SUSTAINABLE AND RESILIENT MOBILITY IN THE 14 METROPOLITAN CITIES CAPITALS[1]

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Abstract. In an environmental sustainability perspective, aimed at promoting a cultural shift inspired by environmental respect and the improvement of urban mobility, the research project pursues the objective of determining some indicators sensitive to territorial differences, robust and suitable for exploring the dynamics and factors of sustainable mobility compatible with local development and territorial policies. To conduct the research and allow multidimensional analysis and evaluation of sustainable mobility differences at the territorial level, it was chosen to construct a composite index that allows for the synthetic measurement of complex and multidimensional phenomena. Sustainable urban mobility is analysed considering three domains: private motorization; public transport; active mobility and sharing.

1. Introduction

Sustainable mobility is a crucial issue for governance, the ecosystem, road safety and people's health itself. Starting from the Green Deal (European Green Pact), the strategic initiatives promoted by the European Commission aim to start the EU on the path to a green transition, with the ultimate goal of achieving climate neutrality by 2050. Intermediate objective: reduce greenhouse gas emissions by 55% compared to 1990 levels by 2030 (NetZero2030).

With the aim of raising awareness among citizens and stakeholders, the paper represents the first results of a multidimensional analysis on the 14 capital municipalities of metropolitan cities, part of a broader research project (Sustainable and Resilient Mobility (MOSER) with the following objectives. In particular, the research project proposes to:

- ✓ identify methods and models for the multidimensional analysis and evaluation of sustainable mobility at a territorial level;
- ✓ design an integrated monitoring system on territorial inequalities;

[1] This article is the result of the collaboration between the authors. In particular: Anna Maria CECCHINI wrote Paragraph 1; Susi OSTI wrote Paragraph 2; Monica BAILOT wrote Paragraph 3; Valeria QUONDAMSTEFANO wrote Paragraph 4; Livia FIORONI wrote the Paragraph 5; Valentina SPINELLA wrote the Paragraph 6. However, the present paper is the result of a joint work.

- ✓ increase knowledge of the phenomena, raise awareness among citizens and institutions of the related environmental impact.

The literature on the topic includes some interesting studies based on official data, such as the MobilitAria 2018 Report (Kyoto Club and CNR-IIA), which analyzes the trend of air quality and sustainable mobility in the 14 major Italian cities over the decade 2006-2016; the 21st Report on the Mobility of Italians (Isfort, 2024), which contains a description of individual indicators to represent the trend of the phenomenon, but lacks synthetic indices comparable over time and space. Hence the need to calculate a general composite index.

To carry out the research and enable a multidimensional analysis of territorial differences in sustainable mobility, a composite index was developed to provide a synthetic measurement of complex and multidimensional phenomena. Sustainable urban mobility is analysed considering three domains: private motorisation, public transport and active mobility and sharing. The *Adjusted Mazziotta-Pareto Index* (AMPI) was calculated for each domain, focusing on 14 Metropolitan city capitals, over the period 2016-2022.

2. Data Base

When constructing a synthetic index, the selection of indicators is the result of a trade-off between redundancy and loss of information. The starting database comprises 35 simple indicators from 2016 to 2022, with territorial detail including provincial capitals, geographical subdivisions, and the national total.

Following an in-depth descriptive analysis—including tables, graphs, and statistical measures to facilitate a comprehensive understanding of sustainable mobility dynamics—the trends of several key indicators were examined. The selection of these indicators was guided by a reasoned and conceptually grounded criterion, ensuring that the final set adequately represents all relevant aspects within the three domains: Private Motorisation, Public Transport, and Active Mobility and Sharing. The selected indicators are national in scope, representative of the phenomenon under investigation, and many are aligned with the objectives of specific legislation and are commonly used in international comparisons.

Among other qualities, all indicators are well documented and regularly updated. They are considered robust, as they are based on national and/or international standards and benefit from broad consensus regarding their validity. This ensures their comparability over time and across different geographic contexts. The chosen indicators show variations in time and space, making them largely sensitive to the dynamics of the multidimensional phenomenon to be analysed, and are available in time and spatial series.

In Italy, the private car dominates urban travel. Between 2016 and 2022, in all cities, the motorization rate remained very high, with more than six cars per ten inhabitants. At the end of this period, the number of cars per inhabitant is still growing, driven by the evolution of teleworking/working for home (WFH), although it has not reached 2019 levels. However, the pressure on the environment caused by vehicle traffic depends not only on the number of vehicles but also on their composition. An adequate number of low-emission vehicles can reduce this pressure. In contrast to the motorization rate, the index of pollutant potential associated with vehicles on the road has shown a decreasing trend in recent years: between 2016 and 2022, it fells from 153.0 to 116.2 in Italy.

In the post-pandemic scenario, weak signs of ecological transition are emerging from cities. Public transport is struggling to recover after the drastic reduction in passenger numbers caused by the health restrictions introduced to contain COVID-19 infection. It is still unclear how active walking and cycling will evolve in the years to come, despite having boomed during the pandemic.

The National Plan for Cycling Mobility has set the goal of achieving a density of 32 km of cycling paths per 100 km² by 2024. In Italy, despite a significant increase in the period 2016-2022 (from 21.9 km/100 km² to 27.9 km/100 km²), the gap to the target is still evident.

3. Metadata

The information sources of the selected individual indicators are the Istat survey ‘Urban Environmental data', *Automobile Club Italiano* (ACI) archives and the *Pubblico Registro Automobilistico* (PRA) archives. The following indicators are calculated on data from ACI and the PRA archives. Inhabitant data are derived from the Permanent Population and Housing Census (PPHC); therefore, all indicators per inhabitant are recalculated in time series based on the revision of the intercensary interval of the resident population.

Domain “Private Motorization”:

(A) *Motorization rate for car and motorcycles (per 1,000 inhabitants).* Ratio of the number of passenger cars/motorcycles and the resident population in the reference year multiplied by 1,000 (-);

(B) *Percentage of cars with low-emission.* Ratio of the number of cars with electric traction, hybrids (dual engine, electric and combustion), gas (methane, LPG or hydrogen) or bi-fuel (dual fuel, petrol and gas) and the total number of cars multiplied by 100 (+);

(C) *Percentage of cars with high-emission (Euro 4 or lower).* Ratio of the number of passenger cars with an emission class less than or equal to 4 and the total number of cars multiplied by 100 (-);

(D) *Index of pollutant potential of cars.* Ratio of the sum of the number of high (from Euro 0 to Euro 3) and medium polluting (powered by petrol or diesel from Euro 4 to Euro 6) passenger cars and the sum of medium polluting and low polluting (electric cars and other low emission cars from Euro 4 to Euro 6, hybrid, powered by natural gas or LPG or bi-fuel) ones multiplied by 100 (-).

The source of the following indicators is the ‘Urban Environmental data' survey. Istat launched it in 1998 in the 20 regional capital municipalities and 2 provincial capitals, Bolzano and Catania. Since 2002, this survey has involved all provincial capital municipalities.

Domain “Public Transportation”:

(A) *Demand for local public transportation (annual passengers per inhabitant).* The indicator considers all the following modes of LPT: Bus, Tram, Trolleybus, Underground, Waterborne transport, Funicular, Cable car and other hectometric systems. Suburban or metropolitan rail services are excluded and the indicator corresponds to the average number of LPT passengers per inhabitant (+);

(B) *Availability of buses for local public transport (vehicles per 100 thousand inhabitants).* Ratio of the number of vehicles available for daily public transport operations and the resident population in the reference year multiplied by 100,000 (+);

(C) *Total seat-kilometers offered by local public transport (values per inhabitant).* Ratio of the number of seat-km (summation, for each vehicle used, of the product of available seats and kilometers travelled) and the population resident in the reference year (+).

Domain “Active mobility and sharing”:

(A) *Density of bicycle paths (km per 100 square km of land area).* Ratio of the length of cycle paths, expressed in km, to the reference land area according to the Istat geographic information system (+);

(B) *Vehicle availability of car sharing services (vehicles per 10 thousand inhabitants).* Ratio of the number of public cars available for reservation (station-based or free flow) and the resident population in the reference year multiplied by 10 thousand (+);

(C) *Availability of vehicles used for bike sharing, scooter sharing and electric micromobility services (vehicles per 10 thousand inhabitants).* Ratio of the number of public vehicles for micromobility on reservation and the resident population in the reference year multiplied by 10 thousand (+).

4. Methodology

To evaluate the differences in sustainable mobility at territorial level, taking into account the spread of people's modes of travel, with particular reference to private, collective and smart mobility, a composite indicator was selected.

The construction of a composite indicator is a complex process that involves aggregating individual indicators into a single index, grounded in an underlying conceptual framework that reflects the multidimensional nature of the phenomenon being measured. The main challenges in this approach include the choice of the theoretical framework, the selection of the most representative indicators, and their treatment to compare and aggregate them. The first challenge is the choice of the theoretical framework, which is crucial for guiding the construction of the composite indicator (OECD, 2004). This framework must capture all relevant dimensions of the studied phenomenon, as a lack of clear theory can result in an indicator that does not accurately reflect the multi-dimensional concept. Another critical step is the selection of representative indicators.

The chosen indicators must be relevant, measurable, and reliable to ensure the validity and relevance of the composite indicator. An inadequate selection of indicators can compromise the reliability and validity of the composite index. Once the indicators have been selected, they must be processed and normalized to ensure comparability across units and dimensions. Normalization methods such as standardization or min-max transformation are commonly used, but the right method can vary depending on the nature of the indicators and the theoretical model adopted. The next step is the aggregation of these indicators. This process can be complex, requiring decisions on how to weight the different indicators and which aggregation method to use, such as arithmetic means, weighted means, geometric means, or other advanced statistical methods. After constructing the composite indicator, it is essential to validate its accuracy and reliability through robustness tests, sensitivity analyses, and comparisons with existing measures.

Validation ensures that the composite indicator provides a truthful and useful representation of the multi-dimensional concept.

Finally, the composite indicator must be correctly interpreted and clearly communicated. The results should be presented in a way that is accessible to stakeholders, enabling them to inform policy or managerial decisions effectively.

In summary, constructing a composite indicator requires a series of well-considered steps, each presenting specific challenges. A rigorous methodology and a clear theoretical understanding are fundamental to creating a composite indicator that is useful, accurate, and representative of the multi-dimensional phenomenon under examination.

In this paper, to synthesize the individual indicators into a single measure, the *Adjusted Mazziotta-Pareto Index* (AMPI) is used (Mazziotta-Pareto, 2016), a partially non-compensatory composite index based on a standardization of individual indicators which makes the indicators independent of the unit of measurement (De Muro *et al*., 2011). This summary measure is designed to rescale individual indicators in the range (70; 130) according to two "goalposts," i.e., a minimum and a maximum value representing the possible range of each variable for all periods and all units. This index makes it possible to measure, in a synthetic way, complex and multidimensional phenomena in space and time ensuring robustness.

The AMPI is calculated for the 14 metropolitan city capitals (Turin, Milan, Venice, Genoa, Bologna, Florence, Rome, Naples, Bari, Reggio di Calabria, Palermo, Messina, Catania, and Cagliari) between 2016-2022 years. The comparison at territorial level is facilitated because 100 represents the reference value of Italy in 2016; values higher than 100 indicate an advantageous situation (high sustainable mobility), while lower values indicate a disadvantageous situation (low sustainable mobility).

5. Analyses of results

The following section reports the results for each domain and for the overall AMPI that considers the three domain together.

5.1. Private Motorization

The domain “Private Motorization” take into account four individual indicators: motorization rate for car and motorcycles, percentage of cars with low-emission, percentage of cars with high-emission (Euro 4 or lower) and the index of pollutant potential of cars. Figure 1 shows the values of AMPI and ranking for metropolitan city capital and geographic areas in the period 2016-2022. Values greater than 100 of AMPI indicate a low use of private motorization (sustainable mobility higher than Italy in 2016), lower values indicate a high use.

The AMPI value for Italy showed a steady increase over the period considered, growing from 100 in 2016 to 112.26 in 2022. This indicates that policies aimed at promoting green motorization have had a positive impact, leading to improved sustainable mobility over time. Regarding to metropolitan cities capitals, over the period considered, the top six - Bologna, Venice, Florence, Milan, Turin and Genoa - always maintain the same position. Until 2019, the seventh position was held by Bari (the only southern city with values consistently above 100) that passed to Rome from 2020. Palermo and Cagliari always maintain the ninth and tenth positions, respectively. The 11th position was held by Messina until 2019, after which it was taken by Naples. Reggio di Calabria occupied twelfth place for the first three years, then was overtaken by Naples in 2019 and later by Messina, ultimately falling to thirteenth place. Catania remained in last position throughout the entire period.

Figure 1 – *Domain "Private Motorization": AMPI and ranking of metropolitan cities capitals. Years 2016-2022.*

	2016		2017		2018		2019		2020		2021		2022	
Territory	AMPI	Ranking	AMPI	Ranking	AMPI	Ranking	AMPI	Ranking	AMPI	Ranking	AMPI	Ranking	AMPI	Ranking
Turin	103.46	5	104.66	6	107.32	5	110.11	5	113.00	5	116.43	5	118.33	5
Milan	104.85	4	107.29	4	109.63	4	112.36	4	114.67	4	117.72	4	120.54	3
Venice	109.96	2	112.54	2	114.86	2	117.60	2	119.75	2	122.60	2	124.88	2
Genoa	102.57	6	104.69	5	106.62	6	108.44	6	110.90	6	114.17	6	116.78	6
Bologna	115.14	1	117.34	1	119.59	1	121.94	1	124.27	1	126.88	1	128.73	1
Florence	107.52	3	109.66	3	111.23	3	112.79	3	114.96	3	117.97	3	119.95	4
Rome	99.35	8	102.10	8	104.85	8	107.16	8	109.40	7	112.23	7	114.34	7
Naples	85.83	13	89.18	13	92.01	13	94.71	12	96.52	11	99.02	11	101.10	11
Bari	101.30	7	103.56	7	105.50	7	107.28	7	109.25	8	112.03	8	111.33	8
Reggio Calabria	88.79	12	90.60	12	92.22	12	93.68	13	94.70	13	96.59	13	98.08	13
Palermo	93.50	9	95.53	9	97.28	9	98.83	9	100.03	9	101.94	9	103.71	9
Messina	89.84	11	91.63	11	93.20	11	94.88	11	95.82	12	97.51	12	99.21	12
Catania	78.54	14	80.67	14	82.15	14	83.07	14	84.50	14	86.58	14	87.99	14
Cagliari	90.69	10	92.49	10	94.19	10	95.85	10	97.32	10	99.73	10	101.49	10
ITALY	100.00		102.15		104.08		106.02		107.84		110.32		112.26	

Source: based on Istat data

5.2. *Public Transportation*

The domain "Public Transportation" consider three individual indicators: demand for local public transportation, availability of buses for local public transport and total seat-kilometers offered by local public transport. Figure 2 highlights, the level of public transportation for each metropolitan city in the period 2016-2022. Values greater than 100 indicate above-average public transport use; lower values display a low use. Between 2016 and 2022, Venice presents the highest level of AMPI, the lowest value (119.55) recorded in 2020 due to the Covid-19 pandemic, while the highest value, it was registered in 2019 (126.66).

Messina ranked last in 2016 and 2019 with an AMPI value of 85.16 and 85.99, but showed a slight improvement over the period considered, reaching to 88.89 in 2022 and surpassing Palermo, Reggio di Calabria and Naples. Palermo ranked last in 2017, 2018, 2020, 2021 and 2022, with an AMPI value of 87.36 in 2017 that further declined to 85.47 in 2021, even if registers a slight improvement to 86.42 in 2022. Venice and Milan break away from the other cities, indicating a more intensive use of public transportation. A clear division emerges between metropolitan city capitals in the North and Center and those in the South. The only exception is Cagliari, which alternates between third and fourth place in the ranking, with AMPI values ranging from a minimum of 108.20 to a maximum of 111.38.

Figure 2 – *Domain "Public Transportation": AMPI and ranking of metropolitan cities capitals. Years 2016-2022.*

	2016		2017		2018		2019		2020		2021		2022	
Territory	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**
Turin	108.21	6	108.57	5	106.77	6	108.97	5	103.33	5	100.74	7	103.39	7
Milan	120.38	2	121.79	2	121.85	2	123.33	2	112.70	2	119.73	2	120.28	2
Venice	**126.48**	**1**	**126.62**	**1**	**126.37**	**1**	**126.66**	**1**	**119.55**	**1**	**123.37**	**1**	**124.50**	**1**
Genoa	105.14	8	105.47	7	104.74	7	105.29	7	99.67	8	100.49	8	102.01	8
Bologna	105.56	7	105.10	8	104.70	8	104.60	8	101.23	7	102.84	6	103.91	6
Florence	108.57	5	109.18	4	111.16	3	112.32	3	107.50	4	110.02	4	110.81	3
Rome	110.78	3	108.33	6	107.20	5	107.63	6	102.76	6	105.36	5	105.72	5
Naples	88.59	11	91.57	11	93.06	11	88.97	11	86.66	12	87.68	12	86.94	13
Bari	95.31	9	93.89	9	94.55	9	94.78	9	93.21	9	93.61	9	93.47	9
Reggio Calabria	88.49	12	88.64	12	88.06	12	87.92	12	88.23	11	88.42	11	88.59	12
Palermo	86.68	13	**87.36**	**14**	**87.16**	**14**	86.85	13	**85.73**	**14**	**85.47**	**14**	**86.42**	**14**
Messina	**85.16**	**14**	87.57	13	87.50	13	**85.99**	**14**	86.58	13	87.26	13	88.89	11
Catania	92.11	10	93.49	10	93.95	10	94.06	10	92.07	10	92.76	10	90.88	10
Cagliari	109.09	4	109.51	3	109.61	4	111.38	4	108.20	3	110.48	3	110.26	4
ITALY	**100.00**		**99.99**		**99.87**		**100.03**		**96.74**		**98.28**		**98.83**	

Source: based on Istat data

5.3. *Active mobility and sharing*

Regarding the domain "Active mobility and sharing" (Figure 3) that considers three individual indicators (density of bicycle paths, availability of vehicles for car sharing and bike sharing services, scooter sharing and electric micromobility services), an AMPI value higher than 100 indicates above-average use (relative Italy in 2016) of active mobility and sharing services (car, bike, scooter sharing and electric micro mobility), while lower values indicate the opposite.

Figure 3 – *Domain "Active mobility and sharing": AMPI and ranking of metropolitan cities capitals. Years 2016-2022.*

	2016		2017		2018		2019		2020		2021		2022	
Territory	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**
Turin	118.82	2	128.59	3	126.38	3	124.57	3	122.86	4	125.06	3	132.74	2
Milan	**128.30**	**1**	**140.58**	**1**	**144.96**	**1**	**141.12**	**1**	**144.38**	**1**	**143.77**	**1**	**149.43**	**1**
Venice	98.32	7	98.38	9	99.15	8	99.37	8	104.76	5	104.96	6	105.17	6
Genoa	94.39	11	95.07	11	95.03	12	95.34	11	96.02	10	97.78	9	98.45	9
Bologna	104.45	4	104.54	4	116.54	4	120.03	4	124.28	3	127.13	2	128.44	3
Florence	115.77	3	129.99	2	130.42	2	132.43	2	133.84	2	119.30	4	126.52	4
Rome	101.07	5	102.07	5	103.21	5	104.24	5	104.06	7	107.48	5	108.40	5
Naples	95.39	10	94.89	12	95.31	11	95.22.	12	95.58	11	96.74	10	96.75	12
Bari	96.83	9	96.69	10	95.97	10	96.33	10	96.51	9	96.51	11	97.28	10
Reggio Calabria	**93.45**	**14**	**93.66**	**14**	**94.21**	**14**	95.02	13	95.32	13	95.59	12	94.57	13
Palermo	98.41	6	99.20	7	99.48	7	99.71	7	100.01	8	99.70	8	100.22	8
Messina	93.78	12	93.78	13	94.56	13	**94.56**	**14**	**94.56**	**14**	**94.73**	**14**	**93.78**	**14**
Catania	93.72	13	98.71	8	97.56	9	96.61	9	95.36	12	95.47	13	97.16	11
Cagliari	97.57	8	99.57	6	101.13	6	102.76	6	104.74	6	103.80	7	104.79	7
ITALY	**100.00**		**102.00**		**103.22**		**102.85**		**102.87**		**103.33**		**104.74**	

Source: based on Istat data

From 2016 to 2022, Milan has the highest level of AMPI increasing over time, from 128.30 in 2016 to 149.43 in 2022. Over the seven years of analysis, three metropolitan cities alternate the second place in the ranking: Turin (2016 and 2022), Florence (from 2017 to 2020) and Bologna (2021). Between 2016 and 2018, the city that makes the least use of active mobility and sharing services is Reggio Calabria, while since 2019 Messina occupies the last place. Despite being below the threshold value, both show a slight improvement until 2021, while in 2022 the AMPI values decreas. Rome, the most populated city, maintains the fifth position in the years 2016, 2017, 2018, 2019, 2021 and 2022, dropping to seventh in 2020.

Respectively the AMPI value increased from 101.07 in 2016 to 108.40 in 2022, indicating a more intensive use of active and sharing mobility.

5.4. Overall AMPI

The overall AMPI considers the three domain together, providing a synthetic measurement of sustainable mobility in the metropolitan cities capitals. The results show that in Italy, the AMPI values constantly increase between 2016 and 2022, indicating an increasing sustainable mobility over time. The AMPI value grow up from 100 in 2016 to 104.99 in 2022. Milan presents the highest level of AMPI over the period considered, the lowest value (117.04) is recorded in 2016 while the highest value is registered in 2022 (128.64). Catania is always in the last position, with an AMPI value of 87.60 in 2016 and 91.85 in 2022. Among the southern and island cities, the only metropolitan city that presents values above 100 are Cagliari, starting from 2018 and Bari in 2021 and 2022. The overall AMPI confirms a clear distinction between the metropolitan cities in the North-Central and in the South island.

Figure 4 – *Overall AMPI and ranking of metropolitan cities capitals. Years 2016-2022.*

	2016		2017		2018		2019		2020		2021		2022	
Territory	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**	**AMPI**	**Ranking**
Turin	109.79	4	112.97	3	112.76	4	114.11	4	112.50	5	113.19	5	116.94	5
Milan	**117.04**	**1**	**121.71**	**1**	**123.44**	**1**	**124.49**	**1**	**122.22**	**1**	**125.97**	**1**	**128.54**	**1**
Venice	110.39	3	111.33	4	112.36	5	113.42	5	114.26	4	116.36	3	117.47	4
Genoa	100.49	7	101.52	7	101.88	7	102.72	8	101.80	8	103.65	8	105.15	8
Bologna	108.17	5	108.67	5	113.25	3	115.00	3	115.58	3	117.86	2	119.24	2
Florence	110.50	2	115.47	2	116.91	2	118.44	2	117.73	2	115.82	4	118.75	3
Rome	103.49	6	104.08	6	105.06	6	106.32	6	105.33	6	108.28	6	109.36	6
Naples	89.76	12	91.82	11	93.44	11	92.88	11	92.71	11	94.22	11	94.56	11
Bari	97.75	9	97.88	9	98.43	9	99.15	9	99.18	9	100.07	9	100.11	9
Reggio Calabria	90.18	11	90.92	12	91.42	13	92.10	12	92.64	12	93.39	12	93.58	13
Palermo	92.61	10	93.77	10	94.34	10	94.77	10	94.78	10	95.15	10	96.20	10
Messina	89.46	13	90.92	13	91.65	12	91.53	13	92.14	13	92.96	13	93.77	12
Catania	**87.60**	**14**	**90.33**	**14**	**90.74**	**14**	**90.87**	**14**	**90.42**	**14**	**91.45**	**14**	**91.85**	**14**
Cagliari	98.54	8	100.04	8	101.25	8	102.94	7	103.22	7	104.48	7	105.39	7
ITALY	**100.00**		**101.37**		**102.36**		**102.91**		**102.28**		**103.74**		**104.99**	

Source: based on Istat data

6. Conclusions

Realizing that urgent measures and new models of governance are needed, with our MOSER “Sustainable And Resilient MObility” project we intend to address issues related to the current spread of people's modes of travel, with particular reference to private and collective mobility and delving into the issues of road safety and smart mobility. To provide new insights that are also useful to public decision makers.

Through the process of constructing an environmental sustainability index, we have identified basic, individual indicators for sustainable and resilient mobility, which operationalize these concepts. This intricate task involved thorough research and analysis to ensure that the indicators accurately reflect the various dimensions of sustainable mobility. Thanks to the availability of official statistical data, we identified three domains within which the analyses are robust and consistent: mobility infrastructure, public transport availability, and environmental impact. At the current state of the analysis, the work done shows that, in recent years, there has been increased interest in sustainable mobility issues, ranging from green and sharing policies to a growing awareness of the need for enhancing public transport.

This heightened interest is partly driven by global climate change concerns and the need to reduce urban congestion and pollution. However, a significant challenge we face is the limited availability of local-level data and the lack of long-term time series, which are crucial for tracking progress and trends over time.

The results of this analysis between 2016 and 2022 show a varied picture but with clear trends for Italy's major metropolitan cities. Overall, Italy has seen a steady improvement in sustainable mobility, as evidenced by the increase in AMPI values in all three domains analyzed: Private Motorization, Public Transport, and Active and Shared Mobility. This suggests that policies and investments to promote greener alternatives to private transportation are having a positive impact nationwide.

Specifically, for Private Motorization, there is clear success in initiatives to encourage the use of low-emission vehicles, with Italy moving progressively toward greater sustainability. Northern cities such as Bologna, Venice, Florence, Milan, Turin and Genoa are confirmed as leaders in this area. As for Public Transport, Venice and Milan stand out for intensive use, albeit with fluctuations due to the Covid-19 pandemic, while the gap between North/Central and South remains significant, with the exception of Cagliari. Finally, the domain of Active and Shared Mobility sees Milan emerge as an excellence, demonstrating strong adoption of services such as car, bike and scooter sharing, and electric micromobility. In summary, while the country as a whole is progressing, a clear geographic dichotomy remains, with cities in the North and Center leading the transition to sustainable mobility. The cities of the South and Islands, while showing some signs of improvement (such as Cagliari and, to a lesser extent, Bari), are generally in more backward positions, with Catania remaining at the tail end.

These disparities highlight the need for targeted policies and specific investments to reduce the gap and promote more equitable and sustainable mobility throughout the country. The comparative model thus obtained allows the identification of areas where good practices need to be extended and can be replicated on a larger scale.

The pandemic may serve as a pivotal moment, potentially marking a dividing line between an Italy that is "not very green" and an Italy that is eager to adopt more sustainable travel practices. During the pandemic, there was a noticeable shift towards new modes of travel, such as scooters, bicycles, and car sharing, alongside efforts to enhance public transport. These changes were driven by the necessity to maintain social distancing and reduce reliance on crowded public transport, thereby accelerating the adoption of greener travel alternatives.

The project will continue with the analysis of two domains, Land and Environment and Road Incidentally. The Territory and Environment domain will explore how land use and environmental factors influence mobility patterns, while the Road Incidentally domain will examine safety aspects (in relation to deaths and injuries in accidents). A synthesis of all domains will then be conducted to provide a comprehensive assessment of mobility in Italy.

This holistic approach will allow us to identify areas where sustainable mobility can be further promoted and highlight best practices that can be adopted nationwide. Analytical focuses are being developed where data availability allows, ensuring that each domain is thoroughly examined. Additionally, we are implementing a set of simple indicators for each domain to facilitate comparison and monitor progress over time.

The ultimate goal of the MOSER project is to promote a process of cultural change that highlights the environmental benefits achievable through more sustainable mobility. By demonstrating the positive impacts on air quality, public health, and urban livability, the project seeks to drive investment in local development and spatial planning policies that support sustainable practices.

Promoting a transition to greener mobility options not only helps in combating climate change but also enhances the quality of life for residents by creating more livable, efficient, and connected communities. Through education, policy advocacy, and collaboration with local governments and stakeholders, we strive to foster a collective commitment to sustainable mobility and help pave the way for a greener future. In line with what has been stated so far, significant investments in infrastructure and monitoring systems are desirable.

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