

From Isolation to Inclusion: the Multidimensional Transport Poverty Index in Portugal

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Executive Summary

Transport poverty limits people's access to essential opportunities and exacerbates social and territorial inequalities. Portugal lacked a replicable and updatable tool capable of monitoring this phenomenon on a continuous basis, in support of public mobility policies and the implementation of the Social Climate Fund.

This project develops the Multidimensional Transport Poverty Index (IMPT), built exclusively from open data. It integrates four dimensions: accessibility, mobility, affordability and road safety. It was applied to the 124 parishes of the Lisbon Metropolitan Area (AML), producing a detailed portrait of the territorial distribution of transport poverty. The results are available on a publicly accessible dashboard at <https://ushift.pt/apps/impt>.

The IMPT does not prescribe interventions. It is a diagnostic and prioritisation tool, whose implementation lies with the municipalities and transport authorities, according to their own realities and objectives.

Recommendations

- Use the IMPT as a territorial diagnostic tool and for prioritising areas of intervention within planning instruments (e.g., SUMP, Municipal Master Plan);
- Define a municipal, regional or national strategy for the eradication of transport poverty;
- Explore each dimension independently, enabling the definition of goals, targets, and the monitoring of respective progress;
- Ensure institutional continuity of the open data sources that feed the index, and their periodic updating (e.g., Census and IMob cycles).
- Replicate the IMPT in other Metropolitan Areas and municipalities at the national level, exploring its scalability down to the municipal level;
- The quality of the IMPT is dependent on the data that feeds it. Therefore, improving open data policies, including microdata, should be a priority in order to enable a more detailed and accurate assessment of transport poverty in Portugal.

Intended recipients of the policy brief

- Institute for Mobility and Transport (IMT);
- Lisbon Metropolitan Transport Authority (TML) and other transport authorities;
- Municipal Councils and Intermunicipal Communities (CIM);
- PLANAPP and the Portuguese Environment Agency (within the scope of the Social Climate Plan).

Introduction and Problem Statement

Transport poverty is a multidimensional issue which arises when individuals or households face limited, inaccessible, or inadequate transport options, thereby compromising access to essential services and opportunities, including healthcare, employment, recreation, and food. It disproportionately affects low-income populations and peripheral areas, contributing to social and territorial exclusion (Lucas et al., 2016; Allen & Farber, 2019).

The European Union formally recognised this reality in Regulation (EU) 2023/955, which establishes the Social Climate Fund. Transport poverty is defined therein as the inability or difficulty to afford private or public transport costs, or the lack of or limited access to the transport necessary to reach essential socioeconomic services. The operational application of this concept requires measurement instruments adapted to the specificities of regional and national contexts.

Although the literature offers robust approaches for measuring transport poverty (Kelly et al., 2023; Lucas et al., 2016), these are frequently based on primary data collection or proprietary data, making them costly to maintain and difficult to replicate systematically. Furthermore, municipal authorities, intermunicipal communities, and transport operators in Portugal lack a comparable and up-to-date cross-territorial indicator.

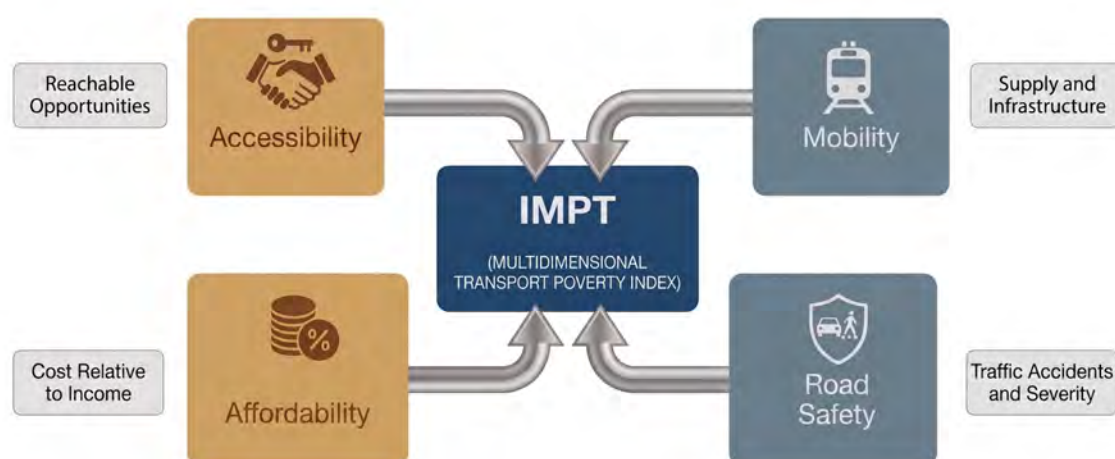
This project addresses this gap by developing the Multidimensional Transport Poverty Index (IMPT), designed exclusively from publicly available, updatable secondary data at the parish level. The scope of the project ends with the construction of the index, its application to the AML, and the provision of a visualisation tool. The IMPT is therefore an instrument to support the definition, prioritisation and implementation of public policy interventions, which can be used by local, regional and national authorities.

Analysis / Key Findings

The construction of the IMPT followed a composite approach (UN, OECD), aggregating normalised indicators across four dimensions that the literature identifies as core (Lucas et al.

2016) for the assessment of transport poverty (Figure 1): Accessibility, Mobility, Affordability and Road Safety (within the scope of transport externalities).

Figure 1 – The IMPT and its dimensions



Source: Generated by Nano Banana

Data sources

The IMPT was built exclusively from publicly available (open) secondary data collected on a regular basis, a necessary condition for the

tool's sustainability as a periodic monitoring instrument. Table 1 lists the main data sources used per dimension.

Table 1 – Data sources

Source	Dimensions	Data used
INE — Census 2021	Affordability, Safety	Population, median household income, housing costs, socioeconomic characteristics
Mobility Survey 2017 (INE)	Affordability, Mobility	Travel patterns, modal share by parish, number of vehicles per household
GTFS (PT operators)	Mobility	Timetables, service frequencies, weighted waiting time, stop coverage, number of transfers
PT transport operators' annual accounting reports	Affordability	Average monthly public transport pass price per passenger, and average single on-board ticket price per passenger
OpenStreetMap (OSM)	Accessibility, Mobility	Road network, cycling network, pedestrian infrastructure, points of interest
TML / PMUS	Accessibility, Safety	Shared mobility, crashes data (ANSR)
Global Building Atlas	Accessibility	Location of workplaces (<i>proxy</i> for employment)

Dimensions and indicators

- **Accessibility (A):** access and travel time, door-to-door, to essential amenities (healthcare, schools, supermarkets, green spaces, recreation, and leisure), calculated using a door-to-door travel time matrix built with r5r (Pereira et al., 2021) based on OSM, digital elevation models, and GTFS feeds from all operators.
- **Mobility (M):** Commuting travel times (to work), existence of pedestrian and cycling infrastructure, public transport stop coverage and frequency, and presence of shared mobility points.
- **Affordability (Ae):** the cost of commuting by car and public transportation, calculated for all trips in the 2017 IMob survey, weighted by the modal share observed in the parish and adjusted for median household income.
- **Safety (S):** total accidents, 30-day fatalities, severity index, among other accident indicators, based on official ANSR data, normalised by population.

The key indicators were aggregated at the parish level for each dimension, with weights derived from a combination of principal component analysis (PCA), modal distribution and validation with AML municipalities during an interactive workshop held in April 2026. The purpose of PCA was to identify and capture latent variance patterns among the included indicators, avoiding reliance on arbitrary weighting.

For the Lisbon metropolitan area case study, the first principal component (PCA1) captures between 45% and 60% of the original information in each dimension (except for Affordability, which was calculated using a specific indicator).

Each dimension has scores ranging from 0 to 100, with 100 assigned to the parish or area with the best performance in that dimension compared to others, and 0 to the worst. These values are relative and derived from indicator normalisation. Therefore, the higher the dimension score, the better the performance.

Multidimensional Transport Poverty Index

The four dimensions are then aggregated to create the Multidimensional Transport Poverty Index, using three different but complementary methods outlined in Table 2. This diversity aims to support different policy analyses, highlighting distinct dynamics in the data, allowing for a better fit in interpreting results across various contexts.

As the IMPT measures Transport Poverty, for the result to be coherent with the concept, the value obtained from the equations presented in Table 2 is then inverted $\frac{1}{IMPT}$, so the IMPT ranges from 0 a 100, with 100 representing the highest level of transport poverty in the analysed areas, and 0 the lowest. In summary, the lower the index, the better the transport conditions across all dimensions.

Table 2 – IMPT computation methods

Method	Equation	Interpretation
Geometric mean "Critical"	$IMPT_{geo} = A * M * Ae * S^{1/4}$	<i>Non-compensatory</i> : non-linearly penalises dimensions with very low values. Highlights the most severe situations where at least one dimension is severely deficient.
Entropy weights "Contrasting"	$IMPT_{co} = \prod_{j=1}^n D_{ij}^{w_j}$ Where w_j is the weight of dimension j computed by the entropy method and D_{ij} is the score of dimension j in parish i.	<i>Non-compensatory</i> : Weights are determined by the empirical dispersion of dimensions across parishes: the dimension that varies most across territories receives the highest weight. Maximises and benefits territorial contrast and is useful for competitive prioritisation of interventions.
Arithmetic mean "Balanced"	$IMPT_{avg} = \frac{A + M + Ae + S}{4}$	<i>Compensatory</i> : high vulnerability in one dimension can be offset by good performance in others. Suitable for defining aggregate policy targets and communicating to non-specialist audiences.

IMPT Dashboard

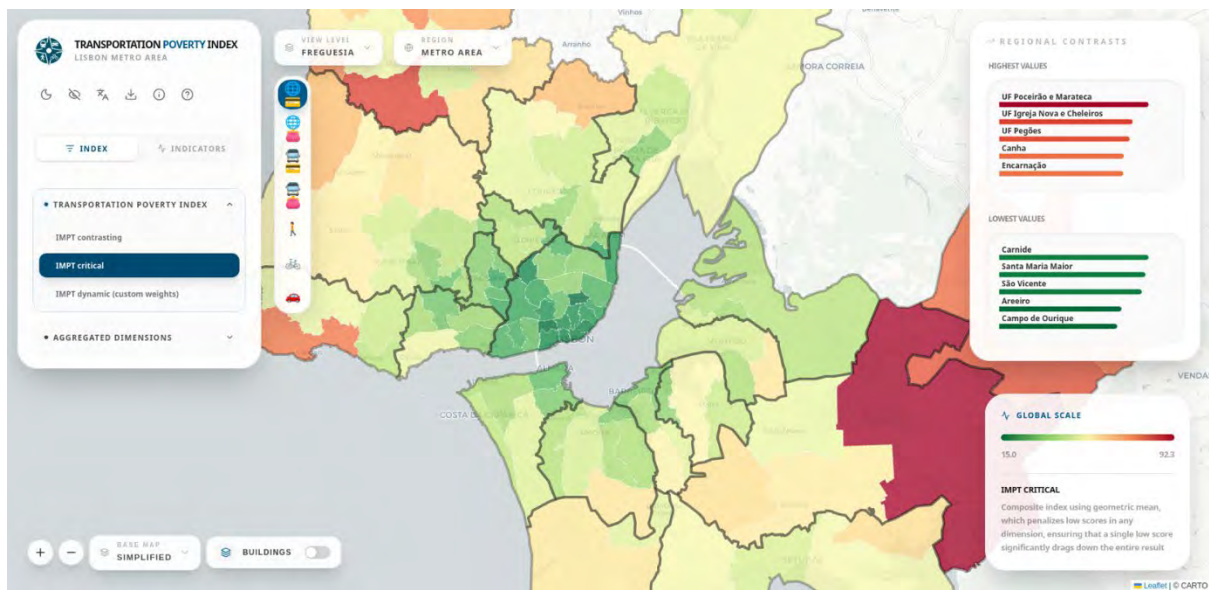
The interactive visualisation and monitoring tool (Figure 2) provides the overall index, results for each dimension by transport mode, indicators, key statistics and summary sheets at various scales (parish, municipality and grid).

In addition to visualising results, this tool also allows the calculation of the aggregate index adjusted to the user's priorities (dynamic or "political" IMPT). For this purpose, an AHP

(Analytical Hierarchy Process) questionnaire is provided, which, by comparing preferences between dimensions, allows the definition of their mathematical weights in an individualised but consistent manner.

Indicator data and results can be downloaded from the platform. The detailed methodological report, R code, and datasets used are also available, ensuring full replicability.

Figure 2 –IMPT dashboard



Available at <https://u-shift.pt/apps/impt>

Results

For the AML case study, the results are presented as an example of the proposed methodology for the IMPT “contrasting”. The

top 5 parishes with the lowest and highest IMPT are presented in Tables 3 and 4, respectively.

Table 3 – 5 Parishes with lower Contrasting IMTP

Parish	IMPT “contrasting”
Arroios	13.4
Areeiro	14.9
Campo de Ourique	15.0
Santo António	15.3
Santa Maria Maior	15.6

Table 4 – 5 Parishes with higher Contrasting IMPT

Parish	IMPT “contrasting”
União de Freguesias de Poceirão e Marateca	92.3
União de Freguesias de Igreja Nova e Cheleiros	82.4
União de Freguesias de Pegões	80.6
Canha	77.0
Encarnação	76.6

The application to the AML reveals that transport poverty does not strictly align with the urban-rural axis. High IMPT levels are observed both in peripheral parishes in the north and south of the AML (typically with lower public transport provision and greater car

dependence), and in urban parishes with degraded affordability relative to local income, or in parishes where a high level of transport poverty results from exposure to road accident risk. The reading by dimension is therefore as relevant as the aggregate reading.

Policy Options and Recommendations

The IMPT is a diagnostic and decision-support instrument that enables:

- *Territorial diagnostics*: identifying parishes and areas of particular vulnerability to transport poverty, in alignment with the definition in Regulation (EU) 2023/955.
- *Investment prioritisation*: supporting the ranking of measures in Sustainable Urban Mobility Plans (SUMP), Intermunicipal Mobility and Transport Plans (PIMT) and Municipal Master Plan (PDM) revisions.
- *Longitudinal monitoring*: tracking the evolution of transport poverty between Census updates, the Mobility Survey, and administrative data, enabling the assessment of the impacts of interventions carried out by municipalities and other entities.

Recommendations:

- Identify the stakeholders that should intervene in the prioritised areas.
- Define a strategy for the eradication of transport and mobility poverty with specific targets.
- Provide continuity to the datasets and other sources used to compute the IMPT.
- Periodically update the IMPT to monitor transport poverty evolution.
- Apply the IMPT at the national level down to at least the municipal level.
- Exercise caution when using the “balanced” IMPT, as it assigns equal weight to all dimensions and may mask dimensions that require intervention.
- Set individual goals for each of the dimensions that make up the IMPT independently, allowing for flexibility in goal setting as well as consideration of context-specific community needs.

Conclusion

The IMPT demonstrates that it is possible to measure and monitor transport poverty in Portugal based exclusively on publicly available secondary data, ensuring replicability and sustainability. The application to the AML produced a detailed territorial portrait, available on an interactive dashboard with summary sheets at different scales.

The IMPT thus constitutes a strategic tool to support the transition towards fairer, evidence-informed mobility, aligned with the objectives of territorial cohesion and social inclusion.

The added value of the index lies in rigorous diagnostics, support for prioritisation, and the monitoring of public policies aimed at correcting socio-territorial inequalities. The concrete

definition of interventions remains the responsibility of municipalities, CIM and transport authorities, who have the territorial proximity and political mandate to respond to the identified vulnerabilities.

The IMPT is a relative value, intended for comparative purposes. A score of 100 or 0 should not be universally interpreted as the “ideal” or the “worst”, respectively

Replication in other regions of the country depends, above all, on the continuity and quality of open data at the parish and municipal levels. The data, methodological detail, and code for calculating the IMPT and its indicators are available at ushift.pt/apps/impt, which enables their replication in other regions.

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