cenit magazine
Science for transport

Innovation in Transport Review

ISSUE 1

20 cenit anniversary

Cenit magazine
Issue #1
November 2022
cenit.es

Welcome

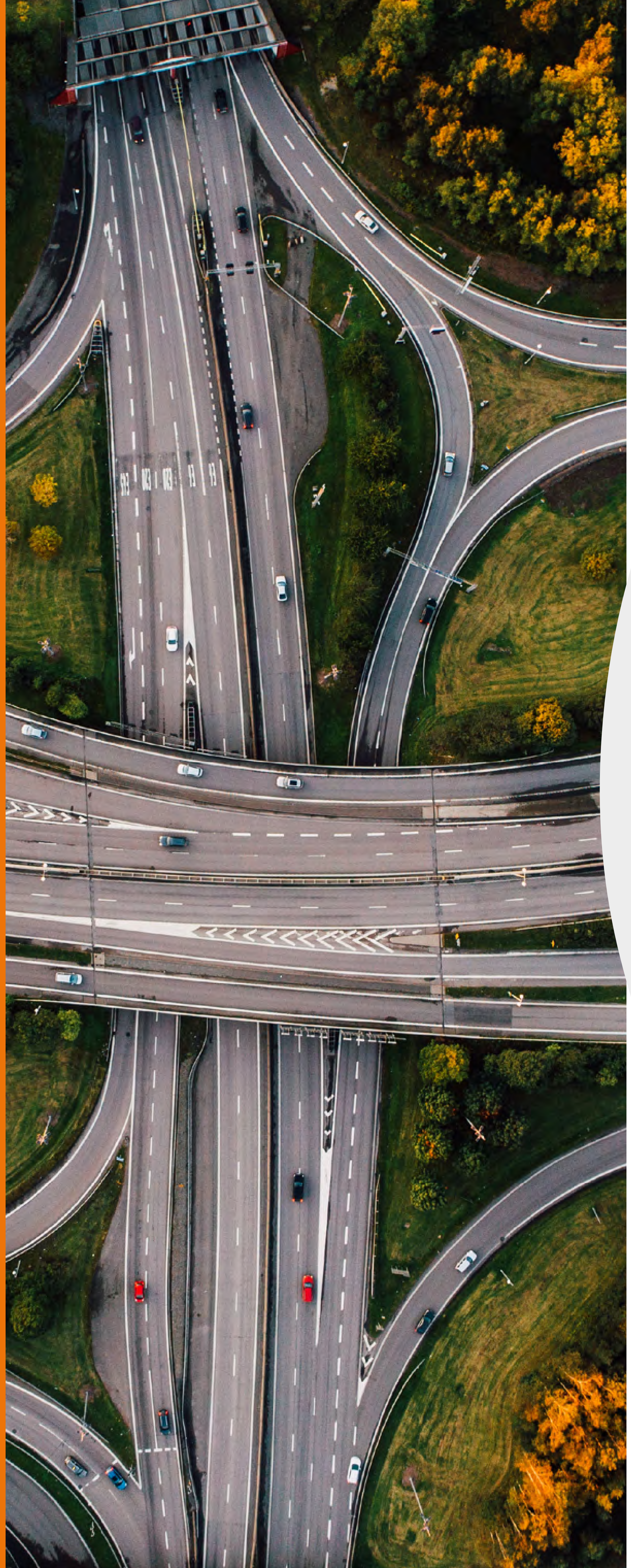
Welcome to the 2022 edition of the **Innovation in Transport Review** by the Center for Innovation in Transport (CENIT). This year we are celebrating the 20-year anniversary of Cenit, since it was first created as a public consortium between the regional government of Catalunya (Departament de Territori i Sostenibilitat) and the Universitat Politècnica de Catalunya-Barcelona Tech (UPC). Since 2017, CENIT has formed part of The International Center for Numerical Methods in Engineering (CIMNE).

Over this period we have witnessed huge changes in the transportation landscape and the increasing need for innovation, technology and flexibility to create a sustainable model that will help to protect our future communities and environment. Cenit continues to work with enthusiasm, dedication and adaptability to achieve one of the greatest challenges of the 21st Century - efficient, sustainable transportation and to provide knowledge to policy makers.

I would like to take this opportunity to thank all the public entities and private companies that have collaborated with CENIT over the last 20 years, and especially the Department of Territory of the Generalitat de Catalunya for their support.

In this issue we present some of our recent research ranging from port sustainability, smart deliveries and last-mile logistics, the challenges of financing public transport to traffic modeling.

DR. SERGI SAURÍ MARCHÁN
DIRECTOR



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Road to Port Sustainability: Initiatives and Good Practices of European Ports.

AFRICA MARRERO

80% of the world's freight transport is carried by sea. This makes maritime transport a fundamental axis in the development of a country's economy. However, maritime transport has an impact not only on the economy but also on the environment and especially on the increase of greenhouse gases. In 2018, according to EMSA (EMSA,2018) ships calling at EU and European Economic Area ports emitted around 140 million tonnes of CO2 (18% of global CO2 emissions from shipping). According to the EMSA report, European Maritime Transport Environmental Report 2021, of the total CO2 emissions around 40% comes from voyages between EU Member States' ports and while ships are in port, while 60% is produced during voyages in and out of the European Union. Faced with this alarming situation, the European Union has tightened emission policies and regulations within the EU in order to meet sustainability targets.

One month after the MEPC76, where tougher measures were expected from the IMO, the European Union published a set of communications with a series of measures to reduce GHG emissions in maritime transport in European waters.

Of these communications, the following can be highlighted:

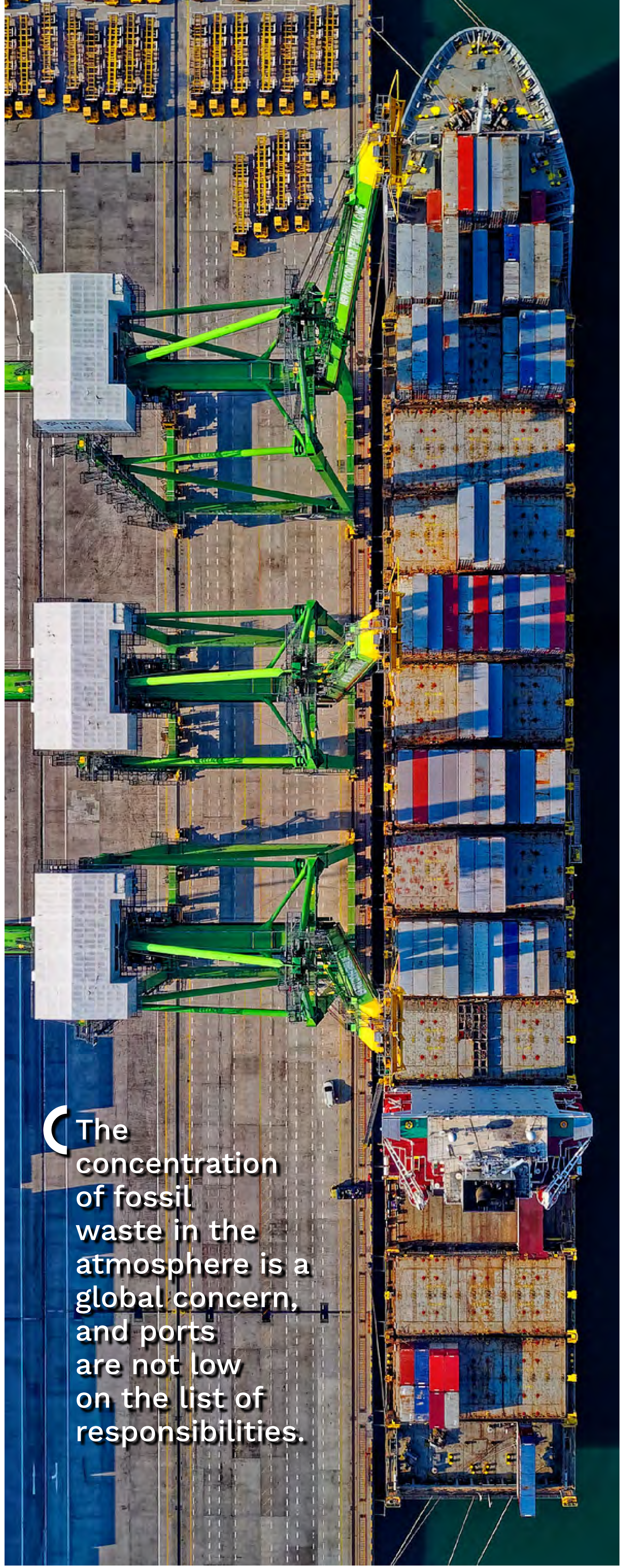
› COM (2021) 550, which dealt with a set of proposals to comply with the Euro pean Green Deal (Fit for 55), including: Gradually extending the EU Emissions Trading Scheme over the period 2023 to 2025, the FuelEU Maritime proposal to promote sustainable maritime fuels, irrespective of their flag, arriving in or leaving EU ports.

› COM (2021) 551, which includes the revision of the EU ETS Directive for the gradual inclusion of emissions from maritime transport, whereby a ship will have to pay 20% of its emissions in 2023, increasing each year until reaching 100% of emissions in 2026.

› COM (2021) 562, limiting greenhouse gas intensity (grams of CO_2 equivalent per MJ) according to a reduction on a reference value (average greenhouse gas intensity of energy used on board ships in 2020 determined on the basis of data monitored and reported under Regulation (EU) 2015/757).

› COM (2021) 563 final: revision of Directive 2003/96/EC on energy taxation, with a view to strengthening the FuelEU maritime targets.

*CO_2 emission report, EMSA/Thetis-MRV, European Maritime Safety Agency (https://mrv.emsa.europa.eu/#public/eumrv).



In addition, the growing footprint of freight transport in contemporary intercontinental travel, especially those related to international sub-continental supply issues, is well documented. The transport sector's thirst for fossil fuels spews an unreasonable amount of carbon, driving an ever-increasing demand for polluting resources. The concentration of fossil waste in the atmosphere is a global concern, and ports are not low on the list of responsibilities. A striking illustration of this is the clamour for the change to clean and renewable energy in the face of climate change and its consequences, including global warming, sea level rise and extreme weather conditions, causing flooding and droughts.

Moving towards alternative energy sources poses a mortal threat to fossil fuels in the immediate future. Authorities and top corporate executives are beginning to recognize the situation and to push for major changes in energy and environmental conditions. Innovation strands that set costly and energy-inefficient mobility patterns must be avoided. Suppliers and transporters are already confronting an unprecedented development of the technology needed to adapt facilities to renewable fuels, in order to boost the energy transition.

Hence, as demonstrated in most projects in this document, port administration has shifted decisively in favour of the renewable energies port model, which has gained wide acceptance across the industrial mobility world. The question remains as to whether the model would engender more efficient ports and whether more concessions would be granted to foreign terminal operators, and with what consequences for indigenous and current initiatives.

Among all the existing possibilities, one of the main ones is hydrogen, in addition to LNG (Liquified Natural Gas). Both are becoming very important energy carriers, transported underground through pipelines and ships. Many ports are choosing to develop their projects around them, not only because of their excellent physical properties that facilitate transport in various steps, but also because of their low production cost. Without going any further, hydrogen production by means of electricity from hydropower is nowadays a widely known and highly developed technique.

Examples of good practices of European Ports

The Port of Oslo's vision is to become the world's most environmentally friendly urban port. The Port of Oslo will make significant investments in the power grid to increase the use of shore power for vessels and charging stations to load batteries. Port equipment and machinery in the port can also be charged, and cargo shipped onward by trucks or by rail. Developing a zero-emissions port has significant costs. In the port of Sydhavna alone, more than NOK 200 million will be invested in emissions-free infrastructure over the coming decades. Shipping lines must rebuild their fleet, and port operators need to invest in zero-emissions vehicles at the terminal and for transport.

The Port of Oslo has studied the role of electrification to help it become a zero-emissions port. The use of locally produced biogas and hydrogen is also being considered. As an urban port, Oslo is well-positioned to build an emissions-free logistics network, at sea and on land, able to expand without additional emissions.

Niedersachsen Ports. The project WASh2Emden examines the opportunities to exploit the so-far unused electricity, convert it, and then store the new form of energy as "green" hydrogen and utilize it in various applications in the port. This aims to create emission reductions for the shoreside port operation, in logistics, but also for ships moored in the port, by utilizing regeneratively produced hydrogen.

The Port of Amsterdam, with Project Clean Amsterdam's sailing, clean battery, you don't need air-polluting, noisy, smelly diesel generators and you relieve the electricity network. The choice for this floating battery also reduces traffic and saves parking spaces. The battery recharges with renewable energy sources from the port. Think of wind energy from Windpark Ruigoord, solar energy and energy from biomass from AEB. Smarter, faster and cleaner!

Clean energy on demand for the city and port every two weeks the battery changes between projects in the port and in the city. In this way, the battery supplies energy to projects that need it at that time.

The Port of Hirtshals expects that fossil fuels, which have a negative environmental impact, soon will be a thing of the past. Therefore, the port wants to focus on a greener alternative in the form of biogas and Power-to-X (PtX), which is based on green hydrogen produced from wind energy. For this very reason, the Port of Hirtshals has gathered a group of specialists with knowledge of PtX to give the port inspiration for further processes regarding the port's role in future energy supply to the transport sector. The idea is to start production of future climate friendly fuels such as hydrogen, ammonia and methanol. The port considers energy as one of its future business areas. In collaboration with qualified partners, the aim of the port is to work commercially for the establishment of hydrogen production, as well as the production of other green fuels based on wind.

The Port of Helsinki is taking steps to reach 2035 as a completely green port, but the model of new technology development to reduce its carbon dependency is still at the initial stage. The key aspects of the port's responsibility management model are environmental, social and financial. The Port has a sustainable development team that develops and implements responsible port operations together with other departments, and it also has a certified operating system that fulfils the requirements of standards ISO 9001, ISO 14001 and ISO 45001.

Carbon-neutral Port of Helsinki 2035 Manifestation.

Targets and measures to achieve it:

A 25 per cent reduction in vessel emissions.

› Shore power capabilities for nine berths
› Making alternative fuels available at Helsinki ports
› The continued development of an environmental program targeted at ships

A 60 per cent reduction in emissions from heavy goods vehicles.

› Minimizing the use of transport vehicles at ports
› Introducing incentives to use low-emission vehicles

A 60 per cent reduction in emissions from work machines used in the harbour area.

› Enabling the electrification of work machine infrastructure
› Encouraging the use of biofuels

The Port of Helsinki should be carbon neutral in terms of its own emissions by 2035.

› Minimizing the Port's energy consumption by modernizing heating, installing LED lighting, and increasing the use of solar panels
› Acquiring necessary energy from carbon-free sources
› Helping to lower subcontractors' carbon footprints via procurement

Tackling Climate Change in Ports with the PIONEERS Green Deal project.

Today's society faces the greatest challenge of the twenty-first century: the climate emergency. To tackle this, it must move towards a more sustainable mobility based on new technologies, among which we can highlight the automation of processes and the digitalization of logistics chains. Increasing environmental pressure also demands the need to find solutions that are more efficient and sustainable, especially in transport, which is one of the most polluting sectors.

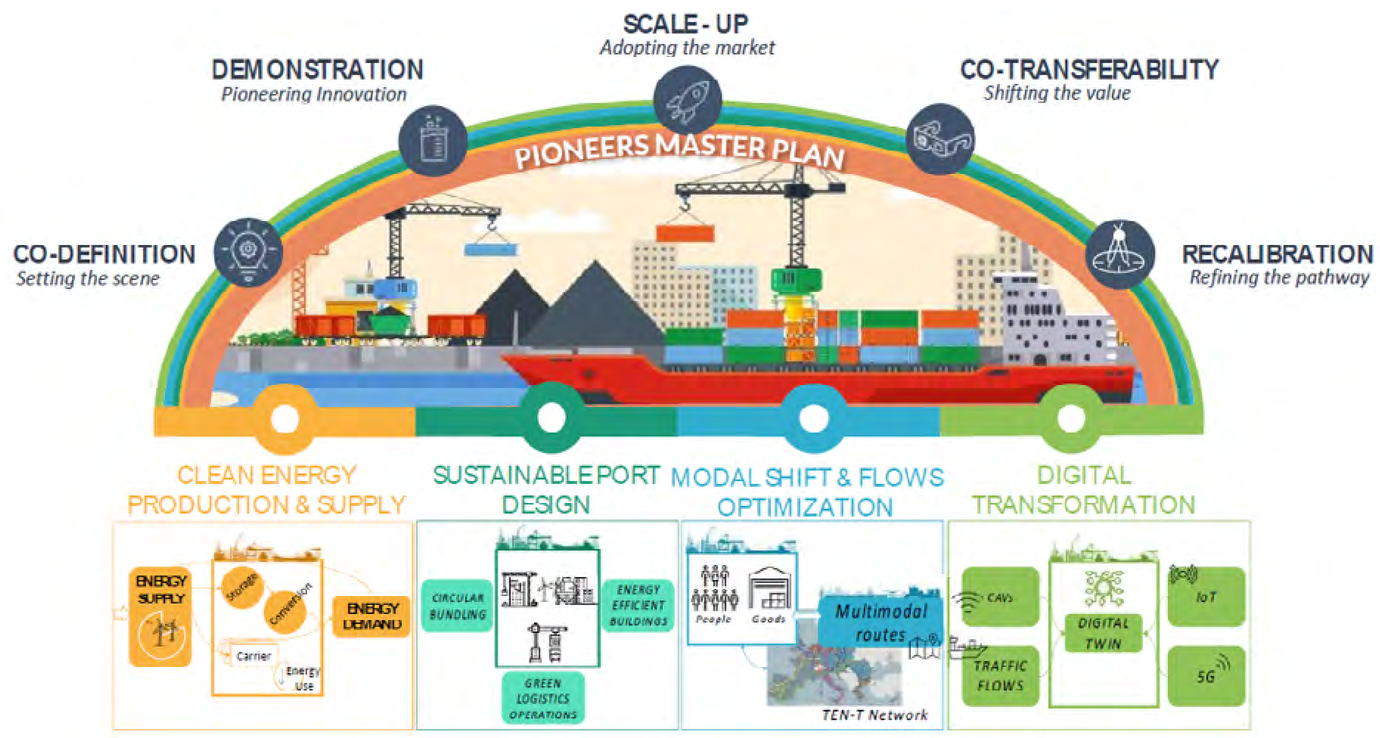
JAVIER GARRIDO

Ports are really the place where practically all existing modes of transport converge today, making them the ideal place to test new technologies that allow for decarbonization and transport efficiency.

The Project PIONEERS- Portable Innovation Open Network for Efficiency and Emissions Reduction Solutions, led by the Port of Antwerp and in which the Port of Barcelona, Constanza and Venlo participate as a consortium, has been one of those chosen by the European Commission to define the decarbonization and energy transition plan of European ports.

The sustainability of ports is approached from numerous angles in this European project. CENIT, together with the Port of Barcelona, is collaborating on the development of several pilots, as well as on the Master Plan for Energy Transition. In addition, CENIT is also actively involved in the evaluation of the 19 pilots that will be carried out, through the definition of KPIs and baseline and future scenarios that will allow the project to be assessed from a socio-economic point of view.

In order to address the challenge for European ports of reducing GHG emissions while remaining competitive, the Ports of Antwerp-Bruges, Barcelona, Venlo and Constanta will implement green port innovation demonstrations across four main pillars: clean energy production and supply, sustainable port design, modal shift and flows optimization, and digital transformation. PIONEERS is coordinated by the Port of Antwerp-Bruges and a consortium of 46 partners.



To tackle climate change and improve the sustainability of the port and logistics chains, the following demos will be carried out within the framework of the PIONEERS project:

PILLAR	ACTION		ANTWERP	BARCELONA	VENLO	CONSTANTA
Clean energy production and supply	A1	Energy generation from currents	D	NA	TA	TA
	A2	On-shore wind production	LA	TA	TA	TA
	A3	Hydrogen refuelling infrastructure	D	LA	TA	TA
	A4	A corridor of modular docking stations for energy containers	D	NA	D	TD
	A5	Battery Storage & Smart Management of Green Energy	D	LA	TD	TD
	A6	Multi-fuel port	LA	TA	TA	TA
	A7	OPS for ferries	LA	LA	TA	TA
	A8	Tugboats on H_2 and methanol	LA	TA	TA	TA
	A9	Hydrogen heating for buildings	D	LA	TA	TD
Sustainable port design	A10	Local resource recovery for green, circular concrete	D	LA	LA	TA
	A11	Power-to-methanol	LA	TA	TA	TA
	A12	Steam and waste heat	LA	NA	TA	TA
	A13	NextGen District	LA	TD	TA	LA
	A14	Zero pellet loss & plastic catcher	LA	NA	TA	TA
	A15	Electric green last-mile	TA	TA	D	TA
	A16	Green Straddle Carriers	D	TA	LA	TD
	A17	Antwerp@c - partnership for CO_2 capturing and utilisation	LA	TA	TA	TA
Modal Shift and Flows Optimization	A18	IT Platforms for planning multimodal transport	D	TD	TD	TD
	A19	Realizing a modal shift in the commute of port employees	D	TD	LA	TD
	A20	Cargo Flow Optimisation	D	TA	TD	TA
	A21	Multimodal access to port using a Maas platform	NA	D	NA	TD
	A22	Cargo Flow Prediction	D	LA	TD	NA
Digital Transformation	A23	Automated container shuttle solutions for port operations	D	TA	TD	TD
	A24	Automated vessels	D	TA	TA	TA
	A25	Vessel traffic optimisation	D	LA	TA	TD
	A26	Maritime 5G for intelligent vessel location	TA	D	TA	TA
	A27	Containers transport forecast	TA	D	TA	TA
	A28	Digital Twin	D	TD	TA	TD

D Demonstrations. **TD** Demonstrations transferred during the Project. **LA** Linked Actions. **TA** Transferred After the project

This project has recieved funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 101037564

Towards the Blue Economy: Developing the National Maritime Policy and Strategy for Trinidad and Tobago.

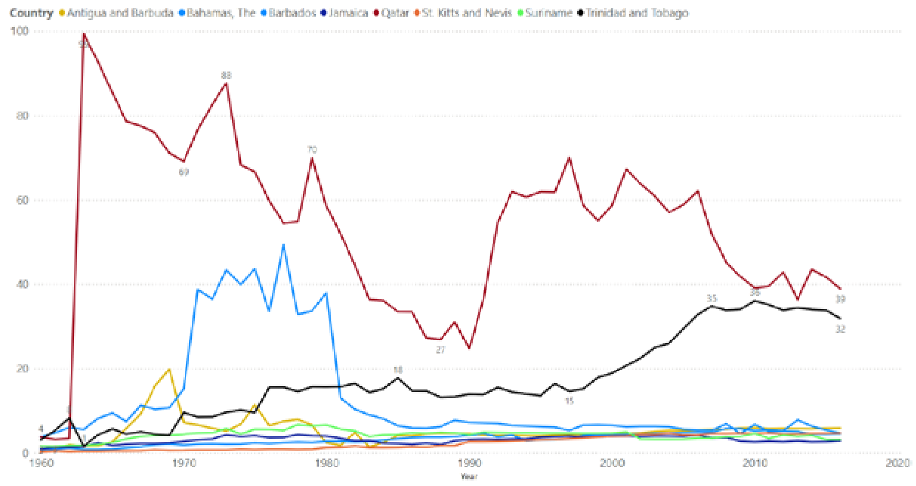
GENÍS MAJORAL

The Government of Trinidad and Tobago identified the maritime sector, which encompasses marine transportation and shipping, safety, security, tourism, the marine environment, and related administration and legislation, as one of the key national economic areas. In that regard, Trinidad and Tobago's ocean-based economy within its EEZ (Exclusive Economic Zone) is estimated to be worth US$22.5 billion or 81% of the country's total GDP (2015 market value). It is one of the strategic economic areas for the country's development. That is the reason the Government of the Republic of Trinidad and Tobago considered it appropriate in 2019 to commission a consultancy project for the development of a Maritime Policy and Strategy for the country. The consortium was formed by CENIT (Barcelona), CPCS (Canada) and Marine Institute (Canada).

The new National Maritime Policy and Strategy is aimed at maximising the sustainable use of its ocean and sea resources, while enabling the growth of its maritime economy through improving the competitiveness of the shipping industry and balancing the safety and security interests of the sector.

The result is the Maritime Strategy and Policy of Trinidad and Tobago including a Vision, a set of Policy Directives and Statements, Strategic Objectives, specific Action Plans, a Monitoring and Evaluation Framework and a Governance Model.

The Maritime Policy and Strategy was developed taking into account Blue Economy principles. Blue Economy refers to the range of economic sectors and related policies that together determine whether the use of oceanic resources is sustainable. The concept seeks to promote economic growth, social inclusion, and the preservation or improvement of



CO_2 metric tons per capita.

social inclusion, and the preservation or improvement of livelihoods, while at the same time ensuring environmental sustainability of the ocean and coastal areas. Essentially, developing a Blue Economy is about sustainable use of the ocean resources. Moreover, the Blue Economy was already a Priority Area of Trinidad and Tobago's National Environmental Policy.

A bit of Trinidad and Tobago

The energy sector of Trinidad and Tobago (40% of GDP and 70% of exports in 2019) is one of the mainstays of the country's economy, especially petroleum and its derived products that, for example, are the basis of energy consumption. This comes at the cost of being one of the world's biggest contributors to CO2 emissions per capita, close to Qatar (first in CO2 emissions per capita), and far from the rest of CARICOM countries. Therefore, one of Trinidad and Tobago's current weaknesses is its energy mix dependence on natural gas and oil.

Trinidad and Tobago, the largest economy in CARICOM, dominates regional trade amounting to about 70% of intra-CARICOM exports for a significant period of time, despite intra-CARICOM trade being a small market. Trinidad and Tobago has two main ports that provide container trade: The Port of Port of Spain and the Port of Point Lisas. Both ports offer domestic and transshipment trade, with Point Lisas dominating domestic trade. This differentiation has resulted in specialization at the port of Point Lisas for this type of trade, primarily serving shipping lines connecting with the United States. Meanwhile, the Port of Port of Spain serves larger carriers for both domestic trades and regional transshipment. Despite being in the middle of international routes, there is still room for growth and ports like those in the Bahamas dominate shipping.

This contrasts with the lives of local communities. For example, fisheries and tourism. Fisheries is a relevant sub-sector for the people of Trinidad and Tobago and its added value to the country is high since many rural coastal communities depend on the fishing sector. The social significance of the sub-sector is emphasized by the fact that most fish landings come from small-scale fisheries. Statistically, tourism and related activities may only account for an overall 7.8% of GDP. However, direct employment generation was estimated to be 17,500 jobs (3.7% of total employment), even more than the energy sector according to the National Tourism Policy (2021-2030). These livelihoods continue to be at risk, hence the reason behind resourcing schemes to support the survival of tourism jobs and fisheries communities.

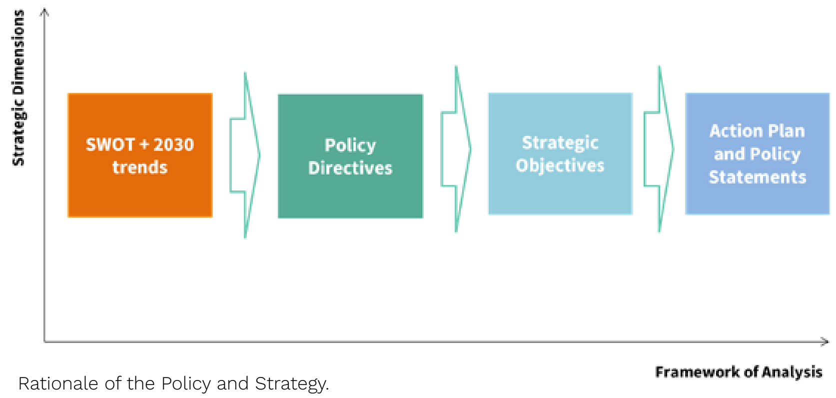
> Trinidad and Tobago's rich Blue Economy is a potential source for its economic diversification to sustainable sectors and reducing its dependence on petroleum.

Methodology

The work carried out during the consultancy was structured into three levels of analysis: first, a vision of the country, with a time horizon of 2030; second, a strategy; and finally, concrete action to develop the strategy.

Several methodological tools were used, but most importantly, the consultancy was based on frequent communication with the stakeholders' to enrich the analysis with their insight.

In the first stage, a gap analysis was carried out. The main issues and challenges of the sector were identified, which can be grouped around the following dimensions: agencies and other public bodies, legislation, spatial planning, public awareness and education, research, natural resource management, innovation and development and other



Rationale of the Policy and Strategy.

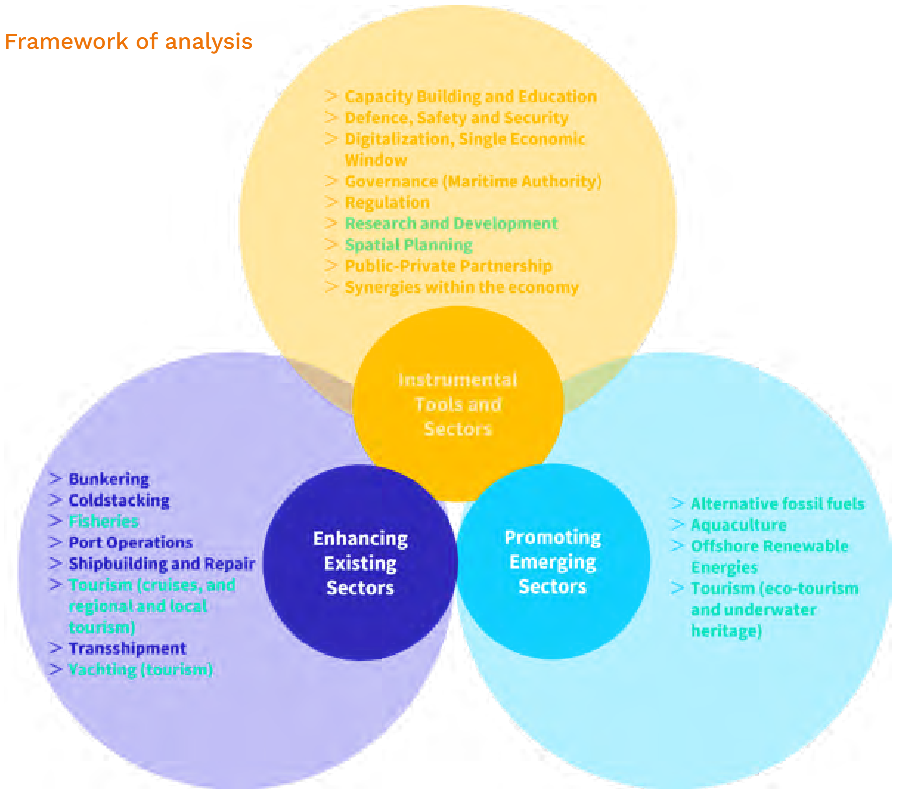


Figure 4. Core areas and key strategic areas, turquoise accent on Blue Economy sectors.

public policies (tax, financing, natural resource management, etc.). To gather the sector's concerns and issues, 42 stakeholders were interviewed several times and desk research was conducted as well. Then, together with an analysis of global trends (climate change, new technologies, global trade, etc.) and current best practices in the maritime sector, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was built. Moreover, a PESTLE analysis was conducted to understand the external factors (Political, Economic, Social, Technological, Legislative, Environmental) as well as a detailed analysis on the existing legislation and regulation.

At that point, and following the UN Decade of Ocean Science for Sustainable Development (2021-2030) and the Trinidad and Tobago vision for sustainable development, the maritime strategy must be in line with the UN Sustainable Development Goals (SDGs) of the United Nations. The three dimensions are economic development, environmental sustainability and social development. Each action should be aligned with the development of each dimension and not undermine one dimension in favour of another. Moreover, a framework of analysis is derived consisting of three cross-cutting core areas that embody the fundamental principles of the Policy and Strategy, and that encompass all outputs from Policy Directives to specific Action Plans. These are: (improving) Instrumental Tools and Sectors, Enhancing Existing Sectors and Promoting Emerging Sectors.

Once the context and framework were established, and with constant communication between the government and the sector stakeholders, the Policy and Strategy were laid out. At the Vision level, the Vision of the Strategy, Policy Directives, Policy Statements and Strategic Goals were set out. All of these should be guiding principles that Trinidad and Tobago should follow regardless of the actual implementation of action plans in the future. Finally, a total of 40 specific action plans were laid out, detailing specific steps for implementation, responsible agents and promoters, time horizon, expected impact as well as a risk assessment and monitoring indicators.

> All Policy Directives, Policy Statements, Strategic Objectives and Action Plans were developed following UN SDGs 2030.

Definition of a Variable Speed Limit System for the Northern Access to Barcelona.

FRANCISCO RODERO & PERE ARROM

This report summarises the most relevant details about the definition of an algorithm which, based on the results of a traffic simulation of the area, sets the maximum speed while minimising environmental impact and easing traffic management.

Barcelona is surrounded by the sea and mountains so the access by vehicle is limited to specific points, and as in many medium and large cities, there are hot spots at certain times. This is the case for the northern access where 3 high density roads merge at a single point with up to 20 lanes in parallel, resulting in traffic jams and both air and noise pollution. The picture below shows the actual location together with the segments of the corridor that have been included in the simulation stage.

The first step to achieving the expected objective was to build the simulation model by importing the road network from *OpenStreetMap* cartography and performing a review of lane configuration, current speeds of sections and allowed turns.

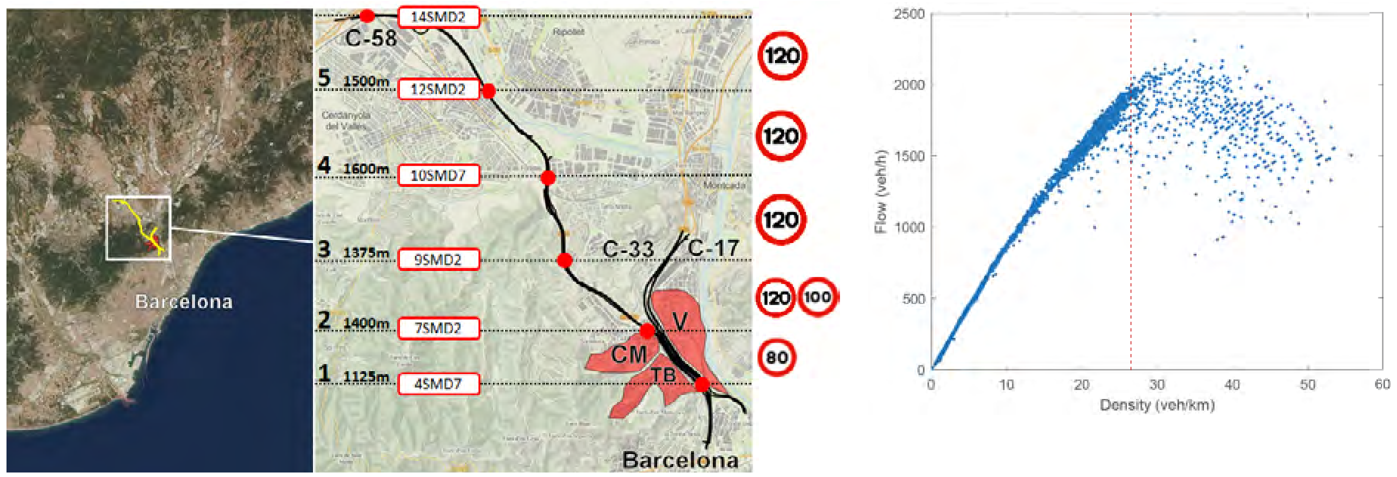
The model also includes horizontal and vertical signalling, traffic lights with their real control plans and a categorization of the vehicles being simulated according to the last official analysis available in the region of Catalonia. The latter not only affects the size of the entities from the visual perspective, but also the outputs of the built-in emissions model in Aimsun, the simulation engine selected. Aimsun also provides one interesting feature through an application programming interface that allows for an extension of the capabilities of a model with custom coding, which perfectly fits with the requirement of having a mechanism that modifies the speed of section according to traffic conditions.

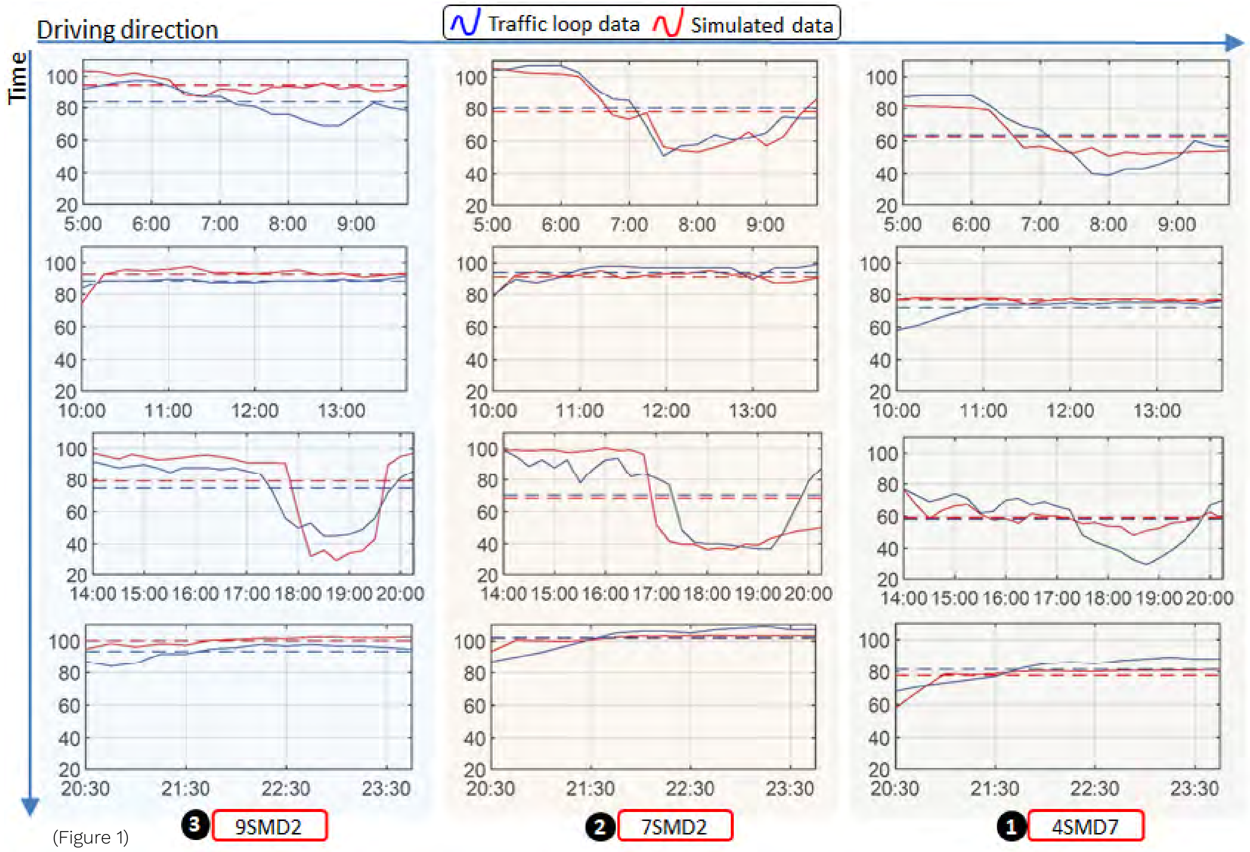
As a best practice in simulation, the more accurate the behaviour is the more trustworthy the results will be. Therefore, once the model has been built, a calibration phase is needed in order to ensure that it reproduces the correct behaviour of drivers as it occurs in reality. This process has taken place considering the following scenarios: two peak hours (morning and evening), the off-peak in between and the night period.

Each of these scenarios is characterised in terms of average traffic and speed based on different traffic loops along the main corridor where the system is expected to be deployed. Counts from the loops are one of the tools used to calibrate, together with a proper enforcement of maximum speeds at the ends of the network to consider affects coming from the non-simulated part.

As an example, the following image depicts the results of the calibration stage from the vehicle speed perspective for the closest segments to the city of Barcelona and for the three scenarios. (Figure 1)

Calibration was the most complex step by far, since the fine-tuning of the configuration parameters that define how people drive on high-density roads, such as the reaction time in a per-car-type basis, both aggressiveness and cooperation during lane change manoeuvres or the adjustment of the car-following model have a direct impact on the stop-go effect.





(Figure 1)

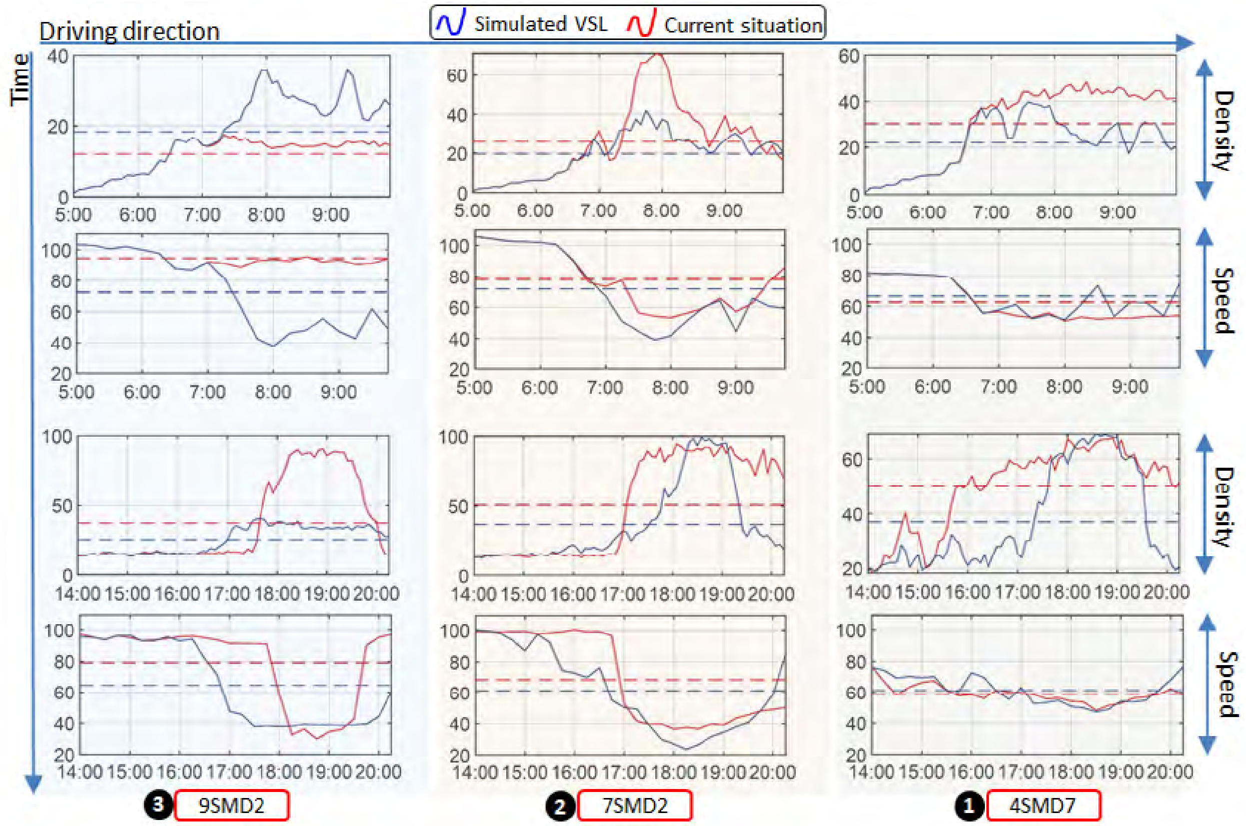
The algorithm is based on the relationship between traffic engineering variables: speed, flow and density; also known as fundamental diagrams on traffic flow. The graph shows when congestion appears by means of dot dispersion, 25 veh/km approximately for the case study. The main objective is to avoid these situations, not by moving the congestion from the bottleneck to another place, but by spreading the traffic along a wide area to make it more fluid and less dense.

How does it work? The algorithm does not seek the best speed configuration given a scenario; it does not predict either. What it does is implement a set of rules that react to the current state of traffic, information which is directly obtained from the model every 5 minutes thanks to the integration of the code with the simulation engine, as mentioned above. Starting from the closest section to the city, the algorithm compares density with the optimal value to decide if speed in the next section upstream should be increased or decreased. Then, it iterates all over the sections until the furthest one, also taking into consideration additional constraints that limit the gap between consecutive sections and intervals for both safety and eco-driving purposes.

> This variable speed system helps decreasing emissions by making traffic more fluid.

The results reveal that during the night or the off-peak, the algorithm does not react since density never exceeds the optimal value. On the other hand, during the peak hours the algorithm needs to reduce density to improve traffic conditions resulting in an impact on the speed and travel time upstream. However, the overall performance is better than without a speed variable system.

The picture below shows the difference between having a VSL or not during the two peak intervals of the day. Results of the simulation are given for both density and speed along the three closest segments to Barcelona. Mainly focusing on segments 1 and 2, density is reduced during the morning while its appearance is delayed about two hours in the evening.



Taking the Handbook on the external costs of transport from the European Union as the reference for the unit cost for each indicator, the next table shows the overall improvement in terms of environmental impact and travel time.

Indicator	Units	Cost (*)	Difference between current scenario and VSL				Daily Benefit
			Morning	Off-peak	Evening	Night	
Travel time	h	12,1	15,88	-8,35	262,44	11,95	3.411,11 €
CO_2	tn	100	10,12	-0,19	24,53	1,11	3.558,14 €
NOx	kg	6,8	32,42	-0,74	72,39	3,85	733,83€
PM	kg	348	7,43	-0,13	16,85	0,93	8.724,30€

(*) Travel time cost for short distance and commuter; value for NOx is the average between city and rural scenario; PM corresponds to exhaust in metropolitan scenario. All costs in €.

Finally, considering the total daily benefit as the sum of the daily benefit for all the considered indicators and a total of 200 working days per year, the economic assessment results in an estimated benefit of about 3.2M€ per year.

Results of Several Projects on Smart Deliveries.

PACO GASPARÍN

By 2050, it is estimated that 68% of the world's population will live in urban areas while the global freight demand is expected to triple according to ITF (International Transport Forum) studies[1].

In the context of freight transport, last mile distribution represents one of the gravest problems plaguing the urban areas of large cities. For instance, in Europe, urban freight vehicles comprise approximately 10–15% of the total vehicle kilometres travelled[2]. Moreover, the last mile is considered one of the most expensive, inefficient and polluting parts of the supply chain. Freight vehicles are responsible for more than 50% of the NOx emissions of the transport sector[3]. Additionally, the fact that most of the door-to-door deliveries are carried out by small vans implies that the carbon footprint per kg is higher than that of transport by a bigger truck. This growing number of vehicle and transport needs in urban areas is leading to a severe impact on the quality of life in cities.

Last mile distribution strategies can contribute to ameliorating the negative impacts of urban logistics. They can be influenced by different factors and may even conflict and require careful prioritisation on a city-by-city basis. The most important of these are:

› Urban congestion
› Number of trucks in the city
› Pollution, noise and energy consumption
› Local business development

One of the best-known solutions to addressing the various problems of last mile distribution is the creation of urban micro-consolidation centres. There are different types of micro-consolidation measures, these are:

› Loading and unloading areas
› Collection point (Click and collect)
› Smart points
› Micro consolidation centre (platforms)
› Logistics facilities
› Micro consolidation centres in combination with Smart Points

In the following study, different pilot cases are presented by applying a micro urban consolidation centre in Barcelona, where transport operators could store their products and transfer them to electric cargo bikes for the last mile of urban distribution.

1-Nations United (2018) World Urbanization Prospects, Demographic Research.

2-CIVITAS (2015) 'Making urban freight logistics more sustainable', Civitas Policy Note, pp. 1–63. Available at: http://www.eltis.org/resources/tools/civitas-policy-note-making-urban-freight-logistics-more-sustainable.

3-Dablanc, L. (2011) 'City Distribution, a Key Element of the Urban Economy: Guidelines for Practitioners'. Edward Elgar Publishing

Figure 1: Transhipment terminal

Figure 2: Area of implementation

SIMILE[4]

The UCC was tested on a small scale combining the use of two electric tricycles (cargo bikes) and an urban transhipment terminal located in the city centre.

Promoted by the City Council, but with the strong collaboration of private operator, Vanapedal.

The large vehicles dropped off the goods at the UCC and, during the same day, Vanapedal managed to deliver these parcels to retailers and end-customers.

Different KPIs were calculated to analyse the impact of the solution. The most relevant ones are:

› Savings per van: 64km/day
› CO_2: 1,9 tonnes saved during the pilot
› Litres of fuel saved during the pilot: 2.400L

GROWSMARTER[5]

The hub was located next to the Estació de França in order to be able to provide the service in the old part of Barcelona (Ciutat Vella). The pilot test started with 4 cargo bikes and ended with about 15. The Barcelona City Council helped by lending the premises to the distribution company.

Objectives of the micro distribution of goods in Barcelona:

› A more efficient and effective freight transport system in the city.
› Reduction of CO2 emissions.
› Test a new sensory system to track the position of cargo bikes, monitor pollutants and other environmental parameters.

The following KPIs were calculated for the evaluation of the measure:

› Reduction of CO_2 emissions: 96%.
› Reduction of energy use (kwh): 98%.
› Noise reduction (dB): 21.7%.

4-https://www.fundacion.valenciaport.com/en/project/smile-smart-green-innovative-urban-logistics-for-energy-efficient-mediterranean-cities/

5-https://grow-smarter.eu/home/

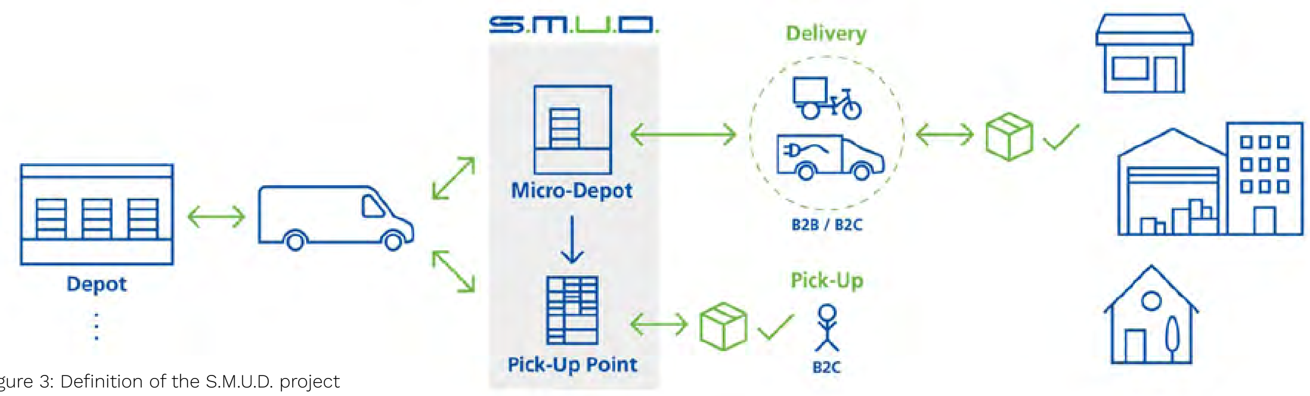


Figure 3: Definition of the S.M.U.D. project

S.M.U.D.[6]

Shared micro depots urban pickup and delivery (S.M.U.D.) objectives:

› To create a collaborative living lab environment that supports cities and companies to take a step forward towards eco-efficient and city-friendly urban logistics.

› Two living labs: in Helmond (NL) did not start during the project due to problems with COVID, and in Helsinki (FI) the living lab has a shared micro depot with cargo bikes, set up for deliveries.

› Provide cities with guidance on how to set up micro depots.

6- https://www.eiturbanmobility.eu/projects/shared-micro-depots-for-urban-pickup-and-delivery/

Figure 4: One of the designs of Esplugues de Llobregat case

Figure 5: Parcel box

HALLO[7]

Hubs for Last Mile Delivery Solutions (HALLO) objectives:

AMB objectives:

› Alleviate local environmental and traffic problems in urban areas by creating UCDCs on LEZ boundaries.

› Create two distribution centres (Esplugues de Llobregat and Cornellà de Llobregat).

› Avoid deliveries in urban areas with highly polluting freight vehicles and thus achieve a reduction of pollution and congestion in cities.

› Use electric vehicles, cargo bikes and alternative fuel vehicles for urban deliveries.

› Create the possibility of a more efficient business model.

Stockholm demonstrates four complementary actions:

› Test deliveries without fossil fuels

› Delivery solutions

› Micro terminal (Söder Mälarstrand)

› Stakeholder dialogue to reinforce current strategies

Finally, only part of the efficiency of the business model could be assessed. For this, the logistics operator created two products: a refrigerated box and a parcel box. Both of these had the dimensions of a European pallet. The analysis that could be made was on the Parcel box product and the time saved by using this product was calculated. The Parcel Box offers direct loading of a European pallet without the need to assemble and disassemble the load.

The implementation of the Parcel Box has resulted in

› Saving 12.87 minutes, i.e. 52% less time than doing it manually.

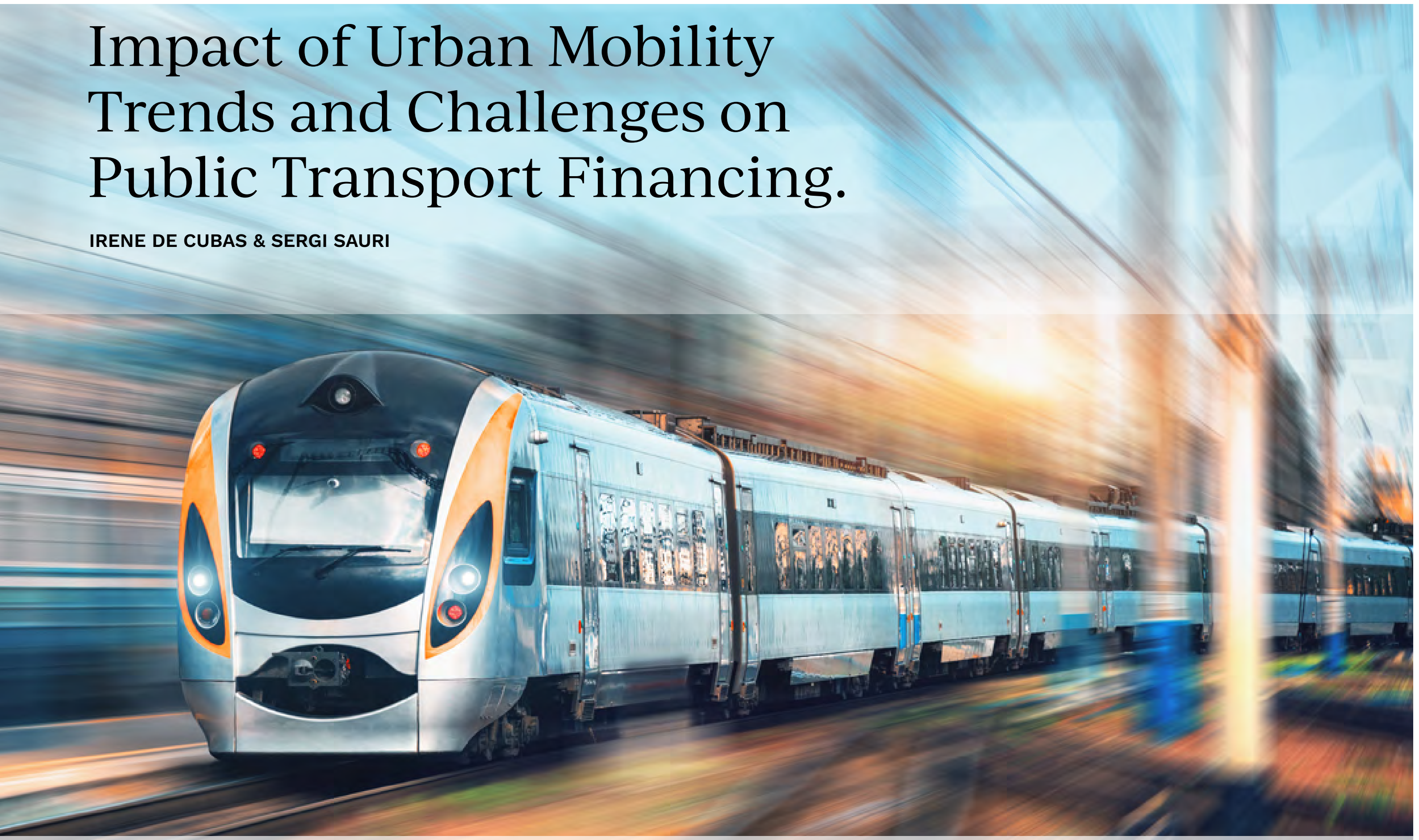
The main conclusions of the projects are:

› The micro consolidation centre solution helps to reduce emissions, energy, congestion, noise, among others, in the implementation area.

› The business model is improving towards a sustainable model, but there is still a long way to go.

› The urban freight transport possibilities are generally determined by policies of public authorities, such as the local government, national government and, for some issues, even the European Commission (e.g., setting EURO standards for truck engines).

7-https://www.eiturbanmobility.eu/projects/hubs-for-last-mile-delivery-solutions/



Impact of Urban Mobility Trends and Challenges on Public Transport Financing.

IRENE DE CUBAS & SERGI SAURI

Urban Public Transport (UPT) plays an essential role in dealing with diseconomies of urban agglomerations, such as traffic congestion, air pollution and noise. Transport authorities must ensure the financial sustainability of UPT systems whilst fares and other direct revenues typically do not cover the cost of the service.

Future trends and challenges in urban mobility will have an impact on the main variables of UPT financing: fare revenue, investing costs and operating costs. The main objective of this article is to identify the most relevant mobility trends that affect the financing of UPT both directly and indirectly, and then, create connections between these trends and UPT financing variables.

Despite the difficulty of establishing future scenarios for urban mobility, due to the multiple factors affecting it, it is possible to identify the trends that will probably have the strongest influence. Broadly speaking, two main types of trends can be recognised: those exogenous and endogenous to mobility.

Some trends and challenges are caused by factors from outside the transport sector, which are named **exogenous trends** to urban mobility. The most important exogenous trends are ageing population (EX-1), low car ownership (EX-2), gentrification (in some cities) (EX-3), shift in energy sources (EX-4), green financing (EX-5), sustainable financing (EX-6), health crisis (EX-7), natural disasters (EX-8), sharing economy (EX-9) and e-commerce (EX-10).

Endogenous trends to the transport system that will redraw urban mobility can also be listed. These are autonomous and connected fleet (EN-1), Zero Emission Vehicles (ZEV) (EN-2), shared mobility (car-sharing, moto-sharing, bike-sharing) (EN-3), Mobility as a Service (MaaS) (EN-4), new information and communication technologies (ICT) (EN-5), on-demand services (EN-6), micromobility (EN-7) and multi-modality (EN-8).

The relationships between the expected effects of the trends specified previously and public transport variables are identified and analysed. Causal relationships can be analysed in a **unidirectional analysis** – effects of trends on UPT variables – and in a **multidirectional analysis** – complex system of positive and negative impacts among trends and UPT variables-.

The trends identified in this paper and their implications on UPT are analysed in the **unidirectional analysis**. The effect on UPT has been divided into three main financial parameters: investing costs, operation costs and fare income. Information was filled in a table which is developed into a more visual graph by transforming the impact into a score from -3 (negative impact ---) to 3 (positive impact +++) as shown in Figure 1.

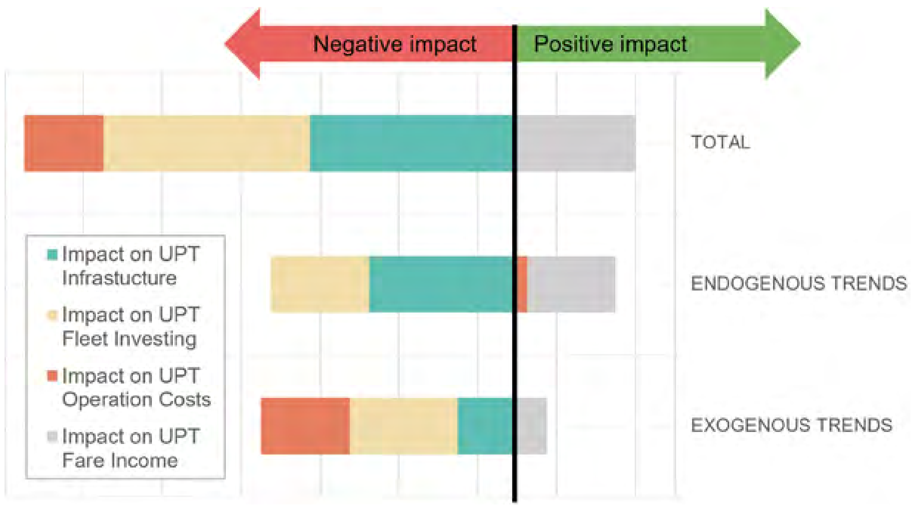


Figure 1

From a general point of view (Figure 1), exogenous trends and challenges have a negative impact on investing and operation costs and a positive impact on fare income. However, endogenous trends have a higher negative impact on investing costs and a positive impact on operation costs and fare income. Overall, the negative impact on UPT is more elevated than the positive impact. Operation expenditure is very equilibrated since some trends are helpful for lower maintenance costs (for instance, autonomous vehicles and new technology) and others may have a negative effect (for instance, on-demand services and gentrification). Trends have mainly positive effects on UPT fare income since it is one of the principal goals (for instance, multi-modality and sustainable financing).

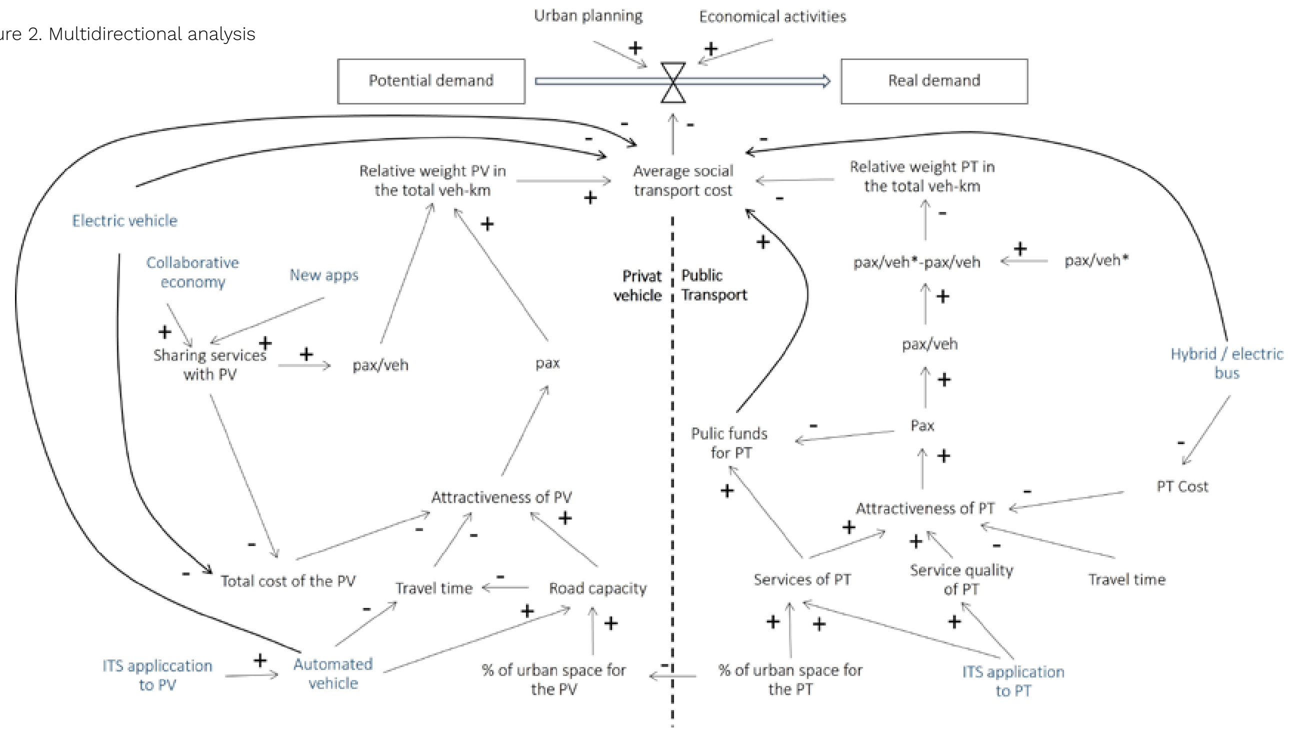
The scheme is a more complex model: there are correlations among all trends and UPT variables, therefore the methodology applied to analyse the **multidirectional analysis** is system dynamics modelling (SD). System dynamics is an interdisciplinary, well-established method that enables us to analyse the correlation and cause-effect relationship among all variables in complex systems and use them to design more effective decision making and learning. The SD was implemented through a Stock and Flow Diagram (SFD) in Figure 2. The arrows indicate the causal relationship between two elements and the sign (+ or -) indicates a positive or negative effect. Trends and challenges are represented in blue. Firstly, to interpret Figure 2, the upper range of the SFD shows a potential demand for mobility that becomes real depending on three main variables: urban planning, economic activities, and the average generalised cost of mobility. Two non-biunivocal and often interlinked subsystems can be identified in terms of average generalised transportation cost: the use of public transport (right range) and private vehicle (left range).

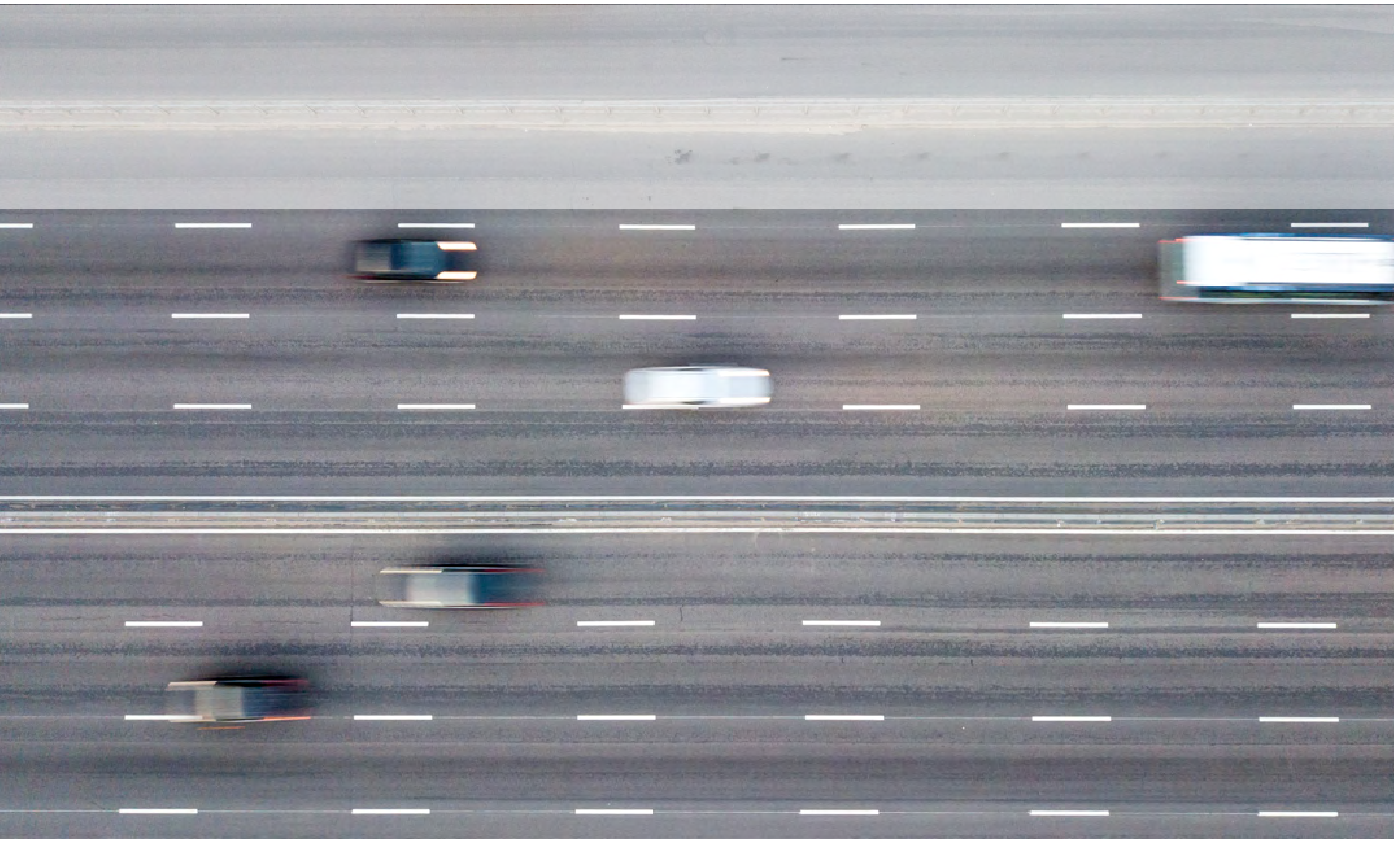
After analysing the effect of the trends in UPT variables from an unidirectional and multidirectional analysis, the final review is introducing these into a SWOT analysis of the UPT financing system. Therefore, a double SWOT analysis is conducted, looking first at revenues and then at expenses.

The conclusion of this article is that in the coming years, public transport authorities will have to address an increased need for funding in the context of breakthrough changes in urban mobility. This will require a long-term vision of the mobility model, a difficult exercise per se aggravated by a technological environment with a fast clock speed.

Thus, transport authorities will need additional financing resources to implement all future trends. All of this will represent an increase in investment needs, mainly in new technologies, more environmentally sustainable fleet renewals and improvements in accessibility to UPT. This challenge demands active research on innovative ways to sustainably finance UPT within an evidence-based and context-specific approach.

Figure 2. Multidirectional analysis





AI and Last-Mile Logistics.

DR. MUHAMMAD AWAIS SHAFIQUE

We are living in a world where online shopping is quite popular and steadily increasing, especially getting a huge boost during Covid. Hence, the importance of timely and accurate last-mile delivery has increased manifolds. However, this last link in the delivery system is also one of the most demanding and expensive stages. In fact, according to various estimates and surveys, the cost for last-mile is about 53% of the overall logistic cost. With the rapid increase in e-commerce and intensification in competition among retailers offering services such as same-day delivery and even one-hour delivery, pressure on efficient last-mile has aggravated. Add to this the abrupt growth in the food delivery sector. In the US, food deliveries are expected to grow at a rate of 20% annually. Then there are huge seasonal demands during Christmas, New Year, Black Friday, etc. These demands add to the challenges already faced by logistics companies. Fortunately, Artificial Intelligence (AI) is here to assist. As AI is already transforming warehouse and supply chain management, it can assist in optimizing last-mile logistics while cutting down on the associated costs.

Route Optimization

One of the most crucial elements in last-mile logistics is route optimization. A well-optimized route can save time, reduce vehicle miles, cut down on emissions, and economize the delivery operations. Planning of delivery routes requires the understanding and inclusion of several factors in the design process such as traffic congestion, availability of resources, and customer preferences.

Using historical data of deliveries, deep learning neural networks can be trained to propose the most efficient route by taking into account factors like delivery addresses, delivery times, and order specifications. The trained model can then be used to provide suggestions for route optimization based on incoming order details.

Greenplan, a DHL-financed startup, developed a route optimization algorithm called "last-mile" that when tested, resulted in a 20% reduction in delivery costs as compared to standard routing solutions.

Delivery Scheduling

Another important element that is linked to route optimization is scheduling the deliveries. Scheduling allows the company to retain enough vehicles and personnel to manage all the deliveries in time. Optimizing it would mean mitigating the risk of ending up under-resourced (staff or vehicles) on one end, while on the other end decreasing underutilized resources.

A different machine learning algorithm may be trained parallel to the route optimization algorithm, to predict the resources required for making the deliveries and then optimize the scheduling of those deliveries.

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Inspection upon Truck Loading

Once the logistic trucks are all loaded for the deliveries, they need to be manually inspected to ensure all the orders are loaded correctly. It can be a laborious and error-prone activity. Therefore, a lot of research has been conducted to automate this task by employing image processing algorithms. These machine learning algorithms can very quickly identify defective or damaged parcels within an image and flag them for human inspection, hence saving time and money.

Dynamic Pricing

Another aspect requiring input by AI is pricing. The logistics companies are usually working in a competitive environment with low profit margins. Since the logistics market is very volatile, the companies need to always keep their prices updated so that they remain competitive while still making a profit. Machine learning algorithms can easily take into account all externalities such as competitor prices, current market conditions, demand for the product, willingness to pay, etc., and provide dynamic pricing so that the company doesn't end up overpricing or underpricing their services or products.

In fact, according to various estimates and surveys, the cost for last-mile is about 53% of the overall logistic cost.

Autonomous Deliveries

Recently, there has been a huge interest in developing autonomous vehicles and drones for last-mile deliveries. Such innovations are completely dependent on AI for their existence. Many companies are testing prototypes, and it will not be too far in the future when the last-mile delivery sector will be predominantly governed by autonomous vehicles.

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_Transport Economics

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_Public urban transport

_Traffic Modelling

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Designed by gs-crea.com
Deposito legal 34562728
November 2022

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