2014, p. 101), the system dynamic model "can be used to test which parameters play a significant role in the stability and response of the system and the tools such as CLD and stock-flow diagrams enable a transparent approach to communicating results with stakeholders including the use of insight simulators and gaming tools which other approaches often lack".

As highlighted above, numerous scholars state that the SD methodology can be applied to the urban transportation sector. At the same time, this methodology can also be applied to the freight transport sector. Applying the SD approach to the freight transport sector offers a holistic view of the entire system by highlighting all the actors involved, including, for example, carriers, shippers, and freight forwarders.

In detail, the System Dynamics (SD) approach (Forrester, 1961; Sterman, 2000) was recommended by Bivona and Bilek (2022) as a way to examine the system complexity of the Engagements Volontaires pour l'Environnement (EVE) program in the freight transport sector. Using an SD model, the EVE program coordinator can formulate and assess efficient policies to pursue the desired objectives. Hence, the SD model can support the EVE coordinator in evaluating the program's effectiveness and testing alternative strategies (Bivona & Bilek 2022). According to Bivona and Bilek (2022), few studies look into voluntary environmental programs that use dynamic approaches (see Tan & Blanco, 2009 for an exception). Bivona and Bilek (2022) did work to offer an additional investigation in that last direction. As stated by Bivona and Bilek 2022, the EVE program seems to work particularly well with the SD methodology since it tries to enhance decision makers' learning processes so they can cope with complicated phenomena more effectively.

The work of Bivona and Bilek highlights how the SD approach can help to examine the system complexity of the Voluntary Environmental Programs (VEPs) in the freight transport sector.
As shown by several studies highlighted above, the SD methodology is well suited to the transportation sector.

3.5 Conclusions

This chapter introduced a systemic methodological approach, namely the Dynamic Performance Governance (DPG) approach, to support decision-makers at the policy and management levels in formulating and implementing more effective policies in reducing the environmental impact of the transportation sector, as well as better coordination of each actor's actions involved and to support collaborative governance. Moreover, the system dynamic methodology and how it can support performance management in the freight transport sector, characterized by complexity and dynamism, was introduced. The next chapter will apply the Dynamic Performance Governance (DPG) approach to the Voluntary Environmental Program in the French freight transport sector. Several simulations will be conducted from the model to understand what policies are most effective in increasing the performance of VEPs in France.

References

ABBAS, K. A., & BELL, M. G. (1994). System dynamics applicability to transportation modeling. *Transportation Research Part A: Policy and Practice, 28*(5), 373–390.

AGRANOFF, R., & MCGUIRE, M. *(2003). Collaborative public management: New strategies for local governments. Georgetown University Press.*

ANSELL, C., & GASH, A. (2008). Collaborative governance in theory and practice. Journal of public administration research and theory, 18(4), 543-571.

ARGYRIS, C., & SCHON, D. (1978). Organizational learning. A theory of action perspective. Reading, Mass: Addison Wesley.

ARGYRIS, C. (2002). Double-Loop Learning, Teaching, and Research. Academy of Management Learning & Education, 1(2), 206–218.

AUSTRALIAN PUBLIC SERVICE COMMISSION (2007). Tackling wicked problems: A public policy per- spective. Commonwealth of Australia, Barton.

AXELROD, R. (1997). Advancing the art of simulation in the social sciences. In R. Conte, R. Hegselmann, & P. Terna (Eds.), Simulating social phenomena (pp. 21–40). Berlin: Springer.

BENTRUP, G. (2001). Evaluation of a collaborative model: a case study analysis of watershed planning in the Intermountain West. *Environmental Management*, *27*(5), 739-748.

BIANCHI, C. (2010). Improving performance and fostering accountability in the public sector through system dynamics modelling: From an 'external' to an 'internal' perspective. Systems Research and Behavioral Science, 27(4), 361–384.

BIANCHI, C. (2012). Enhancing performance management and sustainable organizational growth through system-dynamics modelling. In S. N. Grösser & R. Zeier (Eds.), Systemic management for intelligent organizations (pp. 143–161). Springer-Verlag.

BIANCHI, C. (2015). "Enhancing Joined-Up Government and Outcome-Based Performance Management through System Dynamics Modelling to Deal with Wicked Problems: The Case of Societal Ageing." *Systems Research and Behavioral Science* 32 (4): 502–505.doi:10.1002/sres.2341.

BIANCHI, C. (2016). *Dynamic performance management* (Vol. 1). Berlin: Springer.

BIANCHI, C., & TOMASELLI, S. (2015). A dynamic performance management approach to support local strategic planning. International Review of Public Administration, 20(4), 370–385.

BIANCHI, C., & VIGNIERI, V. (2020). Dealing with "abnormal" business growth by leveraging local area common goods: An outside-in stakeholder collaboration perspective. International Journal of Productivity and Performance Management. https://doi.org/10.1108/IJPPM-07-2019-0318

BIANCHI, C., BERECIARTUA, P., VIGNIERI, V., & COHEN, A. (2019). Enhancing urban brownfield regeneration to pursue sustainable community outcomes through dynamic performance governance. International Journal of Public Administration. https://doi.org/10.1080/01900692.2019. 1669180.

BIANCHI, C., BOVAIRD, T., & LOEFFLER, E. (2017). Applying a dynamic performance management framework to wicked issues: How coproduction helps to transform young people's services in Surrey County Council, UK. *International Journal of Public Administration*, 40, 833– 846.

BIVONA, E., & BILEK, G. M. (2022). Environmental Voluntary Programs in the Transport Industry in the Post-COVID Situation: The French Experience. In *Understanding the Dynamics of New Normal for Supply Chains: Post COVID Opportunities and Challenges* (pp. 81-99). Cham: Springer International Publishing.

BIVONA, E., & MONTEMAGGIORE, G. B. (2010). Understanding short- and long-term implications of "myopic" fleet maintenance policies: A system dynamics application to a city bus company. *System Dynamics Review, 26*(3), 195–215.

BOVAIRD, T. (2007). Beyond engagement and participation: User and community coproduction of public services. Public Administration Review, 67(5), 846–860.

BRETSCHNEIDER, B., CHOI, Y., NABATCHI, T., & O'LEARY, R. (2012). Does public value matter for collaboration? Evidence from an experimental analysis. In *Creating Public Value Conference, University of Minnesota, September* (pp. 20-22).

BREWS, P. J., & HUNT, M. R. (1999). Learning to plan and planning to learn: Resolving the planning school/learning school debate. Strategic Management Journal, 20, 889–913.

CEPIKU, D. (2017). *Collaborative Governance*. In: Klassen T., Cepiku D. and Lah T.J. (eds), Routledge Handbook of Global Public Policy and Administration. London: Routledge, pp.141-156.

CHRISLIP, DAVID, AND CARL E. LARSON. (1994). Collaborative leadership: How citizens and civic leaders can make a difference. San Francisco, CA: Jossey-Bass.

COSENZ, F. (2022). Adopting a dynamic performance governance approach to frame interorganizational value generation processes into a university third mission setting. *Governance and Performance Management in Public Universities: Current Research and Practice*, 87-108.

COSENZ, F. (2022). *Managing Sustainable Performance and Governance in Higher Education Institutions: A Dynamic Performance Management Approach* (Vol. 5). Springer Nature.

COSENZ, F., & NOTO, G. (2016). Applying system dynamics modelling to strategic management: A literature review. *Systems Research and Behavioral Science, 33*(6), 703–741.

COSENZ, F., & NOTO, G. (2018). Fostering entrepreneurial learning processes through dynamic start-up business model simulators. *The International Journal of Management Education, 16*(3), 468–482.

DE GEUS, A. (1988). Planning as learning. Harvard Business Review, 66(2), 70–74.

EL ANSARI, WALID. (2003). Educational partnerships for public health: Do stakeholders perceive similar outcomes? *Journal of Public Health Management Practice* 9:136–56.

FORRESTER, J. W. (1961). *Industrial dynamics*. Cambridge, MA: MIT Press.

GEOGHEGAN, TIGHE, AND YVES RENARD. (2002). Beyond community involvement: Lessons from the insular Caribbean. *Parks* 12 (2): 16–26.

GILLIAM, AISHA, DAVID DAVIS, TRACEY BARRINGTON, ROMEL LACSON, GARY UHL, ANDURSULA PHOENIX. (2002). The value of engaging stakeholders in planning and implementing evaluations. *AIDS Education and Prevention* 14 (Suppl. A): 5–17.

GRÖßLER, A., THUN, J. H., & MILLING, P. (2008). System dynamics as a structural theory in operations management. Production and Operations Management, 17(3), 373–384.

HAGHSHENAS, H., VAZIRI, M., & GHOLAMIALAM, A. (2015). Evaluation of sustainable policy in urban transportation using system dynamics and world cities data: A case study in Isfahan. Cities, 45, 104–115.

HEAD, B. W., & ALFORD, J. (2015). Wicked problems: Implications for public policy and management. Administration and Society, 47(6), 711–739.

HEAD, B., AND J. ALFORD. (2013). "Wicked Problems: Implications for Public Policy and Management." *Administration & Society*. doi:10.1177/0095399713481601.

KOLB, D. (1984). Experiential learning. Englewood Cliffs: Prentice Hall.

LÆGREID, P., & RYKKJA, L. H. (2014). Governance for complexity–how to organize to handle «wicked issues»?.

LAH, T. J. (2017). *The Routledge Handbook of global public policy and administration.*

LASKER, ROZ D., AND ELISA S. WEISS. (2003). Broadening participation in community problem- solving: A multidisciplinary model to support collaborative practice and research. *Journal of Urban Health*: Bulletin of the New York Academy of Medicine 80:14–60.

LIU, S., TRIANTIS, K. P., & SARANGI, S. (2010). A framework for evaluating the dynamic impacts of a congestion pricing policy for a transportation socioeconomic system. *Transportation Research Part A: Policy and Practice, 44*(8), 596–608.

MEADOWS, D. (1980). The unavoidable a priori. In J. Randers (Ed.), *Elements of the system dynamics method*. Waltham, MA: Pegasus Communications.

MINTZBERG, H. (1993). The pitfalls of strategic planning. California Management Review, 36(1), 32–45.

MINTZBERG, H. (1994A). Rethinking strategic planning part I: Pitfalls and Fallacies. Long Range Planning, 27(3), 12–21.

MINTZBERG, H. (1994B). Rethinking strategic planning part II: New roles for planners. Long Range Planning, 27(3), 22–30.

MORECROFT, J. D. (2015). *Strategic modelling and business dynamics: A feedback systems approach*. John Wiley & Sons.

NOTO, G. (2017). Combining system dynamics and performance management to support sustainable urban transportation planning. *Journal of Urban and Regional Analysis, 9*(1), 51–71.

NOTO, G. (2020). *Strategic Planning for Urban Transportation: A Dynamic Performance Management Approach* (Vol. 3). Springer Nature.

NOTO, G., & BIANCHI, C. (2015). Dealing with multi-level governance and wicked problems in urban transportation systems: The case of Palermo municipality. *Systems, 3*(3), 62–80.

PFAFFENBICHLER, P., EMBERGER, G., & SHEPHERD, S. (2010). A system dynamics approach to land use transport interaction modelling: The strategic model MARS and its application. *System Dynamics Review, 26*(3), 262–282.

PFEFFER, J., & SALANCIK, G. R. (1978). *The external control of organizations: A resource-dependency perspective* Harper & Row New York USA.

PLUMMER, RYAN, AND JOHN FITZGIBBON. (2004). Co-management of natural resources: A proposed framework. Environmental Management 33:876–85.

ROGERS, TODD, BETH HOWARD-PITNEY, ELLEN C. FEIGHERY, DAVID G. ALTMAN, JERRY M. ENDRES, AND APRIL G. ROESELER. (1993). Characteristics and participant perceptions of tobacco control coalitions in California. *Health Education Research, Theory &Practice* 8:345–57.

ROUSSOS, STERGIOS TSAI, AND STEPHEN B. FAWCETT. (2000). A review of collaborative partnerships as a strategy for improving community health. *Annual Review of Public Health* 21:269–402.

SAPORITO G., BIVONA E. AND COSENZ F. (2022) Article in review. Fostering the reduction of CO2 emissions in the transport sector. A collaborative governance approach to implementing Voluntary Environmental Programs

SCHNEIDER, MARK, JOHN SCHOLZ, MARK LUBELL, DENISA MINDRUTA, AND MATTHEW EDWARDSEN. (2003). Building consensual institutions: Networks and the national estuary program. *American Journal of Political Science* 47:143–58.

SHEPHERD, S. P. (2014). A review of system dynamics models applied in transportation. *Transportmetrica B: Transport Dynamics, 2*(2), 83–105.

STERMAN, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world. London: McGraw-Hill.

STERMAN, J. (2014). Interactive web-based simulations for strategy and sustainability: The MIT Sloan LearningEdge management ight simulators, part I. System Dynamics Review, 30(1–2), 89–121.

TAN, K. C., & BLANCO, E. E. (2009, June). System dynamics modeling of the SmartWay transport partnership. MIT Engineering Systems Division & CESUN. Presented at the Second International Symposium on Engineering Systems at the MIT Center for Transportation and Logistics, Cambridge, Massachusetts.

TETT, LYNN, JIM CROWTHER, AND PAUL O'HARA. (2003). Collaborative partnerships in community education. *Journal of Education Policy* 18:37–51.

TOMPKINS, E. L., & ADGER, W. N. (2004). Does adaptive management of natural resources enhance resilience to climate change?. *Ecology and society*, *9*(2).

TORFING, J., & ANSELL, C. (2017). Strengthening political leadership and policy innovation through the expansion of collaborative forms of governance. Public Management Review, 19(1), 37–54.

VANGEN, S., & HUXHAM, C. (2003). Nurturing collaborative relations: Building trust in interorganizational collaboration. *The Journal of applied behavioral science*, *39*(1), 5-31.

VENNIX, J. A. M. (1990). *Mental models and computer models, design and evaluation of a computer-based learning environment for policy-making*. Unpublished doctoral dissertation, Radboud University, Nijmegen.

WARNER, J. F. (2006). More sustainable participation? Multi-stakeholder platforms for integrated catchment management. *Water resources development*, *22*(1), 15-35.

WEECH-MALDONADO, R., & MERRILL, S. B. (2000). Building partnerships with the community: lessons from the Camden Health Improvement Learning Collaborative. *Journal of Healthcare Management*, *45*(3), 189-205.

Chapter 4: Applying Dynamic Performance Governance in the French freight transport sector: a case study

4.1 Introduction

Chapter 3 introduced the collaborative governance approach, which can help to overcome the limits of VEPs and support a more effective implementation in the freight transport sector, thus fostering the reduction of CO2 emissions. Additionally, the preceding remarks suggested the Dynamic Performance Governance (DPG) approach as a systemic methodological approach to support decision-makers at the policy and management levels to formulate and implement more effective policies to reduce the environmental impact of the transportation sector while at the same time coordinating the actions of each actor involved in a better way and supporting collaborative governance. Moreover, the System Dynamic (SD) methodology and how it can support performance management in the freight transport sector was introduced.

Focusing on a case study in France, this chapter gives an overview of a voluntary program in France in a first step: the EVE program "Engagements Volontaires pour l'Environnement" (Voluntary Commitment to the Environment) which aims at increasing transportation operator efficiency and decreasing greenhouse gas (GHG) emissions. Secondly, this chapter identifies the main motivations and barriers to promoting VEP in the transport industry that emerged from field research conducted with a sample of logistics service providers engaged in the EVE program in France. The result is then used to build a DPG chart and a Causal Loop Diagram (CLD), including the feedback mechanisms that impact the performance of VEP. Finally, an SD model is used to investigate alternative policies to increase the performance of the EVE program in France (Bivona et al., 2023).

The advantages of the DPG and SD approaches and further research on this relevant topic are mentioned in the conclusion.

4.2 The Voluntary Environmental Programs in the freight transport sector in France

As the previous chapters have shown, implementing the "decarbonization" policy in the transport and logistic sectors is embedded in a complex structure. Public and private initiatives are deployed worldwide to encourage the realization of this policy. Among the measures of the "decarbonization" policy, the goal of improving the energy efficiency of road transport stands out. This action is crucial to achieving the objectives of a low-carbon strategy at the country level. As stated in the previous chapters, two different, although complementary, approaches emerged since the 1990s to reduce carbon emissions in the transport sector. Both refer to mandatory programs regulated by specific legislations and voluntary programs, engaging multiple public and private actors (Bivona et al., 2023). In France, a regulatory device regarding the transport of freight and passengers was set up in October 2013. This regulation requires the calculation and reporting of the carbon emission for every transport service having a point of origin or destination on or to French territory (decree 2011-1336)[13].

Research about these mandatory programs in France (Mendy Bilek et al., 2017) confirms the importance of such a regulatory system. However, research findings also remarked that regulation does not seem to be the sole sufficient factor driving real change in the system (Bivona et al., 2023). Here, voluntary programs come into play.

The French government and public authorities have recently focused mainly on reducing CO2 emissions, which is thought necessary to reduce global warming. Increasing road transportation's energy efficiency is more important than ever to meet the French National Low Carbon Strategy goals. These goals appear to be

[13]Décret n° 2011-1336 du 24 octobre 2011 relatif à l'information sur la quantité de dioxyde de carbone émise à l'occasion d'une prestation de transport. https://www.legifrance.gouv.fr/loda/id/JORFTEXT000024710173

attainable only if all stakeholders in road transportation try to increase their energy performance (Bivona and Bilek, 2022).

In the early 2000s, the French Agency for Environment and Energy (ADEME) demonstrated the necessity of reorganizing production and purchasing systems to increase environmental performance and economic competitiveness to adequately prepare the transport and logistics sector to meet this challenge. By stimulating several supply chain participants, particularly shippers (manufacturers and distributors) and carriers, they were brought to work together to manage their environmental and energy performance (Bivona and Bilek 2022).

The EVE initiative, which stands for "Engagements Volontaires pour l'Environnement" (Voluntary Commitment to the Environment) in French, aims to increase transportation operator efficiency and decrease greenhouse gas (GHG) emissions. The program is linked to efforts focused on achieving the 2050 carbon neutrality goal of the French National Low Carbon Strategy. This is why the French Ministry of Ecological and solidarity transition (such as the Ministry in charge of transportation) promotes the EVE program, financed by energy savings certificates provided by Total Marketing France. It brings together several stakeholder groups from the public and private sectors. In this case of France, the EVE project is supervised by the "French Environment & Energy Management Agency" ADEME (Agence de l'Environnement et de la Maîtrise de l'Énergie). It is coordinated and implemented by a non-profit organization, the "Eco CO2”. The Eco CO2 covers a variety of activities. To involve as many operators in the freight industry as possible, it first sponsors and promotes the program's objectives. Second, it coordinates the development of efficient energy-saving and emission-reduction strategies with major French freight professional groups (such as AUTF, CGI, FNTR, FNTV, OTRE, and Union TLF), also EVE program partners. Examples include creating fuel-efficient technology and using tracking tools to track efficiency growth and reduce emissions. Additionally, Eco CO2 offers the "Objectif CO2" certification to transport companies that adhere to the recommended measures (Bivona e Bilek 2022).

The freight industry and the ADEME may benefit from the projected success of the EVE initiative.

On the one hand, the assistance of professionals can help the freight industry achieve fuel savings, increasing the sector's competitiveness. The "Objectif CO2" certification may also help transportation companies increase their image and satisfy clients' expectations, who pay special attention to suppliers who follow GHG emission reduction strategies.

On the other hand, due to the decrease in fuel use and CO2 emissions, the EVE program can assist ADEME in pursuing the French National Low Carbon Strategy (Bivona e Bilek 2022).

Wolmarans et al. (2014) show an interesting dynamic. According to them, shipper initiatives are largely driven by company policy and tend to pass sustainability requirements onto the carriers working for them. Adopting sustainable business practices is a big incentive for carriers because they can use these to improve their competitiveness and reduce costs (Bivona et al., 2023). However, the lack of uniform assessment and reporting mechanisms greatly reduces its value in influencing decisions for shippers and the carriers (Bynum et al., 2018). Moreover, the multiple relationships between public and private actors involved in the program (ranging from the program coordinator to the transport organizations), the differences among the transport operators' sub-groups, and the resistance of transport firms to introduce innovative practices impacting the environment are reasonable problems which might prevent the achievement of the desired project outcomes. France's recently launched EVE program is no exception (Bivona et al., 2023).

Mendy Bilek et al.'s (2017) previous study supported the notion that "the regulatory and voluntary mechanisms do not seem sufficient to stimulate, on their own, a real dynamic of change.". Because of the factors above, it is crucial to research the roles and interdependencies between the various stakeholders, such as public agencies and private transportation companies involved in VEP, and how to encourage positive interactions among them (Bivona e Bilek 2022).

To deal with numerous entanglements and complexity within the transport and logistics sector, the "French Environment & Energy Management Agency" ADEME supervises the EVE project and finances research to explore alternative policies to improve project performance (Bivona et al., 2023).

Existing research on greening freight transportation to decrease CER (Prakash and Potoski, 2012; Bivona and Bilek, 2021; Bynum et al., 2018; Tan and Blanco, 2009; Wolmarans et al., 2014) identified several elements which affect VEPs practices: the presence of several stakeholders with conflicting goals, the pressure of stakeholders on the decision of the organization to enroll in voluntary environmental and legal issues. They also pointed out appropriate tools and methodologies to improve the performance of such a system.

Following the systemic approach suggested by previous scholars, who asserted the need to adopt a holistic perspective to adequately cope with the above complexity (Tan and Blanco, 2009; Bivona and Bilek, 2021), we used the Dynamic Performance Governance (DPG) approach and the System Dynamics (SD) methodology (Forrester, 1961; Sterman, 2000).

As mentioned in the previous chapter, the DPG approach matches the freight transport sector well because it can deal with the complexity of this special domain through a systemic view of the freight transport sector. Moreover, as will be shown below, It can highlight all the actors involved in the EVE program and the interaction between them (Bianchi 2016). The SD method is an acknowledged approach to scrutinizing green issues (Stave, 2002; Kuai et al., 2015; Bivona et al., 2019) and to explore alternative scenarios and managerial policies and is used here concerning the VEP in France (Bivona et al., 2023).

In detail, first, the main motivations and barriers to promoting VEP in the transport industry, which emerged from field research conducted with a sample of logistics service providers engaged in the EVE program in France, will be identified. Secondly, the result is then used to build a DPG chart and a Causal Loop Diagram (CLD), including the feedback mechanisms that impact the performance of VEPs. Thirdly, an SD model is used to investigate alternative policies to increase the performance of the EVE program (Bivona et al., 2023).

The literature review and interviews with stakeholders of a sample of logistics service providers offered the basis to build and test a Dynamic Performance Governance (DPG) chart and a Causal Loop Diagram (CLD), which have been converted into a Stock and Flow model. The SD model was used to explore alternative scenarios to improve the performance of voluntary environmental practices, such as the EVE program (Bivona et al., 2023)

Researchers conducted more than 20 of these interviews with leading companies in France considered shippers and Logistics Services Providers engaged in the EVE voluntary program. To ensure a wide time range, these interviews with transport managers, buyers, and CSR managers were conducted within the same company over a period of 8 months from April 2021 to November 2021 (Bivona et al., 2023)

The field research conducted with the sample of LSPs engaged in the EVE program provided clues regarding the main motivations and barriers which will be listed below (Bivona et al., 2023).

Transport is an area in which the economic criterion is crucial to make the final decision. With this in mind, the pressure from customers who ask for green services and LSPs who offer green services to stand out from the crowd competition turns decarbonization into a meaningful criterion in logistics decisions. Because shippers are increasingly pressured to improve the sustainability of their supply chains by customers, stakeholders, investors, and non-governmental organizations, environmental criteria are gradually being deployed in business relationships.

By bowing to this pressure and selecting LSPs with lower emissions, shippers improve their environmental performance (Bivona et al., 2023)

The motivations to participate in a VEP are both internal and external and are depicted in the figure below.

In detail, from figure 29, it is possible to notice the principal motivations to participate in a VEP with samples and referred cases (Bivona et al., 2023).

Principal Motivation	Source of the Motivation	Samples Quotes	Cases perceiving these motivations
Internal Motivation for Enrollment	Company Values	"Precisely in relation to the values of our company, of the bio, of the respect of the environment, we said to ourselves there is something to do, we can do better on the transport so we launch ourselves." **FRET21-I1**	Fret21-I1,, Fret21-I4, Fret21-I7, Fret21-11,EVCOM-I2, ObjCO2-I3
	Motivations for internal teams	"For me it was more a will to show that we were motivated by engaging also outside but also for the troops to motivate them to succeed but for me without pressure." **Fret21-I7**	Fret21-I1, Fret21-I6 , Fret21-I7, Fret21-I10, , ObjCO2-I1
	Formalization of company's commitments internally	"Clearly the approach is integrated, it was rather an opportunity to promote things that have already been done and to look at the FRET21 and EVE approach which allowed us to structure and formalize and give an external framework to our company" **Fret21-I3**	Fret21-I1, Fret21-I3 , Fret21-I7, Fret21-I13,EVCOM-I2, ObjCO2-I1, ObjCO2-I3
External motivation for Enrollment	Regulatory Pressure (Coercitive)	" the regulations were going to be more coercive on CO2, as we have seen in industry, with CO2 limits and quotas, so it is always better to make a commitment in order to show that an effort is being made, voluntarily, rather than waiting for the legislator to come and impose things" **FRET21-I5**	Fret21-I1, Fret21-I4 , Fret21-I5, Fret21-I6, Fret21-I8,EVCOM-I1, ObjCO2-I3
	External Communication	"when I saw this program just starting, I thought it was a good way to formalize and make visible our commitment." **EVCOM-I3**	Fret21-I1, Fret21-I6, Fret21-I4, Fret21-I7, EVCOM-I3,ObjCO2-I1
	Legitimacy	"Obviously we have communicated within our network of logistics service providers [...] to materialize these actions also on perimeters that go a little beyond what Fret-I3 masters, but which implies choices among our logistics service providers and in particular on the transport part, on the choice of less polluting materials, in particular via the use of alternative gasoil resources" **Fret21-I3**	Fret21-I1, Fret21-I3 , Fret21-I4, Fret21-I9,EVCOM-I2, EVCOM-I4, ObjCO2-I2

Figure 29. "Internal and external motivation for enrolment" (Bivona et al., 2023).

Figure 30 below shows the principal barriers. Concerning the obstacles, the difficulty in convincing internal clients to move away from strict economic arbitrage and integrate positive impacts is mentioned. A challenge is also the lack of creating a cross-company community of practice on these issues, enabling discussion with other stakeholders on certain difficult points in the introduction of decarbonization (Bivona et al., 2023).

Principal barriers	Sources of the barriers	Samples Quotes	Cases perceiving these barriers
Scope of intervention of the EVE Program	The lack of internationalization of the program	"Afterwards, in terms of labeling, it is true that "" is a European company whereas the EVE program is something really... French and our vision and the question we ask ourselves is that... As a European company, would we use another label? " **ObjCO2-I3**	Fret21-I2, Fret21-I6 , Fret21-i7, Fret21-I10, Fret21-I11,EVCOM-I1, ObjCO2-I3
Lack of cooperation	The lack of trust between Carriers and Suppliers	"You also have to trust the carriers because they have data but you can't check them all the time, as I said above, so the brake may be not trusting the providers and not believing in their results, in their data." **Fret21-I5**	Fret21-I1, Fret21-I5, Fret21-I9, EVCOM-I5, ObjCO2-I1
	An asymnetrical relationship between the shipper and the carrier	"Which makes the balance of power immediately complicated because when you have to negotiate with a buyer who represents 25% of your turnover necessarily, it is he who will have the last word because we will not afford to rob him" **Fret21-I4**	Fret21-I1, Fret21-I2 , Fret21-I4, Fret21-I7, Fret21-I9,EVCOM-I2, ObjCO2-I3
Technical	Infrastructure in poor condition	"On the multimodal aspect, unfortunately the infrastructures are a very, very big obstacle and the road remains by far the most operational mode." **Fret21-I10**	Fret21-I1, Fret21-I3, Fret21-I7, Fret21-10, Fret21-I11, EVCOM-I1, ObjCO2-I1
Lack of resources	The high cost of alternative vehicles	"The rates remain exorbitant, 600,000 euros for a road tractor, even with aid, it takes us down to between 120,000 and 200,000 euros" **ObjCO2-I2**	Fret21-I1, Fret21-I2 , Fret21-4, Fret21-I7, Fret21-8,EVCOM-I2, ObjCO2-I2
Organizational	The complexity of multimodal organization	"Many organizational constraints weigh on the railway at the moment, In this context, keeping this mode of transport on the domestic market is already a significant effort on a daily basis." **Fret21-I8**	Fret21-I1, Fret21-I2, Fret21-5, Fret21-I6, Fret21-I8,EVCOM-I2, EVCOM-I4, ObjCO2-I2

Figure 30. “Principal Barriers for joining the program”. (Bivona et al., 2023).

It is noteworthy that the program is limited to some extent: it encourages more collaboration, but at the same time, most of the practices it fosters remain intra-organizational. In addition to the already mentioned obstacles, sharing information is a big challenge. This is due to a lack of coordination and communication between the stakeholders which impedes dialogue and the sharing of good practices (Bivona et al., 2023). Figure 31 shows some principal collaborative approaches with given samples.

Principal collaborative approach	Nature of the collaboration	Samples Quotes	Stakeholders in charge of the collaboration
Sharing Best practices	Benchmarking for Sustainable logistics practices focus in particular on tools and methodologies for calculating and measuring CO2 emissions.	..." I made a guide of good practices that was 80 pages long, that text, no one wants it, no one reads it and no one has time to take care of it. I summarized it in 18 slides, with photos, it is: here is a line of thought, here is an idea, this is an idea and that's all."**FED1**	Professionnal Federation (FED1, FED2, FED3)
	The good practices of competitors are of interest to shippers and are incentives for new environmental practices	"the shippers you interviewed, the FRET 21 I5 or I6 they are a driving force and transmission routes on their sectors. In fact, the idea is how these shippers embark their suppliers and how in certain sectors of activity we have big leaders."**FED1.**	FED1, FED2, Fret21-I1, Fret21-I10 ,EVCOM-I1,
Shared Investment and Experimental process	Experimentation on new energies, Technical Innovation	"for these players it increases a little the volume of the activity and also, beyond the tariff revaluation that I mentioned, we also have issues of commitment in the long term, where potentially it can lead to a multi-year agreement in order to allow the carrier to amortize the investment he has been able to make on refueling facilities in particular". **Fret21-I1.**	Fret21-I1 , Fret21-4, Fret21-I6, Fret21-10,EVCOM-I1, ObjCO2-I1
Collaborative SC design	Mutualization, Pooling, Collaborative planning, Dedicated transport organization	"we have a number of service providers on which we have set up very alternative solutions, the B100 in Rennes, the cargo bike obviously on the 22 cities on which we have operated, the hydrogen traction that we are mounting, gas and biogas tractions. There are some where there is a real... Modal shift of course. We are currently studying with the French Deutsche Bahn to switch groupage lines to rail, there are plenty of initiatives indeed, we have very meticulous relations". **Fret 21- I8**	Fret21-I1, Fret21-I3 , Fret21-I7, Fret21-I13,EVCOM-I2, ObjCO2-I1, ObjCO2-I3
Sourcing and performance collaboration	Selection criteria	"In my bidding criteria, I did put that it was a condition that would become essential if they were not in some way committed or if they did not have actions on their side, we would not be able to work with them." **Fret21-I4**	Fret21-I1 , Fret21-4, Fret21-I6, Fret21-10,EVCOM-I1, ObjCO2-I1

Figure 31. "Collaboration between stakeholders" (Bivona et al., 2023).

4.3 A Dynamic Performance Governance approach in the freight transport sector in France

In the third chapter, the Dynamic Performance Governance (DPG) approach (Bianchi, 2016; Bianchi et al., 2019; Bianchi & Vignieri, 2020) as a method to investigate and manage the freight transport sector, offering an inter-organizational point of view to foster policy coordination and collaborative governance to promote sustainable socio-economic development and to improve community outcomes was introduced (Bovaird, 2007; Torfing & Ansell, 2017; Bianchi & Vignieri, 2020). As mentioned in the previous chapter, the DPG method uses System Dynamics (SD) models, which have successfully supported a descriptive perspective in policy evaluation and performance management. This facilitates communication and sharing of comprehension of the reasons and effects behind the observed governance structure between network members (Bianchi et al., 2019).

The DPG charts highlighted in figures 32 and 33 below focus on carriers and shippers sub-systems involved in the EVE Program.

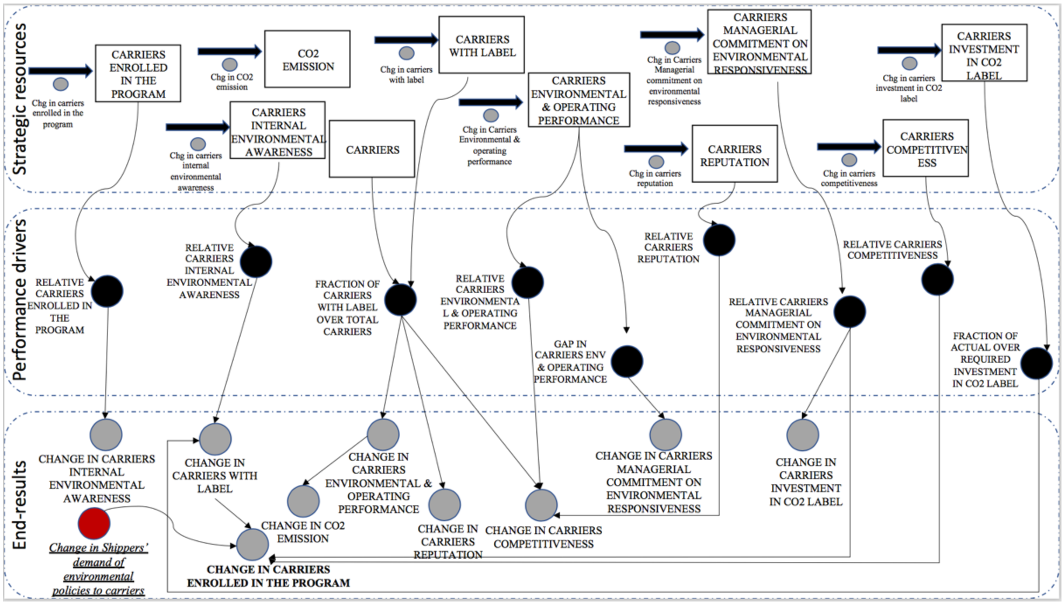

Figure 32. DPG of carriers

From figure 32 above concerning the DPG of carrier's sub-system, it is possible to notice the end-results, the performance drivers, and the strategic resources.

As mentioned in the previous chapter, the end results are attained by the organization or system generated by the management cycle (producing process) (Bianchi et al., 2019; Cosenz, 2022; Noto, 2020).

The end-results of the DPG chart of carriers sub-system are:

- Change in carriers' internal environmental awareness
- Change in carriers with label
- Change in carriers enrolled in the program
- Change in CO2 emission
- Change in carriers' Environmental & operating performance
- Change in carriers' reputation
- Change in carriers' competitiveness
- Change in carriers' managerial commitment to environmental responsiveness
- Change in carriers' investment in CO2 labels.

From the DPG chart of carriers sub-system, it is possible to notice the connection between carriers and shippers through the end result of shippers' "change in shippers' demand of environmental policies to carriers," which affects the end result of carriers' “change in carriers enrolled in the program”. This connection demonstrates the pressure of shippers on carriers.

From the end-results, it is possible to identify the performance drivers, which are, as mentioned in the previous chapter, intermediate results that evaluate a system's state by contrasting it to a benchmark or a goal value. The performance drivers can change the end results (Bianchi, 2016).

The performance drivers related to the DPG chart of carriers are the following:

- Relative carriers enrolled in the program
- Relative carriers' internal environmental awareness
- Fraction of carriers with the label over total carriers
- Relative carriers environmental & operating performance
- Gap in carriers' environmental & operating performance
- Relative carriers' reputation
- Relative carriers' managerial commitment to environmental responsiveness
- Relative carriers' competitiveness
- Fraction of actual over required investment in CO2 label

The following can be noted to elaborate on this list: the performance driver “relative carriers enrolled in the program” is a ratio between the actual carriers enrolled in the program over the total carriers. The performance driver “relative carriers' internal environmental awareness” is a ratio between the actual carriers' internal environmental awareness over a desired level. The performance driver, “fraction of carriers with the label over total carriers”, shows the ratio of actual carriers with the label over total carriers. The performance driver, “relative carriers' environmental & operating performance,” portray the ratio between the actual carriers' environmental & operating performance over the carriers' environmental & operating performance of other carriers. The performance driver “gap in carriers environmental & operating performance” shows the gap between the actual carriers' environmental & operating performance over the desired level. The performance driver, “relative carriers' reputation,” is a ratio between the actual reputation over the reputation of other carriers. The performance driver, “relative carriers' managerial commitment to environmental responsiveness”, shows a ratio between the actual carriers' managerial commitment to environmental responsiveness over the desired level. The performance driver “relative carriers competitiveness” is a ratio between the competitiveness of the carriers enrolled in the program over the competitiveness of other carriers. The performance driver, “fraction of actual over required investment in CO2 label,” shows the ratio between the actual investment in CO2 label over the required investment.

Moreover, from figure 32, it is possible to identify the strategic resources linked to performance drivers.

The strategic resources linked to the performance driver of the DPG chart of carriers sub-system are:

- Carriers enrolled in the program
- CO2 emission
- Carriers’ internal environmental awareness
- Carriers
- Carriers with label
- Carriers environmental & operating performance
- Carriers’ managerial commitment to environmental responsiveness
- Carriers’ reputation Carriers’ competitiveness
- Carriers’ investment in CO2 label

Figure 33 below highlights the DPG of shipper’s sub-system, whereby the end results, the performance drivers, and the strategic resources are highlighted in particular.

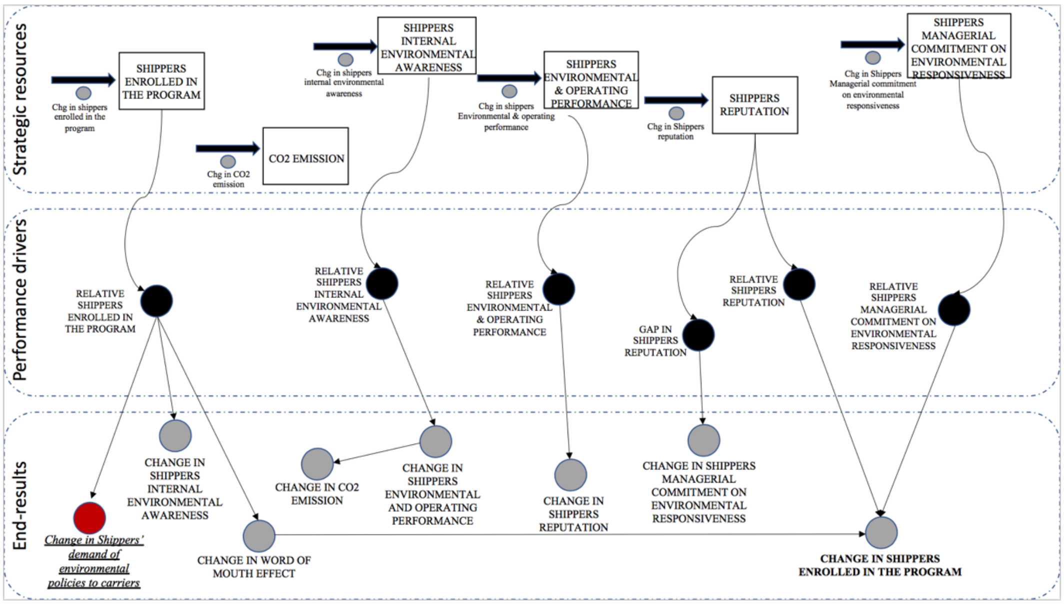

Figure 33. DPG of shippers

The end results of the shippers' sub-system are:

- Change in shippers' demand for environmental policies for carriers
- Change in shippers' internal environmental awareness
- Change in the word of mouth effect
- Change in CO2 emission
- Change in shippers' environmental and operating performance
- Change in shippers' reputation
- Change in shippers' managerial commitment to environmental responsiveness
- Change in shippers enrolled in the program

The performance drivers of the DPG chart of shipper's sub-system are:

- Relative shippers enrolled in the program
- Relative shippers' internal environmental awareness
- Relative shippers environmental & operating performance
- Gap in shippers' reputation
- Relative shippers' managerial commitment to environmental responsiveness

In detail, the performance driver “relative shippers enrolled in the program” is a ratio between the actual shippers enrolled in the program over total shippers. The performance driver, “relative shippers' internal environmental awareness,” is a ratio between the actual shippers' internal environmental awareness over the desired level. The performance driver “relative shippers environmental & operating performance” shows the ratio between the actual shippers' environmental & operating performance of the shippers enrolled in the program over the competitors' environmental & operating performance. The performance driver “relative shippers reputation” is a ratio between the actual reputation of shippers enrolled over the reputation of shippers not enrolled in the program. The performance driver, “relative shippers' managerial commitment to environmental responsiveness”, highlights a ratio between the actual shippers' managerial commitment to environmental responsiveness over a desired level.

The strategic resources of the DPG chart of shipper’s sub-system are:

- Shippers enrolled in the program
- CO2 emission
- Shippers' internal environmental awareness
- Shippers environmental & operating performance
- Shippers reputation
- Shippers' managerial commitment to environmental responsiveness

From figures 32 and 33 above of the two DPG charts related to the carriers sub-system and shippers sub-system, one can see the relevance of the DPG approach. Especially with its inter-organizational point of view, it can help to understand the relations between, in this case, carriers and shippers. As mentioned in the previous chapter, the DPG approach supports the formulation of policies. It enhances performance governance by adopting interpretative lenses for analyzing how and why performance measurements change over time due to implemented policies, activities of the stakeholders, and external circumstances (Bianchi, 2016; Bianchi et al., 2019).

The next section will show the Causal Loop Diagram (CLD), the Stock and Flow Diagram (SFD) and the simulations related to the EVE program in France.

4.4 The System Dynamic approach

Based on findings of existing literature on VEP and the results of field research, the Causal Loop Diagram (CLD) of carriers and shippers sub-systems and the System Dynamic (SD) model of carriers, shippers and freight forwarder sub-systems were built. The CLD and the SD model of different actors participating in the EVE program in France are presented below. The SD model aims to explore and test alternative policies that are viable options for public decision-makers and hence help improve EVE project performance. The SD modelling process is characterized by an interactive nature, which is also positively highlighted in the literature (Richardson and Pugh, 1981; Roberts et al., 1983; Vennix, 1996; Sterman, 2000) between the multiple steps and the different actors involved, like the modeler and the final user. To present as comprehensive a picture as possible, a formal approach characterizing all stages of the modelling process with a focus on the collection, storage and analysis of both quantitative and qualitative data is used (Kim and Andersen, 2012; Luna-Reyes and Andersen, 2003; Sterman, 2000) (Bivona et al., 2023).

The different steps that were followed are listed below:

- Problem articulation
- Dynamic hypothesis
- Model formulation
- Model testing
- Policy design and evaluation

First, the research groups, consisting of Professors from the French Universities (IAE Pau-Bayonne, Savoie Mont Blanc) and the University of Palermo, devoted themselves to the *problem articulation* in numerous meetings. With this, the main focus was to identify the boundaries of the analysis, in which context VEPs are applied, and which actors are involved. Once these questions had been answered, the second step was to formulate the *dynamic hypotheses*. Based on information derived from the first step and existing research, a preliminary CLD was created. Interviews with LSP staff engaged in field studies were also consulted.

Doing so, the preliminary CLD gets validated and enriched through conducting multiple group model-building sessions (Vennix, 1996). The CLD was presented during the "Sustainable Logistics Workshop" held on May 2022 in Bayonne (France), attended by about 20 managers of the LSPs involved in the EVE program. Based on the introduction of the CLD at the workshop in France and the positive feedback received, the process reached the next step, namely, the *model formulation*. Following the previous analysis, the University of Palermo research group built a preliminary SD model, which was subsequently adjusted over time based on comments and suggestions of the colleagues of partner universities and ADEME. As the model was created, the next step was *model testing,* during which the correct formulation and robustness of the model were verified (Barlas, 1996). Finally, the last step refers to *policy design and evaluation,* assessing alternative policies to improve the performance of the EVE program (Bivona et al., 2023)

Below, the CLD related to shippers and carriers sub-systems is illustrated.

4.4.1 The Causal Loop Diagram

The main causes-and-effects relationships between variables related to the carrier's sub-system and the shipper's sub-system can be tracked in the Causal Loop Diagram (CLD) in figure 34 below. As the analysis has shown, freight forwarders play a more marginal role in the process. For this reason, the CLD includes only the sub-systems of carriers and shippers (Bivona et al., 2023).

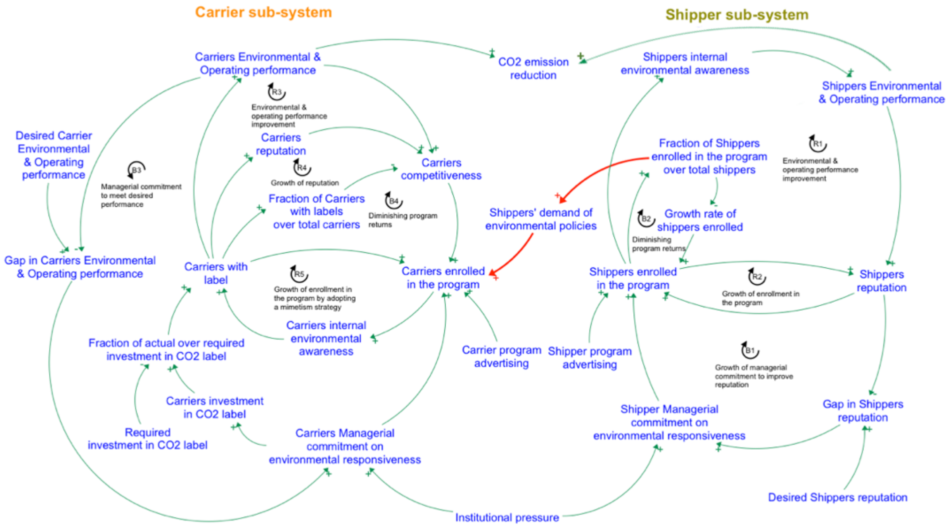

Figure 34. Causal Loop Diagram (CLD)

4.4.1.1 Shippers' sub-system

The sub-system of shippers highlighted in figure 34 above is characterized by two balancing loops (B1 and B2) and two reinforcing loops (R1 and R2).

Taking a closer look at the reinforcing loop "R1-*Shippers Environmental & operating performance improvement*", this specific loop shows how an increase in "Shipper Program advertising" affects "Shippers enrolled in the program". As the "Shippers enrolled in the program" grows up, "shippers internal environmental awareness", "shippers Environmental & Operating performance," and "Shippers reputation" increase too. An increase in "Shippers' reputation" boosts "Shippers enrolled in the program". The reinforcing loop "R2-*Growth of shippers enrolled in the program*" highlights how an increase in "Shippers enrolled in the program" also has a direct effect on boosting "Shippers' reputation" which as an effect generates a growth in "shippers enrolled in the program". On the other side, the balancing loop "B1-*Growth of Shippers managerial commitment to improving Reputation"* shows how an increase in "Institutional Pressure on Shippers" influences "Shipper managerial commitment on environmental responsiveness". As the "Shipper managerial commitment on environmental responsiveness" grows up, "Shippers enrolled in the program" and "Shippers reputation" increase too. An increase in "Shippers' reputation" generates a decrease in the "Gap in shippers' reputation" which leads to a decrease in “Shipper managerial commitment on environmental responsiveness”. Moreover, the “B2-*Diminishing Shippers program returns*” shows how growth in “Shippers enrolled in the program” has a positive impact on the “Fraction of Shippers enrolled in the program over total shippers”. As the “Fraction of Shippers enrolled in the program over total shippers” increases the “growth rate of shippers enrolled in the program” decreases. Additionally, growth in the “Fraction of Shippers enrolled in the program over total shippers” boosts the “Shippers’ demand for environmental policies”. As the “Shippers’ demand for environmental policies” increases, this generates pressure on carriers and increases the “Carriers enrolled in the program” (Bivona et al., 2023)

4.4.1.2 Carriers sub-system

Figure 34, which shows the carriers sub-system, emphasizes three reinforcing loops (R3, R4, and R5) and two balancing loops (B3 and B4).

In particular, in the same way as shippers for carriers, the advertising initiatives affect “Carriers enrolled in the program”. The “R3-*Carriers Environmental & operating performance improvement”* shows how a boost in “Carrier Program advertising” directly influences the number of “Carriers enrolled in the program”. As “Carriers enrolled in the program” grows up, “Carriers internal environmental awareness”, “Carrier with label”, “Carriers Environmental & Operating performance” and “Carriers competitiveness” raise too. Increasing “Carriers' competitiveness” generates growth in “Carriers enrolled in the program”. The reinforcing loop “R4-*Growth of carriers reputation*” shows how growth in “Carriers enrolled in the program” creates an increase in “Carriers' internal environmental awareness” and “Carriers with the label”. The “Carriers with the label” boost “Carriers reputation”. As an effect, a growth in “Carriers' reputation” increases the “Carriers' competitiveness” and, as a result, a generate a rise in “Carriers enrolled in the program”. The reinforcing loop “R5-*Growth of Carriers enrolled in the program adopting a mimetism strategy*” shows how an increase in “Carriers enrolled in the program” boosts the “Carriers' internal environmental awareness” and “Carriers with the label”. The “Carriers with the label” also directly affect “Carriers enrolled in the program”.

On the other side, the balancing loop "B3-*Carriers managerial commitment to meet Desired Environmental & Operating performance*" highlights how growth in "Institutional pressure" influences "Carriers Managerial commitment on environmental responsiveness". A growth in "Carriers Managerial commitment on environmental responsiveness" boosts the "Carriers investment in CO2 label" and this increases the "Fraction of actual over required investment in CO2 label". Growth in the "Fraction of actual over required investment in CO2 label" boosts the "Carriers with the label" and this increases the "Carriers Environmental & Operating performance". The growth in the "Carriers Environmental & Operating performance" leads to a decrease in the "Gap in Carriers Environmental & Operating performance" and as a consequence, this generates a reduction in "Carriers Managerial commitment on environmental responsiveness". Turning to the balancing loop "B4-*Diminishing Carriers program returns*" this loop shows how a boost in "Carriers enrolled in the program" generates a growth in "Carriers internal environmental awareness" and "Carrier with the label". A growth in "Carrier with the label" generates a raise in "Fraction of Carriers with the label over total carriers". As the "Fraction of Carriers with the label over total carriers" increases, this leads to a decrease in "Carriers competitiveness". A decrease in "Carriers' competitiveness" boosts a reduction in "Carriers enrolled in the program".

Furthermore, the CLD in Figure 34 highlights how a growth in the "Environmental & Operating performance" of carriers and shippers sub-systems produces an increase in CO2 emissions reductions (Bivona et al., 2023).

Below, the stock and flow structure related to shippers, carriers and freight forwarder sub-systems is illustrated.

4.4.2 The Stock-and-Flow structure

In contrast to the CLD, the stock and flow diagram (SFD) is quantitative and aims to replicate the reinforcing and balancing loops previously introduced on the CLD. The SFD was built using the software Stella Architect, using the data collected from the interviews conducted by the research group of IAE France. The goal is to replicate the trend of the obtained data and to highlight the levers on which to act to achieve the objectives set.

The model illustrates the sub-systems of carriers, shippers and freight forwarders. Some of the variables in the model are consistent with the information in the literature and the interviews with stakeholders, as shown in figure 35 and figure 36.

Reference SD model variable	***Source of motivation***
IM_1	Company Values
IM_2	Motivations for internal teams
	Formalization of company's commitments internally
EM_1	Regulatory Pressure (Coercitive)
	External communication
EM_2	Legitimacy

Figure 35. *"Corresponding relationships between the field research results and the key variables identified in the SD model"*. Adapted from (Bivona et al., 2023)

Reference SD model variable	***Source of the barriers***
BA_1	The lack of internalization of the program
	The lack of trust between carriers and suppliers
BA_2	An asymmetrical relationship between the shippers and the carriers
	Infrastructure in poor condition
BA_3	The high cost of alternative vehicles
	The complexity of multimodal organization

Figure 36. *"Corresponding relationships between the field research results and the key variables identified in the SD model"*. Adapted from *(Bivona et al., 2023)*

In detail, the sub-system of carriers is shown in figure 37, the sub-system of shippers is depicted in figure 38, and the sub-system of freight forwarders is illustrated in figure 39.

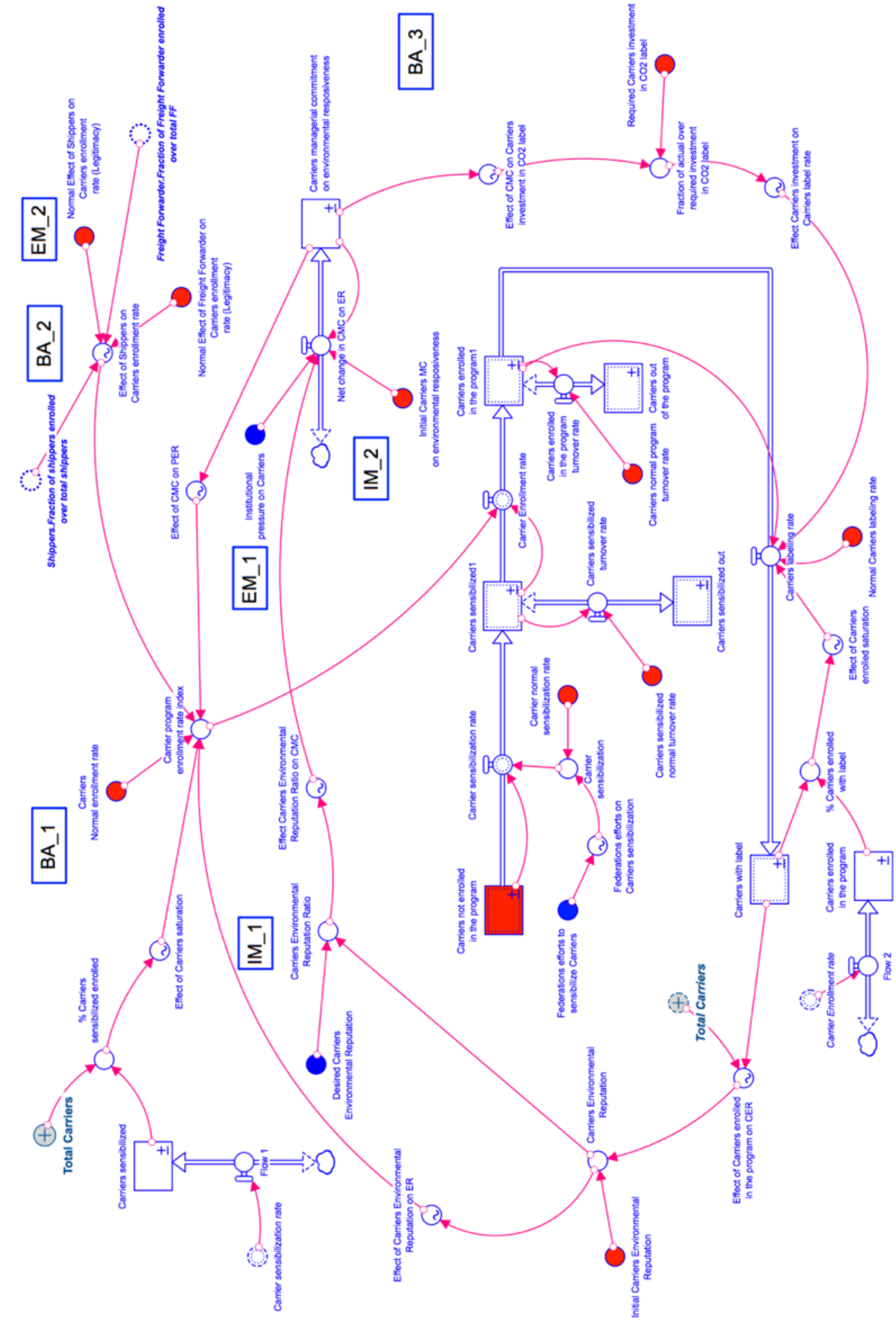

Figure 37. *Stock and flow diagram of carriers*. Adapted from (Bivona et al., 2023)

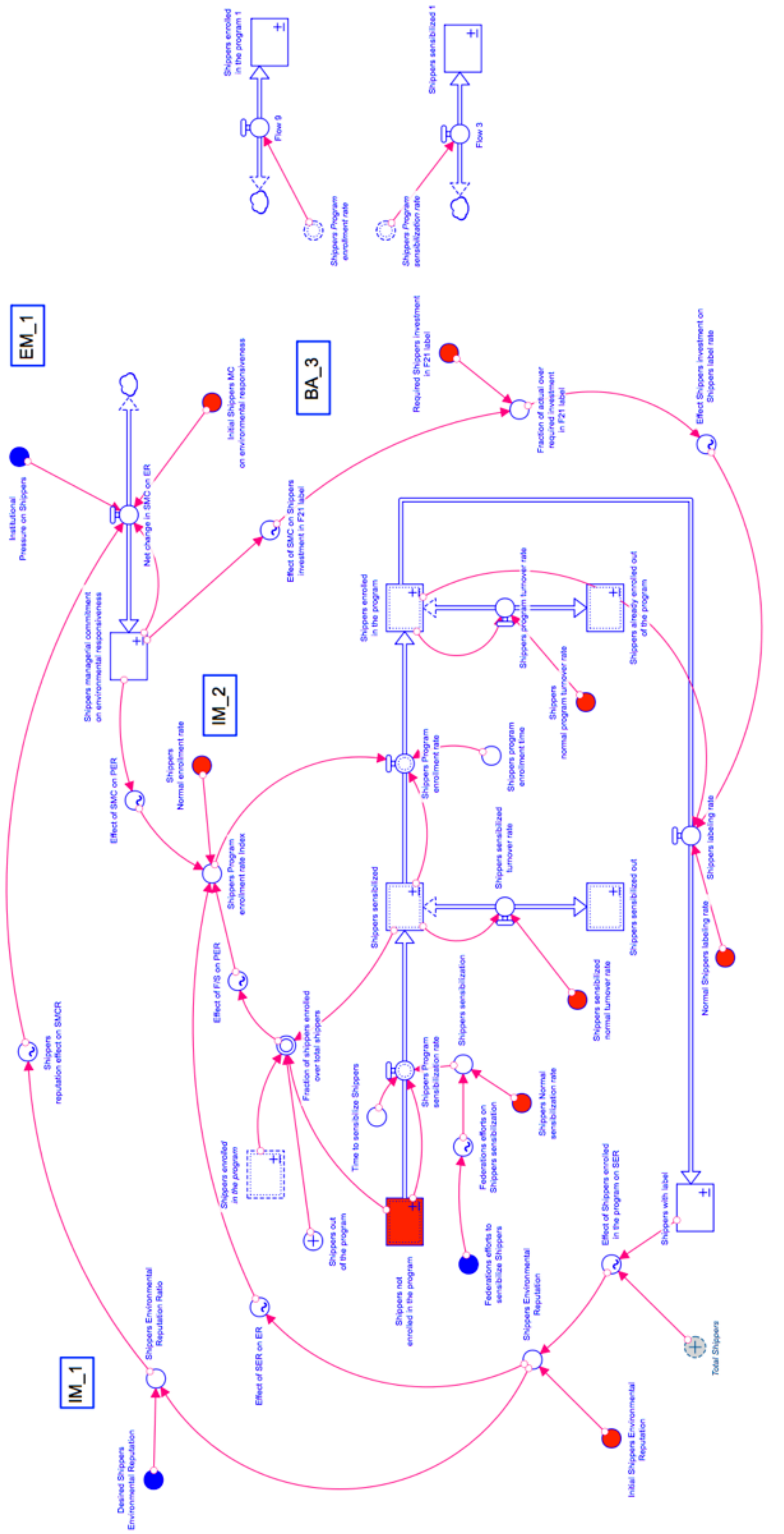

Figure 38. *Stock and flow diagram of shippers*. Adapted from (Bivona et al., 2023)

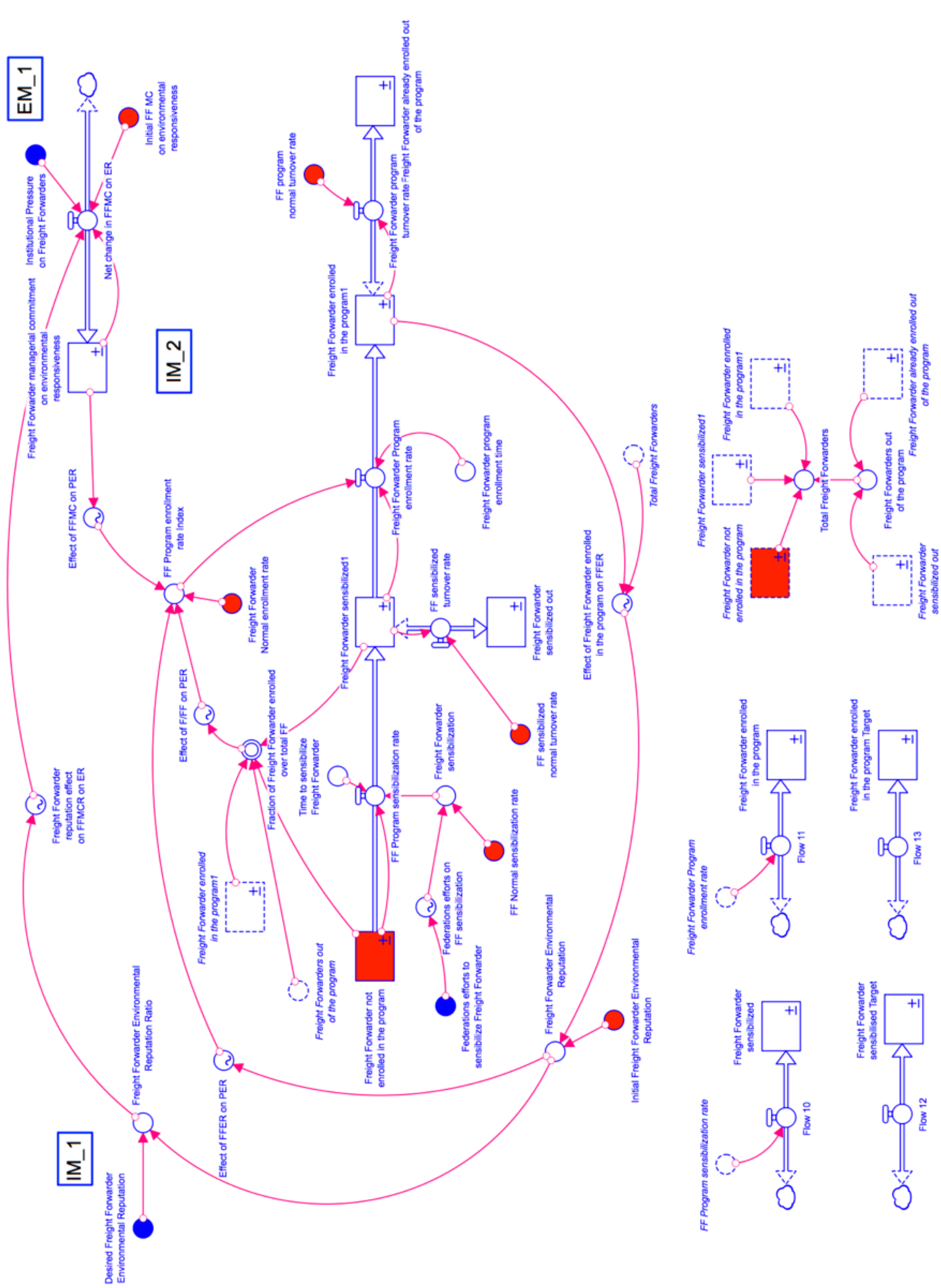

Figure 39. Stock and flow diagram of freight forwarders. Adapted from (Bivona et al., 2023)

Through simulations of the model, the next paragraph will analyze four scenarios related to different policies impacting the performance of the EVE program.

4.4.3 Simulations

From the model highlighted in the previous paragraph, four scenarios related to different policies impacting the EVE program's performance are compared here.
The scenarios are the following:

- Scenario (a) replicates the current status of the program, associated with medium federations' effort to sensibilize carriers/shippers/freight forwarders and medium desired carriers/shippers/freight forwarders' environmental reputation.
- Scenario (b1, b2, b3) highlights the effect of one policy, namely high federations effort to sensibilize carriers/shippers/freight forwarders. This policy is introduced in month 23 (November 2022, the last data set available).
- Scenario (b4, b5, b6) draws attention to two policies. It shows the effect of high federations' efforts to sensibilize carriers/shippers/freight forwarders and the effect of highly desired carriers/shippers/freight forwarders' environmental reputation. These policies are introduced in month 23 (November 2022, the last data set available).
- Scenario (c) shows high efforts in all policies.

Each graph portrays two lines: the "red" line, which depicts the target to be achieved over time, and the "blue" line, which portrays the results achieved by the different scenarios. It is worth noting that the medium and high values are estimated by observing the information and data available (Bivona et al., 2023).

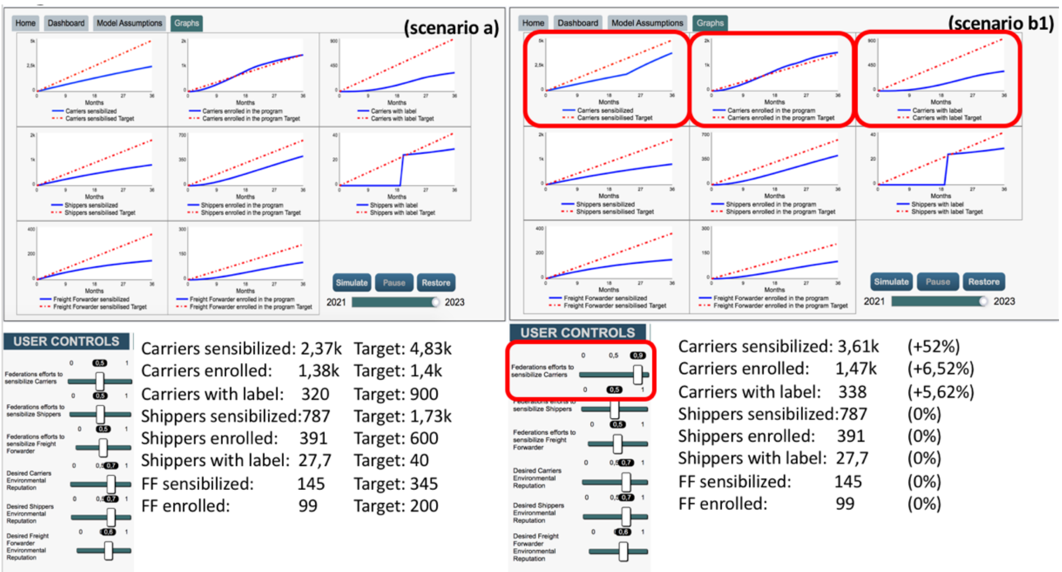

Figure 40. *"Overview high federations effort to sensibilize carriers"*. Adapted from (Bivona et al., 2023)

Figure 40 (scenario b1) proves that a higher "Federations efforts to sensibilize Carriers" boost "carriers sensibilized", "carriers enrolled" and "carriers with the label" compared to figure 40 (scenario a).

A closer look at figure 40 scenario (a) shows that the carriers' sensibilized amount to 2,37k while the sensibilized carriers' target amount to 4,83k. Scenario (b1) shows that with the policy "high federations effort to sensibilize carriers" the carriers sensibilized become 3,61k.

Figure 40 scenario (a) shows that the carriers enrolled are 1,38k, and the carriers enrolled target is 1,4k. From scenario (b1), where there is the effect of the policy "high federations effort to sensibilize carriers", the carriers enrolled become 1,47k.

Following figure 40 scenario (a), it can also be observed that the carriers with labels are 320, and those with label targets are 900. From scenario (b1), which shows the effect of the policy "high federations effort to sensibilize carriers", the carriers with labels are 338.

Concerning the overview of the effect of the policy "high federations effort to sensibilize carriers" on carriers, shippers and freight forwarders provided by figure 40, the following can be said in summary: a "high federations effort to sensibilize carriers" has an effect only to carriers sensibilized (+52%), carriers enrolled

(+6,52%) and on carriers with a label (+5,62%) compared to the scenario (a). As seen in figure 40, this policy does not affect shippers and freight forwarders.

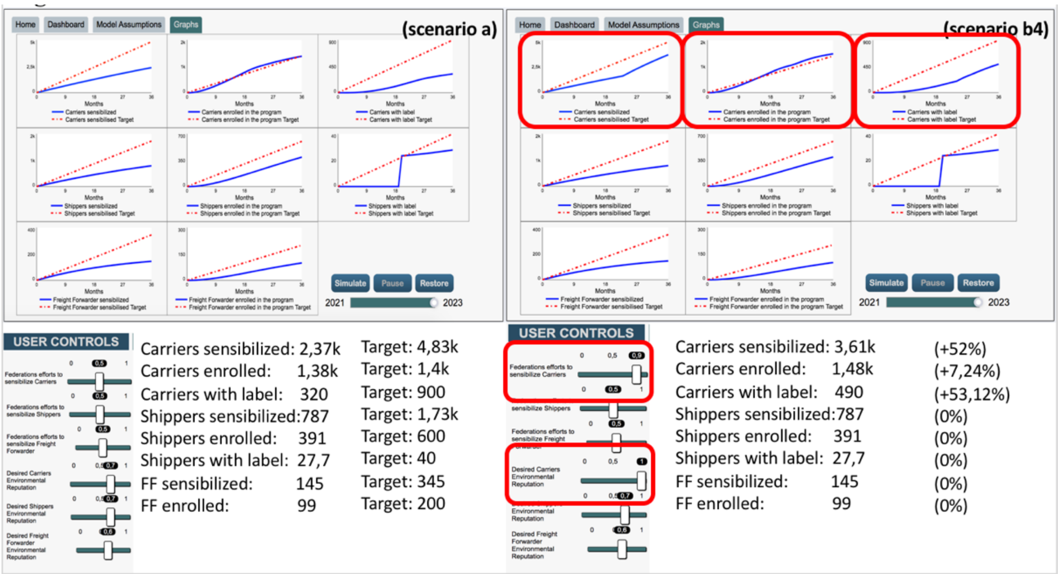

Figure 41. "Overview *high federations efforts to sensibilize Carriers" and "Desired Carriers Environmental Reputation".* Adapted from (Bivona et al., 2023)

Figure 41 (scenario b4) shows how an increase in "Federations efforts to sensibilize Carriers" and a boost in "Desired Carriers Environmental Reputation" have a greater effect on "carriers with label" compared to figure 41 (scenario a) and compared to only an increase in "Federations efforts to sensibilize Carriers". Figure 41 scenario (a) shows that the carriers with the label are 320, and those with the label target are 900. From scenario (b4), which shows an increase in "Federations efforts to sensibilize Carriers" and in "Desired Carriers Environmental Reputation" the Carriers with the label are 490.

Figure 41 shows the effect of increased "Federations efforts to sensibilize Carriers" and "Desired Carriers Environmental Reputation" to carriers, shippers, and freight forwarders. Through these increases, there is a remarkable effect on the carriers with the label (+53,12%) compared to scenario (a) and compared to only an increase in "Federations efforts to sensibilize Carriers".

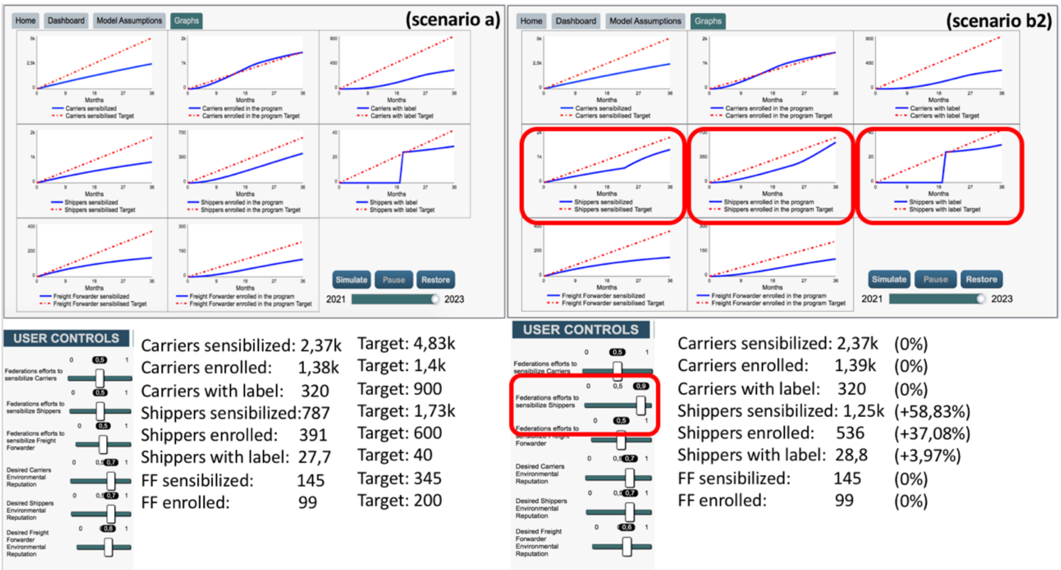

Figure 42. *"Overview high federation efforts to sensibilize Shippers".* Adapted from (Bivona et al., 2023)

Figure 42 (scenario b2) highlights how an increase in "Federation efforts to sensibilize shippers" boosts "shippers sensibilized", "shippers enrolled" and "shippers with label" compared to figure 42 (scenario a).

Figure 42 scenario (a) shows that the shippers' sensibilized are 787 and the shippers' sensibilized target is 1,73k. From scenario (b2), where there is an increase in "Federation efforts to sensibilize Shippers", the shippers sensibilized are 1,25k.

According to figure 42 scenario (a), the shippers enrolled are 391 and the shippers enrolled target are 600. From scenario (b2), where there is an increase in "Federation efforts to sensibilize Shippers", the shippers enrolled are 536.

Looking at the shippers with labels, figure 42 scenario (a) shows that the shippers with the label are 27,7 and the shippers with the label target are 40. From scenario (b2), where there is an increase in "Federation efforts to sensibilize Shippers", the shippers with label count 28,8.

Figure 42 shows an overview of the effect of the policy "Federation efforts to sensibilize Shippers" to carriers, shippers and freight forwarders. In detail, an increase in "Federation efforts to sensibilize Shippers" affects shippers sensibilized (+58,83%), shippers enrolled (+37,08%), and shippers with the label (+3,97%) compared to scenario (a). As seen in figure 42, this policy does not affect carriers and freight forwarders.

Figure 43. "*Overview high "Federations efforts to sensibilize Shippers" and high "Desired Shippers Environmental Reputation"*. Adapted from (Bivona et al., 2023)

The Figure 43 scenario (b5) shows how an increase in "Federations efforts to sensibilize Shippers" and a boosts in "Desired Shippers Environmental Reputation" have a greater effect on "shippers enrolled" and "shippers with label" compared to figure 43 (scenario a) and compared to only an increase in "Federations efforts to sensibilize Shippers". In detail, from figure 43 scenario (a), the shippers with the label are 27,7 and those with the label target are 40. From scenario (b5), where there is an increase in "Federations efforts to sensibilize Shippers" and in "Desired Shippers Environmental Reputation" the shippers with label amount to 30,6.
Figure 43 scenario (a) regarding shippers enrolled shows that the shippers enrolled in the program amount to 391 and the target is 600. From the scenario (b5), which shows an increase in "Federations efforts to sensibilize Shippers" and in "Desired Shippers Environmental Reputation" the number of shippers enrolled turned to 553.
Figure 43 scenario (b5) shows an overview of the effect of the policy "Federation efforts to sensibilize Shippers" and "Desired Shippers Environmental Reputation" on carriers, shippers and freight forwarders. In particular, an increase in "Federation efforts to sensibilize Shippers" and "Desired Shippers Environmental Reputation" affect shippers enrolled (+41,43%) and shippers with the label (+10,46%) compared to scenario (a) and compared to only an increase in "Federations efforts

to sensibilize Shippers”. As seen in figure 43, this policy does not affect carriers and freight forwarders.

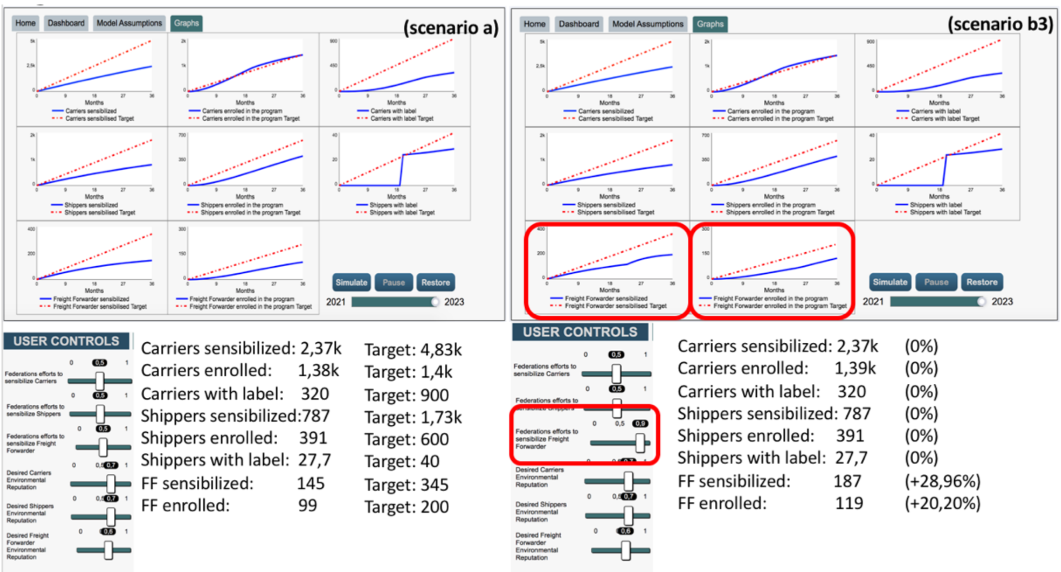

Figure 44. *“Overview high “Federations efforts to sensibilize Freight Forwarder”.* Adapted from (Bivona et al., 2023)

Figure 44 scenario (b3) shows how a higher “Federations efforts to sensibilize Freight Forwarders” boost “freight forwarders sensibilized” and “freight forwarders enrolled” compared to the figure 44 scenario (a). In figure 44 scenario (a), the FF sensibilized are 145 and the FF sensibilized target is 345. From scenario (b3), where there is an increase in “Federations efforts to sensibilize Freight Forwarders”, the FF sensibilized are 187.

As figure 44 scenario (a) shows, the FF enrolled is 99, and the FF enrolled in the program target is 200. From scenario (b3), which considers an increase in “Federations efforts to sensibilize Freight Forwarders”, the FF enrolled are 119.

Figure 44 shows an overview of the effect of the policy “Federations efforts to sensibilize Freight Forwarder” to carriers, shippers and freight forwarders.

Thereby it turns out, from figure 44 scenario (b3), that an increase in “Federation efforts to sensibilize freight forwarder” has an effect on freight forwarder sensibilized (+28,96%) and freight forwarder enrolled (+20,20%) compared to the scenario (a). This policy does not affect carriers and shippers.

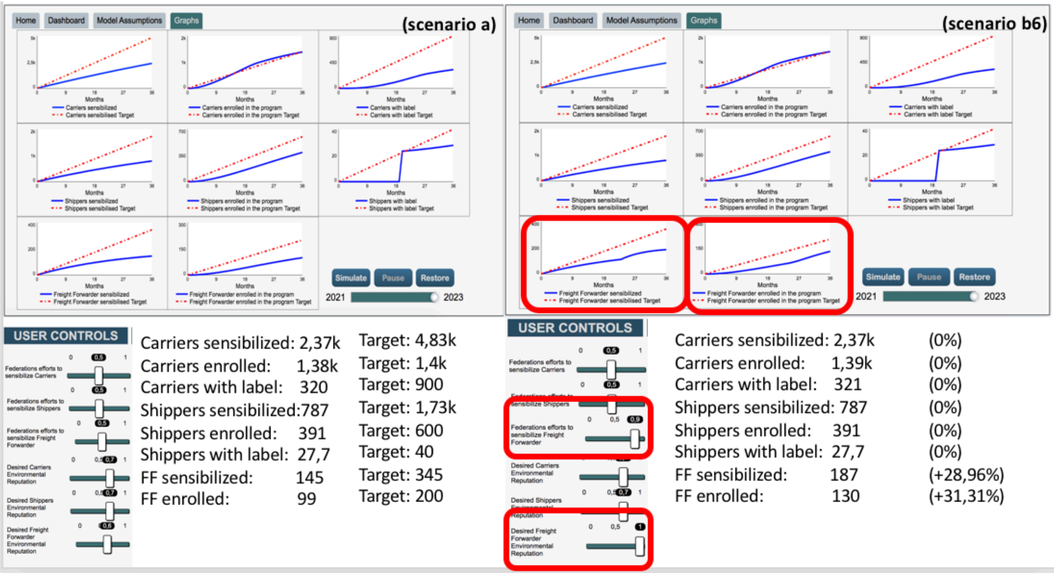

Figure 45. "*Overview high "Federations efforts to sensibilize Freight Forwarder" and high "Desired Freight Forwarder Environmental Reputation".* Adapted from (Bivona et al., 2023)

Figure 45 (scenario b6) shows how an increase in "Federations efforts to sensibilize Freight Forwarder" and a boost in "Desired Freight Forwarder Environmental Reputation" have a greater effect on "freight forwarder enrolled" compared to figure 45 (scenario a) and to only an increase in "Federations efforts to sensibilize Freight Forwarder". Figure 45 scenario (a) shows that the FF enrolled is 99, and the FF enrolled in the program target is 200. From scenario (b6), where there is an increase in "Federations efforts to sensibilize Freight Forwarder" and in "Desired Freight Forwarder Environmental Reputation" the FF enrolled are 130.

As can be seen from the figure 45 scenario (b6), an increase in "Federation efforts to sensibilize freight forwarder" and in "Desired Freight Forwarder Environmental Reputation" have an effect on the number of freight forwarders enrolled (+31,31%) compared to the scenario (a) and there is an increase in the freight forwarder enrolled compared to only an increase in "Federations efforts to sensibilize Freight Forwarder". As seen from the figure 45 scenario b6, this policy does not affect carriers and shippers.

Figure 46. *"Overview collaborative approach"*. Adapted from (Bivona et al., 2023)

Figure 46 scenario (c) shows the effect of multiple policies introduced simultaneously. It includes growth in "federations effort to sensibilize carriers/shippers/freight forwarders" and "desired carriers/shippers/freight forwarders environmental reputation". Compared to scenario (a) and compared to the previous simulations, a collaborative approach generates an increase in the performance of the EVE program. This generated an increase in carriers sensibilized (+52%), carriers enrolled (+7,97%), carriers with the label (+53%), shippers sensibilized (+58,83%), shippers enrolled (+41,43%), shippers with the label (+10,46%), FF sensibilized (+28,96%), and FF enrolled (+31,31%) simultaneously.

4.5 Conclusions

As mentioned in the previous chapters, the implementation of a decarbonization policy in the transport sector is embedded in a complex system. The foregone chapters have made clear that the freight transport sector is a complex system because of the continuous changes in the impacts on the environment mainly generated by the CO_2 emissions, the complexity on the government of this sector, both at an organizational level and inter-organizational level related to the several actors involved in it and can therefore be defined as a wicked problem. Wicked problems are contrary to their tame counterparts, which are simple to define and formulate and have a high potential for standard or routine solutions (Head & Alford, 2015). Here, it is important to note that the word "wicked" does not necessarily indicate "evil" but rather refers to issues that are challenging to define and manage (Australian Public Service Commission, 2007; Head & Alford, 2015). As mentioned previously, the Voluntary Environmental Programs (VEPs) represent a policy lever to reduce the CO2 emissions in the freight transport sector and are therefore crucial to reaching the SDGs. This thesis suggested a collaborative approach that can help support more effective implementation of VEPs in the freight transport sector, thus leading to the reduction of CO2 emissions. More precisely, the implementation of a collaborative governance approach in the freight transportation sector can foster the effectiveness of VEPs in terms of the participant number in the program and in the results achieved by the organizations that participate in the program regarding the reduction in CO2 emission. Aside from the positive effect on the participant number, the collaborative governance approach also increases communication among all the actors involved in the program (e.g., public agencies, shippers, carriers, and freight forwarders). Doing so leads to more awareness of the potential benefits of VEPs and fosters value co-creation by stimulating a shared vision of the goals to be achieved (Saporito et al., 2022).

For investigating and managing the freight transport sector, we suggested a systemic methodological approach, the Dynamic Performance Governance (DPG) (Bianchi, 2016; Bianchi et al., 2019; Bianchi & Vignieri, 2020) approach. This approach, introduced in the case of VEPs in France, offers an inter-organizational point of view to support decision-makers at the policy and management levels in formulating and implementing more effective policies to reduce the transportation sector's environmental impact. At the same time, this approach allows for improved coordination of each actor’s action involved and supports collaborative governance. Further, it helps to understand how different actors are moving forward. For example, meetings highlight policies and strategies to improve performance (Bovaird, 2007; Torfing & Ansell, 2017; Bianchi & Vignieri, 2020). Moreover, the DPG method using System Dynamics (SD) models - which have successfully supported a descriptive perspective in policy evaluation and performance management - facilitates communication and sharing of comprehension of the reasons and effects behind the observed governance structure between network members (Bianchi et al., 2019). As highlighted previously, systemic logic can help a lot, as actors have the opportunity to understand how to improve. Based on the findings of the evaluation of the French case, the program in its current state is limited. Applying this specific type of logic is important to reach the program's full potential. The program, at its current state, encourages more collaboration, but at the same time, most of the practices it fosters remain intra-organizational. In addition to the already mentioned obstacle, sharing information is a big challenge. This is due to a lack of coordination and communication between the stakeholders, which impedes dialogue and the sharing of good practices (Bivona et al., 2023).

To overcome the program's limits in France in its current state, we applied the DPG approach in the last chapter. We did this to offer an inter-organizational point of view, which supports decision-makers at the policy and management level to get an overview of the system. This overview helps to understand the system's complexity better and formulate and implement more effective policies to reduce the environmental impact and support collaborative governance. In detail, the DPG charts we built focus on the sub-system of carriers and shippers involved in the EVE Program. From the DPG charts, it is possible to notice the connection between the sub-systems of carriers and shippers and how the shippers put pressure on carriers through the demand for environmental policies. Moreover, with its inter-organizational point of view, the DPG approach can help understand the relations between the sub-system of carriers and shippers and give an overview of the system and the related variables.

Additionally, as shown in the last chapter, the CLD of the sub-systems of carriers and shippers makes it possible to understand the causal connections between the system variables.

Thanks to implementing a systemic logic and the design of SFD, the levers to achieve the objectives set have an inter-organizational point of view: the model depicts the sub-system of carriers, shippers, and freight forwarders and their associated variables to each other. The model demonstrates how the different actors are moving by replicating the trend of the obtained data from France. Conversely, this helps determine which levers must be used to achieve the desired effect. The simulations of the model showed that a collaborative approach - which includes implementing multiple policies introduced simultaneously on carriers, shippers, and freight forwarders – may increase the results compared to other policies. In detail, simulations have shown that the implementation of a collaborative approach may lead to an increase in the performance of the EVE program in France. This can increase carriers sensibilized, carriers enrolled, carriers with the label, shippers sensibilized, shippers enrolled, shippers with the label, FF sensibilized, and FF enrolled simultaneously.

On the one hand, systemic logic can help a lot, as pointed out through the application of the French case. On the other hand, adopting a systemic approach has several limitations. First, as noted earlier, the freight transport sector is complex as many actors are involved. Second, there is no experience in applying systemic approaches in this context. Furthermore, the model related to the France case cannot predict the future, which makes it necessary to update the model over time as data are collected to make the simulations more realistic. This stresses that the model cannot guarantee that certain results will be achieved over time. The model, also presented at the "International System Dynamics Conference 2023" held in Chicago, USA, requires a process of continuous updating over time, making it possible to increasingly improve the model based on the collected data. This implies that implementing different suggested policies bears a risk since the model cannot predict the future and guarantee the achievement of certain outcomes. Moreover, there might be obstacles in applying a collaborative approach due to the difficulty communicating between the actors involved. Additionally, a further limitation might be the lack of understanding of the benefits of adopting the collaborative approach. If the advantages are not recognized, the interest in implementing the approach decreases. In addition, a further limitation is the impossibility of comparing the results achieved by applying policies in the French case with other countries due to the lack of application of this approach in VEPs in other countries. A further limitation is the focus on France: as the work presented here has worked exclusively with French data and only refers to France, comparable data/results from other countries are missing. However, this limit is, at the same time, an

interesting starting point for additional research. Further research and data collection from other countries could clarify whether the same effects as in France can be observed in other countries.
In terms of another case study, studying the exact opposite of France could be scientifically exciting; for example, a country not in Europe that does not belong to an industrial region and where environmental protection awareness is not as strong as in France. Because other factors have to be considered in such a country, such a study could help adjust the model once again.
To overcome the problems mentioned above, we suggest introducing the figure of the learning facilitator. The learning facilitator can greatly help the different actors involved in understanding how the model works and support the implementation of the systemic approach, as he/she represents an expert figure in this area. In addition, the learning facilitator can promote collaboration between the different actors involved, such as in the case of France, the carriers, shippers, and freight forwarders, making them understand the benefits of adopting such an approach and the results that can be achieved.
Moreover, further research can be oriented to develop a systemic approach in Voluntary Environmental Programs (VEPs) in multiple countries.
Additionally, as has been pointed out many times before, the transport sector is a complex system and therefore artificial intelligence (AI) can prove to be a very powerful and useful tool in addressing the challenges in the transport sector. Artificial Intelligence (based on digital models, algorithms and technologies that reproduce perception, reasoning, interaction and learning) has recently matured to become a central factor in the digital transformation of society, affecting most economic activities and offering opportunities for increased productivity, technological development and advanced analytical activities in all sectors (Programma Strategico Intelligenza Artificiale 2022-2024)[14]. Several studies, including that of Abduljabbar et al. 2019, have already looked at artificial intelligence (AI) in the transport sector. In my opinion, future research could deal

[14] Programma Strategico Intelligenza Artificiale 2022-2024 a cura del Ministero dell'Università e della Ricerca, del Ministero dello Sviluppo Economico e del Ministro per l'Innovazione Tecnologica e la Transizione Digitale.

with the study of the introduction of artificial intelligence in VEPs in the freight transport sector, in order to make the communication and information exchange between the numerous actors involved in VEPs more effective and efficient, in order to increase the performance and significantly reduce the communication time between the different actors.

References:

ABDULJABBAR, R., DIA, H., LIYANAGE, S., & BAGLOEE, S. A. (2019). Applications of artificial intelligence in transport: An overview. Sustainability, 11(1), 189.

AUSTRALIAN PUBLIC SERVICE COMMISSION (2007). Tackling wicked problems: A public policy perspective. Commonwealth of Australia, Barton.

BARLAS, Y. (1996), "Formal aspects of model validity and validation in system dynamics", System Dynamics Review, John Wiley & Sons, US, Vol. 12 No. 3, pp. 183-210.

BIANCHI, C. (2016). *Dynamic performance management* (Vol. 1). Berlin: Springer.

BIANCHI, C., & VIGNIERI, V. (2020). Dealing with "abnormal" business growth by leveraging local area common goods: An outside-in stakeholder collaboration perspective. International Journal of Productivity and Performance Management. https://doi.org/10.1108/IJPPM-07-2019-0318

BIANCHI, C., BERECIARTUA, P., VIGNIERI, V., & COHEN, A. (2019). Enhancing urban brownfield regeneration to pursue sustainable community outcomes through dynamic performance governance. International Journal of Public Administration. https://doi.org/10.1080/01900692.2019. 1669180.

BIVONA, E., & BILEK, G. M. (2021). Using System Dynamics modelling to frame environmental voluntary commitment programs: the French experience. In 38th International Conference of the System Dynamics Society (Vol. 1, pp. 71-82). Curran Associates, Inc.

BIVONA, E., & BILEK, G. M. (2022). Environmental Voluntary Programs in the Transport Industry in the Post-COVID Situation: The French Experience. In *Understanding the Dynamics of New Normal for Supply Chains: Post COVID Opportunities and Challenges* (pp. 81-99). Cham: Springer International Publishing.

BIVONA, E., BILEK, G. M., SAPORITO G., COSENZ F., CERESIA F., CALVI R., MECHOUAR Y. (2023) "Barriers and motivations impacting on the performance of voluntary environmental programs: the EVE program" presented at the conference “2023 International System Dynamics Conference” July 23-27 2023 (Chicago).

BIVONA, E., CERESIA, F., & TUMMINELLO, G. (2019). Overcoming managers’ myopic decisions in a waste collection company: lessons from a system dynamics-based research. Journal of Modelling in Management, 14(4), 1023-1041.

BOVAIRD, T. (2007). Beyond engagement and participation: User and community coproduction of public services. Public Administration Review, 67(5), 846–860.

BYNUM, C., SZE, C., KEARNS, D., POLOVICK, B., & SIMON, K. (2018). An examination of a voluntary policy model to effect behavioral change and influence interactions and decision making in the freight sector. *Transportation Research Part D: Transport and Environment*, *61*, 19-32.

COSENZ, F. (2022). *Managing Sustainable Performance and Governance in Higher Education Institutions: A Dynamic Performance Management Approach* (Vol. 5). Springer Nature.

FORRESTER, J.W. (1961), Industrial Dynamics, MIT Press, currently available from Pegasus Communications: Waltham, MA, Cambridge.

HEAD, B. W., & ALFORD, J. (2015). Wicked problems: Implications for public policy and management. Administration and Society, 47(6), 711–739.

KIM, H. AND ANDERSEN, D.F. (2012), “Building confidence in causal maps generated from purposive text data: mapping transcripts of the Federal Reserve”, System Dynamics Review, Vol. 28 No. 4, pp. 311-328.

KUAI, P., LI, W., CHENG, R., & CHENG, G. (2015). An application of system dynamics for evaluating planning alternatives to guide a green industrial transformation in a resource-based city. Journal of Cleaner Production, 104, 403-412.

LUNA-REYES, L. F., & ANDERSEN, D. L. (2003). Collecting and analyzing qualitative data for system dynamics: methods and models. System Dynamics Review, 19(4), 271-296. https://doi.org/10.1002/sdr.280

MENDY BILEK G., FABBES-COSTE N., KACIOUI-MAURIN E., LAZZERI J., ROUSSAT C., 2017, Obligation d’affichage des informations CO2

Transport: de la règlementation aux pratiques ? Logistique & Management, Issue 2.

NOTO, G. (2020). *Strategic Planning for Urban Transportation: A Dynamic Performance Management Approach* (Vol. 3). Springer Nature.

PRAKASH, A., & POTOSKI, M. (2012). Voluntary environmental programs: A comparative perspective. Journal of Policy Analysis and Management, 31(1), 123-138.

RICHARDSON, G.P. AND PUGH, A.L. III. (1981), Introduction to System Dynamics Modeling with DYNAMO, Productivity Press, Cambridge.

ROBERTS, N.H., ANDERSEN, D.F., DEAL, R.M., GRANT, M.S. AND SHAFFER, W.A. (1983), Introduction to Computer Simulation: The System Dynamics Modeling Approach, Addison-Wesley, Reading.

SAPORITO G., BIVONA E. AND COSENZ F. (2022) Article in review. Fostering the reduction of CO2 emissions in the transport sector. A collaborative governance approach to implementing Voluntary Environmental Programs

STAVE, K. A. (2002). Using system dynamics to improve public participation in environmental decisions. System Dynamics Review: The Journal of the System Dynamics Society, 18(2), 139-167.

STERMAN, J. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World. Boston, MA: Irwin/McGraw-Hill.

TAN, K.C., BLANCO, E.E., 2009. System Dynamics Modeling of the SmartWay Transport Partnership. MIT Engineering Systems Division & CESUN. Presented at the Second International Symposium on Engineering Systems at the MIT Center for Transportation and Logistics, Cambridge, Massachusetts (June).

TORFING, J., & ANSELL, C. (2017). Strengthening political leadership and policy innovation through the expansion of collaborative forms of governance. Public Management Review, 19(1), 37–54.

VENNIX, J.A.M. (1996), Group Model Building: Facilitating Team Learning Using System Dynamics, Wiley, Chichester.

WOLMARANS, P., HYLAND, E., ATHERTON, S., BOVET, D., BRYAN, J., CHENG, A., 2014. Sustainability Strategies Addressing Supply-Chain

Air Emissions. National Cooperative Freight Research Program and the Transportation Research Board of National Academies, 28.

List of figures: