TEN-T ANALYSIS: TEN-T ACCESSIBILITY AND PROJECT IMPACT ON TEN-T NETWORK

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MOVE21 – Multimodal and interconnected hubs for freight and passenger transport contributing to a zero emission 21st century

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Project Executive Summary

The main objective of MOVE21 is to transform European cities and functional urban areas into climate neutral, connected multimodal urban nodes for smart and clean mobility and logistics. MOVE21 will do this through an integrated approach in which all urban systems are connected, and which addresses both goods and passenger transport together. As a result, MOVE21 will improve efficiency, capacity utilisation, accessibility and innovation capacity in urban nodes and functional urban areas.

The integrated approach in MOVE21 ensures that potential negative effects from applying zero emission solutions in one domain are not transferred to other domains but are instead mitigated. It also ensures that European transport systems will become more resilient. Central to the integrated approach of MOVE21 are three Living Labs in Oslo, Gothenburg, and Hamburg and three replicator cities Munich, Bologna and Rome. In these, different types of mobility hubs and associated innovations are tested and means to overcome barriers for clean and smart mobility are deployed. The Living Labs are based on an open innovation model with quadruple helix partners. The co-creation processes are supported by coherent policy measures and by increasing innovation capacity in city governments and local ecosystems. The proposed solutions deliver new, close to market ready solutions that have been proven to work in different regulatory and governance settings. The Living Labs are designed to outlast MOVE21 by applying a self-sustaining partnership model.

MOVE21 partners

local city authorities, regional authorities, technology and service providers, public transport companies, SMEs, research institutions, universities and network organisations.

- **Norway**: City of Oslo, Akershus County, Ruter, Urban Sharing, Mixmove, Institute of Transport Economics, IKT-Norge
- **Sweden**: City of Gothenburg, Rise Research Institutes of Sweden, Business Region Gothenburg, Volvo Technology, Renova, Parkering Göteborg
- **Germany**: City of Hamburg, City of Munich, Hafencity University Hamburg, DB InfraGO
- **Italy**: Metropolitan City of Bologna, Roma Servizi per la Mobilità, Roma Tre University
- **Belgium**: Eurocities, Polis
- **The Netherlands**: TNO
- **Greece**: Hellas Centre for Technology and Research

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Deliverable executive summary

Key words

#1 Trans-European Transport Network (TEN-T), #2 Scan-Mediterranean (Scan-Med) TEN-T corridor, #3 Impact Analysis, #4 Key Performance Indicators, #5 MOVE21 impact on TEN-T network

Executive Summary

This deliverable analyses the project's impact on the Trans-European Transport Network (TEN-T), focusing on accessibility, sustainability, and efficiency along the Scandinavian-Mediterranean (Scan-Med) corridor. It highlights how MOVE21 measures and solutions implemented and tested in the three Living Labs of Oslo, Gothenburg, and Hamburg, with replication in Rome, Bologna, and Munich contribute to a) TEN-T requirements: improvement of multimodal transport integration; development of infrastructure for alternative fuels; enhancement of urban freight and passenger services and b) urban nodes priorities by: advancing first- and last-mile connectivity, enabling seamless intermodal transfers, and mitigating negative environmental impacts in cities.

By fostering innovation capacity and public-private partnerships, MOVE21 ensures that urban nodes serve as key access points to the wider TEN-T network, supporting the transition towards zero-emission, efficient, and inclusive urban mobility. Based on the ex-post evaluation results, KPIs related to the environmental and traffic impacts of intermodal passenger and freight hubs are used to calculate the upscaled impact of MOVE21 on the TEN-T Scan-Med Corridor. The upscaling of MOVE21 results is based on a structured methodology combining real-world pilot data, citizen surveys and modelling techniques. The calculations rely on the analysis of the data collected through questionnaire surveys. The focus of these surveys was to assess the potential and actual modal shift towards more sustainable transport options facilitated by the development of MOVE21 measures and solutions. A multinomial logit (MNL) model was used to estimate adoption rates of mobility hubs, considering demographic, behavioural, and policy factors. Scenario evaluations assessed potential impacts under different levels of adoption, helping to define strategies for wider implementation along the Scan-Med corridor. MOVE21 estimations concluded in a 14% CO_2 reduction, equivalent to removing 1.8 million cars, and a 14% decrease in NOx emissions, improving air quality. As regards the public transport use this could increase by 4%. Freight vehicles may reduce by 11%, improving logistics efficiency. Economically, the upscaling of MOVE21 measures and solutions estimate an 8% increase in green jobs and a 30% reduction in investments (estimated costs for mobility hubs and urban logistics consolidation centres) across the corridor. By providing a replicable framework for urban mobility transformation, MOVE21 paves the way for scalable, long-term improvements across the TEN-T network.

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1 List of abbreviations and acronyms

Acronym	Meaning
API	Application Programming Interface
EC	European Commission
FUAs	Functional Urban areas
KPI	Key Performance Indicator
LLs	Living Labs
MaaS	Mobility-as-a-Service
MNL	Multinomial Logit
PPPs	Public-Private Partnerships
PT	Public Transport
QS	Questionnaire Survey
RCs	Replicator Cities
Scan-MED	Scandinavian-Mediterranean TEN-T corridor
SUMP	Sustainable Urban Mobility Plan
TEN-T	Trans-European Transport Network
WP	Work Package

2 Purpose of the deliverable

2.1 Purpose of Deliverable and attainment of objectives

The current deliverable describes the application of Task 8.4 “Upscaling impacts on TEN-T accessibility and network performance”. It contains the results of the evaluation of interventions at TEN-T level, focused on the Scan-Med Corridor. Within D8.7 the project’s impacts on the TEN-T network are assessed, by scaling up the impacts from the Living Lab cities and the Replicator Cities against performance indicators identified for that purpose.

The deliverable’s objective has been achieved to the fullest and was submitted on time.

2.2 Intended audience

The main internal audience of this deliverable is the Project Coordinator, the WP Leaders, MOVE21 Executive Board the Living Lab and the Replicator cities representatives. However, D8.7 is a public document aiming to showcase how the implemented and piloted MOVE21 measures and solutions can bring an actual impact on TEN-T accessibility and network performance. Therefore, it is open to a wider audience, such as urban nodes and corridor coordinators, European Commission Services and any other interested bodies.

2.3 Structure of the deliverable and links with other work packages/deliverables

The deliverable consists of five sections overall. Initially all the relative administrative information (authors, Deliverable number, document history, etc) and project information (project summary, project partners, abbreviations and acronyms useful to guide through the deliverable, are provided). Following, the purpose and the objectives of the project are described, ending up to its structure and its links with other work packages. The third section outlines the key elements of the TEN-T network and its development, focusing on sustainability, connectivity, and interoperability. It discusses the role of urban nodes in enhancing multimodal transport systems and emphasizes the integration of urban and regional transport systems, digitalization, and efforts to reduce environmental impacts while improving access and efficiency for both passengers and freight across Europe. In the fourth section, MOVE21 achievements are briefly presented and analyzed focusing on their contribution to the TEN-T network priorities and the urban node requirements. Based on the MOVE21 evaluation framework and main KPI results from the ex-post evaluation phase, the fourth section also presents the methodology applied to upscale the MOVE21 results on the Scan-Med TEN-T corridor. Results are related to i) environmental impact, ii) freight and urban logistics efficiency and iii) economic and social benefits. The fifth and last section provides a summary of the project’s impact on the Scan-Med TEN-T axis and recommendations for future project replication and scalability.

This deliverable is linked to i) D8.6 *Ex-post evaluation of the impact analysis framework*; findings from the ex-post evaluation phase were used as a base for shaping the methodology followed for assessing the project’s impact on the TEN-T network, ii) D4.3 *Upscaling plan and transferability assessment - Governance*, D5.3 *MOVE21 Technologies Upscaling and transferability assessment* and D6.7 *MOVE21 guide on improving city‘s capacities for promoting sustainable mobility and logistics innovation*; insights from these three deliverables were used to link MOVE21 measures and solutions‘ contribution to TEN-T and urban nodes priorities and requirements, iii) D10.7 *SUMP Topic Guide*; findings from D8.7 will be included in the SUMP Topic guide.

3 Trans-European network analysis

3.1 Trans-European background

The Trans-European Transport Network (TEN-T) is a European Union policy framework aimed at creating a comprehensive and integrated transport infrastructure across Europe. Established under Decision No 1692/96/EC [1] in 1996 and later updated by Regulation (EU) No 1315/2013 [2], TEN-T network is designed to improve connectivity, efficiency, and sustainability in transportation across the EU and its neighbouring regions.

More specifically, TEN-T network aims to:

- foster efficient transportation for people and goods
- ensure access to jobs and services
- enable trade and economic growth

The TEN-T framework underpins the EU's transport and economic policies:

- Supports the European Green Deal [3] by promoting low-carbon transport solutions.
- Contributes to the Single European Transport Area [4], ensuring seamless mobility of goods and people.
- Drives investments in smart, resilient, and interoperable infrastructure to foster innovation and economic growth.

As part of the TEN-T governance, nine European Transport Corridors support the completion TEN-T transport network, facilitating cross-border cooperation and focusing on multimodal transport integration by connecting major urban centres, ports, airports, and logistics hubs [5].

1. Atlantic
2. Baltic-Black Sea-Aegean Sea
3. Baltic Sea- Adriatic Sea
4. Mediterranean
5. North Sea- Rhine-Mediterranean
6. North Sea-Baltic
7. Rhine-Danube
8. Scandinavian-Mediterranean
9. Western Balkans-Eastern Mediterranean

Since its inception, the TEN-T framework has led to significant improvements in cross-border connectivity, reduced travel times, and enhanced infrastructure quality. However, challenges such as funding gaps, regulatory barriers, and technical standardization persist. Addressing these issues is critical to achieving the 2030 and 2050 TEN-T milestones. In June 2024, the Council adopted a revised regulation regarding EU guidelines [6] for the development of the TEN-T transport network, posing as an overall objective the establishment of a single multimodal Union wide transport network of high quality.

3.2 EU guidelines for the development of the trans-European transport network

According to the revised EU guidelines, the TEN-T aims to enhance the social, economic, and territorial cohesion of the EU by establishing a sustainable, safe, efficient, and resilient single European transport area and seeks to deliver European added value through:

- Sustainability by: i) promoting zero and low-emission mobility aligned with EU CO_2 reduction targets, ii) developing an interoperable, environmentally friendly transport network that reduces pollution, congestion, and accidents, iii) ensuring energy security.
- Cohesion by i) improving accessibility and connectivity, ii) enhancing interoperability, iii) integrating long-distance, regional, and local transport, including urban nodes.
- Efficiency by i) eliminating infrastructure bottlenecks and missing links, ii) integrating and interconnecting transport modes, iii) promoting of cost-effective, high-quality infrastructure and digital systems to boost economic growth
- User Benefits increase by i) ensuring accessible, safe, and high-quality transport services for all including the vulnerable groups, ii) enhancing climate resilience, iii) promoting active mobility (e.g., walking, cycling) and seamless connectivity.

The TEN-T is consisted of three layers: i) the core network including the most important connections between major cities and nodes; must be completed by 2030, ii) the extended core network that needs to be completed ten years later, in 2040 and iii) the comprehensive network which connects all regions of the EU to the core network and needs to be completed by 2050. [7].

Based on this, the nine TEN-T corridors encompass the core network or extended core network which are of the highest strategic importance for the development of sustainable and multimodal freight and passenger transport flows in Europe and for the development of interoperable high-quality infrastructure and operational performance.

3.3 Analysis of the general priorities

The revised EU guidelines outline the general priorities on which the development of the core, the extended core and the comprehensive TEN-T network should be based. More specifically under Article 12, the guidelines highlight measures that prioritise sustainability, connectivity, and interoperability in the transport infrastructure development across Europe. These measures aim to foster cohesion among EU Member States while aligning with the Union's broader climate, economic, and social goals. In more detail:

Sustainability is one of the driving forces behind these priorities. The EU has been committed to reduce the environmental footprint of its transport sector, which significantly contributes to greenhouse gas emissions and air pollution. To meet its climate goals, the Union has prioritised the increase of share and the capacity of low-emission and zero-emission transport infrastructure for freight and passengers. (e.g. development of charging stations for electric vehicles used for both freight and passenger needs). The shift towards cleaner modes of transport aims not only to reduce emissions but also to improve public health by decreasing air pollution, particularly in urban areas.

Equally important is the need for enhanced **connectivity and accessibility** across Europe, which goes beyond just linking major cities; it ensures that all regions, including peripheral and remote areas, are integrated into the broader European economy. By improving transport infrastructure in underserved areas, the EU seeks to create a more inclusive and balanced economic development, where all regions

can benefit from better access to services. Connectivity also addresses social exclusion by ensuring that people in isolated areas can access opportunities, such as jobs, education, and healthcare.

Interoperability between transport systems is another crucial priority especially in urban areas, ensuring that different modes of transport including active modes work together to serve passenger and freight simultaneously. This includes not just physical connections but also digital integration. For example, the use of digital platforms enables real-time tracking of goods and allows travellers to access in real time, information across multiple modes of transport and shared mobility services. This seamless integration of transport modes also supports the transition to sustainable mobility, as passengers are more likely to choose environmentally friendly options when they can easily combine them in a convenient and cost-effective way.

The guidelines also prioritise the **importance of ensuring accessibility for all users**, including those with disabilities or reduced mobility. This is a key part of the EU's broader goal of social inclusion, as accessible transport networks are essential for ensuring equal opportunities for all citizens, regardless of their physical abilities or socio-economic status. Improvements in this topic should include better access to stations, vehicles and information systems, making it easier for people with disabilities to navigate the transport network. Furthermore, the guidelines stress out the importance of improving social conditions for transport workers as this creates a sustainable transport sector that ensures services are reliable for workers.

Promoting digitalisation is also one of the basic priorities in the revised EU guidelines, as digital technologies optimize a transport system's operation. Digital tools have been found to increase efficiency, reduce delays, and enhance safety. For example, the integration of smart technologies into transport infrastructure allows for better management of traffic flows and real-time monitoring of transport conditions.

To generalise, the revised EU guidelines are designed to create a transport system that is not only efficient and interconnected but also sustainable, resilient, and inclusive. By focusing on the above-mentioned priorities, the EU aims to foster economic growth, social cohesion, and environmental sustainability, contributing to the long-term prosperity and well-being of its citizens. The guidelines ensure the TEN-T network is adaptable, secure, and ready to support the EU's goals for a green, digital, and inclusive future.

3.4 Urban nodes requirements

Urban nodes refer to areas where different components of the TEN-T transport infrastructure such as ports, passenger terminals, airports, railway stations, bus terminals and logistic platforms are interconnected with each other [8]. The revised TEN-T regulations has designated 431 urban nodes on the network to take up the important role of becoming intermodal connectors that link local, regional and international transport flows. Focusing on the Urban Node Components, the regulations outline the necessary characteristics and criteria for order urban nodes to be recognized as part of the TEN-T.

Urban nodes components according to Article 40 of the EU revised guidelines, should include transport infrastructure that forms part of the TEN-T network, including bypasses to facilitate traffic flow around urban centres, reducing thus congestion and improving connectivity.

Additionally, urban nodes should provide access points to the TEN-T, operating in a non-discriminatory manner to ensure equitable access for all operators and users. Examples of such access points include ports, airports, railway stations, bus terminals, and multimodal freight terminals. This emphasis on

diverse access points highlights the importance of multimodal transport integration, a key goal of the TEN-T framework.

Also, a city can be characterized as an urban node if it numbers a population of 100,000 inhabitants or more. However, the regulation accounts for regional variations by providing an exception for NUTS 2 regions. If no city within a NUTS 2 region meets the population threshold, the main urban centre of that region can be designated as an urban node. This provision ensures regional balance and inclusivity, particularly in less densely populated areas. Annex II of the TEN-T regulation lists the EU-cities recognized as urban nodes. Inclusion in this list signifies alignment with TEN-T's objectives. By specifying both the infrastructural requirements and population thresholds, the regulation ensures that urban nodes contribute to the overall efficiency and multimodality of the TEN-T network.

Article 41 of the EU revised guidelines introduces key requirements to enhance urban mobility, promote sustainability and improve the efficiency of the transport network. The focus is on creating transport systems that are better integrated, greener, and more efficient.

A major requirement is the development of infrastructure for alternative fuels, ensuring urban areas have recharging and refuelling facilities for cleaner energy vehicles. This supports the EU's goals to reduce fossil fuel use and adopt sustainable energy solutions.

By 2027, a Sustainable Urban Mobility Plan (SUMP) should be adopted and monitored for each urban node. The SUMP should integrate different transport modes, encourage the use of low-and zero-emission vehicles, reduce air and noise pollution and assess how accessible transport is for users. In addition, urban areas must collect and share data with the EU on transport sustainability, safety, and accessibility, using specific methods and indicators to track progress.

By 2030, multimodal passenger hubs must be developed to improve connections for the first and last mile of trips. These hubs should provide easy access to public transport and active mobility options like cycling and walking. They must also include at least one recharging station for buses and coaches. By 2040, urban areas must establish at least one multimodal freight terminal, as long as it is economically and socially beneficial. These terminals will enable the transfer of goods between different types of transport and ensure enough capacity for shipments.

To make sure these plans are carried out, the EU will set clear rules for data collection and submission, including timelines. These measures aim to keep urban transport systems on track with the EU's sustainability and transport goals.

3.5 Additional priorities for urban nodes

Further to the general priorities on which the development of the TEN-T network should be based and the urban nodes explicit requirements, the EU revised guidelines also suggest several additional priorities for the urban nodes. These priorities aim to enhance the integration and sustainability of urban transport systems within the broader TEN-T network, targeting both at passenger and freight transport while emphasizing efficiency, environmental impact, and connectivity.

The need for effective first and last mile connections is highlighted, particularly between urban areas and the TEN-T network's access points. These connections, such as metro and tram systems, are seen as vital for optimising the performance of the entire TEN-T network.

The seamless interconnection between the TEN-T network and regional and local sustainable transport systems is also a priority. For passengers, this means providing access to multimodal digital mobility services that allows users to access information, book, pay for their trips and retrieve tickets, all while optimizing travel itineraries. These services aim to improve traffic management, road safety, and reduce congestion and air pollution. For freight, focus is on developing urban logistics facilities like micro-hubs and cycle logistics hubs, particularly those connected with railway and waterborne transport infrastructure, to consolidate deliveries and reduce the impact of urban freight deliveries.

The importance of integrating passenger transport infrastructure between various modes of transport (rail, road, air, and maritime), while ensuring the promotion of active transport modes such as walking and cycling, is also a key priority. Similarly, the interconnection of freight transport infrastructure is stressed out, facilitating connections between rail, road, air, and maritime transport, and integrating logistics platforms and facilities.

A crucial concern that is highlighted is the mitigation of negative impacts on urban areas from transiting rail and road transport, such as noise and pollution. The promotion of zero-emission, low-noise transport and mobility is also emphasized, including the greening of urban fleets for both passenger and freight vehicles. Additionally, there is a push to increase the modal share of public transport and active modes, supported by measures such as developing safe and secure infrastructure for these modes. Efficient, low-carbon, and low-noise urban freight delivery is another important aspect, aiming to make urban deliveries more sustainable.

Connectivity between urban and rural areas should also be improved, providing access to smart, sustainable, and affordable transport options. Finally, the adoption of ICT tools and intelligent transport systems is critical, ensuring open access for all operators and allowing for optimized vehicle itineraries, real-time information on alternative fuel infrastructure and overall improvements in traffic flow, congestion, air quality, and road safety.

4 Assessing project impact on the TEN-T network

4.1 MOVE21 achievements

In the framework of the MOVE21 project several innovative measures and solutions were implemented and replicated within the Living Labs (LLs) of Oslo, Gothenburg and Hamburg and the Replicator Cities (RCs) of Rome, Bologna and Munich, all located along the TEN-T Scandinavian-Mediterranean corridor. The implemented measures and solutions focused on improving accessibility and addressing key urban mobility challenges. They aimed to reduce CO_2 and NO_x emissions, optimise travel times and increase the capacity of municipalities to implement sustainable mobility solutions through knowledge-sharing, regulatory advancements, policymaking, new collaboration schemes and new business models' development. The measures and solutions have been categorised based on the services provided. The categorisation highlights their role in improving last-mile connectivity, promoting active and shared mobility, integrating logistics and freight solutions, and fostering governance innovations. A brief overview of measures and solutions is provided below.

4.1.1 Combining passenger and freight mobility services

Innovative solutions to integrate passenger and freight transport were piloted within the project, addressing challenges in coordination, logistics infrastructure, and regulatory frameworks. In Hamburg, the ***MOIA service*** was tested for combined transport with city couriers, utilising free shuttle capacity outside peak hours to reduce empty runs and increase efficiency. ***Oslo's Mobility-on-Demand service*** combined parcel deliveries with existing mobility-on-demand transport services, aiming to reduce private vehicle use.

4.1.2 Implementation of micro mobility hubs

The integration of various modes such as car-sharing, bike-sharing, e-scooters, etc, to address first and last mile challenges by offering easy transitions between transport options and creating micro mobility hubs were also tested in several MOVE21 cities. The ***Klippan hub*** in Gothenburg enhanced multimodal connectivity by repurposing parking spaces to support shared vehicles and cargo bikes. In Munich, ***100 mobility points*** were developed within the project period and additional 100 are planned to be completed by 2026, focusing on multimodal mobility, space efficiency, and urban quality of life. In each mobility point, shared mobility services were integrated with the existing public transport system. Bologna introduced temporary mobility micro hubs for bicycles and the use of cargo bikes during major public events. The ***Mobility Hub Network*** in Oslo enhanced interconnectivity between different parts of the city, providing easier access to public transport and shared mobility services, fostering both territorial and social cohesion in a region (Grorud valley) with previously underserved connectivity. In line with its Sustainable Urban Mobility Plan, Rome implemented **bike boxes and sharing services** in metro and regional railway stations.

4.1.3 Establishment of Mobility Hotels

The concept of **m*obility hotels*** was introduced in the MOVE21 project to support sustainable urban logistics and micromobility solutions by integrating shared mobility services, logistics consolidation, and space for businesses and service providers, contributing to more efficient and cleaner urban transport. In MOVE21, two mobility hotels were established. The ***Nordstan Mobility Hotel*** was developed in Gothenburg, located in a central shopping and business district. The hotel, offers a shared fleet of micro mobility vehicles, a battery swap station, a cargo bike hub for last-mile delivery, and a 24/7 unmanned warehouse store for professional service providers. By promoting micro mobility over cars, congestion is alleviated, environmental quality is improved and vacant retail spaces are revitalized. The ***Kaia***

Mobility Hotel was established at Filipstad, Oslo, considered as a key logistics location near major transport routes. Kaia supports bicycle-based urban logistics by providing leasing, maintenance, and storage for cargo bikes, as well as rest areas for workers. A battery-swapping station has also been installed. Plans for future expansion include small-scale freight consolidation and warehouse facilities.

4.1.4 Neighbourhood hubs, micro-depots & automated logistics systems for goods deliveries

Neighbourhood hubs served multiple purposes beyond mobility, integrating logistics, social services, and cultural activities to improve urban living. Micro-depots, developed as lightweight modular container units to fit into regular parking spaces, provided flexible logistics solutions. The ***Holstenstraße hub*** in Hamburg combined social initiatives with commercial logistics and served as a transhipment point for last-mile cargo-bike deliveries. Essential services to homeless and disadvantaged individuals were also provided. The ***Kaltenkircher Platz hub*** featured a ***micro-depot***, a dedicated parking zone for micro mobility a car-sharing station, and bicycle racks to support public transport integration. A local cargo-bike logistics provider used this facility to optimize last-mile deliveries with emission-free vehicles. In Bologna an ***automated logistics system*** was tested for consolidating and trans-shipping parcels using dedicated lockers. The system facilitated the transfer of goods from conventional vans to zero-emission vehicles, ensuring sustainable last-mile deliveries within the Limited Traffic Zone and the historic city centre.

MOVE21 measures and solutions, highlighted key regulatory, technical, and legal challenges, including fragmented EU policies, procurement restrictions, interoperability between service providers, insurance concerns, and personnel training. Achievements through the measures' and solutions' implementation and operation are briefly presented below.

4.1.5 Enhancement of policy coherence and regulatory framework adaptation

The policy integration across multiple domains—mobility, logistics, infrastructure, and spatial planning enabled better urban governance. In most of solutions new governance models were introduced involving public authorities, private sectors and civil community. As part of MOVE21 regulatory and contractual frameworks that support mobility hubs, multifunctional spaces that integrate logistics, mobility, and social services were developed. Oslo's **Mobility Hub Network** required adjustments in land-use policies and contractual agreements between municipalities and service providers. The ***Holstenstraße Hub*** combined logistics with social services, highlighting the importance of flexible governance structures**.** The ***Nordstan Mobility Hotel*** revealed that policy support for shared mobility and micro mobility regulation is a prerequisite for an efficient operation [9].

4.1.6 Enhancement of social cohesion, safety and community integration. Promotion of inclusiveness and accessibility

The ***Holstenstraße hub*** and the ***Nordstan Mobility hotel*** created gathering points for various user groups, including workers, local residents, logistics operators and disadvantaged individuals enhancing the social cohesion. The ***Holstenstraße hub*** contributed to reducing crime risks in the area by increasing pedestrian transport and integrating social welfare services with logistics. The ***Kaltenkircher Platz*** hub demonstrated how urban logistics hubs could be combined with recycling stations and micro mobility services, making them multi-use spaces that benefit both businesses and communities. In the ***Klippan hub***, wayfinding and signage was improved, enhancing pedestrian safety and reducing confusion. Regarding inclusiveness and accessibility, the ***Nordstan Mobility Hotel*** supported individuals with no access to private vehicles by providing shared mobility services for blue-collar workers [10].

4.1.7 Digital Integration

Technological innovation was a driving force behind the development and implementation of certain MOVE21 measures and solutions, enabling more efficient, sustainable, and scalable mobility interventions. In the cases of Oslo's ***Mobility-on-Demand*** service and Hamburg's ***MOIA service***, the use of digital and smart technologies supported the coordination of the on-demand shuttles and the ride-pooling alongside parcel delivery services, creating multi-use transport models that optimize both passenger and freight flows. The ***Klippan*** case integrated shared bikes with a parking app, allowing drivers to transition to bikes seamlessly.The ***Kaia Mobility Hotel*** provided real-time data sharing between logistics and micro mobility services [11]. In **Oslo**, micro-mobility services were integrated into the public transport system via the **Ruter App**, allowing users to plan multimodal trips, reserve bikes, and make seamless payments. In all cases the implementation and operation of new digital mobility services required public-private partnership agreements with more flexible frameworks and provisions for data exchange. This process necessitated the development of new legal contracts and a revision of procurement standards and practices to support integrated mobility solutions [12].

4.1.8 Public-private collaborations

As highlighted in the MOVE21 White Paper "Working Together, Public-Private Collaboration in urban mobility and logistics" (2024) the successful operation of MOVE21 relied on the strong collaboration between public and private actors who worked collaboratively to integrate diverse services. Strategic partnerships between public authorities, logistics companies, mobility providers, and other stakeholders were essential for the success of the MOVE21 measures and solutions to foster innovation and scalability. The new concept of ***mobility hotels*** was based on public-private collaborations involving municipal departments, business development organizations, micromobility operators, logistics providers, and property owners. Their establishment demonstrated how shared infrastructure and services can enable greener last-mile logistics, promote sustainable business models, and enhance the transition towards zero-emission urban transport. However, the ***Nordstan*** case revealed that policy support for shared mobility and micromobility regulation is a prerequisite for an efficient operation [9], while also data-sharing agreements between micro mobility providers and city authorities should be standardised.

4.2 MOVE21 contribution to TEN-T network priorities

The TEN-T network aims to achieve a seamless and sustainable transport system across Europe, focusing on three key priorities: sustainability, connectivity, and interoperability. With the aim to reduce environmental impact and make the network more efficient, EU suggests the implementation of low- and/or zero-emission transport infrastructure that improves the connections between cities and remote areas and ensures that different transport modes work together smoothly. These efforts are designed to create a more inclusive, accessible transport system that benefits both major cities and underserved regions, while also supporting the EU's goals of reducing emissions, improving air quality, and promoting public health.

MOVE21 plays an important role in advancing these goals, particularly in the urban areas of the Scandinavian TEN-T corridor. Taking advantage of the three LLs key location (Oslo, Gothenburg and Hamburg), and the three RCs (Rome, Bologna and Munich) across this corridor, it focuses on the development of multimodal mobility hubs within their functional urban areas (FUAs) to serve as vital nodes for first/last mile passenger and freight trips empowering sustainable, digital, and inclusive mobility solutions. These hubs act as connection points for different transport modes, improving the overall efficiency of the TEN-T network. They are designed to support the transition to low and zero-emission transport and provide inclusive transport options for all users. This approach, highlights the

increasing role of cities in the TEN-T network and strengthens EU's vision for a green future. MOVE21 also highlights the role of local authorities and stakeholders' engagement in driving innovation. By building capacity and encouraging cross-sectoral collaboration, MOVE21 provides cities the knowledge to create sustainable mobility solutions [10]. A more detailed analysis of MOVE21's contributions to the main TEN-T network priorities is presented below.

Priority a: increasing the share and the capacity of more sustainable transport for freight and passengers, in particular with a view to reducing greenhouse gas emissions and pollution and increasing the social and economic benefits derived from transport

MOVE21 promotes sustainable transport by implementing measures and solutions that integrate low-emission and zero-emission transport options for both freight and passengers. More specifically, MOVE21 innovations support the use of electric vehicles, shared mobility services, and active mobility directly reducing greenhouse gas emissions and pollution. For example, ***Kaltenkircher Platz*** hub, directly supports this priority by integrating emission-free last-mile logistics with enhanced multimodal passenger mobility. The hub reduces greenhouse gas emissions and pollution by facilitating cargo bike deliveries from a micro-depot, decreasing reliance on conventional freight transport. Additionally, shared mobility services—including e-scooters, bicycles, and car-sharing—enhance connectivity to public transport, encouraging a shift away from private cars. Another example is the ***Kaia Mobility Hotel*** in Oslo which encourages the use of zero-emission vehicles for urban logistics and facilitates bicycle-based deliveries. Additionally, Oslo, piloted the combination of passenger and freight transport in the same vehicles through the ***mobility-on-demand solution,*** similarly to the ***MOIA*** service which piloted for a specific time period within the project in Hamburg.

Priority b: ensuring enhanced accessibility and connectivity for all regions of the Union while taking into consideration territorial and social cohesion, and including the specific case of the outermost regions and other remote, insular, peripheral and mountainous regions

MOVE21 improves connectivity by providing solution for first/last mile trip and in some cases by linking urban with peri-urban areas. Being more specific, the ***Mobility Hub Network*** in Oslo addresses accessibility in the Grorud Valley, an area with limited public transport options across the valley. By establishing hubs at strategic locations (Grorud Station, Haugenstua, and Furuset metro), the initiative improves connectivity for residents in peripheral areas, fostering social cohesion and accessibility. The project thus allows peri-urban regions to access economic opportunities and services. The ***Holstenstraße Hub*** in Hamburg enhances accessibility by combining last-mile logistics and social services, making the area more connected and accessible to local residents, including those in need. Its multi-functional approach ensures inclusivity and improves connectivity within the neighbourhood. Munich's ***mobility points*** enhance accessibility by providing first/last mile connections between remote and central areas through the city's public transport system. These hubs, which integrate shared mobility services such as car-sharing and bike-sharing, enable residents in urban, peripheral and more isolated areas to easily access public transport and other urban amenities. This approach fosters territorial cohesion by improving connectivity across different regions, ensuring that even the more remote parts of Munich are well-integrated into the city's broader transport network. By facilitating seamless transitions to public transport, these mobility points contribute to greater social inclusion and regional accessibility. In this line, Munich is also setting up an agreement with the surrounding municipalities to set up a common network of hubs.

Priority c: ensuring optimal integration of the transport modes and interoperability between transport modes, including active modes of mobility in urban areas

MOVE21 enhances the integration of transport modes by establishing hubs that connect various transport modes. In ***Kaltenkircher Hub*** in Hamburg the integration of shared mobility services (e-scooters, car-sharing, and bike racks) with public transport connections strengthens the interoperability between different modes of transport, making it easier for users to switch between modes and promoting sustainable, multimodal travel. The ***Klippan hub*** in Gothenburg facilitates the integration of various transport modes by reconfiguring parking spaces to accommodate shared vehicles and cargo bikes, improving the overall connectivity between modes like cars, bikes, and micro mobility options. Munich's ***mobility points*** ensure the optimal integration of shared systems (car-sharing, bike sharing) in the city's public transport system. Rome's ***bike boxes and sharing services*** near metro and regional railway promote the optimal integration of transport modes by enabling seamless connections between cycling and public transport. This integration supports sustainable, multimodal travel, improving urban mobility and making it easier for residents and visitors to navigate the city using a combination of active and public transport options.

Priority e: deploying the necessary infrastructure which ensures a seamless circulation of zero and low emission vehicles

MOVE21 supports the deployment of infrastructure for zero- and low-emission transport, such as charging stations for electric vehicles and facilities for green freight solutions. This infrastructure ensures the seamless circulation of sustainable transport options, helping to reduce emissions and improve energy security in the TEN-T network. The ***Kaia Mobility Hotel*** provides essential infrastructure for zero-emission vehicles, such as charging facilities and weather-protected storage for electric cargo bikes. This infrastructure helps ensure the smooth operation of zero-emission vehicles, facilitating sustainable logistics solutions. The ***Kaltenkircher Hub*** supports zero-emission transport with its logistics micro-depot and the use of electric cargo bikes for last-mile delivery, contributing to seamless circulation of low-emission vehicles within the urban environment. The ***Nordstan Mobility Hotel*** in Gothenburg, provides battery swap and a fleet of electric cargo bikes to service providers to conduct their services in the nearby area.

Priority f: promoting the efficient, seamless and sustainable use of the infrastructure and, where necessary, increasing capacity

The ***Holstenstraße Hub*** efficiently uses urban infrastructure by integrating logistics and social offerings in one location. Its multifunctional and multiuser operation concept allows the hub to adapt to changing needs, ensuring sustainable use and maximizing available space. ***The Nordstan Mobility Hotel*** maximizes the use of urban space by providing a shared facility for micromobility services, including e-bikes and delivery solutions. It increases capacity for sustainable transport solutions and fosters more efficient use of public and private resources. The ***Klippan hub*** promotes efficient use of existing infrastructure by reallocating parking spaces to shared mobility services, maximizing the utility of available space. This also helps in reducing parking congestion and enhancing the overall capacity for sustainable transport options. Rome's ***bike boxes*** near metro and regional railway stations promote the efficient, and sustainable use of infrastructure by optimizing limited space for both cycling and public transport. By providing dedicated areas for bikes, these installations ensure safe, accessible parking for cyclists, which encourages the use of active transport.

Priority h: improving the quality of services and social conditions for transport workers, accessibility for all users, including persons with disabilities or reduced mobility and other people in situations of vulnerability, preventing and mitigating transport poverty

MOVE21 focuses on inclusive mobility and works to prevent transport poverty by ensuring that underserved urban and peri-urban areas have access to affordable, sustainable, and efficient transport options. The ***Holstenstraße Hub*** is an example of how transport infrastructure can contribute to social welfare. By offering services like food donations and counselling alongside last-mile logistics, it serves vulnerable communities and other needs. The ***Kaltenkircher Hub*** improves accessibility by offering a range of services that encourage the use of low-emission transport modes. Additionally, the integration of public transport services, bike racks, and e-scooter parking helps make the area more accessible for all residents, including those with mobility challenges. The ***Mobility on demand for freight and people solution*** provides mobility on demand service for senior citizens while also offer home transport of goods from stores. The ***one stop e-shop for park-and-bike in Klippan hub*** aims to improve the overall quality of transport services by offering shared bikes, e-scooters, and cargo bikes, which are accessible and provide a low-cost alternative to private car travel. This can help reduce transport poverty by offering affordable, sustainable mobility solutions, especially for vulnerable groups. The ***Mobility Hub Network*** in Oslo, helps residents of more peripheral areas access sustainable transport options, reducing reliance on private cars. The project enhances interconnectivity between different parts of the city, providing easier access to public transport and shared mobility services, fostering both territorial and social cohesion in a region (Grorud valley) with previously underserved connectivity.

4.3 MOVE21 contribution to urban nodes priorities and additional requirements

Measures and solutions implemented and tested under MOVE21 contributed to **TEN-T urban node priorities** by i) facilitating multimodal transport connections, ii) offering alternative fuel infrastructure and iii) enhancing both passenger and freight services. These contributions were achieved through four strategic focus areas: digitalization and technological innovation, governance innovation and policy integration, enhancement of innovation capacity for sustainable mobility and business model's development through public-private collaboration. Focus areas not only met the current demands of urban mobility but also aligned with the **additional TEN-T urban node requirements,** thus paving the way for the broader integration of urban transport networks within the TEN-T network and beyond**.** The additional requirements refer to: first and last mile connections to TEN-T access points; seamless interconnection between TEN-T infrastructure and regional and local transport; sustainable, seamless, and safe interconnections between various transport modes; mitigation of negative environmental impacts in urban areas; promotion of low-noise, zero-emission transport; increase of the modal share of public transport and active modes; promotion of low-carbon urban freight delivery; increased connectivity between urban and rural areas; wider deployment of ICT tools for traffic management, reducing congestion, and improving road safety. Below, a detailed overview of the four focus areas is presented, highlighting MOVE21 contribution to urban nodes priorities and requirements.

4.3.1 Digitalization and Technological Innovation

MOVE21 introduced digital tools and smart mobility solutions [11], to enhance **first and last-mile connectivity** and **seamless interconnection between *TEN-T and local infrastructure***, directly supporting the priorities of multimodal transport connections development and passenger and freight services enhancement. In Oslo for example, the integration of micromobility services with public transport, via the Ruter App, allowed seamless trip planning, bike reservations, and digital payments; the open-source API used in this system is easily replicable by other cities, facilitating urban access to **TEN-T network entry points such as metro stations and tramways**. The deployment of mobility hubs in Oslo and Gothenburg supported the **interconnection of multiple transport modes** (bikes, e-scooters, car-sharing, and public transport) while incorporating real-time data-sharing technologies. These hubs improved **traffic flow management**, optimised multimodal itineraries, and contributed to **reducing congestion and air pollution**—all of which align with TEN-T requirements for sustainable

urban mobility and **safe interconnections between transport modes**. The implementation of smart parking services in Gothenburg further facilitated seamless transport mode transitions, encouraging a shift away from private vehicle use towards ***low-noise, zero-emission transport***. The measures and solutions also explored passenger-freight integration, such as Hamburg's MOIA on-demand ride-pooling service and Oslo's mobility-on-demand service, which optimized underutilized transport capacity for freight deliveries during non-peak hours. These solutions aligned with TEN-T's goals **for efficient, low-carbon urban freight delivery** and consolidated logistics facilities to **reduce congestion and emissions**.

4.3.2 Governance Innovation and Policy integration

MOVE21 introduced multilevel governance frameworks and policy innovations to support the systematic integration of urban transport policies across different sectors [9], directly contributing to multimodal transport connections while also addressing TEN-T requirement on **regional and local transport interconnections.** The LLs in Oslo, Gothenburg and Hamburg fostered public-private collaborations that enabled municipalities, private sector stakeholders, and research institutions to co-create scalable urban mobility solutions. This approach aligns with TEN-T's requirement for improved governance structures to support multimodal and alternative fuel infrastructure. The project also facilitated the regulatory adaptation of land-use policies in Oslo, allowing for the expansion of mobility hubs, and in Hamburg, where contractual agreements supported multi-functional transport areas. These measures enhanced the integration of **active mobility modes** and urban freight consolidation hubs, key elements of TEN-T's requirements for improved urban logistics and active mode infrastructure. Through harmonized governance structures, the project increased the accessibility between urban and rural areas, **ensuring sustainable, smart, and affordable mobility solutions**—another key TEN-T urban node requirement.

4.3.3 Enhancement of innovation capacity for sustainable mobility

MOVE21 strengthened cities' ability to innovate and adopt sustainable mobility solutions, addressing governance challenges such as segregated municipal departments, conservative approaches and insufficient knowledge-sharing mechanisms—which often hindered the implementation of such innovative measures and solutions. The Innovation Capacity Framework developed under the project, empowered cities to assess and enhance their ability to integrate multimodal transport solutions, ensuring long-term sustainability and scalability [10]. MOVE21 introduced multilevel governance models that facilitated collaboration across various levels of government, supporting the TEN-T goal of integrating **urban and regional transport policies to enhance overall accessibility and interconnectivity**. By promoting cross-sectoral collaboration and knowledge-sharing, the project encouraged cities to increase the modal share of public transport and active modes, in line with TEN-T's requirements to **reduce emissions, improve road safety, and promote public transit and active mobility solutions**. Oslo, Gothenburg, and Hamburg demonstrated the potential of MOVE21's strategic solutions—such as dedicated innovation leadership roles, cross-departmental cooperation, and self-assessment tools—to improve governance and accelerate the adoption of multimodal transport innovations.

4.3.4 Business model's development through Public-Private Partnerships

MOVE21 measures and solutions emphasized the critical role of public-private collaboration in transforming urban mobility systems [12]. In line with the TEN-T priority of **facilitating multimodal transport connections**, MOVE21 leveraged these types of collaborations to integrate passenger and freight transport, optimizing underutilized transport capacity, such as through Hamburg's on-demand ride-pooling services for parcel deliveries and Oslo's mobility-on-demand system. These solutions

allowed the efficient, low-carbon urban freight delivery by utilizing shared infrastructure, thus **minimising congestion and emissions**. This approach not only contributes to better integration of freight within urban mobility systems but also supports the TEN-T requirement of **increasing the modal share of public transport and active modes.** The successful implementation of mobility hotels, micro-depots and micro logistics in cities like Gothenburg, Oslo, Bologna, Rome and Munich, further highlighted the scalability of these innovative business models, directly contributing to **seamless interconnection between transport modes**. This helped in **reducing negative environmental impacts** and promoted a ***low-noise, and zero-emission transport***, aligning with the additional TEN-T urban node requirements. Public-private collaborations also provided the opportunity for cities to offer alternative fuel infrastructure as part of their integrated transport solutions. By incentivizing shared logistics and multi-use transport models, these partnerships ensured the deployment of sustainable solutions such as electric cargo bikes and the expansion of low-carbon delivery options, addressing TEN-T's goal of **reducing emissions and promoting sustainable urban freight delivery.** The use of digital technologies integrated through digital agreements and data-sharing mechanisms, ensured that MOVE21's innovative business models are adaptable and scalable. These technological solutions enhance the overall connectivity between urban and rural areas, while **optimizing traffic flow, reducing congestion, and improving road safety**—key aspects of the additional TEN-T urban node requirements.

4.4 Assessing the impact of MOVE21 on Scan -Med TEN-T level

4.4.1 MOVE21 evaluation framework in brief

The MOVE21 impact assessment approach [13] integrates three conceptual levels; Level 1: The Innovation enabler topics; Level 2: The cities procedures (LLs and RCs) and Level 3: The Impact oriented indicators. In more detail:

Level 1 performs a parallel performance evaluation of solutions at the three thematic areas of urban social layer, governance, and technical integration. The urban social layer considers the close link between social and spatial components of cities, social acceptance of the measures to be deployed and whether they are well-suited to deliver impacts on social cohesion. The layer feeds the impact assessment by calculating the impact of the innovative measures on social cohesion, livability, safety, and comfort in cities.

The governance innovation is related to the needed actions that should be done in order to solve specific problems and barriers as regards governance structures and specific parameters such as regulatory knowledge, stakeholders, resource mobilization, legitimacy and entrepreneurial experimentation. The area feeds the impact assessment by estimating the upgrade of innovation capacity to understand the governance drivers and barriers for implementing innovative solutions as well as the number of policy solutions proposed.

The integration of technical solutions is related to the evaluation of the implemented solutions as regards the achievement of the connectivity and interoperability among them. The current thematic area feeds the impact assessment by calculating the upgrade of the passenger and freight urban network connectivity.

Level 2 monitors the cities activities, in order to assess their processes, impacts and implementations. The processes include efforts for increasing the innovation capacity in the cities and the local ecosystems. This level will create a self-sustaining partnership model based on strong partnerships for zero emission solutions with the aim to create long lasting change and impact. The model involves

quadruple helix partners, public authorities, researchers, businesses, and citizens. The activities taking place as result of the partnership model are going to be monitored using a continuous loop of observations, reflections and actions that will also feed the evaluation framework, calculating indicators that examine the improvement of the cities' operation and the innovations' deployment.

Level 3 addresses the development of the result indicators measuring the performance of the project. This level includes indicators that are linked to the previous two levels but also additional quantitative indicators for estimating the impact on different thematic areas. In this context four impact areas are proposed. Main indicators per area are presented in the Figure 1.

- Impact area 1: Long-term decarbonisation
- Impact area 2: Sustainable, inclusive, safe and secure mobility system.
- Impact area3: improvements of the efficiency and accessibility of the transport networks/systems covering the TEN-T urban nodes
- Impact area 4: Social cohesion, economic development and public perception resulting in behavioural and policy change

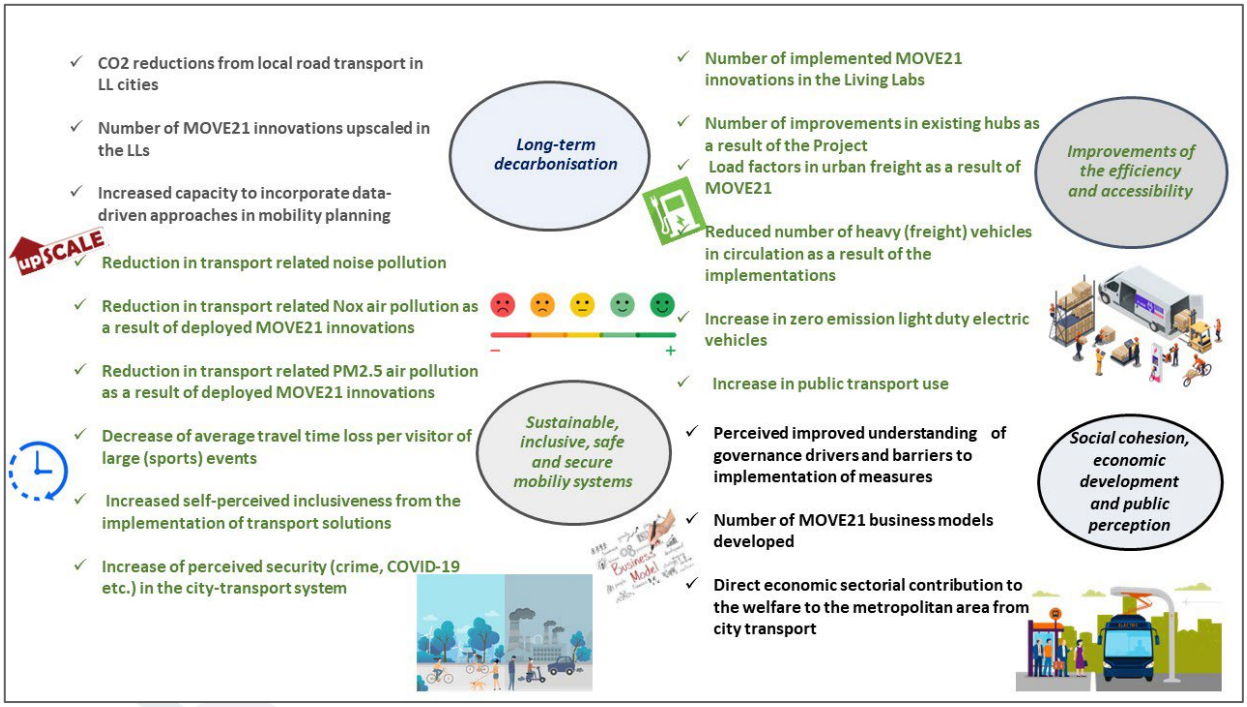

Figure 1: MOVE21 impact assessment main indicators per thematic area.

For the implementation of the methodological approach, data sources used include outcomes of local/regional transport models and simulations, citizen questionnaire surveys, statistics of planning agencies, transport operators' surveys and LL and RC representatives' surveys. A detailed schematic representation of the approach is presented in Figure 2.

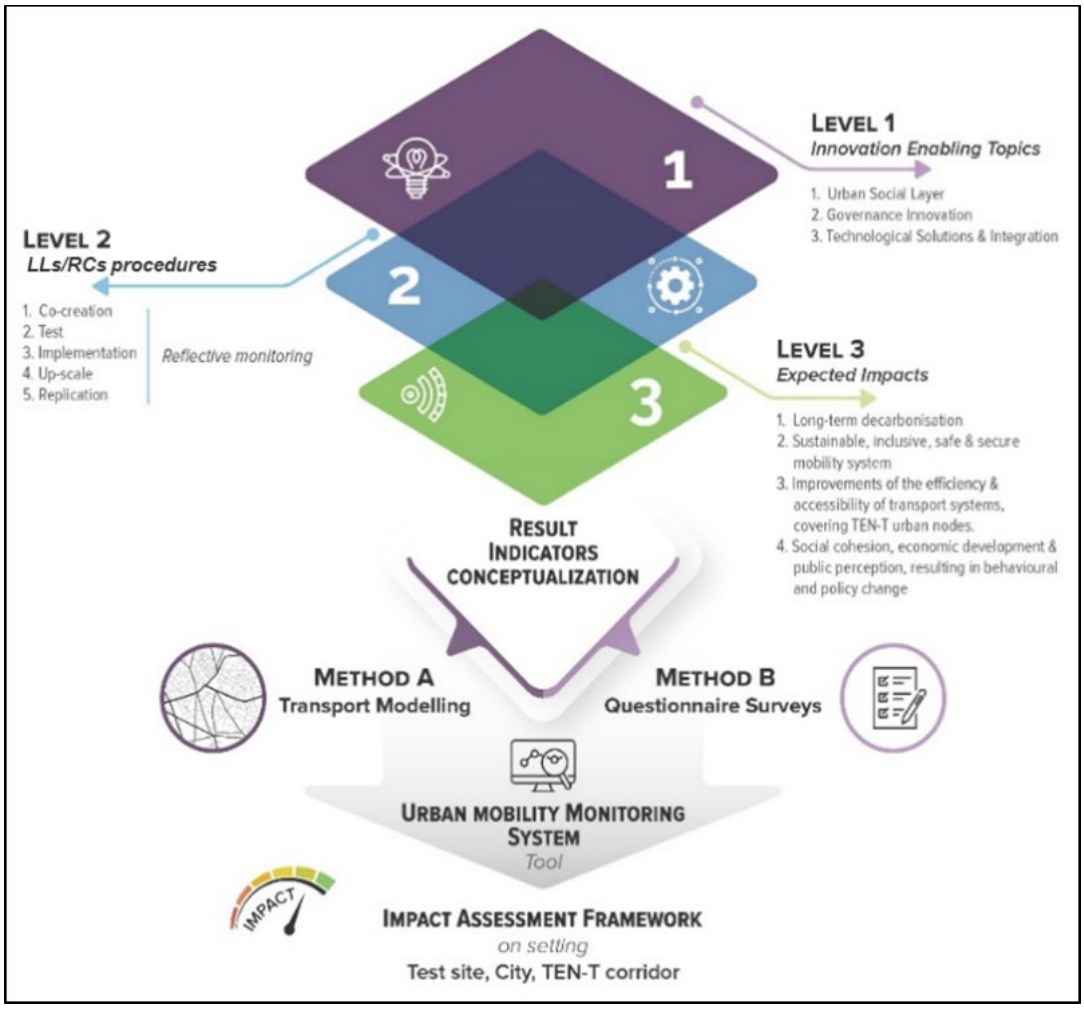

Figure 2: MOVE21 impact assessment methodological approach for the LLs.

The ex-post evaluation [14] of the level 3 KPIs are related to the environmental and traffic impacts of intermodal passenger and freight hubs. These KPIs were also used for calculating the upscaled impact of MOVE21 in the TEN-T Scan-Med Corridor. The calculation relies on the analysis of user opinions, primarily collected through surveys conducted between June and September 2024 in the three LLs. The focus of these surveys was to assess the potential and actual modal shift toward more sustainable transport options facilitated by the development of multimodal hubs. These shifts are key in evaluating environmental benefits, particularly emission reductions due to the use of public or sustainable transport instead of private cars.

The data collection was mainly based on questionnaire surveys. The surveys aimed to capture changes in behaviour among both users and non-users resulting from the introduction of MOVE21 services and innovations. The surveys targeted actual users of the pilot services, providing direct insights into the impact of MOVE21.

It should be noted that due to the complexity of the KPIs and the extensive data required for their calculation, only a minimal number of questionnaires were completed during the on-the-spot surveys.

The calculation of the environment related KPIs was based on the development of a Multinomial Logit (MNL) model which estimated the adoption of mobility hubs based on data gathered from the online

and on-site surveys in the three cities. However, due to the lack of specific data collected in Hamburg, it was not possible to develop or apply the MNL model for this city.

During the ex-post evaluation of the project impact, the calculation of CO_2, Nox and PM2.5 savings per mobility hub user in each city took place, using the estimated model and additional travel behaviour data and car usage metrics. The methodology used for the calculation is presented below.

Step 1: Determine the Joint Probability of Being a Hub User and a Car Driver
The first step is to determine the proportion of individuals who are both mobility hub users and car drivers. This is important as car drivers primarily contribute to emission savings when using mobility hubs.

Step 2: Calculate Average Car Driver Habits
Quantification of the average kilometres driven by mobility hub car drivers and their accessibility to the nearest hub.

Step 3: Estimate Modal Shift Behaviour
This step assesses the extent to which mobility hubs encourage their existing users to replace car trips with more sustainable travel modes calculating for each city the veh/kms that can be replaced from sustainable modes of transportation.

Step 4: Assess Current Environmental Impact
Based on the previous data, the environmental impact of mobility hub use was calculated, focusing on emissions' reduction. By accounting fuel consumption, emission factors, and the proportion of trips shifted to mobility hubs, the estimation of savings per car-driver of a petrol vehicle was realized.

Step 5: Scenarios Evaluation
For upscaling of the result, during this phase the potential environmental benefits of mobility hubs under varying levels of adoption and accessibility were examined, focusing on medium and high penetration scenarios. These scenarios considered different probabilities of car drivers becoming hub users, percentages of trips transitioned to sustainable modes, and metrics of hub accessibility.

The baseline case serves as a reference point, reflecting current adoption rates and hub accessibility. The medium penetration scenario envisions a moderate increase in both adoption rates and accessibility, while the high penetration scenario represents a strong shift with substantially higher adoption and accessibility improvements. These scenarios enable a stepwise assessment of the environmental impact of mobility hubs, highlighting their role in lowering emissions and enhancing car-driver savings.

Using the above-mentioned methodology and the outcomes of the survey results, the influencing parameters and the final impacts that MOVE21 measures and solutions can bring to the Scan-Med TEN-T corridor were estimated and are presented in the following section.

Before presenting the parameters and results of the evaluation analysis for passenger trips mainly, it is important to highlight that the main data was collected from users and potential users of the multimodal hubs in Oslo and Gothenburg. These hubs had been in operation and offering services to the public for more than three months before the evaluation period.

Even though the main concept and services offered by the two hubs seem quite similar, there is a significant difference that affects the presented results, as they are designed to upscale specific types of hubs based on the characteristics and needs of each TEN-T city.

The multimodal hub in Klippan, Gothenburg, is located in an urban area, just 2 km from the city centre, with frequent and well-connected public transport services. Its proximity to the city centre allows residents of Klippan to use micromobility options, such as walking and biking, for their daily trips. Nevertheless, the hub serves as a transfer point for people commuting from suburban or rural areas, providing Park-and-Ride and/or Park-and- Bike services. The hub aims to encourage people to reduce private car usage and shift towards multimodal transport options, including public transport, shared bikes, and shared e-scooters.

On the other hand, the multimodal hub in Grorud Valley, Oslo, is located over 10 km from the city centre, in an area that previously had limited access to the public transport network. Many residents of this area have to walk more than 15 minutes to reach a public transport stop, and their overall daily commute often exceeds the hour. As a result, car dependency is higher in Grorud compared to the Oslo municipal average. The primary goal of the Oslo hub was to facilitate a modal shift by offering Park-and-Ride and Bike-and-Ride services, encouraging residents to adopt more sustainable transport options for their daily trips to and from the city centre.

4.4.2 Influencing Parameters for effectively upscaling Move21 results on Scan-Med TEN-T Axis

The analysis of the citizens surveys in the three LLs highlighted the influence parameters that are most important for the successful implementation of the multimodal mobility hubs and the scalability of MOVE21 results along the Scan-Med TEN-T corridor. These parameters include:

1. Demographics (age, gender)
2. Driving license possession and car dependency
3. Distance to mobility hubs
4. Digital readiness (smartphone usage)
5. Governance and policy integration

The main outcomes and results of this analysis as well as initial proposals for the efficient upscaling of the MOVE21 measures and solutions in the main cities of the TEN-T axis are presented below.

1. **Demographic Influence: Age and Gender on Mobility Hub Adoption**

According to MOVE21 survey results analysis, younger individuals (18-35) are more likely to adopt mobility hubs due to higher environmental awareness, greater use of digital mobility tools and lower car ownership rates. From the other hand, older individuals (50+) show lower adoption rates due to resistance to digital mobility solutions, higher car dependency and limited physical accessibility to hubs.

The MNL model created for the LLs of Oslo and Gothenburg, indicated the above-mentioned influencing factors calculating specific negative coefficient for age (-2.69 in Oslo, -1.98 in Gothenburg) confirming the higher adoption rates among younger individuals. The projection of these results to the Scan-Med impact is mainly focused on the profile of the cities as regards the age of the cities' population. In cities with younger populations (e.g., Berlin, Copenhagen, Naples) a higher mobility hub adoption can be succeeded while in older population cities (e.g., Rome, Palermo) more targeted policies (subsidies, incentives, awareness programmes) should be implemented in order to ensure a similar hub adoption. The population characteristics and the expected mobility hub adoption rate in indicative cities of the axis is presented in the table below.

City	% Population <35 years	Expected Mobility Hub Adoption Rate
Oslo	42	High (25-30%)
Gothenburg	39	High (20-25%)
Hamburg	35	Medium (15-20%)
Stockholm	40	High (20-25%)
Copenhagen	38	Medium-High (18-22%)
Berlin	40	High (20-25%)
Munich	37	Medium (15-20%)
Bologna	36	Medium (15-20%)
Rome	30	Medium-Low (10-15%)
Naples	38	Medium (15-20%)
Palermo	32	Medium-Low (12-16%)

Table 1: Population characteristics and the expected mobility hub adoption rate.

As regards the influence of the gender in mobility hub adoption the survey results highlight that women are less likely to use mobility hubs due to safety concerns at night, family-related travel needs and lower engagement with micromobility (e.g., e-scooters). On the other hand, men are more likely to use mobility hubs for commuting and logistics. The successful operation of the mobility hubs in TEN-T axis cities which could maximize the attraction of users towards sustainable modes and solutions requires a large investment in safety (enhanced lighting, installation of hubs close to popular/crowded places like terminals, shopping malls etc.) and family-friendly transport services (e.g., childcare services at hubs).

2. Driving License Possession and Car Dependency

According to the analysis of the survey results, driving license holders are more likely to use mobility hubs, especially in interurban areas such as Groruddalen in Oslo. This is mainly due to the integration of Park-and-Ride services and the enhanced first-mile/last-mile connectivity provided through multimodal solutions (e.g. car owners drive to hubs and switch to public transport).

According to the results of the MNL Model (Oslo, Gothenburg), the strong influence of driving license possession was also confirmed, as positive coefficients (0.471 in Oslo) indicate that licensed drivers are more likely to use hubs. **This is largely influenced by the specific target group of the survey (residents of rural areas near the Grorud Valley). This factor is crucial, as MOVE21 aims to achieve behavioral change through multimodal hubs, particularly among citizens accustomed to car use, especially those living in suburban or rural areas**. To further extend the above-mentioned outcomes to the remaining cities of Scan-Med corridor, the following aspects should be highlighted:

- In high-car-ownership cities (Rome, Munich, Berlin), the introduction **of mobility hubs in the rural and suburban areas** requires strong Park-and-Ride integration.
- In lower-car-ownership cities (Copenhagen, Stockholm), direct public transport connections are more crucial.

Following similar findings in international literature [15], there is a strong link between strategies for implementing mobility hubs and driving license possession and/or car ownership rates in a given area. A high rate of driving license possession is often associated with a strong private car culture and the prevalence of suburban residential areas. In such contexts, the first step toward achieving a sustainable mobility shift is the introduction of Park-and-Ride hubs. These hubs should also integrate car-sharing systems, particularly in cities with extensive interurban areas where public transport services are infrequent. The work of Czarnetzki, F., & Siek, F. [16] analyzed the positive effect of introducing decentralized mobility hubs that provide car-sharing services in areas with a high rate of private car ownership to promote sustainable transport.

Conversely, in cities where driving license possession is lower and urban development is characterized by high-density structures, it is crucial to invest in high-quality public transport services. To enhance accessibility and encourage sustainable mobility, these services should be complemented by bike-sharing systems, particularly for first- and last-mile connectivity. Based on the above-mentioned issues and considering the structure of the Scan-Med axis cities, specific recommendation strategies are indicatively presented below.

City	Driving License Possession (%)	Recommended Strategy
Oslo	85	Park-and-Ride Hubs
Gothenburg	82	Mixed Hubs (Bike + Car)
Hamburg	78	Mixed Hubs (Bike + Car)
Stockholm	70	Public Transport Focus
Copenhagen	72	Public Transport Focus
Berlin	75	Public Transport Focus
Munich	80	Park-and-Ride Expansion
Bologna	77	Mixed Hubs (Bike + Car)
Rome	68	Public Transport Focus with shared bike services
Naples	65	Public Transport Focus with shared bike services
Palermo	60	Public Transport Focus with shared bike services

Table 2: Driving licence possession and relevant recommended strategy.

3. Distance to Mobility Hubs and Accessibility

The analysis of citizens' responses regarding the distance and accessibility parameters influencing their willingness to use a mobility hub revealed that shorter travel distances to hubs lead to higher adoption rates. This was also confirmed by the negative coefficient of travel time in the MNL model. Specifically, the values of -1.01 in Gothenburg and -1.23 in Oslo suggest that every 1 km increase in distance reduces the adoption by approximately 3-5%.

Based on these results, it can be concluded that in dense cities along the Scan-Med axis (Copenhagen, Berlin, Rome), multimodal hubs need to be located within 1-2 km of users, while in cities with extensive suburban and rural areas (Munich, Naples), Park-and-Ride hubs should be situated within a maximum of 5 km. **It should be emphasized once again that these proposals are primarily based on the results from the specific type of multimodal hubs tested in Gothenburg and Oslo. These hubs, through their location and the offered park-and-ride services, are designed to serve residents of rural or interurban areas, aiming to reduce car usage by minimizing trips to the city center.**

In parallel, in the case of Klippan, the hub seeks to encourage also individuals/residents living closer to the city center to shift towards micromobility options or public transport modes. Table 3 presents initial proposals for the optimal hub distances in the main cities along the axis.

The experience from MOVE21 demonstrated that the introduction of mobility hubs at longer distances in suburban low-density areas, such as Grorud in Oslo, can yield highly successful results, as people can be served through Park-and-Ride services. Similarly, in urban neighborhoods such as Klippan in Gothenburg, short-distance hubs provide additional opportunities for Walk-and-Ride or Bike-and-Ride solutions. Both cases have proven to be effective alternatives for promoting a shift toward more sustainable modes of transport.

City	Distance to hub (km)
Oslo	3.5
Gothenburg	3
Hamburg	3
Stockholm	1.5
Copenhagen	1.5
Berlin	1.5
Munich	2.5
Bologna	2
Rome	1.5
Naples	2.5
Palermo	3

Table 3:. Optimal hub distance according to the city density.

4. Digital Readiness (Smartphone Usage)

Another influencing factor in the adoption of multimodal hub services appears to be the smartphone usage. According to the survey, higher smartphone usage correlates with a greater likelihood of using mobility hub services. The MNL model calculated strong positive coefficients for this relationship (0.659 in Gothenburg, 0.202 in Oslo).

There are specific key enablers that should be considered when introducing or operating a multimodal mobility hub, such as the availability of digital payments, Mobility-as-a-Service (MaaS) applications, and on-demand booking for the provided services.

Taking into account the OECD Digital Economy Report [18], which provides country-level smartphone adoption rates across Europe, as well as the Eurostat Digital Economy & Society Database [19], which reports digital adoption levels in urban areas, some initial proposals for mobility hub digital strategies in the main cities along the Scan-Med axis are presented in the next table.

City	Smartphone Penetration (%)	Mobility Hub Digital Strategy	Proposal for digital strategies
Oslo	90	Fully Digital Integration	High smartphone penetration supports complete digital integration, enabling seamless booking, navigation, and payments.
Gothen-burg	88	MaaS-Enabled Hubs	High smartphone penetration and strong public transport integration make Gothenburg a strong candidate for MaaS-driven mobility hubs.
Hamburg	85	On-Demand Ticketing	Strong but slightly lower smartphone penetration than Oslo and Berlin. Prioritizing on-demand ticketing ensures accessibility for less digitally engaged users.
Stock-holm	94	Fully Digital Integration	Stockholm has one of the highest smartphone adoption rates in Europe. The city also leads in MaaS integration (Mobility-as-a-Service), making full digital adoption the ideal strategy.
Copen-hagen	92	MaaS-Enabled Hubs	High smartphone penetration and strong public transport integration make Copenhagen a strong candidate for MaaS-driven mobility hubs.
Berlin	89	On-Demand Ticketing	Berlin has a strong digital infrastructure but also diverse mobility behaviors, requiring a focus on on-demand mobility services.
Munich	87	On-Demand Ticketing	Strong but slightly lower smartphone penetration than Oslo and Berlin. Prioritizing on-demand ticketing ensures accessibility for less digitally engaged users.
Bologna	85	On-Demand Ticketing	Lower smartphone penetration necessitates a transition strategy, balancing digital services with cash payment options.
Rome	80	Hybrid Model (Cash + Digital)	Lower smartphone penetration necessitates a transition strategy, balancing digital services with cash payment options.
Naples	75	Gradual Digital Transition	Smartphone usage is lower than in Northern Europe. A phased approach to digital integration with parallel cash services is necessary.
Palermo	70	Gradual Digital Transition	Palermo has the lowest smartphone penetration in the study. Gradual adoption of digital services, with government incentives for smartphone use, is recommended.

Table 4: Smartphone penetration and proposed mobility hub digital strategy.

The above-mentioned strategy highlights that it is very crucial for the relevant stakeholders to adopt specific policy for supporting the digital integration of transport services, subsidizing also smartphone apps for lower-income users.

5. Governance and Policy Integration

The governance and policy analysis and work that have been done during the MOVE21 pilot measures and solutions design and implementation, in close collaboration between the LLs (WP6) and the policy and governance experts (WP4 and WP9), emphasised the importance of policy coherence between different European and national policies and the barriers that the governance structures can bring to the scalability of the multimodal hubs. A first review of the Scan-Med main cities resulted in a first classification of their governance structure as follows.

- Oslo, Gothenburg, Hamburg (LL cities) seem to have strong municipal control on city level but not necessarily on FUA-level, and this can speed up the adoption of the multimodal hubs. Strong investments are needed for maximising the effectiveness of the offered mobility solutions as well as incentives for public-private collaboration models.
- Rome, Berlin, Bologna and Thessaloniki seem to have a more decentralised governance which can slower the adoption of mobility hubs. Harmonization of policies between municipal/metropolitan, regional and national level is required as well as stronger PT integration.
- Munich, Copenhagen are some good examples for efficient introduction and operation of multimodal hubs as there is strong municipal control but also strong public-private cooperation.

4.4.3 Upscaling MOVE21 impacts along the Scan-Med TEN-T Corridor

Considering the MOVE21 ex-post impact analysis [14], which was mainly based on the results of the citizens (users and non-users) survey and the implementation of the MNL model for estimating the upscale of the project results to the city level, the specific section presents the upscaling of the project potential impact along the Scan-Med TEN-T corridor. The impact will be mainly concentrated to the following aspects.

- Environmental impacts (CO_2, NOx, PM2.5 reductions)
- Transport efficiency & modal shifts
- Urban logistics & freight efficiency
- Socioeconomic & policy impacts
- Scalability challenges & financial needs

Regarding environmental impacts, the survey data collected in Oslo and Gothenburg was expanded and applied to other Scan-Med cities to estimate changes in car driver behaviour following the implementation of mobility hubs. Specifically, the analysis considered the reduction in the average weekly kilometres travelled by car drivers. The data used for this estimation included the average trip distance to the main activity for car drivers (~25 km/hr), the average hub access travel time by car, mean hub access travel time by bike, the average hub access travel time by walking, and the average hub access distance.

For the increase in public transport use, the modal shift percentages calculated from the surveys in Oslo, Gothenburg, and Hamburg were used to estimate the corresponding impact in other Scan-Med

cities. This estimation was based on the existing public transport usage levels and total population of each city.

The MOVE21 surveys did not provide accurate data on the project's impact on freight transport, the reduction of freight vehicles was therefore assessed using data from urban logistics relevant studies [20,21]. These studies estimated a reduction of 15%-36% with the introduction of freight consolidation centres. Additionally, EU urban freight research indicates that switching to centralized last-mile hubs can reduce freight trips by 10%-20%. Based on the types of hubs developed during the MOVE21 pilot actions and their potential citywide scale-up, an approximate estimation of freight vehicle reduction was made and extended to other Scan-Med cities.

The estimation of job creation was based on national labour statistics, considering workforce expansion in public transport operations, the growth of last-mile logistics employment, and the increasing demand for digital and data-related jobs driven by mobility innovations. Taking into account these factors, along with the investment that the new hubs will bring at the city level and the absence of relevant input from MOVE21 surveys, an approximate estimation was conducted.

Finally, the investment needs were calculated based on the estimated costs of mobility hub implementation, which was approximately €10 million per hub, as well as urban logistics consolidation centre investments, estimated between €20 million and €50 million per hub. These figures were combined with projections of the total infrastructure expansion required for each city to determine the overall financial requirements for scaling up the project.

4.4.3.1 Environmental Impact: Reducing Emissions Across the Scan-Med Corridor

MOVE21 measures and solutions have demonstrated a significant potential in reductions of CO_2, NOx, and PM2.5 emissions. The expansion of this impact to the Scan-Med corridor has been estimated by calculating the cumulative impact across major urban nodes, applying the results of the MNL model, according to the main characteristics of each node (population, area, density, current modal split). The main environmental impact KPIs results as regards the CO_2, NOx, and PM2.5 reductions are presented in the next table.

City	CO_2 Reduction (%)	NOx Reduction (%)	PM2.5 Reduction (%)
Oslo	13%	12%	12%
Gothenburg	15.8%	14%	8%
Hamburg	18%	16.3%	11.8%
Stockholm	15%	15.6%	16.0%
Copenhagen	14%	15.0%	15.9%
Berlin	16%	15.5%	14.4%
Munich	14%	13.2%	14.0%
Bologna	12%	13.5%	12.5%
Rome	14%	15.8%	14.1%
Naples	12%	13.3%	12.0%
Palermo	10%	11.9%	11.4%
Total	**~14% avg.**	**~14% avg.**	**~13% avg.**

Table 5:. Main environmental impact KPIs in the Scan-Med Corridor Main Cities after the upscale of Move21 solutions.

The average CO_2 reduction is estimated at 14%, equivalent to removing 1.8 million private cars from the road transport network annually. NOx could be reduced by 14%, leading to a major improvement in urban air quality and a reduction in respiratory illnesses. Additionally, PM2.5 reduction is estimated at 13%, significantly lowering fine particulate pollution and providing substantial public health benefits. Cities with high private car traffic, such as Berlin, Hamburg, and Rome, demonstrate the greatest CO_2 reductions, while Stockholm and Copenhagen could achieve significant NOx and PM2.5 savings.

4.4.3.2 Transport Efficiency and Modal Shift

The evaluation of MOVE21 measures and solutions revealed a quite notable increase of public transport use and reduction in private car dependency. Specifically, the upscaling of the citizen survey indicates that the introduction of the current pilot hubs and services could lead to a 3% increase in public transport usage in Oslo, a 5% in Gothenburg, and a 6% increase in Hamburg. The upscaled results, based on the MNL model for the main cities along the Scan-Med corridor, are presented in the next table.

City	Public Transport Increase (%)
Oslo	3%
Gothenburg	5%
Hamburg	6%
Stockholm	4%
Copenhagen	4%
Berlin	5%
Munich	5%
Bologna	3%
Rome	4%
Naples	3%
Palermo	2%
Total	**~4% avg.**

Table 6: Public Transport increase in the Scan-Med Corridor main cities after MOVE21 measures and solutions upscale.

4.4.3.3 Freight and Urban Logistics Efficiency

The results of the assessment of the impact that the new logistic services in the multimodal passenger and logistic hubs can bring to the Scan-Med cities is presented in Table 7.

City	Freight Vehicle Reduction (%)
Oslo	12.5%
Gothenburg	13.3%
Hamburg	10.0%
Stockholm	13.3%
Copenhagen	12.7%
Berlin	8.3%
Munich	11.1%
Bologna	9.3%

Rome	8.7%
Naples	9.4%
Palermo	10.0%
Total	**~11.00%**

Table 7: Freight trips reduction in the Scan-Med Corridor Main Cities after MOVE21 measures and solution solutions upscale

An upscaling of the MOVE21 measures and solutions is estimated to bring up to approximately 11% reduction of freight vehicles, in the Scan-Med corridor cities' urban networks. Major improvements in urban logistics would align with the EU's Sustainable and Smart Mobility Strategy.

4.4.3.4 Economic and Social Benefits

The new multimodal passenger and freight hubs created by MOVE2 and the introduction of many micromobility, public transport, and urban logistics services that are mainly based on new business models, are estimated to generate new green jobs. The potential increase in jobs as well as the investment reduction in the main cities of Scan Med corridor are presented in the following table.

City	Job Creation (%)	Investment reduction (%)
Oslo	8.0%	30.0%
Gothenburg	8.2%	30.0%
Hamburg	8.3%	33.3%
Stockholm	8.6%	31.4%
Copenhagen	7.7%	30.8%
Berlin	8.3%	27.8%
Munich	8.0%	35.0%
Bologna	6.7%	24.0%
Rome	7.5%	28.1%
Naples	8.2%	29.4%
Palermo	8.3%	30.0%
Total	**~8.0% reduction**	**~30.0% reduction**

Table 8: Financial impacts in the Scan-Med Corridor Main Cities after MOVE21 measures and solution solutions upscale

5 Conclusions

5.1 Summary of MOVE21 Impact on the Scan-Med Corridor

the MOVE21 project has demonstrated that a transformative effect can be achieved on urban mobility, logistics, and environmental sustainability within the TEN-T Scan-Med Corridor. Future implementation of multimodal mobility hubs, digital integration and sustainable logistics solutions in major cities along the corridor are estimated to significantly contribute in reducing emissions, optimizing transport efficiency, and fostering socio-economic growth. Findings from Section 4.3.2 provide a comprehensive overview of MOVE21 impacts, highlighting key areas of progress and their implications for the future development of urban transport systems across the corridor.

The impact expansion to the Scan-Med corridor has been assessed by aggregating the effects across the major urban nodes, utilizing the MNL model based on key characteristics such as population, area, density, and current modal split. According to the analysis, the total CO_2 reduction is estimated at 14%, equivalent to removing 1.8 million private cars from the road transport network each year. NOx emissions could decrease by 14%, contributing to improved urban air quality and a decline in respiratory illnesses. Furthermore, PM2.5 levels are projected to drop by 13%, significantly reducing fine particulate pollution and delivering notable public health benefits.

Transport efficiency and modal shifts have been another critical focus of the project. Specifically, the upscaling of MOVE21 measures and solutions in major cities of the Scan-Med Corridor, revealed that approximately 4% increase in public transport use and a decline in private car dependency can be achieved. **As described in the evaluation framework section (4.4.1), the main passenger mobility measures that have been evaluated—and appear to have the potential to generate the aforementioned impact—include the introduction of multimodal hubs in areas where residents from rural and interurban areas can access services such as Park-and-Ride, Park-and-Bike, or Bike-and-Ride.**

Similarly, freight and urban logistics efficiency can be significantly enhanced through the introduction of innovative logistics solutions. The upscaling of MOVE21 measures and solutions concluded that approximately an 11% reduction of freight vehicles can be achieved, in the Scan-Med corridor.

From an economic and social perspective, the new multimodal passenger and freight hubs established by the MOVE21 project, along with the introduction of various micromobility, public transport, and urban logistics services primarily based on new business models, estimated to increase the percentage on new green jobs providing substantial benefits for the cities along the Scan-Med corridor. More specifically, an 8% increase in job creation and a 30% reduction in investments was estimated that can be achieved in Scan-Med Corridor level, from upscaling MOVE21 measures and solutions.

To further illustrate the impact of MOVE21, a graphical representation has been developed and presented in the next figure, mapping out the key areas of influence across the Scan-Med corridor with emphasis on project partner cities. The map provides a clear depiction of all estimations as regards CO_2, Nox and PM2.5 reductions across cities as well as the increase in public transport ridership and jobs within urban nodes.

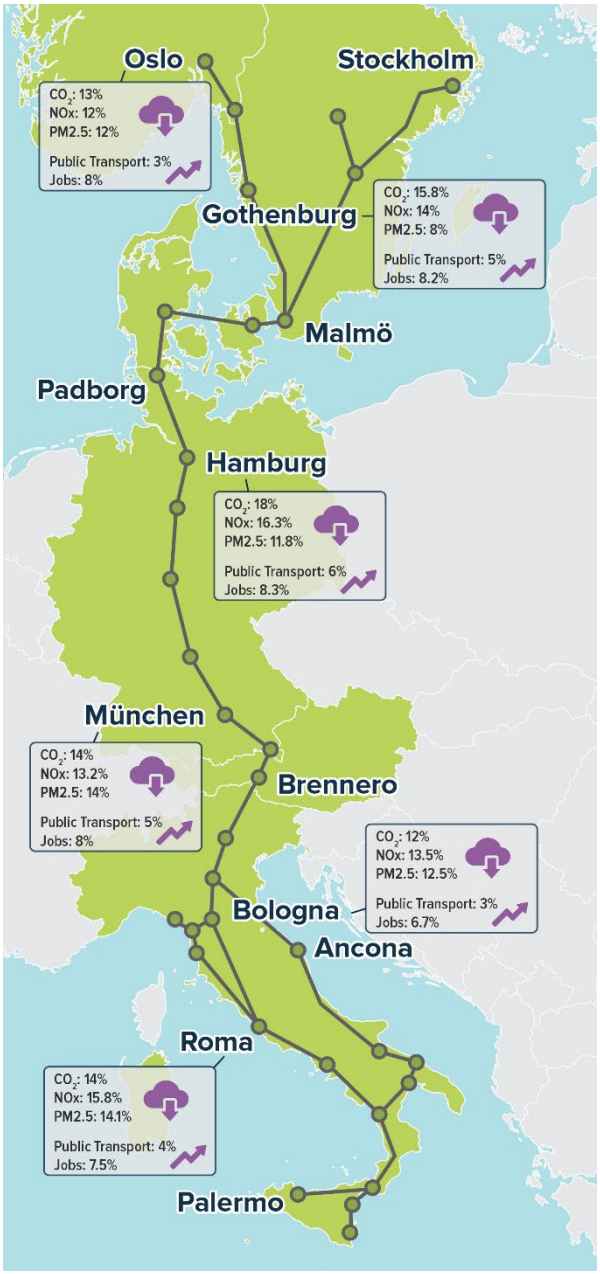

Figure 3: MOVE21 upscaled impact in the Scan-Med TEN-T corridor

MOVE21 established a replicable framework for integrating sustainable transport solutions within the TEN-T network. By aligning urban transport policies with broader European objectives, the project provides a strategic pathway for future interventions aimed at reducing congestion, improving air quality, and enhancing overall transport efficiency. As European cities continue their transition towards sustainable mobility, the lessons and successes of MOVE21 serve as a valuable reference point for scaling these solutions across other key urban nodes within the Scan-Med corridor and beyond.

5.2 Recommendations for Future Project Replication and Scalability

MOVE21 demonstrated significant success in implementing multimodal urban transport solutions within its Living Labs and replicator cities. These results provide valuable insights into how such innovations can be further scaled and integrated within the broader TEN-T network. Replication and scalability require a strategic approach encompassing policy frameworks, technological advancements, infrastructure expansion, and investment mechanisms.

A fundamental aspect of successful replication lies in the strengthening of policy and governance frameworks. Regulatory harmonization and policy coherence is essential to ensure consistency across urban nodes within the TEN-T network. Cross-border cooperation must be prioritized to align policies governing multimodal transport hubs, shared mobility services, and urban logistics. Furthermore, municipal capacity building plays a crucial role in the implementation and sustainability of mobility hubs. Investment in training programmes and technical assistance for local authorities is necessary to support the effective adoption and enforcement of mobility policies. The establishment of strong public-private partnerships will further facilitate investment in transport infrastructure and innovative mobility solutions, ensuring the long-term viability of these initiatives.

The integration of digital technologies and smart mobility solutions is another critical component for scalability. The implementation of MaaS platforms can significantly enhance user experience and improve the efficiency of multimodal hubs. To achieve this, policymakers must support the development of seamless ticketing systems, digital payments, and trip planning applications. Real-time data exchange is also essential in optimizing passenger and freight movements. Standardizing digital interfaces between mobility providers, urban authorities, and transport operators will foster interoperability within the TEN-T network. Additionally, the adoption of AI-driven predictive analytics for demand forecasting, as well as the exploration of automated transport solutions such as autonomous shuttles and delivery drones, will enhance efficiency and sustainability across urban nodes.

Scaling up mobility hubs and logistics solutions requires the implementation of modular and adaptive hub models. These hubs should be designed with flexibility in mind, allowing for easy customization based on urban density, demographic needs, and regional transport patterns. Integrating passenger and freight services within these hubs has been proven effective in reducing congestion and emissions, an approach that should be expanded. Sustainable urban freight solutions, such as micro-depots and cargo bike logistics, should be widely adopted to improve last-mile delivery efficiency while minimizing environmental impacts.

The financial sustainability of mobility hubs must also be addressed to ensure long-term success. MOVE21's replication across the TEN-T network requires sustained financial investment. Utilizing European Union funding mechanisms, such as the Connecting Europe Facility (CEF) and Horizon Europe, as well as national funding programmes, will be key in bridging financial gaps. Additionally, private sector engagement must be encouraged through tax incentives, subsidies, and grants for businesses investing in sustainable transport infrastructure, electric mobility, and logistics solutions. Developing long-term business models, including dynamic pricing mechanisms, revenue-sharing models with private operators, and government-backed operational funds, will further support the financial sustainability of these projects.

Knowledge sharing and capacity building must be prioritized to facilitate widespread adoption. The establishment of best practice networks among TEN-T urban nodes will allow stakeholders to exchange insights, success stories and challenges. Continuous training programmes and workshops for policymakers, urban planners, and transport operators will enhance expertise in implementing and

scaling sustainable urban mobility initiatives. Collaboration with universities and research institutions will further drive innovation in transport policies, governance models, and emerging mobility technologies.

Environmental and social sustainability considerations must be integrated into all future replication efforts. The significant reductions in CO_2, NOx, and PM2.5 emissions achieved by MOVE21 measures and solutions underscore the need for further expansion of low-emission transport corridors and the electrification of freight and passenger transport. Ensuring social equity in mobility is another critical aspect, requiring accessibility for all users, particularly vulnerable populations. Affordability, safety, and inclusion must be key priorities in the design and implementation of multimodal hubs. Additionally, integrating transport planning with land-use strategies will improve the efficiency of urban mobility, reduce urban sprawl, and promote walkable and bike-friendly environments.

By implementing these strategies, MOVE21 measures and solutions can be successfully replicated and expanded across the TEN-T network, fostering a more integrated, sustainable, and efficient European transport system. Lessons learned from MOVE21 provide a roadmap for policymakers, transport operators, and urban planners to drive innovation in sustainable urban mobility, setting the foundation for the future of interconnected and environmentally friendly urban transport solutions.

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