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## **Table of Contents**

Executive Summary	4
0. Introduction	5
1. Methodology	6
1.1 Approach	6
1.2 Data collection	7
2. PESTEL Analysis Results	7
2.1 Political Factors	7
2.2 Economic Factors	7
2.3 Social Factors	7
2.4 Technological Factors	8
2.5 Environmental Factors	8
3.6 Legal Factors	8
3.7 Conclusion	8
4. Barriers and Constraints	9
4.1 Structural Barriers	9
4.2 Financial Constraints	9
4.4 Behavioral and Social Barriers	9
4.5 Policy and Regulatory Challenges	9
5. Drivers and Enablers	10
5.1 Technological Drivers	10
5.2 Policy and Governance Enablers	10
5.3 Economic Opportunities	10
5.4 Environmental Drivers	10
5.5 Public Awareness and Societal Shifts	11
5.6 Conclusion	11
6. Recommendations	11
6.1 Addressing Barriers	11
6.2 Leveraging Drivers	11
6.3 Regional Cooperation	12
7. Conclusions	12
References and resources	13

## **Executive Summary**

The deliverable "D.1.1.3 Analysis of Drivers and Barriers to Smart Mobility Solutions Uptake in the Adriatic-Ionian Region" presents an in-depth examination of the critical factors influencing the adoption and implementation of smart mobility solutions within the region. By leveraging the PESTEL framework (Political, Economic, Social, Technological, Environmental, and Legal factors), the report identifies key barriers, drivers, and enablers, offering actionable insights to foster sustainable and integrated mobility systems.

The primary objective of this report is to assess how external factors shape the deployment of smart mobility solutions across six pilot territories in the Adriatic-Ionian Region. The analysis evaluates the challenges and opportunities facing regional stakeholders, providing recommendations to overcome obstacles and enhance smart mobility uptake by utilizing and assessing the answers of the pilot territories for the *Deployment of Smart Mobility Questionnaire*.

Moreover, the analysis developed under *Activity 1.1* underscores the importance of regional cooperation and knowledge sharing to overcome challenges and achieve sustainable mobility objectives. By fostering partnerships among governments, private entities, and local communities, the Adriatic-Ionian Region can build scalable, inclusive, and sustainable mobility systems. Through targeted interventions and cross-border collaboration, the region is well-positioned to unlock the potential of smart mobility and enhance regional connectivity, sustainability, and economic growth.

## 0. Introduction

The purpose of this document is to analyze the key **barriers, constraints, drivers, and enablers** influencing the adoption and implementation of **smart mobility solutions** in the **Adriatic-Ionian Region (AIR)**. By conducting a comprehensive PESTEL analysis (Political, Economic, Social, Technological, Environmental, and Legal factors), the document aims to provide actionable insights into the challenges and opportunities shaping the future of smart mobility within the region.

The Adriatic-Ionian Region represents a unique geographical and economic area that faces both shared and localized mobility challenges. These challenges include urban congestion, fragmented transport networks, environmental concerns, and the need for seamless cross-border connectivity. At the same time, the region is rich in potential, with increasing interest in sustainable mobility, technological advancements, and initiatives supported by local and EU-level policies.

Smart mobility solutions, such as electric vehicles, shared mobility services, digital platforms, and multimodal transport systems, offer a transformative opportunity to address these challenges. However, their successful implementation requires understanding the underlying factors that drive or hinder their uptake.

This document seeks to:

- **Identify barriers and constraints** (e.g., financial, infrastructural, regulatory, and behavioral) that slow the deployment of smart mobility solutions in AIR.
- **Explore drivers and enablers** (e.g., technological advancements, policy initiatives, public awareness, and economic opportunities) that can accelerate their adoption.
- **Provide a strategic foundation** for addressing challenges and leveraging opportunities to promote the smooth deployment of smart mobility solutions, contributing to the region's sustainability, connectivity, and economic growth.

By highlighting both challenges and opportunities, the analysis aims to guide policymakers, stakeholders, and mobility actors in creating a more efficient, sustainable, and integrated transport system across the Adriatic-Ionian Region.

This analysis focuses on identifying the drivers, barriers, and enablers for the uptake of smart mobility solutions within the **AIR**, using the **PESTEL framework** to evaluate the Political, Economic, Social, Technological, Environmental, and Legal factors influencing these processes. The study aims to provide a comprehensive understanding of the challenges and opportunities for the deployment of smart mobility solutions in the region.

The analysis is based on **qualitative and quantitative data** collected from six **pilot territories** that are part of the project. Data was gathered through a structured **questionnaire** designed to assess key factors affecting smart mobility. The findings are enriched with input from local stakeholders, case studies, and contextual data, offering a holistic view of the specific needs and conditions within these territories.

By combining data-driven insights with the PESTEL framework, this analysis provides a structured approach to understanding the regional context and informing strategies for accelerating the adoption of smart mobility solutions in the Adriatic-Ionian Region.

## 1. Methodology

### 1.1 Approach

The analysis employs the **PESTEL framework**, a widely recognized tool for assessing external factors that influence a specific industry, project, or region. PESTEL stands for **Political, Economic, Social, Technological, Environmental, and Legal** factors, and it provides a structured approach to identifying opportunities and constraints in a dynamic environment.

#### Explanation of the PESTEL Framework

1. **Political Factors**

These include government policies, regulations, and political stability that impact the development and deployment of smart mobility solutions. In the Adriatic-Ionian Region, political factors such as regional transport policies, EU funding programs, and cross-border collaborations were considered.

2. **Economic Factors**

The framework examines financial conditions, investment levels, and economic disparities. In the AIR, economic aspects such as regional income levels, the affordability of smart mobility solutions, and funding opportunities were key areas of focus.

3. **Social Factors**

Social dimensions assess public behavior, cultural attitudes, demographic trends, and social acceptance of new mobility technologies. In the context of AIR, factors like urbanization, population density, and public awareness were analyzed.

4. **Technological Factors**

These cover the availability and accessibility of advanced technologies, infrastructure for smart mobility, and innovation capabilities. Specific attention was given to digital readiness, data-sharing mechanisms, and emerging mobility technologies in the AIR.

5. **Environmental Factors**

Environmental considerations include climate change, sustainability goals, and ecological impacts. In the AIR, these factors were evaluated to understand how environmental challenges drive or hinder smart mobility adoption.

6. **Legal Factors**

This aspect evaluates legal frameworks, regulatory compliance, and cross-border legal harmonization. The AIR context involved assessing regulations on transport, data protection, and sustainable mobility.

#### Adaptation of PESTEL for Smart Mobility in AIR

The PESTEL framework was tailored to address the specific challenges and opportunities related to smart mobility solutions in the Adriatic-Ionian Region. The adaptation included:

- **Focus on regional dynamics:** The framework was contextualized to reflect the socio-economic diversity and cross-border nature of the AIR.
- **Inclusion of pilot territories:** Data from six pilot territories provided localized insights into how PESTEL factors vary across the region.
- **Smart mobility lens:** Each PESTEL dimension was analyzed through the lens of mobility technologies, services, and infrastructure.

- **Integration of qualitative and quantitative data:** Questionnaire results were mapped to the PESTEL categories, ensuring a comprehensive and balanced analysis.

By adapting the PESTEL framework, the analysis provides actionable insights into the unique conditions of the AIR and identifies strategies for overcoming barriers and leveraging enablers to promote smart mobility.

## 1.2 Data collection

To understand the availability of mobility-related data across the six pilot territories, a structured data collection process was implemented. This process aimed to gather comprehensive and consistent information on various aspects of mobility, including geographic characteristics, traffic patterns, urban mobility. A thorough overview of the collected data and the process is described in D.1.1.2 “*Report on availability of mobility-related data and problems*”.

## 2. PESTEL Analysis Results

### 2.1 Political Factors

Political factors play a significant role in shaping the adoption of smart mobility solutions in the Adriatic-Ionian Region. Supportive government policies, such as subsidies for smart mobility infrastructure, encourage innovation, as seen in territories like Rethymno and Koper. However, outdated regulations in regions such as Novo Sarajevo and Niš create challenges, particularly in integrating modern data systems. Public-private partnerships are also a key driver, with governments in areas like Rethymno and Koper actively collaborating with private entities and universities to develop innovative mobility solutions. On the other hand, political instability in certain regions undermines trust and reduces investments. Additionally, adherence to international data standards, such as the GDPR, ensures data security and privacy but increases the complexity of implementing mobility projects across EU regions.

### 2.2 Economic Factors

Economic factors significantly influence the uptake of smart mobility solutions in the region. **Investment in infrastructure** is a key determinant, with cities like Rethymno and Niš showcasing strong commitments to IoT sensor deployment and mobility platforms. However, areas like Shkodra face *persistent funding challenges*, limiting their ability to adopt advanced technologies. The **cost of technology** also presents a significant barrier. For instance, the high price of real-time monitoring systems, such as thermocameras in Rethymno, restricts large-scale deployment in less affluent territories. Moreover, regions with **higher GDP growth rates** are more likely to prioritize mobility innovations, highlighting a clear alignment between economic stability and the adoption of smart mobility solutions.

### 2.3 Social Factors

Social factors, including public awareness, cultural attitudes, and workforce skills, strongly influence the deployment of smart mobility solutions. In several regions, such as Gorizia and Shkodra, a **lack of public awareness** and engagement with smart mobility solutions hampers adoption efforts. Public education campaigns are essential to drive behavioral change and acceptance of new technologies. Additionally, **cultural resistance** to data sharing and technology adoption is evident in cities like Niš, Koper and Rethymno, where

hesitation to embrace innovations slows progress. Compounding these challenges, there are *significant skill gaps* in data analytics across the region. The shortage of trained professionals often forces territories to rely on external consultants, delaying the implementation of advanced mobility solutions.

## 2.4 Technological Factors

Technological factors play a pivotal role in determining the feasibility and effectiveness of smart mobility solutions. In cities like Rethymno, Niš, and Koper, the deployment of **IoT sensors** and advanced technologies has improved the availability of high-quality mobility data. However, **gaps in digital infrastructure** persist in areas like Novo Sarajevo and Shkodra, where a lack of sophisticated tools limits data collection and analysis. Many regions still rely on outdated software, restricting their ability to utilize **emerging tools** like GIS and predictive analytics. On the other hand, territories that have adopted advanced systems, such as Rethymno's thermocameras, demonstrate the potential of **big data utilization** to enable better traffic analysis and mobility planning.

## 2.5 Environmental Factors

Environmental considerations are increasingly critical for smart mobility in the Adriatic-Ionian Region. **Geographic and climatic constraints** pose significant challenges, particularly in regions like Novo Sarajevo with hilly terrains and areas like Rethymno and Niš where adverse weather conditions impact mobility infrastructure. Despite these challenges, a growing focus on **sustainability** is driving the adoption of mobility solutions aimed at reducing environmental impacts. Leading examples include Koper and Rethymno, where data-driven initiatives are being used to monitor air quality and reduce carbon emissions. However, the **energy demands** of real-time data processing and cloud-based platforms present additional barriers, as they often conflict with regional sustainability goals.

## 3.6 Legal Factors

Legal factors create both challenges and opportunities for the implementation of smart mobility solutions in the region. **Data protection laws**, such as the GDPR, ensure data security and privacy, but they also slow down cross-regional data sharing, particularly in multi-jurisdictional areas like Gorizia. In some territories, such as Niš, Shkodra and Novo Sarajevo, **outdated regulations** limit the deployment of innovative tools and create hurdles for smart mobility adoption. Conversely, forthcoming policies and **regulatory modernization** offer opportunities to streamline processes and enhance cross-border mobility solutions. Additionally, the risk of **litigation** due to inaccuracies or misuse of mobility data highlights the importance of robust verification systems and legal compliance frameworks to ensure the smooth and lawful implementation of these technologies.

## 3.7 Conclusion

The PESTEL analysis demonstrates that the Adriatic-Ionian Region faces a mix of opportunities and challenges in adopting smart mobility solutions. While **technological advancements**, supportive political environments, and a growing focus on **sustainability** drive progress, economic disparities, **regulatory hurdles**, and public resistance remain significant barriers. Addressing these issues requires **policy modernization**, increased **investment in infrastructure**, public awareness campaigns, and the adoption of **energy-efficient technologies** to ensure a sustainable and interconnected mobility future for the region.

## 4. Barriers and Constraints

### 4.1 Structural Barriers

Infrastructure limitations and fragmented systems are among the primary challenges faced in the deployment of smart mobility solutions across the Adriatic-Ionian Region. For example, **Gorizia** and **Shkodra** lack foundational IoT infrastructure, such as IoT sensors, which hinders data collection and real-time traffic management. The lack of integration between urban and suburban transport systems, particularly in territories like **Koper**, exacerbates inefficiencies, limiting the smooth implementation of cohesive mobility solutions.

### 4.2 Financial Constraints

Financial barriers remain a critical issue, with disparities in investment levels between affluent and less developed territories. Areas like **Rethymno** and **Koper** benefit from moderate investments in IoT sensors and mobility platforms. In contrast, **Shkodra** and **Novo Sarajevo** struggle with limited funding, restricting their ability to adopt high-cost technologies like thermocameras or EV infrastructure. High implementation costs make large-scale deployment of smart mobility systems challenging, especially in territories with limited municipal budgets. This financial strain often delays critical investments in infrastructure and technology.

### 4.3 Technological Barriers

Challenges in technology integration and data sharing are pervasive across many regions. While some areas like **Rethymno** and **Niš** have made strides with IoT sensor deployment, other territories lack even the most basic digital infrastructure. Disparities in software capabilities further compound the problem; many territories rely on outdated tools, limiting their ability to implement advanced data integration and predictive analytics. Additionally, the absence of cross-regional data-sharing mechanisms undermines the broader potential of smart mobility initiatives.

### 4.4 Behavioral and Social Barriers

Resistance to change and low public awareness present significant hurdles to the adoption of smart mobility solutions. In regions like **Gorizia** and **Niš**, citizens often exhibit reluctance to adopt new technologies, stemming from a lack of trust and familiarity. Moreover, the limited availability of public awareness campaigns exacerbates the issue, particularly in **Shkodra** and **Gorizia**, where community engagement is critical to fostering acceptance of mobility initiatives. Without addressing these behavioral challenges, efforts to modernize transportation systems will continue to face resistance.

### 4.5 Policy and Regulatory Challenges

Inconsistencies in policies across regions create significant barriers to the deployment of smart mobility solutions. For instance, outdated regulations in **Niš** and **Shkodra** hinder the adoption of innovative tools and data-sharing practices. While frameworks like the **GDPR** provide robust data privacy standards, they also increase complexity, slowing down cross-border collaboration. These regulatory misalignments, coupled with a lack of modernized policies, reduce the overall efficiency of regional smart mobility projects. Advocacy for unified, updated policies is essential to overcoming these challenges.

## 5. Drivers and Enablers

### 5.1 Technological Drivers

Technological advancements serve as a cornerstone for the adoption and success of smart mobility solutions in the Adriatic-Ionian Region. The **integration of IoT (Internet of Things)** technology enables real-time data collection, monitoring, and decision-making, allowing cities to optimize transportation systems efficiently. For instance, IoT sensors deployed in areas like Rethymno and Koper facilitate advanced traffic management and mobility insights. Similarly, **artificial intelligence (AI)** and **machine learning (ML)** are revolutionizing predictive modeling, enabling smarter route planning and traffic flow optimization. Additionally, **digital platforms** supporting ride-sharing, electric vehicle (EV) management, and multimodal transport systems are transforming how mobility solutions are delivered and accessed. These technologies not only improve convenience but also make mobility systems more responsive and scalable.

### 5.2 Policy and Governance Enablers

Government policies and initiatives are critical enablers of smart mobility adoption. **Incentive programs** such as subsidies for EV infrastructure and investments in public transportation systems are encouraging the transition to sustainable mobility models. **International collaborations** under frameworks like the EU Green Deal are fostering cross-border projects and aligning regional goals with global sustainability objectives. Furthermore, local authorities in regions like Rethymno and Koper actively collaborate with private entities and academic institutions to promote innovation and knowledge sharing. These partnerships not only enable the deployment of pilot projects but also improve the scalability of smart mobility solutions across the region.

### 5.3 Economic Opportunities

The smart mobility sector represents a significant **growth market**, offering opportunities for economic development and job creation. Investments in smart mobility technologies, including EVs, IoT infrastructure, and renewable energy systems, are opening up avenues for local businesses and startups to thrive. Additionally, **cost savings** associated with reduced congestion, improved fuel efficiency, and streamlined transportation systems further incentivize the adoption of these solutions. For example, territories with strong economic growth, such as Rethymno, are leveraging these opportunities to align mobility improvements with regional economic priorities.

### 5.4 Environmental Drivers

The increasing focus on **sustainability** and the need to combat climate change are driving the adoption of smart mobility solutions. Data-driven initiatives, such as those implemented in Koper, are helping monitor and mitigate the environmental impact of transportation systems by tracking air quality and carbon emissions. The rise of **green technologies**, including EVs, micromobility options, and renewable energy integration, further supports this transition. These efforts align with global sustainability goals and reinforce the region's commitment to environmentally friendly mobility systems.

## 5.5 Public Awareness and Societal Shifts

Changing societal attitudes toward mobility are fostering a growing demand for **sustainable and efficient transportation solutions**. Public awareness campaigns and the increasing visibility of smart mobility technologies are contributing to greater acceptance and engagement. Furthermore, urbanization and demographic changes are creating a need for smarter, more connected transportation systems that cater to diverse societal needs.

## 5.6 Conclusion

The drivers and enablers discussed above highlight the immense potential for the Adriatic-Ionian Region to adopt and scale smart mobility solutions. Leveraging technological advancements, fostering supportive policies, and capitalizing on economic and environmental opportunities are key to achieving regional mobility goals. At the same time, engaging the public and addressing societal expectations will ensure the long-term success and sustainability of these initiatives.

## 6. Recommendations

### 6.1 Addressing Barriers

To overcome the challenges identified in the analysis, the following measures are recommended:

- **Structural Barriers:** Invest in foundational infrastructure such as IoT sensors, GPS systems, and cloud platforms in underdeveloped territories like Novo Sarajevo and Shkodra. Develop integrated urban and suburban transit systems to address fragmentation in regions like Koper.
- **Financial Constraints:** Secure funding through EU initiatives like Horizon Europe and the Green Deal. Encourage public-private partnerships to share the financial burden of deploying high-cost technologies such as thermocameras and EV infrastructure.
- **Technological Barriers:** Implement standardized technology frameworks to ensure compatibility across regions. Replace outdated software and provide training for staff to enhance digital proficiency.
- **Behavioral and Social Barriers:** Launch targeted public awareness campaigns to educate citizens on the benefits of smart mobility solutions. Encourage community participation to reduce resistance to change.
- **Policy and Regulatory Challenges:** Modernize outdated regulations and advocate for policies that promote data sharing and cross-border collaboration. Create harmonized regulatory frameworks to streamline smart mobility deployment across the region.

### 6.2 Leveraging Drivers

Strategies to capitalize on the identified drivers and enablers include:

- **Technological Drivers:** Promote the adoption of AI, IoT, and digital platforms to enhance real-time traffic management and predictive modeling. Support research and development in smart mobility technologies through partnerships with universities and tech companies.

- **Policy and Governance Enablers:** Align local policies with EU sustainability goals to attract funding and technical support. Expand collaborations with private-sector stakeholders to accelerate the deployment of innovative mobility solutions.
- **Economic Opportunities:** Encourage local businesses and startups to enter the smart mobility market through subsidies and incentives. Highlight cost savings associated with efficient mobility systems to encourage investment.
- **Environmental Drivers:** Leverage global sustainability initiatives to secure funding for green projects. Focus on deploying low-emission vehicles, renewable energy systems, and sustainable transport solutions.
- **Public Awareness and Societal Shifts:** Use success stories and pilot programs to build trust and engagement among citizens. Promote the economic, social, and environmental benefits of smart mobility through region-wide campaigns.

## 6.3 Regional Cooperation

The complexity of smart mobility adoption in the Adriatic-Ionian Region highlights the importance of cross-border partnerships and unified strategies:

- **Cross-Border Collaboration:** Strengthen partnerships under EU-funded programs to align regional goals with international mobility standards. Develop joint initiatives to address common challenges such as regulatory misalignment and infrastructure gaps.
- **Unified Strategies:** Create a regional smart mobility framework that integrates policies, technologies, and funding mechanisms. This will ensure consistency and efficiency in implementing mobility solutions across the region.
- **Knowledge Sharing:** Establish a knowledge-sharing platform to exchange best practices, lessons learned, and technological advancements among pilot territories.

## 7. Conclusions

The PESTEL analysis underscores the immense potential for the Adriatic-Ionian Region to adopt and expand smart mobility solutions. Technological advancements, supportive policies, and sustainability goals present significant opportunities to transform the region's mobility systems. However, barriers such as infrastructure limitations, financial constraints, and regulatory challenges must be addressed through targeted interventions.

Collaborative efforts among governments, private stakeholders, and citizens are essential to overcoming these challenges. By leveraging the region's strengths and addressing its weaknesses, the Adriatic-Ionian Region can achieve its vision of a sustainable, efficient, and interconnected smart mobility system. Unified strategies and cross-border cooperation will ensure that these solutions are scalable, inclusive, and beneficial to all

Table 1: Comparison of Pilot Territories

Territory	Key Drivers	Key Barriers	Opportunities
<b>Novo Sarajevo</b>	High urban density supports public transport	Insufficient infrastructure	Invest in IoT and real-time traffic systems
<b>Rethymno</b>	Established smart parking and e-bike systems	Financial constraints, resistance to change	Expand micromobility options, private partnerships
<b>Niš</b>	Focus on urban mobility and EV integration	Outdated regulations, lack of trust in technology	Enhance collaboration with tech hubs and improve regulations
<b>Koper</b>	Pedestrian-friendly zones, traffic regulation system	Limited control over suburban transport systems	Expand green zones, micromobility, and university partnerships
<b>Gorizia</b>	Congestion reduction focus, urban layout	Insufficient infrastructure, low public awareness	Launch pilot projects for micromobility and public transport improvements
<b>Shkodra</b>	Regional hub with public transport focus	High technology costs, lack of public engagement	Start with IoT deployment and implement EV pilot projects

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