SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

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About GOLIA

GOLIA is a project focused on Governing, Optimising and Leveraging Innovation in cities through a data-driven and social-optimum led approach. It aims to ensure an adaptive, accessible and just mobility system planned and governed through digital assets, and inclusive, co-creative policy making processes. Through the integration of STEM and SSH expertise and approaches, GOLIA will revolutionize spatial and mobility planning by co-developing and testing vision-led Social Optimum Mobility Index, a metric to assess urban mobility systems based not only on economic variables but also on indicators such as social support, healthy life quality or freedom to make transport choices. The index will be location and time dependent to enable dynamic management of transport offer and spaces.

The project will analyse the policy making processes, citizen engagement practices and digital assets of the three Partner cities and using the gained knowledge, it will create an integrated, interdisciplinary and Adaptive Mobility Smart Governance Model. GOLIA aims to understand how, and under which conditions, data generated by Smart Cities can support more inclusive and adaptive mobility governance. The project focuses on the role of AI-based tools, novel communication channels, and consultation methodologies in improving the engagement of citizens and stakeholders in mobility planning and decision-making.

GOLIA also seeks to identify governance models that can help cities design and implement mobility policies that remain effective under conditions of uncertainty, including political instability, extreme weather events, pandemics, and other disruptive situations. These governance models are based on the co-development, co-design, and co-monitoring of mobility policies with citizens, firms, public authorities, and other relevant stakeholders.

Deliverable Detailed Information

Key words

Social Optimum Mobility Index (SOMI), Atlas of Accessibility, transport personas, accessibility mapping

GOLIA Outputs Mapping to GA Commitments

Table 1: Deliverable Adherence to Grant Agreement deliverable and work description

Mapping D1.4 Outputs to the GA Deliverable Description
Extract of the Deliverable Description from the GA *"D1.4 SOMI and atlas of Accessibility. Definition of SOMI applied to every city, including set of maps visualizing current accessibility levels across pilot cities for different mobility solutions."*
Chapters addressing the Deliverable Description *Chapter 3 and Chapter 4*
Justification *Chapter 3 provides the SOMI calculation model and applies the methodology to the pilot cities and Chapter 4 addresses the Atlas of Accessibility component of the deliverable as it presents the methodological approach used to develop the Atlas and the set of maps visualising current accessibility levels across the three pilot cities and interprets the results by destination category and, subsequently, by persona relevance.*
Mapping D1.4 Outputs to the GA Task Description
Extract of the Task Description from the GA *"1.4 will develop the Social Optimum Mobility Planning Index & the new generation transportation model for its implementation by taking into consideration the UN's National Happiness Index and the Sustainable Development Index, specifically adapting these to the transport and mobility context. The methodology begins by defining core dimensions of MaaR such as Accessibility, Sustainability, Efficiency, Equity, and Safety (in line with T1.3), each with specific, measurable indicators like average travel time, carbon emissions per passenger-kilometer, and accident rates per capita. These indicators are then normalized using techniques such as min-max scaling or Z-scores to ensure comparability across different units and scales. Weights for each indicator are assigned based on the importance as determined through ICB stakeholders' consultations using the Analytic Hierarchy Process (AHP) or conjoint analysis, which quantifies stakeholder preferences. Stakeholder engagement is integral to the model's development, with a planned online consultation process designed to be inclusive and accessible, allowing for broad participation from various demographic and professional groups. Feedback from these consultations will feed into iterative loops to refine the index, with additional validation from pilot testing in living labs where the index's performance can be monitored in real-time scenarios. The framework developed for the Index will therefore be approved and confirmed in terms of its metrics, by all the necessary stakeholders, such as governmental and local authorities, transport planners, sociologists and other types of experts. One of the goals of this co-creation activity will be to identify and amend potential discrepancies in the model; a benefit for one group may be considered as*

a cost for another. The SOMI is modelled and integrated in the GO-WISDOM decision-making module (T2.5) for urban mobility planning. By developing the SOMI, Task 1.4 aims to provide a model for: (i) SOMI calculation; (ii) assessing impact of interventions and policies to SOMI; (iii) support SOMI-driven planning and (iv) contribute and develop a comprehensive, dynamic tool that significantly enhances the governance and planning of transport and mobility systems, directly contributing to the creation of a holistic approach for more sustainable, efficient, and equitable urban environments."
Chapters addressing the Deliverable Description *Chapter 2, Chapter 3, Chapter 4*
Justification *Chapter 2 addresses the conceptual part of T1.4 by translating Mobility as a Right and social-optimum principles into a structured set of SOMI Pillars. It adapts wider well-being and social-value concepts to the transport and mobility context and provides the conceptual justification for moving beyond conventional transport-efficiency indicators.* *Chapter 3 addresses the technical, computational and stakeholder-weighting requirements of T1.4. It defines the SOMI calculation framework, including measurable KPIs, normalisation procedures, weighting logic and aggregation from KPI values to persona-level and solution-level SOMI. It also operationalises stakeholder-informed weighting through two complementary processes. First, persona-pillar significance weights were derived from the participatory Mentimeter-based methodology, capturing how relevant each SOMI pillar is for each persona. Second, the Impact Creation Board (ICB) contributed to the weighing of city-level solutions and solution-specific personas through a structured Best-Worst Method exercise.* *Chapter 4 complements the SOMI calculation model by providing the Atlas of Accessibility. It visualises current accessibility levels across the pilot cities using H3-based spatial units and walking-accessibility indicators. The chapter strengthens the spatial and location-dependent dimension of SOMI, which is relevant to the GA ambition for a dynamic and context-sensitive index. The Atlas provides a place-based interpretation of accessibility conditions and helps identify where accessibility opportunities and gaps are located.*

Executive summary

Deliverable D1.4 develops the methodological and operational framework for the Social Optimum Mobility Index and the Atlas of Accessibility within GOLIA. Its purpose is to translate the project's vision of socially optimal and rights-sensitive mobility into a structured assessment approach that can be applied to concrete mobility solutions in the pilot cities. Conventional transport appraisal frequently evaluates success through metrics of traffic efficiency, capacity, travel time or network performance. The deliverable departs from standard methodologies by examining the performance of mobility systems across diverse user groups alongside the distribution of associated benefits and burdens. Assessing equitable mobility provision ensures that proposed solutions advance the principle of Mobility as a Right.

To operationalize these concepts, the Social Optimum Mobility Index integrates both the service and governance dimensions of transport through eight core pillars (Accessibility, Availability, Affordability, Acceptability, Agency, Participation, Legal Recognition and Safety and Security). The methodology links each pillar to measurable KPIs, normalizes KPI values on a common scale, and aggregates them into persona-level and solution-level SOMI results. The approach is designed to remain transparent and auditable, since the indicator definitions, data sources, reference limits, weights and assumptions are explicitly documented.

A central feature of D1.4 is the use of transport personas. The final persona framework reflects the diversity of mobility needs across the three pilot cities, with seven personas for Antwerp, nine for Florence and seven for Pilsen. The persona-based approach prevents the assessment from collapsing all users into a single average traveler. It allows the same mobility solution to be evaluated differently for residents, families, students, commuters, older or less mobile users, visitors, logistics actors and other relevant groups. This is important because a solution may improve overall mobility performance while still creating difficulties for specific user groups.

The SOMI methodology was applied to selected pilot-city mobility solutions in Antwerp, Florence and Pilsen. For Florence, the assessment focuses on 30 km/h traffic-calmed areas, urban logistics micro-hubs and road-space reallocation. For Pilsen, it addresses cycling and bike-share uptake, public transport and first- and last-mile integration, and connected corridors or smart traffic management readiness. For Antwerp, it focuses on Smart Ways to Antwerp, as a multimodal service-quality improvement that may require clearer information, accessibility support or more tailored guidance.

The deliverable also documents the weighting processes used to support SOMI. Persona-pillar significance weights were derived from the Mentimeter-based scoring exercise and then normalised for use in the calculation. Solution-specific persona influence weights were derived through a two-round consultation with the GOLIA Impact Creation Board, involving Round 0 direct 100-point allocations and Round 1 structured Best-Worst comparisons. The final operational persona influence weights used in SOMI are based on the Round 1 results, aggregated across the participating ICB organisations through a normalised geometric mean. Round 0 is retained as a baseline, diagnostic and sensitivity reference.

In parallel, D1.4 introduces the Pilot Use Case Atlas and the Atlas of Accessibility. The Pilot Use Case Atlas documents the KPI mapping process carried out with the three pilot cities and identifies the data needed to calculate and update SOMI. The aim is for KPI values to originate, as far as possible, from official city sources, city-approved documents, open datasets or other traceable technical evidence. This supports transparency in the current assessment and creates the basis for future dynamic retrieval and updating of KPI values through GO-DATA and GO-WISDOM.

The Atlas of Accessibility provides the spatial layer of the methodology. It maps walking-based access to key destination categories and develops persona-oriented accessibility scores that help visualize how accessibility conditions vary within and across the pilot cities. The Atlas does not replace the SOMI calculation. It complements it by showing where opportunities, constraints and potential mobility disadvantages are spatially concentrated. In future iterations, this spatial layer can be further enriched within GO-WISDOM, allowing users to explore alternative combinations of mobility solutions, personas, SOMI pillars and spatial indicators. At this stage, the Atlas should be interpreted as a current spatial accessibility baseline and as a diagnostic complement to SOMI. It does not yet provide a causal estimate of the direct impact of each pilot solution, but it identifies the spatial distribution of accessibility opportunities and gaps that future GO-WISDOM scenarios can use and update.

Overall, D1.4 provides a common assessment logic for evaluating mobility solutions from a social-optimum perspective. It defines the calculation model, the required data structure, the weighting logic, the pilot-city applications and the spatial interpretation layer. Its main contribution is not the production of a single score, but the creation of a transparent decision-support framework that helps cities understand who benefits, who may be disadvantaged, which trade-offs emerge, and what complementary measures may be needed to make mobility interventions more socially optimal.

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List of abbreviations and acronyms

Acronym	Meaning
Accpt	Acceptability
Accs	Accessibility
Aff	Affordability
AHP	Analytic Hierarchy Process
AI	Artificial Intelligence
ANT_MS3	Antwerp multimodal journey-planner measure code in SPINE
Av	Availability
BWM	Best-Worst Method
CERTH	Centre for Research and Technology Hellas
CINEA	European Climate, Infrastructure and Environment Executive Agency
CORDIS	Community Research and Development Information Service
CRITIC	Criteria Importance Through Intercriteria Correlation
CZK	Czech koruna
D1.1	Deliverable 1.1
D1.2	Deliverable 1.2
D1.3	Deliverable 1.3
D1.4	Deliverable 1.4
D2.3	Deliverable 2.3
D2.5	Deliverable 2.5
D6.5	Deliverable 6.5
D6.6	Deliverable 6.6
DEI	Diversity, Equity and Inclusion
DL	Deep Learning
DM	Decreto Ministeriale
DUET	Digital Urban European Twins
DUP	Documento Unico di Programmazione

ECB	European Central Bank
ENGAGEMOVE	GOLIA stakeholder-engagement output
EPA	European Parking Association
EU	European Union
EUR	Euro
EVT	Extreme Value Theory
FLO	Florence solution code
GA	Grant Agreement
GIS	Geographic Information System
GO-DATA	GOLIA data module
GO-INFO	GOLIA information and visualisation module
GO-KNOW	GOLIA knowledge module
GO-WISDOM	GOLIA decision-support module
GO-X	GOLIA digital module family
GOLIA	Governing, Optimising and Leveraging Innovation in cities through a data-driven and social-optimum-led approach
GWR	Geographically Weighted Regression
H3	Hexagonal Hierarchical Geospatial Indexing system
ICB	Impact Creation Board
IDPK	Integrated Transport of the Pilsen Region
IND56-IND58	SPINE monitoring indicator codes
IT	Information Technology
ITF	International Transport Forum
ITI	Integrated Territorial Investment
KPA	Key Performance Area
KPI	Key Performance Indicator
Log	Logistics
LR	Legal Recognition

MaaR	Mobility as a Right
MaaS	Mobility as a Service
MCA	Multi-Criteria Analysis
MCDM	Multi-Criteria Decision-Making
ML	Machine Learning
NGO	Non-Governmental Organisation
OBIS	Optimising Bike Sharing in European Cities
OECD	Organisation for Economic Co-operation and Development
OR	Operations Research
OSM	OpenStreetMap
PAC	Piano di Azione Comunale
Part	Participation
PDF	Portable Document Format
PIL	Pilsen solution code
PMDP	Plzenske mestske dopravni podniky
POLIS	Network of European cities and regions for transport innovation
POT	Peaks over Threshold
PT	Public Transport
PTO	Public Transport Operator
PU	Public dissemination level
PUMP	Plan udrzitelne mobility Plzne
PUMS	Piano Urbano della Mobilita Sostenibile
R&D	Research and Development
Safe	Safety and Security
SDG	Sustainable Development Goal
SECAP	Sustainable Energy and Climate Action Plan
SLP	Spazi di Logistica di Prossimita
SO	Specific Objective

SOMI	Social Optimum Mobility Index
SPINE	Smart Public transport Initiatives for climate-Neutral cities in Europe
SSH	Social Sciences and Humanities
STEM	Science, Technology, Engineering and Mathematics
SULP	Sustainable Urban Logistics Plan
SUMP	Sustainable Urban Mobility Plan
SVS	Sprava verejneho statku mesta Plzne
T1.3	Task 1.3
T1.4	Task 1.4
T2.5	Task 2.5
TCRP	Transit Cooperative Research Program
TEN-T	Trans-European Transport Network
TPL	Trasporto Pubblico Locale
TUMI	Transformative Urban Mobility Initiative
UAM	Urban Air Mobility
UFT	Urban Freight Transport
UITP	International Association of Public Transport
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
VMT	Vehicle Miles Travelled
VRU	Vulnerable Road User
WCAG	Web Content Accessibility Guidelines
WHO	World Health Organization
WP	Work Package
ZMP	Zastupitelstvo mesta Plzne
ZTL	Zona a Traffico Limitato

1 Introduction

1.1 Purpose and Scope of D1.4

Deliverable D1.4 is the methodological bridge between GOLIA's normative vision and its operational analytics. The project documents argue that conventional mobility appraisal remains overly narrow by treating success mainly as network efficiency, capacity management or demand accommodation. The original methodological framing of the project makes the critique explicit; traditional mobility planning appears reactive, departmentally siloed and overly focused on quantitative transport metrics. Consequently, the approach often misses broader social, environmental and governance impacts. The response of GOLIA shifts the paradigm from demand-led to vision-led planning through the Social Optimum Mobility Index (SOMI). SOMI operates as a dynamic index intended to balance diverse stakeholder interests while maximizing social benefits and ensuring Mobility as a Right (MaaR).

Deliverable D1.4 introduces more than a simple set of indicators by specifying how the social-optimum ambition of GOLIA translates into a calculable assessment framework. The document converts the interdisciplinary foundations of the project into a reproducible analytical structure suitable for utilization by the pilot cities and subsequent embedding within GO-WISDOM. The project description of GOLIA repeatedly presents SOMI as a metric designed to assess urban mobility systems through economic and operational variables alongside indicators related to social support, healthy life quality and freedom to make life choices. The index possesses location-dependent and time-dependent characteristics designed to support the dynamic management of transport supply and public space. Concrete index mechanics (variables, thresholds, weights, normalization rules, aggregation logic and reporting outputs) are formalized at the current stage of development.

The primary objective of Deliverable D1.4 involves defining the analytical architecture of SOMI. Following the logic established in the project description and in Deliverable D1.3, the process requires identifying the dimensions of socially optimal mobility, structuring them into pillars and specifying representation through measurable indicators. Deliverable D1.3 clarifies the direct contribution of MaaR to SOMI through normative indicators (such as physical, digital and economic accessibility, territorial equity, safety and the inclusion of vulnerable groups) and through legal and social variables derived from the legal determinant catalogue. Furthermore, the text states the requirement to translate the determinants into measurable and monitorable variables for Task 1.4 using explicit fields such as determinant label, pillar alignment, legal basis, feasibility rating, data-source class, KPI package and units. Rather than inventing the normative structure independently, the deliverable formalizes the existing concepts into a technical scoring system.

A secondary objective of Deliverable D1.4 entails establishing KPI engineering rules. The task necessitates mapping local policy objectives, pilot priorities and selected solutions into comparable indicators under each SOMI pillar while preserving traceability to the underlying legal, social and strategic logic. Deliverable D1.3 frames the handover to Task 1.4 as a compliance-to-measurement approach where legal obligations and rights-based requirements become standardized legal determinants before converting into structured measurement routes. Such a methodology holds particular value for dimensions classified as socially indispensable but unevenly measurable. The catalogue within Deliverable D1.3 distinguishes between Core determinants ready for immediate operationalization and Aspirational determinants requiring proxies, survey modules or phased implementation. Consequently, Deliverable D1.4 avoids treating all indicators as equally mature; instead, the document explicitly separates baseline-ready variables from phased or experimental metrics.

Another objective of Deliverable D1.4 involves defining normalization and aggregation rules to enable cross-pillar and cross-city comparisons without erasing local specificity. The project documents consistently emphasize the need for GOLIA to remain comparable across the three partner cities while remaining sensitive to local context, pilot objectives and available data. The project description presents SOMI as a shared decision-support framework across municipalities that draws on city-specific data and undergoes recalculation as scenarios change. The requirement implies the necessity for Deliverable D1.4 to articulate a common index logic while accommodating local indicator choices and context-specific proxies. In practical terms, the document distinguishes the fixed components of the index from the adaptable elements and details the documentation process for deviations from the common template.

Furthermore, the deliverable introduces the Atlas of Accessibility as the spatial expression of SOMI. The project description characterizes the index as location-dependent and suitable for the dynamic management of transport supply and public spaces. Deliverable D1.3 similarly translates MaaR into inherently spatial determinants (such as access to public transport within a ten-minute walk, guaranteed minimum service in peripheral areas, accessibility of stops and stations and city-specific territorial equity conditions). Deliverable D1.4 establishes the Atlas of Accessibility as the mapping layer to reveal concentrations of opportunity, burden, exclusion and risk. SOMI functions simultaneously as an aggregated score and a territorial diagnostic framework capable of displaying the geography of unequal mobility conditions within each municipality.

The final specific objective involves creating a common reporting and implementation structure for the pilots. Project documentation repeatedly emphasizes transferability, operational usability and dashboard integration. Deliverable D1.3 mandates that each determinant handed over to Task 1.4 includes the minimum fields necessary for technical workstreams and governance follow-up. Additionally, the project description outlines GO-WISDOM as the tool designated to calculate SOMI for each partner city by interfacing with existing municipal tools and data. To ensure municipal reporting remains coherent despite the use of distinct local data infrastructures, Deliverable D1.4 standardizes the calculation formulas alongside templates for metadata, assumptions, units, proxy notes and weighting rationales.

Ultimately, Deliverable D1.4 converts SOMI from a conceptual ambition into a functional methodological engine. The text details the rules to convert municipal visions, MaaR principles, legal determinants, user needs and local data into scores designed to support diagnosis, ex-ante appraisal, scenario comparison and ongoing monitoring. The function remains analytical and governance-oriented; the document establishes an explicit and auditable structure to openly debate value judgments regarding the social optimum. The formalized approach aligns fully with the wider positioning of SOMI as a dynamic, adaptive, stakeholder-informed and rights-sensitive mobility planning instrument.

1.2 Relation to other GOLIA Outputs

D1.4 occupies a bridging role within the GOLIA methodology. It does not operate as an isolated technical note, but as the point where the project's conceptual work, city knowledge and stakeholder priorities are translated into a common assessment logic for the Social Optimum Mobility Index. In practical terms, D1.4 connects the Mobility as a Right framing, the persona and mobility-ecosystem analysis, the selected city solutions and the GO-X / GO-WISDOM decision-support environment.

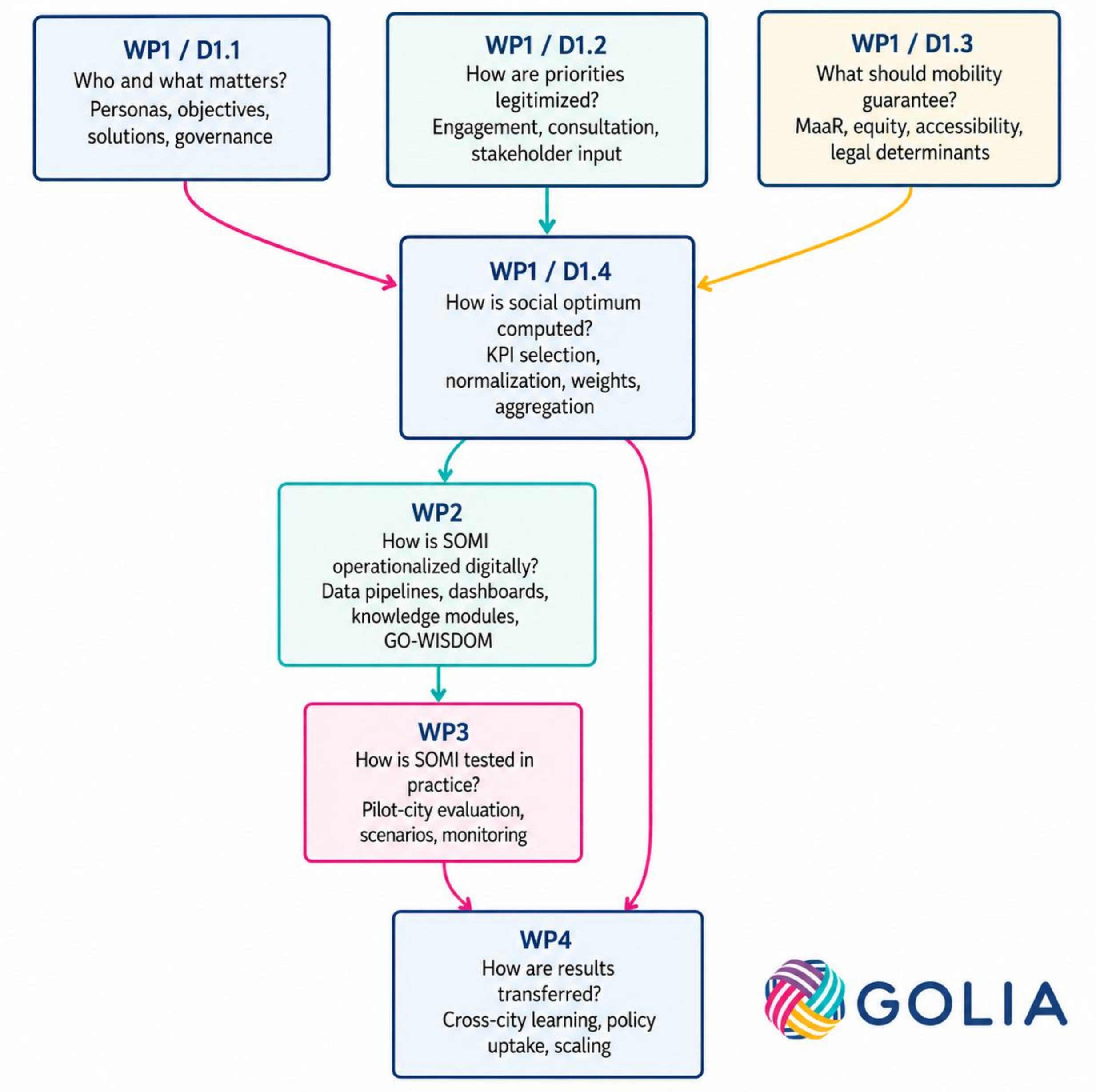

Figure 1: Relation to WPs

Figure 1 positions D1.4 within the wider GOLIA methodological chain. D1.1 provides the persona, objective, solution and governance basis. D1.2 contributes the stakeholder-priority and engagement logic, while D1.3 defines the MaaR, equity, accessibility and legal-determinant foundations. D1.4 translates these inputs into KPI selection, normalisation, weighting and aggregation rules. The resulting SOMI calculation logic then supports WP2 through the GO-X and GO-WISDOM environment, is tested in WP3 through pilot-city evaluation, and contributes to WP4 through cross-city learning, policy uptake and transferability.

1.2.1 Relation to the three-dimensional mobility ecosystem and persona framework

D1.1 provides a descriptive and analytical basis from which D1.4 draws several of its core inputs. It structures the mobility ecosystem through three interacting dimensions: the human and behavioural dimension of user personas, the technical-spatial dimension of mobility solutions and practices, and the institutional dimension of governance and regulation. Its vision-to-requirement logic starts from city visions and translates them into concrete objectives and requirements. D1.4 builds on this structure by using the personas identified in D1.1, the city-specific objectives emerging from the mapping exercise, and the contextual understanding of mobility solutions and governance constraints as inputs for SOMI construction. In this way, D1.1 identifies what matters, for whom, and in which context, while D1.4 defines how these elements are measured, normalised and aggregated.

D1.2, ENGAGEMOVE, provides the participatory logic that informs the weighting and validation functions of D1.4. It defines stakeholder-engagement methodologies, evaluation parameters such as inclusivity and representativeness, and city-specific engagement approaches for Florence, Pilsen and Antwerp. This relationship is important because SOMI is not designed as a purely expert-defined index. Citizen and stakeholder consultation form part of GOLIA's wider governance model, and stakeholder-derived priorities, acceptability considerations and weight elicitation are therefore treated as structured inputs to the SOMI methodology. D1.2 supports D1.4 by providing the procedural basis for identifying whose preferences are considered, how they are captured, and how they are translated into weights, thresholds and validation inputs.

D1.3, Toward a New Definition of MaaR, provides the normative and legal foundation for D1.4. It defines Mobility as a Right as the guarantee that every individual should be able to access essential societal resources through mobility systems that are physically, economically and digitally accessible, inclusive, safe, sustainable and non-discriminatory. D1.3 also identifies legal determinants and frames them as inputs for Task 1.4, where they are transformed into measurable and monitorable variables. D1.4 is therefore the point at which MaaR becomes operational within the SOMI framework. It translates rights-based principles such as equity, accessibility, non-discrimination, participation and legal clarity into KPI structures, normalisation rules and reporting templates. D1.3 supplies the normative content of SOMI, while D1.4 provides the measurement logic.

1.2.2 Connection to the GO-X modules and GO-WISDOM environment

D1.4 has a particularly strong downstream relation to Work Package 2, since WP2 is where the project's digital modules operationalise the knowledge and methods produced in WP1. The project description states that WP2 will develop the four GO-X functional modules: GO-DATA, GO-INFO, GO-KNOW, and GO-WISDOM. D1.4 is especially relevant to the latter three, because it defines the common logic through which data and policy options are interpreted in social-optimum terms.

With respect to GO-DATA, D1.4 provides the specification of what kinds of data are needed to compute SOMI. Since the index depends on normalized KPIs across multiple pillars, D1.4 effectively defines the data requirements for the project: what variables must be collected, at what granularity, how often they should be updated, and how they relate to personas, territories, and intervention scenarios. In that sense, D1.4 acts as a demand specification for WP2's data integration work. GO-DATA may integrate and harmonize city data sources, but D1.4 determines which of those sources are relevant for the social-optimum calculation.

With respect to GO-INFO, D1.4 provides the evaluation structure that can be visualised through dashboards and consultation interfaces. Since GO-INFO is intended to elaborate and visualise city-level data and citizen views in ways that support strategic planning, SOMI gives it a coherent reporting language. Instead of displaying isolated mobility indicators, WP2 can use D1.4's pillar structure and scoring logic to present integrated views of accessibility, affordability, safety, participation, and related dimensions. This makes the outputs more legible to decision-makers and stakeholders.

With respect to GO-KNOW, D1.4 translates conceptual determinants into a reusable analytical schema. The project description explains that GO-KNOW should support scalability and transferability through the elicitation of SOMI determinants. D1.4 is therefore the methodological companion of GO-KNOW: it formalizes the KPI dictionary, bounds, units, and weighting logic that allow determinant-based knowledge to be transferred across cities while preserving a common evaluative structure.

Most importantly, D1.4 is foundational for GO-WISDOM. The project description describes GO-WISDOM as the module that will support implementation of solutions by maximizing SOMI, highlighting conflicts between policy goals, and identifying incentives and nudges that can support disadvantaged groups. This means D1.4 provides the evaluation engine that GO-WISDOM will later execute. Without D1.4, GO-WISDOM would have no transparent way to compare scenarios, quantify trade-offs, or determine whether a policy package improves the social optimum. Thus, the relationship is more than sequential: D1.4 is effectively the analytical backbone of GO-WISDOM's simulation and decision-support capabilities.

1.2.3 Connection to pilot-city application and validation

D1.4 also plays a central role in Work Package 3, where GOLIA tests its methods and tools in Antwerp, Florence, and Pilsen. WP3 is designed to validate both the stakeholder engagement process and the GO-X modules through local use cases and to translate these experiences into multi-dimensional mobility transition plans. In this phase, D1.4 provides the common evaluation framework that makes those tests comparable and policy relevant.

In practical terms, D1.4 enables WP3 to use SOMI in at least four ways. First, it provides a baseline diagnosis, allowing each city to assess its current mobility conditions across the agreed pillars. Second, it supports ex-ante evaluation, enabling cities to compare different mobility solutions or packages before implementation. Third, because SOMI is computed in a persona-sensitive way, it allows WP3 to identify distributional effects, showing which groups or territories benefit and which may be left behind. Fourth, because SOMI is conceived as dynamic and re-computable, it supports monitoring over time, which is essential for the adaptive governance approach GOLIA promotes. As a result, D1.4 makes WP3 more than a set of isolated demonstrations: it gives the pilots a shared analytical language through which results can be interpreted and compared.

1.2.4 Contribution to transferability and exploitation

Beyond its role in supporting the pilot-city applications, D1.4 also contributes to the wider transferability and exploitation potential of GOLIA. By defining a repeatable SOMI methodology, the deliverable provides a common assessment logic that can be communicated beyond the three pilot cities and adapted to other urban contexts. This is important because the project's results need to support not only local analysis, but also wider policy learning, governance recommendations and future uptake of the GO-X and GO-WISDOM environment. As a result, SOMI is not limited to a single local experiment. It is designed as a transferable assessment approach that can help other cities understand how mobility solutions perform from a social-optimum perspective.

1.3 Document Structure

The deliverable is organised into five main chapters, followed by references and appendices that provide supporting evidence, input tables and detailed calculation material.

Chapter 1 introduces the purpose and scope of D1.4. It explains the role of the deliverable within GOLIA and positions SOMI as the methodological bridge between the project's Mobility as a Right vision, the persona and mobility-ecosystem work, the selected pilot-city solutions and the GO-X / GO-WISDOM digital decision-support environment. The chapter also clarifies how D1.4 relates to other GOLIA outputs and how it supports future pilot-city application, transferability and exploitation.

Chapter 2 presents the conceptual framework for defining the Social Optimum. It explains why conventional transport planning metrics are not sufficient for assessing mobility from an equity, inclusion and rights-based perspective. It then links the SOMI framework to the legal and ethical foundations developed in the project, particularly the Mobility as a Right framing, and introduces the eight SOMI pillars that structure the assessment.

Chapter 3 develops the SOMI calculation model. It first reviews relevant literature and identifies the main methodological gaps that SOMI addresses. It then presents the mathematical formulation of the index, including KPI normalisation, pillar scoring, persona-level SOMI, solution-level aggregation and baseline and change assessment. The chapter also documents the persona and solution selection process, the persona-pillar significance weighting process, and the ICB consultation used to derive solution-specific persona influence weights. The second part of the chapter applies the methodology to the pilot-city use cases in Florence, Pilsen and Antwerp. It presents the selected solutions and personas, the KPI structures, the weighting inputs and the resulting SOMI calculations. The city-specific KPI input workbooks developed through iterative exchanges with the pilot cities are provided in Appendix VIII.

Chapter 4 presents the Atlas of Accessibility. It explains the spatial methodology used to calculate walking-based accessibility indicators across the three pilot cities. It then presents category-based accessibility outputs and persona-oriented accessibility scores for Pilsen, Antwerp and Florence. The chapter also explains how the Atlas supports the interpretation of selected mobility solutions by showing the spatial distribution of accessibility opportunities and potential disadvantages.

Chapter 5 presents the conclusions. It synthesises the main contribution of D1.4, explains how the pilot-city findings connect with new-generation transport model components, and describes how SOMI can support planning through GO-WISDOM. It also discusses the main limitations of the current methodology and identifies future research and implementation needs, including improved data pipelines, further validation of persona assumptions and the progressive enrichment of the Atlas of Accessibility as a dynamic spatial decision-support layer.

The appendices provide the supporting material used in the development and application of the methodology. They include the Mentimeter-based persona-pillar scoring exercises, the ICB consultation material, the persona-destination category relevance matrix used for the Atlas, and the city-specific KPI input workbooks for the champion solutions.

2 Conceptual Framework for defining the Social Optimum

2.1 Beyond Traditional Transport Planning

2.1.1 Need for "Social Optimum" vs. System Optimum

Traditional transport planning has often prioritised network performance, capacity management and operational efficiency. These objectives remain important, but they do not fully capture whether mobility systems enable equitable access, social inclusion and participation in urban life. A system may perform efficiently in aggregate while still producing unequal outcomes for low-income users, older people, disabled users, peripheral neighbourhoods or people dependent on public transport. SOMI therefore adopts a broader social-optimum perspective, where mobility performance is assessed through accessibility, affordability, safety, inclusion, participation, legal recognition and user agency, rather than through efficiency alone.

In transport modelling, the distinction between user equilibrium and system optimum is well established. User-equilibrium approaches describe situations in which individual users select routes or modes according to their own perceived cost, while system-optimum approaches seek an allocation that minimises total network cost or maximises aggregate efficiency. Recent traffic assignment and network optimisation studies continue to treat these concepts as central to transport modelling and route choice analysis (Chen et al., 2024; Inal et al., 2026). Yet, from the perspective of socially just mobility, such approaches remain incomplete. They can indicate whether a network operates efficiently, but not whether benefits and burdens are distributed fairly, whether vulnerable users are protected, or whether all residents and city users have sufficient access to essential opportunities.

This limitation is especially important because aggregate efficiency can hide unequal outcomes. A policy may improve average travel time or reduce total congestion while simultaneously worsening access for low-income groups, older people, disabled users, peripheral neighbourhoods, non-drivers or people dependent on public transport. For example, studies of large-scale public transport restructuring show that network reforms may create efficiency gains while also redistributing travel-time burdens and transfer penalties unevenly across users and territories; conventional appraisal tools often fail to capture these equity effects adequately (Weckström et al., 2019). Similarly, accessibility and transport justice research has shown that transport disadvantage is not only a matter of distance or travel time, but also of affordability, safety, service reliability, social exclusion and the ability to participate in daily life (Pereira et al., 2017; Lucas et al., 2016; van Wee and Geurs, 2011).

For this reason, GOLIA adopts the concept of social optimum as a broader evaluative standard. In this context, social optimum does not simply mean the mathematically efficient allocation of traffic flows. It refers to a mobility condition in which transport policies, services and public-space decisions maximise social value while respecting minimum standards of accessibility, affordability, safety, inclusion, participation and rights. A socially optimal mobility system is therefore not only one that moves people and goods efficiently, but one that enables people to reach employment, education, healthcare, public services, culture and social networks under fair and dignified conditions. This interpretation is consistent with the capabilities approach to transport justice, which argues that the relevant object of evaluation is not movement itself, but people’s real freedom to access valued opportunities and participate in society (Hananel and Berechman, 2016; Vecchio and Martens, 2021; Luz and Portugal, 2022).

The need for a social-optimum perspective is further reinforced by research linking mobility, social exclusion and well-being. Stanley et al. (2011) show that mobility limitations are directly connected to social exclusion and subjective well-being, while more recent studies emphasise that “sufficient access” must be assessed in relation to actual activity participation and perceived accessibility, not only spatial proximity or modelled travel times (Pot et al., 2025). This means that a transport intervention cannot be judged only by whether it improves the average performance of a corridor, route or network. It must also be assessed according to whether it reduces exclusion, increases usable access for disadvantaged groups and supports wider well-being.

The shift from system optimum to social optimum also responds to the growing recognition that mobility transitions can reproduce or deepen inequalities if they are evaluated only through technical or infrastructural criteria. Research on just mobility transitions shows that exclusion is often produced through complex combinations of infrastructure gaps, economic barriers, digital exclusion, governance failures and uneven recognition of user needs (Oliveira Soares and Glaser, 2025). Likewise, studies of spatial accessibility and transport inequity show that even data-rich planning environments require explicit equity-sensitive methods to reveal who benefits, who is underserved and where territorial gaps persist (Pönkänen et al., 2025). Therefore, a social-optimum framework must be able to connect operational indicators with distributional, institutional and experiential dimensions of mobility.

Within GOLIA, SOMI operationalises this shift by translating the concept of social optimum into a structured, measurable and comparable index. Unlike a conventional system-optimum approach, SOMI does not treat efficiency as the only or dominant objective. Instead, it evaluates mobility through multiple pillars, including Accessibility, Availability, Affordability, Acceptability, Agency, Participation, Legal Recognition and Safety & Security. This allows the assessment to capture both service performance and governance quality. In practical terms, a policy scenario that improves vehicle throughput but weakens affordability, participation or safety for vulnerable users would not necessarily be considered socially optimal. Conversely, a scenario that produces modest efficiency losses but substantially improves minimum access, safety or inclusion for disadvantaged groups may represent a higher social optimum.

The value of this approach lies in making trade-offs explicit. Traditional appraisal often absorbs social impacts into aggregate cost-benefit calculations, where distributional effects may remain secondary or invisible. SOMI instead treats social impacts as core dimensions of performance. It allows policy-makers to ask not only “does the system work better?”, but also “for whom does it work better?”, “who bears the burden?”, “who gains access?”, and “which rights or capabilities are strengthened?”. This is essential for a vision-led and rights-sensitive mobility framework, because urban mobility decisions are not neutral technical choices; they shape access to opportunity, exposure to risk, social participation and everyday freedom.

Accordingly, the need for “social optimum” in GOLIA arises from the inadequacy of system-level efficiency as a standalone planning criterion. System optimum remains useful for understanding network performance, but it must be embedded within a broader social-evaluation framework.

SOMI provides this framework by integrating efficiency with equity, capability, inclusion, rights and well-being. It therefore enables GOLIA to move beyond traditional transport planning and toward a model of mobility governance that is not only technically effective, but also socially legitimate, territorially fair and aligned with Mobility as a Right.

The relationship between conventional transport planning and the SOMI approach is summarised in Figure 2. Conventional planning and modelling remain necessary for estimating demand, trip distribution, mode choice, network assignment and operational outputs such as travel time, cost, congestion and emissions. SOMI adds a social-optimum interpretation layer to these outputs, allowing mobility solutions to be assessed not only in terms of efficiency, but also through MaaR-relevant dimensions such as accessibility, affordability, agency, safety, participation and legal recognition.

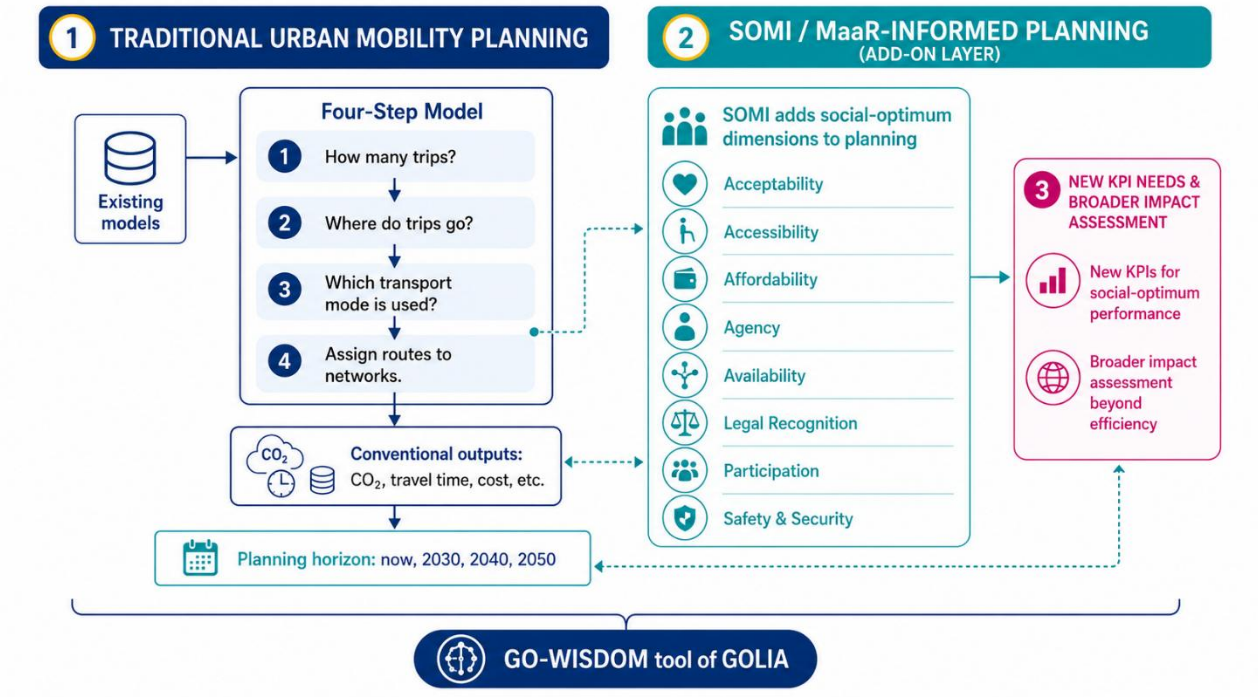

Figure 2: Position of SOMI as a social-optimum layer within the traditional urban mobility planning process

This positioning is important for D1.4 because SOMI is not designed to replace existing planning models. Instead, it extends their use by linking conventional outputs with KPI-based measurement, persona-sensitive interpretation and broader impact assessment. In this way, the same planning process can support GO-WISDOM by showing whether a mobility solution is technically effective, socially inclusive, territorially fair and suitable for monitoring over different planning horizons.

2.1.2 Adapting Global Well-being Indices to Mobility

Global well-being indices have progressively shifted the measurement of development away from purely economic output and toward multidimensional assessments of human welfare, quality of life, social participation, health, environmental sustainability and freedom of choice. This conceptual shift is highly relevant for urban mobility planning. If mobility is understood only as movement, then transport policy is evaluated mainly through travel time, traffic speed, vehicle flow or infrastructure provision. If, however, mobility is understood as a condition for well-being, then the relevant question becomes broader: to what extent does the mobility system enable people to live the lives they value, access essential opportunities, maintain social relationships, participate in public life and experience dignity, safety and autonomy in daily travel?

This is the key rationale for adapting global well-being index logic to the transport domain. Global indices such as happiness, quality-of-life and sustainable-development frameworks do not evaluate society through a single economic variable. Instead, they combine several dimensions that reflect how people experience life conditions. In a similar way, SOMI translates mobility performance into a multidimensional structure that considers not only the supply of transport services and infrastructures but also their contribution to accessibility, affordability, agency, inclusion, perceived legitimacy, safety and rights. This approach is supported by urban planning and transport literature, which increasingly links the built environment, accessibility and transport systems with subjective well-being and quality of life (Mouratidis, 2021; Doi et al., 2008; van Burgsteden et al., 2024).

A first translation concerns happiness and life satisfaction. In global well-being frameworks, happiness is not treated simply as emotional satisfaction, but as a broader indicator of whether people have meaningful opportunities, social support, personal security and freedom in everyday life. In mobility terms, this means that travel should not be assessed only as a cost to be minimized, but also as an experience that can support or undermine well-being. Studies show that perceived accessibility, satisfaction with daily travel and life satisfaction are closely related, especially for older adults and other groups whose participation in daily life depends strongly on the usability of transport options (Lättman et al., 2019). Similarly, research on commuting and travel satisfaction demonstrates that poor infrastructure, congestion, unreliable public transport and safety concerns reduce trip satisfaction and, by extension, quality of life (Majumdar et al., 2021). Therefore, the happiness dimension can be translated into mobility indicators such as perceived accessibility, travel satisfaction, stress, comfort, safety, social connection and freedom to reach valued destinations.

A second translation concerns quality of life and liveability. Quality-of-life frameworks usually include health, environmental quality, access to services, social interaction and neighbourhood conditions. These dimensions have direct equivalents in transport planning. Transport policies shape air pollution, noise, physical activity, time use, access to green space, social interaction and the quality of public space. Anciaes and Jones (2020) argue that transport appraisal should better account for liveability-related impacts such as trip quality, time use, place quality, personal security, community severance, equity, social inclusion, health and well-being. This is important for SOMI because a mobility intervention may improve movement efficiency while damaging place quality or increasing exclusion. Conversely, policies that reduce car dominance, improve walking conditions, strengthen public transport or support proximity-based planning may improve quality of life even when they are not primarily justified by travel-time savings.

A third translation concerns **sustainable development**. The Sustainable Development Goals explicitly connect transport with safe, affordable, accessible and sustainable systems for all. However, the literature also shows that SDG transport measurement can be too narrow when it focuses on access to transport infrastructure rather than real accessibility to opportunities. Brussel et al. (2019), for example, criticise the urban transport SDG indicator for being supply-oriented and for measuring access to transport rather than accessibility through transport. Fried et al. (2020) similarly show that measuring SDG transport targets requires more than identifying whether public transport exists; it also requires understanding affordability, travel time, land-use distribution and the real ability of people to reach opportunities. This distinction is central to SOMI: a socially optimal mobility system is not one that simply provides infrastructure, but one that makes essential destinations reachable under fair, affordable, safe and usable conditions.

A fourth translation concerns equity and “leaving no one behind”. Sustainable-development frameworks are explicitly concerned with reducing inequalities and ensuring that progress is not achieved only for already advantaged groups. In mobility planning, this requires attention to the distribution of benefits and burdens across income groups, genders, ages, abilities, neighbourhoods and temporal patterns of work or care. Hackl (2018) links mobility equity directly to the sustainable development agenda, arguing that mobility can reduce or reproduce inequalities depending on how opportunities are distributed. Similarly, global accessibility mapping shows that access to cities and services is a major determinant of development opportunities and that accessibility inequalities are central to the SDG agenda (Weiss et al., 2018). For SOMI, this means that mobility indicators must be evaluated not only in aggregate but also across personas, territories and vulnerable groups.

A fifth translation concerns community well-being and capability. Recent transport research increasingly argues that mobility should be evaluated through the capability approach, meaning that the focus should be on people’s real freedom to access valued activities rather than on mobility supply alone. Van Burgsteden et al. (2024) develop a framework linking transport policy to community well-being through capability-based dimensions such as safety, health, environment, accessibility and inequalities. This perspective directly supports the SOMI logic: the aim is not to maximize movement for its own sake, but to ensure sufficient accessibility, meaningful choice and fair participation in urban life. In practical terms, SOMI transforms this idea into measurable pillars: Accessibility captures access to opportunities; Affordability captures economic barriers; Availability captures whether services exist when and where needed; Acceptability captures trust, comfort and legitimacy; Agency captures freedom of choice; Participation captures voice in decision-making; Legal Recognition captures enforceable rights and obligations; and Safety & Security captures protection from harm and fear.

The adaptation of well-being indices to mobility also requires methodological care. Composite indices are useful because they allow multiple dimensions to be combined into a single decision-support structure, but they can also hide assumptions if normalization, weighting and aggregation are not transparent. This is why SOMI should not simply import a national-level happiness or sustainability index into transport. Instead, it should translate the logic of those indices into a mobility-specific, auditable framework. Each SOMI pillar should be represented by a clear KPI, each KPI should have explicit lower and upper bounds, and weights should be adjustable to reflect stakeholder priorities and persona-specific needs. This is particularly important because research on transit-oriented development shows that mobility interventions may improve ridership and well-being while also generating gentrification or new social inequalities if distributional effects are not monitored (Wang et al., 2022).

In this sense, the Sustainable Development Index logic contributes the principle of multidimensional sustainability, while the happiness and well-being logic contributes the principle of lived experience. SOMI combines both. It treats mobility as a system that must be environmentally and operationally sustainable, but also socially meaningful, inclusive and rights sensitive. The result is a transport-domain adaptation of global well-being thinking: instead of asking only whether mobility is efficient, SOMI asks whether mobility improves people's ability to access opportunities, participate in society, feel safe, exercise choice and enjoy a better quality of urban life.

Therefore, adapting global well-being-index logic to mobility represents a conceptual and methodological shift in transport appraisal. It moves the assessment focus from movement-based performance to access, capability, and well-being-based evaluation. In this perspective, mobility is understood not only as a transport-sector output, but as a contributor to human development, social participation and quality of life. This provides the foundation for SOMI as a Social Optimum Mobility Index, a framework for translating the broader ambitions of happiness, quality of life and sustainable development into concrete, measurable and comparable mobility indicators.

2.2 Legal & Ethical Foundation (Input from T1.3)

The legal and ethical foundation of the SOMI framework is grounded in the conceptual and normative work developed in Deliverable D1.3, which reframes mobility not as a conventional transport service, but as a condition for accessing essential rights and opportunities in society. Within this approach, mobility is treated as a prerequisite for effective participation in employment, education, healthcare, culture, and civic life. This shift is critical for GOLIA because it moves the assessment of mobility systems beyond aggregate efficiency and toward a rights-based understanding of access, inclusion, and social justice. In this sense, D1.3 establishes MaaR as a normative basis for evaluating whether mobility systems are genuinely capable of supporting equal participation in urban and territorial life.

As formalised in D1.3, this foundation rests on three interdependent principles: equity, accessibility, and sustainability. Equity is understood both horizontally and vertically, meaning that mobility systems must not only treat comparable users fairly, but must also account for different levels of need, vulnerability, and disadvantage. Accessibility is defined in a broad sense, covering physical accessibility of infrastructure and vehicles, economic accessibility through affordability, and digital accessibility through usable information, interfaces, and non-digital alternatives where necessary. Sustainability completes this foundation by ensuring that the right to mobility is aligned with environmental responsibility, public health, and long-term social cohesion. Together, these principles create the ethical basis for a mobility system that is inclusive, non-discriminatory, and designed for universal usability rather than for the average or already advantaged user.

D1.3 also makes clear that MaaR is not limited to a moral aspiration; it is framed as a legally relevant and operational concept. The deliverable links MaaR to the language of fundamental rights by emphasising universality, human dignity, justiciability, and positive obligations on the part of public authorities. In practice, this means that the recognition of MaaR implies duties for states, regions, cities, and mobility providers to guarantee minimum service levels, ensure accessibility, prevent discrimination, maintain affordability, and provide inclusive information and interfaces. It also introduces an important governance dimension: MaaR requires co-development, co-evaluation, and multi-level coordination, so that mobility rights are embedded in planning instruments, public service contracts, and monitoring systems rather than remaining an abstract declaration.

For the purposes of Task 1.4, this legal and ethical foundation is especially important because it provides the normative logic through which SOMI can assess mobility performance in a legally grounded and socially meaningful way. D1.3 explicitly states that the integration of MaaR into SOMI translates normative principles into measurable indicators relating to physical, digital, and economic accessibility, territorial equity, safety, and the inclusion of vulnerable groups. Accordingly, the role of this section in D1.4 is to establish that the index is not value-neutral: it is anchored in a defined rights framework that guides which dimensions must be measured, which user groups must be protected, and which outcomes count as socially acceptable mobility provision.

2.2.1 Mobility as a Right (MaaR) Definition

For the purposes of GOLIA, Mobility as a Right (MaaR) is defined as the right of every person to reach essential societal resources and opportunities - including employment, health, education, culture, and civic participation - through mobility and accessibility systems that are safe, affordable, inclusive, sustainable, and free from discrimination. In D1.3, this definition is explicitly structured around the principles of horizontal and vertical equity, universal accessibility, and environmental sustainability, thereby establishing MaaR as a comprehensive rights-based framework for mobility governance and evaluation. This definition provides the formal basis on which GOLIA can assess whether mobility systems support real access to urban life rather than merely enabling movement.

This definition has four essential components. First, MaaR is universal, meaning that it applies to all persons regardless of age, gender, income, disability, migration status, or digital capability. Second, it is **multidimensional**, since accessibility is not confined to transport infrastructure alone, but extends to pricing, territorial coverage, digital and analogue information, and the practical usability of mobility services. Third, it is **justiciable in orientation**, in the sense that D1.3 frames MaaR as creating positive obligations for authorities and, in some circumstances, horizontal effects vis-à-vis private operators. Fourth, it is governance-based, requiring co-design, co-evaluation, and coordination across governance levels so that the right is embedded in plans, budgets, contracts, and delivery mechanisms.

A further strength of the GOLIA definition is that it explicitly broadens the conventional understanding of mobility rights. D1.3 makes clear that MaaR includes not only the right to move, but also the right to **voluntary immobility**, that is, the right to benefit from proximity, teleservices, and planning arrangements that reduce forced or burdensome travel. This is especially relevant for a socially optimal framework, because it prevents the concept of mobility from being reduced to ever-increasing movement and instead links it to autonomy, proximity, and meaningful access. In this way, MaaR becomes a broader entitlement to usable and fair access, rather than a narrow entitlement to transport supply alone.

Within D1.4, this definition should therefore be treated as the formal normative baseline for SOMI. It establishes that socially optimal mobility must be assessed in relation to whether essential access is guaranteed under conditions of fairness, inclusiveness, accessibility, and sustainability. It also clarifies that the purpose of the index is not simply to measure transport performance, but to evaluate the extent to which mobility systems comply with this rights-based standard.

2.2.2 Translating Rights into Determinants

The selected legal determinants are operationalised in D1.4 through a **common cross-city framework combined with pilot-specific adaptation**, so that the normative foundations established in D1.3 can be translated into a consistent but context-sensitive SOMI structure. In all three pilot cities, the allocation begins from the shared core determinant set validated in T1.3, ensuring methodological comparability across the project and preserving a common legal and ethical baseline for assessing mobility as a right. At the same time, the determinant structure is refined at city level in order to reflect the specific regulatory context, socio-spatial conditions, and mobility priorities of each pilot. This means that Antwerp, Florence, and Pilsen apply the same general logic of rights-based operationalisation, but each city emphasises different determinants according to its own legal and policy context: Antwerp gives greater prominence to inclusion-related determinants, Florence incorporates the legally distinctive dimension of heritage-compatible accessibility, and Pilsen elevates data interoperability as a primary enabling determinant. Where a SOMI pillar is not directly matched by a standalone legal determinant in D1.3, the allocation is completed either through a legally grounded proxy or through complementary governance and stakeholder inputs, thereby ensuring that the final pillar structure remains both normatively coherent and operationally usable.

For Antwerp, the selected determinant set prioritises the cross-city core determinants together with the Antwerp-specific inclusion determinant. The operational allocation is as follows: Acceptability: Safe and Dignified Travel (perceived safety/security) as the best legal-ethical proxy; **Accessibility**: Accessible and Reliable Mobility Information + Inclusive Mobility Design; **Affordability**: Basic Mobility Affordability; **Agency**: Accessible and Reliable Mobility Information; **Availability**: Guaranteed Minimum Service Level; **Legal Recognition**: Guaranteed Minimum Service Level, supported by the Flemish basic accessibility logic and continuity obligations; **Participation**: no standalone legal determinant, but **Social Inclusion of Hard-to-Reach Groups** should be retained here as the closest equity-oriented proxy in the Antwerp case, while clearly noting that it represents inclusion rather than formal participation; **Safety & Security**: Safe and Dignified Travel (VRU safety core + perceived safety/security aspirational). In Antwerp, **Data Interoperability** may be retained as a secondary enabling determinant, but it should not be treated as the lead city-specific legal determinant because D1.3 uses Antwerp primarily as the explicit case for Social Inclusion of Hard-to-Reach Groups and affordability/inclusion constraints rather than as the primary data-interoperability example.

For **Florence**, the selected determinant set should include the common core determinants and the city-specific determinant **Heritage-Compatible Accessibility**. The recommended operational allocation is: **Acceptability**: Heritage-Compatible Accessibility, complemented by Safe and Dignified Travel (perceived safety/security) where user acceptance depends on the practical usability and perceived fairness of access restrictions; **Accessibility**: Accessible and Reliable Mobility Information + Inclusive Mobility Design + Heritage-Compatible Accessibility; **Affordability**: Basic Mobility Affordability; **Agency**: Accessible and Reliable Mobility Information; **Availability**: Guaranteed Minimum Service Level; **Legal Recognition**: Heritage-Compatible Accessibility + Guaranteed Minimum Service Level, since Florence's access and logistics conditions are directly shaped by codified ZTL, heritage, and continuity rules; **Participation**: no dedicated T1.3 legal determinant and therefore to be completed through stakeholder-governance inputs rather than the legal handover; **Safety & Security**: Safe and Dignified Travel (VRU safety core + perceived safety/security aspirational). This is the strongest city-specific differentiation in the three pilots because D1.3 explicitly retains **Heritage-Compatible Accessibility** as a legally distinctive determinant linked to Florence's heritage-sensitive logistics and access constraints rather than folding it into a generic category.

For Pilsen (Plzeň), the selected determinant set combines the common core determinants with a stronger emphasis on Data Interoperability as a city-level enabling determinant. This reflects the role of open, machine-readable and operationally interoperable data in supporting user navigation, system usability and monitorable mobility governance. Within this allocation, Acceptability is linked to Safe and Dignified Travel, particularly through perceived safety and security. Accessibility is linked to Accessible and Reliable Mobility Information, Inclusive Mobility Design and Data Interoperability, since these determinants jointly address the availability, usability and interoperability of mobility information. Affordability is linked to Basic Mobility Affordability, while Agency is linked to Data Interoperability and Accessible and Reliable Mobility Information, as these determinants influence the extent to which users can understand, compare and use available mobility options.

Availability is linked to Guaranteed Minimum Service Level, which captures the need for minimum mobility provision and service continuity. Legal Recognition is linked to Data Interoperability and Guaranteed Minimum Service Level, because both can be connected to explicit legal, administrative or operational obligations that can be monitored over time. Participation is not linked to a dedicated standalone legal determinant in D1.3 and is therefore addressed through governance and stakeholder-input evidence outside the legal determinant catalogue. Safety & Security is linked to Safe and Dignified Travel, covering both vulnerable-road-user safety and perceived safety/security dimensions.

In this allocation, Social Inclusion of Hard-to-Reach Groups is not treated as a separate standalone determinant for Pilsen. Instead, social-exclusion concerns are primarily captured through related determinants, especially Guaranteed Minimum Service Level, Inclusive Mobility Design, Basic Mobility Affordability and Accessible and Reliable Mobility Information. Additional inclusion-specific indicators may be added in future SOMI iterations if the Pilsen evidence base is expanded.

2.3 Introduction of the SOMI Pillars

SOMI is grounded in a conception of urban mobility as a **multidimensional service** essential for well-being. In this view, providing transport is not an end in itself; it is valuable because it enables people to reach jobs, education, healthcare, social activities, and other life goals. This perspective aligns with the emerging "Mobility as a Right (MaaR)" approach which treats mobility as a fundamental enabler of economic and social participation (Drăguțescu, A. & Holve, V. 2025). In practice, MaaR implies that planners must consider whether services are truly **accessible, affordable, safe, and inclusive** for all – not just how fast they move vehicles. By adopting this lens, SOMI extends well-being index logic to transport. Just as health or happiness indexes consider quality, equity, and freedom, SOMI considers multiple **pillars** of transport experience and governance. Concretely, this means mobility is assessed based on eight interrelated dimensions. Efficiency (e.g. speed) and coverage (e.g. travel time) are included, but so are dimensions such as empowerment (agency), social inclusion (participation), and rights (legal recognition) (Beyazit, E. 2011). The index thus shifts the focus away from treating mobility purely as an economic variable, toward a view of mobility as a public good that supports freedom of movement and life choices. Based on this foundation, SOMI uses the following eight pillars (each scored from 0 to 1):

- **Accessibility**: The ease with which people can reach essential opportunities and destinations, such as jobs, education, healthcare, food, public services, and social networks, within reasonable time, cost, and effort. In transport research, accessibility is typically understood not just as movement, but as access to opportunities through the combined effect of land use, transport supply, service quality, and personal constraints. This means the indicator should reflect both spatial coverage and practical usability of the multimodal network: whether relevant destinations are reachable, by whom, at what travel burden, and with what reliability. Accessibility therefore goes beyond simple proximity; it captures how well the transport system enables participation in daily life (Geurs and Wee, 2004).

- **Affordability**: The extent to which people can use available mobility options without facing an excessive financial burden. This pillar captures whether the direct and indirect costs of mobility are reasonable in relation to users' income, household circumstances and travel needs (Venter, 2011). It includes fares, ticket prices, subscription costs, fuel or vehicle-operating costs, parking costs, shared-mobility charges, and the availability of discounts, subsidies or targeted support for vulnerable groups. Affordability is essential because a mobility service may be physically available and geographically accessible, but still unusable if its cost prevents regular or necessary travel (Lucas et al., 2016). In a rights-based mobility framework, affordability therefore reflects whether users can reach essential opportunities without being forced to reduce other basic expenditures or abandon important trips (Venter, 2011; Lucas et al., 2016). Indicators considered may include the public-transport fare burden as a share of income, cost per trip, availability of concessionary fares, transport-cost savings, household transport expenditure, and perceived affordability of mobility options (Venter, 2011).

- **Availability**: The presence of adequate mobility options, modes, services, and supporting infrastructure, when and where they are needed. This dimension captures whether transport supply is offered across space and time, including service coverage, operating hours, frequency, and effective capacity. In multimodal systems, availability also depends on operational resources such as vehicle supply, stop access, interchange opportunities, and curbside space for shared and on-demand services (TCRP, 2013).
- **Acceptability**: The extent to which users regard the mobility system as trustworthy, understandable, comfortable, and legitimate enough to use. This goes beyond stated satisfaction and includes whether people feel safe using the service, receive adequate information, understand how decisions are made, trust operators and technologies, and believe that privacy and data are handled appropriately. Acceptability is also shaped by cultural fit and by whether the service feels socially and procedurally fair to different user groups. In newer mobility contexts, studies of autonomous shuttles show that acceptance is often conditional on clear information, visible safety measures, accessibility design, and confidence in governance and data practices. Indicators considered may include user satisfaction scores, trust ratings, perceived transparency, perceived privacy protection, complaint rates, and willingness to reuse or recommend the service (Hisham et al. 2026)
- **Agency**: The degree to which users can meaningfully choose, combine, and control how they travel in pursuit of valued activities. In a capability-based view of transport, agency is not just the formal existence of options, but people's real freedom to select among them given their resources, constraints, and rights. This includes modal choice, flexibility to chain trips, control over timing and routing, and digital agency such as the ability to access, understand, and use journey-planning and booking tools. In the SOMI framework, agency also includes whether people have enforceable claims to mobility services or reasonable accommodations, rather than being passive recipients of whatever service is offered. Indicators considered may include the number of feasible mode options per trip, app access and usability, booking/control functionality, proportion of trips that can be self-directed without assistance, and perceived freedom of travel choice (Beyazit, E. 2011).
- **Participation**: The extent to which users, affected communities, and stakeholders are genuinely included in mobility decision-making, rather than merely consulted after key decisions are made. This pillar captures whether planning processes allow people to shape priorities, identify local problems, and influence trade-offs in service design, infrastructure, and regulation. It also concerns whether authorities respond to public input, incorporate underrepresented voices, and support co-creation rather than symbolic consultation. In transport planning research, participation is often discussed to improve both legitimacy and decision quality. Indicators considered may include the number and diversity of participants in consultations, share of proposals modified after public input, stakeholder representation metrics, participatory budget or co-design mechanisms, and user-reported influence over decisions (Michela et al. 2016).
- **Legal Recognition:** The extent to which mobility-related rights, duties, and regulatory protections are clearly established, enforceable, and applied consistently across users and modes. This includes

recognition of accessibility rights for persons with disabilities, legal protection against discrimination, and clear regulatory treatment of new services such as e-scooters and app-based mobility. The key issue is not only whether mobility services exist, but whether people can rely on a legal framework that defines entitlements, obligations, and remedies when access is denied or conditions are unsafe or exclusionary. For disabled users in particular, international human-rights law requires equal protection and non-discrimination, making legal recognition central rather than optional. Indicators considered may include the presence of enforceable accessibility statutes, anti-discrimination provisions, complaint and redress mechanisms, legal clarity for emerging modes, compliance audits, and enforcement actions (United Nations, 2006).

- **Safety & Security:** The degree to which the mobility system protects users from both physical harm and personal threat. This pillar has two linked dimensions: **safety**, meaning exposure to crash and injury risk, and **security**, meaning exposure to fear, harassment, violence, or unsafe environments while traveling or waiting. Recent safety research increasingly uses high-resolution sensing, traffic conflicts, and extreme-event analytics to estimate severe risk proactively rather than waiting for crashes to occur. At the same time, security research shows that subjective safety matters in its own right: fear of crime, poor lighting, or perceived disorder can deter use even when objective incident rates are low. A complete mobility assessment should therefore combine objective and perceived measures. Indicators considered may include the crash rates, injury severity, surrogate conflict exposure, near-miss frequency, lighting adequacy, security incident rates, perceived safety scores, and reported harassment or victimization (Hasanpour et al. 2026).

3 SOMI Calculation Model

3.1 Analysis of the Relevant Literature

Recent urban mobility research increasingly treats equity, inclusion, and governance as operational constraints, what can be delivered, to whom, and under what rules-rather than only as planning ideals. Yet the literature remains fragmented across:

(i) safety and risk operationalization using high-frequency sensing and extreme-event analytics;
(ii) latent constructs such as perceived fairness, trust, and acceptability;
(iii) equity/justice frameworks for identifying transport disadvantage; and
(iv) operations/OR approaches that optimize one lever at a time (pricing, matching, routing), often without a consistent multi-pillar, audit-ready aggregation into a comparable “social optimum” score (Dai, et al. 2026).

Safety-risk operationalization without equity-sensitive outcome aggregation is advancing rapidly through detection pipelines that identify rare-but-severe events from sensor/trajectory streams using anomaly detection and extreme value theory. Such work addresses the operational challenge of severe risk concentration in space and time but typically reports “risk reduction” without a standardized way to translate improvements into a multi-pillar, equity-aware outcome portfolio across user groups (Hussain, et al. 2022).

A growing body of work also focuses on improving operational prediction and control via advanced computational models. A comprehensive review of traffic flow prediction highlights the strong performance of deep learning architectures (including graph-based spatio-temporal models) and emphasizes privacy-preserving directions such as federated learning for cross-agency collaboration (Ali et al. 2026). While these advances strengthen the “availability/reliability” evidence base, they do not by themselves establish how performance gains translate into equitable outcomes across user groups or neighbourhoods, an issue that becomes central once policies are assessed through a DEI lens.

Safety-risk operationalization is also a critical issue addressed by the examined literature. Employed methodologies increasingly use high-resolution sensing and surrogate safety measures rather than relying only on crash records. Recent work applying machine learning and extreme value theory to traffic conflicts demonstrates that ML-based sampling (e.g., Isolation Forest) can identify “extreme” conflicts more consistently than classical POT approaches, supporting proactive safety management (Hasanpour et al. 2026). These methods substantively improve the measurement of safety risk (a core SOMI pillar), but they typically remain “single-domain” evaluations: safety improvements are not aggregated with affordability, accessibility, and participation into a comparable social optimum score, nor are they routinely mapped to persona-sensitive or vulnerability-sensitive outcomes.

The emerging issue of equity and justice in research has expanded rapidly and diversified in themes. However, bibliometric and topic-model-based reviews show it can remain reactive to technological and societal shocks, and uneven in geographic coverage-highlighting the need for more systematic, operationalizable measurement frameworks (Liu, & Zhe, 2026). City-specific equity assessments demonstrate how multidimensional frameworks (combining Rawlsian egalitarianism and capability perspectives) can reveal structural inequities, such as transit deserts affecting vulnerable populations and funding allocations that disproportionately prioritize private vehicle infrastructure over modes used by disadvantaged groups (Sarath, et al. 2026). Similarly, transit “gap” measurement frameworks quantify mismatches between transit need and transit provision and show that inequities often follow center–periphery patterns, with built environment effects varying spatially (Liu and Chung 2026). These works strongly motivate equity-centered evaluation, but they also underscore a recurring implementation problem: indicator sets, normalization choices, and aggregation rules differ across studies, limiting comparability across solutions and contexts.

A critical subset of the literature explicitly studies exclusion of marginalized groups and shows why "one-size-fits-all" mobility planning fails. Evidence from Pakistan demonstrates how transgender individuals face social exclusion and harassment in public transport, and how supportive policies may depend on cultural norms, subjective norms, and perceived behavioural control, highlighting the need for KPIs that can capture safety, dignity, and inclusion as operational (Ali et al. 2026). Relatedly, "experienced segregation" approaches aim to quantify how transport and mobility shape social exposure and separation, expanding equity measurement beyond infrastructure access alone (Poorvahedi & Smith-Colin, 2026). These strands connect directly to SOMI's DEI logic: equity is not only a distribution of services, but also a lived experience shaped by safety/security, discrimination, and perceived legitimacy.

Accessibility research increasingly frames equity in terms of access to essential opportunities, especially healthcare. Evidence from rural communities shows that adults with disabilities face transportation barriers that lead to forgone medical care and that ride-sourcing may not resolve this barrier reliably, pointing to deeper issues of affordability, accessibility, and service suitability (Bian et al. 2026). This supports a MaaR/SOMI-style conceptualization in which mobility is evaluated by its ability to enable participation in essential life domains, rather than by travel-time efficiency alone.

Perceived equity and fairness influence trust and acceptance, shaping whether interventions are used and sustained. Research on riders' subjective equity standards in transit shows that perceptions of equity are measurable and policy-relevant but are often separated from objective performance monitoring systems (Chen, Pougala, and Stathopoulos 2026). Gender-based heterogeneity studies similarly show that priorities differ substantially (e.g., women prioritizing safety and cost), reinforcing the need for segmentation/persona-aware evaluation rather than relying on an "average user" assumption (Pitale, Sadhukhan, and Parida 2026). In emerging service contexts, public acceptance studies on autonomous shuttles show that "conditional trust" depends on safety perception, information availability, accessibility design, and governance/data privacy-implying that successful mobility operations require measurable KPIs for acceptability and rights-oriented service design, not only technical performance (Makahleh et al. 2026).

Composite indicators and MCDM are widely used to create actionable decision support for sustainable mobility. Work on composite indicators of sustainable urban mobility demonstrates that rankings can vary materially depending on normalization and aggregation choices; therefore, robust evaluation should be transparent about methodological sensitivity and avoid presenting a single score as a neutral truth (Danielis, Rotaris, and Monte 2017). AHP-based approaches and equity audits provide a structured method to incorporate equity considerations into transport infrastructure evaluation and show that stakeholder preferences can change conclusions-supporting the need for auditable weighting and explicit equity dimensions (Thomopoulos, N., & Grant-Muller, S. 2013). Beyond passenger mobility, urban freight sustainability indicator selection remains less standardized, and multi-criteria selection frameworks have been proposed to close this gap-highlighting the need to treat logistics as part of sustainable urban mobility assessment (Ayadi, 2024). Related MCDM frameworks integrate stakeholder, cost, environment, and energy dimensions for road transport alternatives, illustrating how multi-criteria logic can be operationalized in infrastructure decisions (Hasan, U., Whyte, A., & AlJassmi, H. 2024). Objective weighting approaches, such as CRITIC, are also proposed to reduce subjective bias in weighting criteria-providing additional methodological tools for index construction and robustness checks (Ali et al., 2025).

Urban freight and last-mile logistics interact strongly with urban sustainability outcomes but are often treated separately from passenger-centric equity frameworks. Simulation-based studies of cargo bike delivery demonstrate operational feasibility and sustainability implications in last-mile contexts, but equity impacts typically remain implicit rather than explicitly indexed (Ceccato and Gastaldi, 2023). E-commerce logistics optimization methods (including vector models and dispatch optimization) emphasize cost and performance objectives, again showing a gap in consistent equity integration (Mormul, Shchytov, Shchytov, A. 2025). On the mobility integration side, MaaS-oriented matching methods can improve availability and multimodal feasibility, but equity outcomes are not automatic unless equity-sensitive KPI constraints and distribution-aware aggregation are built in (Wu, Y., Lai, M., & Wang, Y. 2026).

Proximity planning has gained traction through the "15-minute city" concept. GIS-based multi-criteria methods quantify district-level compliance and reveal center–periphery disparities, supporting targeted policy intervention and explicitly index-based spatial assessment (Kłos, M. J., Sierpiński, G., & Nardoianni, S. 2025). Related accessibility index work (e.g., composite transit accessibility indices) provides precedent for measurable, comparable accessibility scoring (Mamun, M. S. A., & Lownes, N. E. 2011). These approaches contribute strongly to the accessibility pillar but do not fully address the broader DEI and governance pillars (participation, legal recognition, agency).

New mobility domains also highlight equity trade-offs. Urban air mobility resilience/equity work proposes indices that reveal non-linear trade-offs in where resilience gains accrue, reinforcing that "more technology" can increase inequality if siting and governance are not equity-aware (Ma et al. 2025). Behavioral and engagement interventions, such as gamification, show promise for shifting mobility choices but reveal major gaps: uneven geographic focus and limited attention to demographic differences in design-again underlining the need for explicit DEI-oriented evaluation criteria (Zhang, Grassi, and Vallati 2026). Financial incentives for cycling have been framed as mobility justice strategies, with design guidelines to avoid reinforcing existing inequities-pointing to KPIs that capture participation, distribution of benefits, and "who is seen" in data (Lima, Behrendt, and Kon 2026). Digital traces (e.g., social media) can also be used to map environmental attitudes and discontent spatially but raise governance and representativeness questions relevant to participation and legitimacy (Lieth and Jünger, 2026).

Table 2: Critical synthesis of the examined literature

Ref	Focus	Objective	Method	Indexing	SOMI pillars	Equity/DEI treatment
Ali, et al. (2026)	Traffic flow prediction	Improve prediction accuracy & future directions	Review of ML/DL models	No	Av	Weak/indirect
Ali, N., et al. (2026)b.	Trans exclusion in PT	Identify exclusion mechanisms & impacts	Case study	No	Safe, Accpt, LR, Part	Strong (explicit DEI group)
Ayadi, H., Benaissa, M., et al. (2024)	Urban freight sustainability	Select sustainability indicators for UFT	MCA indicator selection	Partial (indicator framework)	Log, Env (and sometimes Safe)	Limited
Bian, J., et al. (2026)	Disability & healthcare access	Explain transport barriers to healthcare	Empirical study	No	Accs, Aff, Av	Strong (vulnerable group outcomes)
Ceccato, R., &	Cargo bikes	Test feasibility/sustainability of cargo bikes	Simulation	No	Log, Env	Indirect

Gastaldi, M. (2023).	(last mile)					
Chen, Z., Pougala, J., & Stathopoulos, A. (2026).	Subjective equity standards	Show how riders define equity	Survey/behavioral analysis	No	Accpt, Part (indirect), Av (perceived)	Moderate–strong
Dai, T., et al. (2026)	Fare-free transit justice	Test "justness" under moral principles	Normative OR / optimization	No (objective-based)	Aff, Accs, Av	Strong (Rawls vs utilitarian)
Danielis, R., Rotaris, L., & Monte, A. (2018)	Composite mobility indices	Robust ranking under different methods	Composite indicator + sensitivity	Yes	Accs, Av, Env (varies)	Weak–moderate
Hasan, U., Whyte, A., & AlJassmi, H. (2024).	MCDM road transport	Integrate stakeholder-cost-env-energy	MCDM case study	Partial	Env, Av (and cost)	Weak
Hasanpour, et al. (2026)	Safety EVT + ML	Identify extreme conflicts better than POT	ML + EVT	No	Safe	Indirect
Diakoulaki, D., Mavrotas, G., & Papayannakis, L. (1995).	CRITIC weighting	Objective weighting for MCDM	Method paper	Yes (method)	Cross-cutting	None
Thomopoulos, N., & Grant-Muller, S. (2013)	Equity policy evaluation	Equity-oriented evaluation framework	Policy/program evaluation	Partial	Accs, Aff, Av, Safe	Strong
Kłos, M.J. (2025)	15-minute city	Score districts via GIS multi-criteria	GIS + MCDM	Yes	Accs (strong), Av (indirect)	Indirect

Lieth, J., & Jünger, S. (2025)	Green discontent (Twitter)	Map spatial attitudes	Social media spatial analysis	No	Part (proxy), Accpt (proxy)	Indirect
Zhang, Grassi, and Vallati (2026).	Cycling incentives & justice	Evaluate incentives as equity strategy	Policy/justice framing	No	Accs, Aff, Part, Ag, Safe	Strong
Liu, Y.-F., & Chung, Y.-S. (2026).	Transit gap (Taipei)	Quantify need–provision mismatch	GWR / spatial modeling	Sometimes (gap indices)	Accs, Av	Moderate
Liu & Zhe. (2026)	Transport justice evolution	Map field trends & gaps	Bibliometrics + topic modeling	No	LR/Part (conceptual)	Indirect
Ma, Z., Wang, Z., Peng, Y., Xu, Y., et al. (2026).	UAM resilience & equity	Measure equity/resilience trade-offs	Indexing approach	Yes	Accs/Av (network), Equity	Moderate
Makahleh, H.Y., Johnson, R., et al. (2026).	Shuttle acceptance	Identify acceptance barriers & governance	Focus groups	No	Accpt, Safe, Accs, LR/Part	Moderate–strong
Mamun, M.S.A., & Lownes, N.E. (2011).	Transit accessibility index	Build composite accessibility score	Composite index	Yes	Accs	Indirect
Mormul, M., Shchytov, D., & Shchytov, O. (2025).	E-commerce logistics optimization	Optimize logistics performance	Optimization / vector models	No	Log, Av	None
Pitale, A.M., Sadhukhan, S., &	Gender heterogeneity	Identify gender differences in perceptions	Survey analysis	No	Accpt, Safe, Aff (perceived)	Strong (gender)

Parida, M. (2026)	(transit)					
Poorvahed, E., & Smith-Colin, J. (2026)	Experienced segregation	Measure social exposure effects	Exposure/segregation metrics	Sometimes (indices)	Accs, Part	Strong
Sarath, et al. (2026)	Trans exclusion in PT	Identify exclusion mechanisms & impacts	Case study	No	Safe, Accpt, LR, Part	Strong (explicit DEI group)
Thomopoulos, N., & Grant-Muller, S. (2013)	Urban freight sustainability	Select sustainability indicators for UFT	MCA indicator selection	Partial (indicator framework)	Log, Env (and sometimes Safe)	Limited
Wu, Y., Lai, M., & Wang, Y. (2026).	Subjective equity standards	Show how riders define equity	Survey/behavioral analysis	No	Accpt, Part (indirect), Av (perceived)	Moderate–strong

Building on the critical synthesis presented above, the reviewed literature shows that current mobility assessment approaches provide valuable evidence on specific dimensions such as safety, accessibility, equity, logistics, acceptance and environmental performance, but they remain fragmented in terms of KPI selection, normalisation, aggregation and transferability across cities and solutions. The recurring methodological gaps identified through this review are summarised below, together with the way in which the SOMI methodology responds to them through a common pillar structure, persona-level scoring, explicit weighting and a city-computable assessment pipeline.

Research gap identified in the literature		**How the SOMI methodology addresses the gap**
_Most studies assess one mobility dimension well, such as traffic performance, safety, accessibility, logistics efficiency or justice, but do not provide a shared method for comparing multi-pillar policy packages in one coherent evaluation space.	→	**SOMI** structures all assessed solutions under a common pillar architecture and computes normalized pillar scores and **SOMI** values. This creates one consistent evaluation space for comparing multi-pillar mobility solutions.
_Equity, inclusion and distributional impacts are often discussed, but they are rarely embedded directly into index construction. As a result, impacts on specific user groups can be averaged away in aggregate scores.	→	**SOMI** is first calculated at persona level and then aggregated using explicit persona influence weights. This keeps distributional effects visible before any solution-level or city-level synthesis is produced.
_Accessibility, freight, composite-index and sustainability studies often use different KPI	→	**SOMI** defines a fixed KPI dictionary, including KPI definition, unit, direction of

sets, thresholds, normalisation rules and aggregation methods, which limits transferability across contexts and cities.		improvement, data source and acceptable range. The same normalisation protocol is then applied across the assessed solutions, improving comparability and transferability.
_Many mobility assessment frameworks focus on accessibility, efficiency and environmental performance, while governance-related dimensions such as Legal Recognition, Participation and Agency remain under-measured.	→	SOMI includes Legal Recognition, Participation and Agency as explicit pillars. These dimensions are translated into measurable KPI proxies, so governance, rights and user capability influence the final assessment.
_Acceptance, perceived fairness, subjective safety and lived experience are recognised as important, but they are seldom translated into measurable KPIs that can be tracked and compared across interventions.	→	SOMI introduces a survey-based KPI layer for subjective and perceived impacts, such as perceived safety, fairness, affordability burden, trust and comfort. These indicators can be normalised and included in pillar scoring alongside objective KPIs.
_Composite indices and MCDM approaches often recognise sensitivity and robustness issues, but they rarely provide a repeatable and city-computable pipeline that documents assumptions clearly.	→	SOMI is developed as a transparent computational pipeline with documented normalisation ranges, weights and aggregation rules. Sensitivity checks can be applied through alternative weighting or normalisation assumptions where data allow.
_Many frameworks require rich data, but do not specify what minimum data a city realistically needs in order to compute the index. This limits practical implementation at city scale.	→	SOMI specifies the data requirements for each KPI, including data fields, spatial and temporal granularity, update frequency, responsible data owner and collection method. It also distinguishes between a minimum viable KPI set and an enhanced set for future maturity.
_Existing evaluations are often intervention-specific, city-specific or cross-sectional, with limited ability to compare multiple solutions consistently across personas and over time.	→	SOMI supports consistent comparison across solutions, personas and cities using the same pillar structure and calculation logic. The methodology can be updated over time as new KPI values become available, supporting monitoring and scenario comparison through GO-WISDOM and GO-DATA.

SOMI is computed for multiple solutions under the same framework, and because all indicators are normalized and defined with periodicity, SOMI can be recalculated over time (baseline vs scenario; year-to-year updates). Persona-level computation enables consistent comparison of distributional effects across user groups, solutions and time periods, allowing decision-makers to identify not only whether a mobility intervention improves the overall city-level SOMI, but also which personas benefit, which remain underserved, and where corrective measures or targeted policy adjustments are required.

3.2 SOMI Mathematical Model Development

We conceptualize "socially optimal" mobility as a multi-pillar mobility-system outcome, evaluated simultaneously across cities, mobility solutions, personas, SOMI pillars, and Key Performance Indicators (KPIs). The framework is designed to produce a single Global Social Optimum Mobility Index (Global SOMI), while preserving full analytical traceability at lower levels of aggregation. In this way, the methodology enables both an overall assessment of socially optimal mobility performance and a structured drill-down to the city, solution, persona, pillar, and KPI levels. The notation of model parameters is described as follows:

- Let $c \in \mathcal{C}$ represent a city, where $\mathcal{C}$ is the set of all cities included in the analysis.
- For $\forall c \in \mathcal{C}$, let $s \in \mathcal{S}_c$ represent an examined mobility solution or policy package, where $\mathcal{S}_c$ is the set of solutions evaluated in city c.
- The notation $s = 0$ is reserved for the baseline state, against which the performance of each solution is compared.
- Let $r \in \mathcal{R}_c$ represent a persona considered in city c, where $\mathcal{R}_c$ is the set of representative mobility personas.
- Let $p \in P$ represent a SOMI pillar, where (P) is the common set of SOMI pillars: Accessibility, Availability, Affordability, Acceptability, Agency, Participation, Legal Recognition, and Safety & Security.
- For each city c, solution s, and pillar p, we define a set of KPIs, $\mathcal{K}_{c,s,p}$, where $k \in \mathcal{K}_{c,s,p}$ represents a generic KPI assigned to pillar p, for solution s, in city c.

Personas are used to capture the fact that different user groups experience the same mobility system in different ways. Depending on the city-specific application, personas may include daily commuters, students, older residents, mobility-limited users, shop owners with delivery needs, visitors, suburban commuters, or multimodal travellers.

Because the selected KPIs are expressed in heterogeneous units, such as minutes, euros, percentages, shares, rates, counts, or Likert-scale responses, they are transformed onto a common normalized scale from 0 to 1. On this scale, 1 denotes the best achievable or desired performance and 0 denotes the worst reference performance.

Let $x_{c,s,r,p,k}$ denote the observed or estimated value of KPI k, under pillar p, for persona r, solution s, and city c. For each KPI, two reference limits are defined:

$L_{c,r,p,k}$ as the lower reference limit, and
$U_{c,r,p,k}$ as the upper reference limit, with $U_{c,r,p,k} > L_{c,r,p,k}$.

These limits may be derived from evidence-based thresholds from the literature associated to the urban planning documents of each city. The normalized KPI value is denoted by $z_{c,s,r,p,k} \in [0,1]$ and is calculated according to the nature of the indicator.

For KPIs where higher values indicate better performance, such as accessibility coverage, service availability, or share of machine-readable regulations, normalization is calculated as:

$$z_{c,s,r,p,k} = \frac{x_{c,s,r,p,k} - L_{c,r,p,k}}{U_{c,r,p,k} - L_{c,r,p,k}}, \qquad Eq.(1)$$

For KPIs where lower values indicate better performance, such as travel time, waiting time, affordability burden, or crash exposure, normalization is calculated as:

$$z_{c,s,r,p,k} = \frac{U_{c,r,p,k} - x_{c,s,r,p,k}}{U_{c,r,p,k} - L_{c,r,p,k}}, \qquad Eq.(2)$$

When a SOMI pillar p is represented by more than one KPI, the normalized pillar score is calculated as the simple arithmetic mean of the normalized values of all KPIs assigned to that pillar. Thus, for city c, solution s, persona r, and pillar p:

$$\phi_{c,s,r,p} = \frac{1}{|\mathcal{K}_{c,s,p}|} \sum_{k \in \mathcal{K}_{c,s,p}} z_{c,s,r,p,k}, \qquad \text{Eq. (3)}$$

Where $\phi_{c,s,r,p} \in [0,1]$. This formulation removes the need for within-pillar KPI weights and ensures that the pillar score expresses the average normalized performance of the KPI portfolio used to operationalize that pillar. It also guarantees that pillars represented by multiple indicators remain comparable with pillars represented by fewer indicators.

3.2.1 Persona-Level SOMI for Each Solution and City

Different personas may assign different significance to different SOMI pillars, and these priorities may also vary depending on the specific mobility solution being assessed. For example, accessibility and safety may be especially important for a mobility-limited user when evaluating a physical multimodal intervention, whereas affordability and availability may be more critical for a budget-sensitive student or daily commuter when assessing a public transport or shared-mobility solution. The notation of model parameters is described as follows:

- Let $w_{c,s,r,p}$ denote the significance weight assigned to pillar p for persona r under solution s, in city c, with $w_{c,s,r,p} \geq 0$ and $\sum_{p \in \mathcal{P}} w_{c,s,r,p} = 1$.
- The persona-level SOMI score for city c, solution s, and persona r is then defined as:

$$\mathrm{SOMI}_{c,s,r} = \sum_{p \in \mathcal{P}} w_{c,s,r,p} \; \phi_{c,s,r,p}, \qquad Eq. (4)$$

Substituting Eq. (5), leads to the following Eq. (7):

$$\mathrm{SOMI}_{c,s,r} = \sum_{p \in \mathcal{P}} w_{c,s,r,p} \left[\frac{1}{|\mathcal{K}_{c,s,p}|} \sum_{k \in \mathcal{K}_{c,s,p}} z_{c,s,r,p,k} \right], \qquad Eq. (5)$$

This produces a normalized 0-1 SOMI score for each persona, solution, and city. The persona-level formulation prevents the “average-user collapse,” whereby a solution may appear beneficial in aggregate while reducing performance for a vulnerable or underserved user group.

3.2.2 City-Level SOMI

To aggregate persona-level scores into an overall SOMI score for a specific solution s in city c, let $\pi_{c,r}$ denote the aggregation weight assigned to persona r in city c, with $\pi_{c,r} \geq 0$ and $\sum_{r \in \mathcal{R}_c} \pi_{c,r} = 1$. The persona weights $\pi_{c,r}$ may be defined through several defensible approaches, including: equal weighting across personas; population-based weighting; equity-prioritized weighting, assigning greater importance to vulnerable or underserved groups; or policy-leverage weighting, emphasizing personas most affected by or most relevant to the intervention.

The SOMI score of solution s in city c is:

$$\mathrm{SOMI}_{c,s} = \sum_{r \in \mathcal{R}_c} \pi_{c,r} \; \mathrm{SOMI}_{c,s,r}, \qquad Eq. (6)$$

Substituting Eq. (7) in Eq.(8) leads to the following Eq. (9):

$$\text{SOMI}_{c,s} = \sum_{r\in\mathcal{R}_c} \pi_{c,r} \sum_{p\in\mathcal{P}} w_{c,r,p} \left[\frac{1}{|\mathcal{K}_{c,s,p}|} \sum_{k\in\mathcal{K}_{c,s,p}} z_{c,s,r,p,k} \right], \qquad Eq.(7)$$

This function generates a single optimal social mobility score for each solution within each city, while preserving the contribution of all personas, pillars, and KPIs.

To this end, and to obtain a unified city-level SOMI score, the methodology aggregates the SOMI values of all solutions assessed in that city. Let $\lambda_{c,s}$ denote the aggregation weight assigned to solution s in city c, where $\lambda_{c,s} \geq 0$ and $\sum_{s\in\mathcal{S}_c} \lambda_{c,s} = 1$. The solution weights $\lambda_{c,s}$ may reflect equal importance of all solutions, relative strategic relevance, implementation maturity, budgetary scale, expected territorial impact, or stakeholder-defined policy priorities. The overall city-level SOMI is:

$$\text{SOMI}_c = \sum_{s\in\mathcal{S}_c} \lambda_{c,s}\ \text{SOMI}_{c,s}, \qquad Eq.(8)$$

or, in expanded form:

$$\text{SOMI}_c = \sum_{s\in\mathcal{S}_c} \lambda_{c,s} \sum_{r\in\mathcal{R}_c} \pi_{c,r} \sum_{p\in\mathcal{P}} w_{c,r,p} \left[\frac{1}{|\mathcal{K}_{c,s,p}|} \sum_{k\in\mathcal{K}_{c,s,p}} z_{c,s,r,p,k} \right], \qquad Eq.(9)$$

This city-level function is the appropriate analytical expression when the assessment moves from the global project perspective to a specific city-level interpretation. It aggregates the socially optimal mobility performance of all solutions implemented or assessed in city c, while retaining the underlying solution-, persona-, pillar-, and KPI-level structure.

3.2.3 Baseline and Change Assessment

Since the examined mobility solutions are assessed prior to their implementation, the SOMI framework adopts an ex-ante scenario-based comparison between the current baseline condition and the expected condition under each proposed solution.

- Let $\tau \in \{0,1\}$ denote the assessment state, where $\tau = 0$ represents the baseline or current mobility condition, defined by the current observed KPIs, and $\tau = 1$ represents the prospective scenario defined by the expected or simulated values of the same KPIs under the assumed implementation of solution s.
- For each city c, persona r, and evaluated solution s, the persona-level SOMI change relative to the baseline is calculated as:

$$\Delta\text{SOMI}_{c,s,r} = \text{SOMI}^{(1)}_{c,s,r} - \text{SOMI}^{(0)}_{c,s,r}, \qquad Eq.(10)$$

Where:

- $\text{SOMI}^{(0)}_{c,s,r}$ denotes the baseline SOMI score for persona $r$in city c, measured against the KPI structure relevant to solution s, and
- $\text{SOMI}^{(1)}_{c,s,r}$ denotes the corresponding prospective SOMI score under the assumed implementation of that solution. Accordingly, the expected solution-level SOMI change is:

$$\Delta\text{SOMI}_{c,s} = \text{SOMI}^{(1)}_{c,s,r} - \text{SOMI}^{(0)}_{c,s,r}, \qquad Eq.(11)$$

These change measures indicate whether a proposed solution is expected to improve or worsen socially optimal mobility outcomes for a specific persona and for the aggregated city-level population represented by the persona structure. Because the solutions are not yet implemented, the resulting ΔSOMI values should be interpreted as prospective, scenario-based changes, rather than as empirically observed ex-post impacts.

Table 3: Nomenclature of the Mathematical Model Parameters

Nomenclature	Description	Units
$\boldsymbol{\mathcal{C}}$	Set of cities included in the SOMI assessment	Finite set
$\boldsymbol{c}$	A generic city	$c \in \mathcal{C}$
$\boldsymbol{\mathcal{S}_c}$	Set of evaluated non-baseline solutions in city c	$\{1, \dots, S_c\}$
$\boldsymbol{s}$	A generic evaluated solution in city c	$s \in \mathcal{S}_c$
$\boldsymbol{s = 0}$	Baseline mobility state used for comparison	Reference state
$\boldsymbol{\mathcal{R}_c}$	Set of personas considered in city c	Finite set
$\boldsymbol{r}$	A generic persona in city c	$r \in \mathcal{R}_c$
$\boldsymbol{\mathcal{P}}$	Set of SOMI pillars: Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition, Participation, Safety & Security	Finite set
$\boldsymbol{p}$	A generic SOMI pillar	$p \in \mathcal{P}$
$\boldsymbol{\mathcal{K}_{c,s,p}}$	Set of KPIs assigned to pillar p, for solution s, in city c	Finite set
$\boldsymbol{k}$	A generic KPI	$k \in \mathcal{K}_{c,s,p}$
$\boldsymbol{x_{c,s,r,p,k}}$	Observed or estimated raw value of KPI k, for persona r, under solution s, pillar p, and city c	Real-valued; unit depends on KPI
$\boldsymbol{L_{c,r,p,k}}$	Lower normalization reference limit for KPI k	Real-valued
$\boldsymbol{U_{c,r,p,k}}$	Upper normalization reference limit for KPI k	Real-valued; $U_{c,r,p,k} > L_{c,r,p,k}$
$\boldsymbol{z_{c,s,r,p,k}}$	Normalized KPI value	$[0,1]$
$\boldsymbol{\phi_{c,s,r,p}}$	Pillar score, calculated as the average normalized value of all KPIs belonging to pillar p	$[0,1]$
$\boldsymbol{w_{c,r,p}}$	Parametric significance weight of pillar p for persona r in city c	$w_{c,r,p} \geq 0, \sum_{p \in \mathcal{P}} w_{c,r,p} = 1$
$\mathbf{SOMI}_{c,s,r}$	Persona-level SOMI score for persona r, solution s, and city c	$[0,1]$
$\mathbf{SOMI}_{c,s}$	Solution-level SOMI score for solution s in city c	$[0,1]$

$\mathbf{SOMI}_{c}$	City-level SOMI score aggregating all examined solutions in city c	$[0,1]$
$\boldsymbol{\Delta}\mathbf{SOMI}_{c,s,r}$	Change in persona-level SOMI under solution s, relative to the baseline	$[-1,1]$
$\boldsymbol{\Delta}\mathbf{SOMI}_{c,s}$	Change in city-solution SOMI under solution s, relative to the baseline	$[-1,1]$

3.2.4 Persona and Solution Selection Process

The GOLIA persona and solution selection process followed a city-specific, objective-driven and behaviour-oriented approach. The aim was to ensure that the SOMI calculation is not applied to generic mobility measures or abstract user categories, but to mobility solutions and user groups that are relevant to the three GOLIA pilot cities: Antwerp, Florence and Pilsen.

The process builds directly on the Three-Dimensional Mobility Ecosystem Map developed in D1.1. This ecosystem map combines three analytical layers: the human layer, the spatial/technical layer and the institutional/governance layer. In D1.4, persona selection corresponds mainly to the human layer, solution selection corresponds mainly to the spatial/technical layer, and the institutional/governance layer is reflected through KPIs related to legal recognition, participation, data readiness, implementation feasibility and governance relevance.

For the purposes of this section, the term GOLIA operational assessment objectives refers to the project-specific assessment priorities distilled from the D1.1 city-vision workflow. These objectives translate the pilot cities' visions, challenges and mobility contexts into a focused set of criteria for selecting personas, mobility solutions and KPIs for SOMI. They provide the analytical entry point for D1.4, ensuring that the SOMI assessment remains grounded in the pilot-city context while remaining comparable across Antwerp, Florence and Pilsen.

The following steps explain how the D1.1 inputs were collected, how they were used in D1.4, and what they derived for the SOMI calculation. The methodological workflow followed in D1.4 is summarised in Figure 3. The process starts from the conceptual and literature-based expansion of MaaR into SOMI pillars, then defines the calculation framework, translates city inputs into KPIs and baseline values, prioritises SOMI pillars for city personas, derives solution-specific persona influence weights through the ICB exercise, applies the weights in the SOMI calculation and validates the resulting framework.

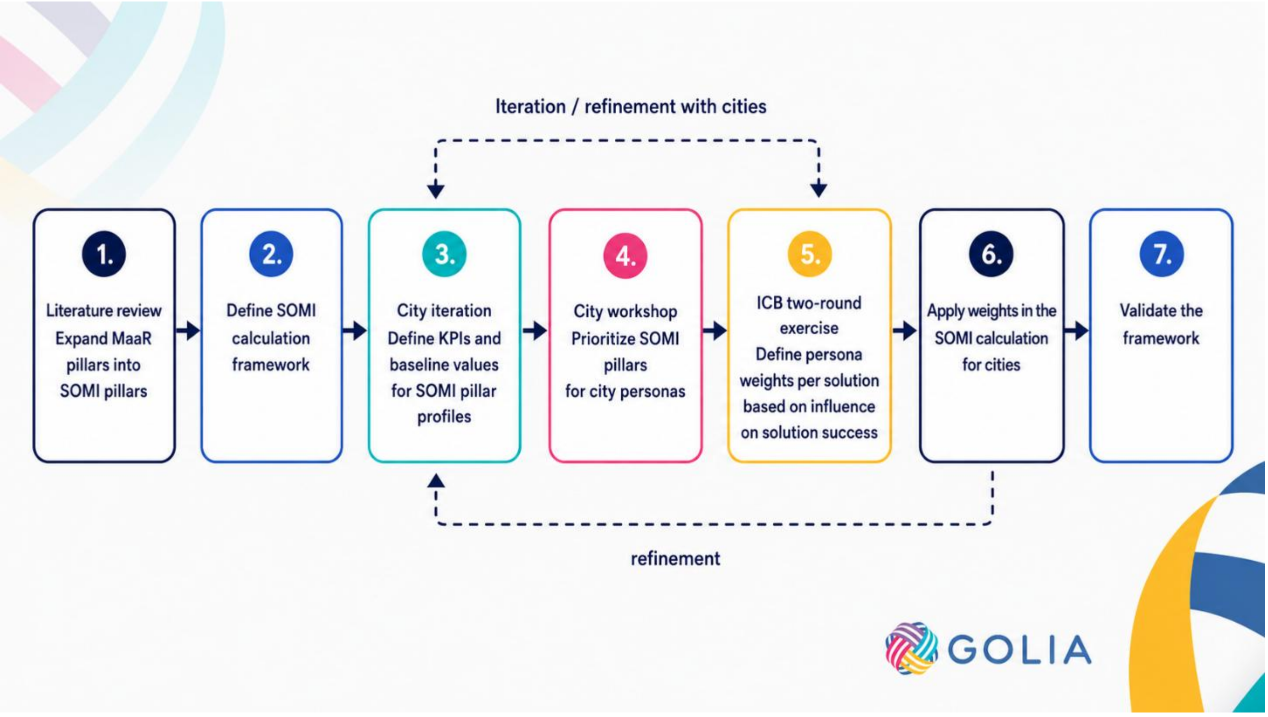

Figure 3: Methodological workflow for developing the SOMI calculation framework

The workflow is iterative rather than strictly linear. City input is used to refine KPI definitions and baseline values, while the application of the calculation framework can lead to further refinement of the data structure, weights and interpretation logic. This iterative structure is important because SOMI is intended to be reusable in GO-WISDOM, where KPI values and scenario assumptions may be updated as new city evidence becomes available.

Step 1: Deriving GOLIA operational assessment objectives from the D1.1 workflow

The process started from the city vision-led workflow developed in D1.1. This workflow began with contextual immersion in the three pilot cities, during which the main mobility challenges, existing digital assets, stakeholder-consultation maturity and long-term mobility ambitions of Antwerp, Florence and Pilsen were reviewed. These inputs were then deconstructed into a hierarchy of objectives and translated into Specific Objectives (SOs) for the purposes of the D1.1 ecosystem mapping.

For D1.4, these SOs are used as GOLIA operational assessment objectives. They define the project-specific logic for deciding which personas and solutions should be assessed through SOMI. They are not used as a substitute for official city planning documents. Instead, they provide a focused analytical frame that makes the SOMI assessment manageable, comparable and clearly connected to the GOLIA pilot logic.

The first table explains how the city-vision and objective-related inputs from D1.1 were collected, how they were used in D1.4, and what they produced for the SOMI assessment.

Table 4: Traceability of Step 1: Deriving GOLIA operational assessment objectives

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
City visions, city challenges, existing	These inputs were collected through the	The inputs were used to translate broad	A city-specific set of GOLIA operational

digital assets, stakeholder-consultation maturity, long-term mobility ambitions and D1.1 SO tables for Antwerp, Florence and Pilsen.	D1.1 City Vision-Led / Vision-to-Requirement workflow. The process started with contextual immersion during the GOLIA Rome Kick-off Meeting, where Antwerp, Florence and Pilsen presented their mobility landscapes, current challenges, existing digital assets, consultation maturity and wider visions for climate-neutral and socially just mobility.	pilot-city visions and challenges into GOLIA operational assessment objectives. These objectives were treated as project-specific assessment objectives for the SOMI methodology, not as the cities' full official SUMP/SULP or statutory planning objectives.	assessment objectives used as the starting point for selecting personas, solutions and KPIs.

The next table presents the operational assessment objectives used in D1.4. The table is included in the main text to make the objectives visible and to avoid leaving them embedded in a long paragraph.

Table 5: GOLIA operational assessment objectives used for persona and solution selection

Pilot city	GOLIA operational assessment objectives used in D1.4	Relevance for persona and solution selection
Antwerp	Reduce car dependency; improve the adoption, functionalities and coverage of Smart Ways to Antwerp; strengthen multimodal alternatives; support metropolitan-scale planning and data sharing; improve communication with target audiences; and support inclusive mobility-policy making for hard-to-reach groups, diverse users, local businesses and logistics service providers.	These objectives guide the selection of personas affected by multimodal information, digital accessibility, regional scale-up, car-dependency reduction and inclusive mobility services. They also justify the assessment of the multimodal journey planner / Smart Ways to Antwerp scale-up as a SOMI-relevant solution.
Florence	Promote innovative logistics policies and strategies in the UNESCO city-centre area; optimise public-space use for sustainable urban logistics; support micro-hubs and sustainable logistics models; improve road safety in line with Vision Zero; extend 30 km/h areas; redesign roads to protect vulnerable users; improve public-space quality; and ensure equitable access to mobility for all users in line with MaaR.	These objectives guide the selection of personas exposed to road-safety, accessibility, public-space and logistics trade-offs, including residents, tourists, businesses, older or less mobile users and logistics actors. They also justify the assessment of Zone 30 / 30 km/h traffic-calmed areas, logistics micro-hubs / Spazi di Logistica di Prossimità, and redistribution of road space.
Pilsen	Better exploit existing digital assets; build a mobility-management approach	These objectives guide the selection of personas affected by commuting, access to

	involving the city, the wider functional urban area and neighbouring communities; improve data sharing and multisectoral data exchange; produce new open-data outputs from the digital twin; promote active modes; enhance multimodal transport including peripheral areas; address industrial-zone commuting; and prepare the city for more connected and automated mobility.	employment, first-/last-mile barriers, active mobility, digital planning and wider functional-area integration. They also justify the assessment of cycling, digital-twin-enabled planning and first-/last-mile access solutions.

This first step ensured that the SOMI assessment remains grounded in GOLIA's pilot-city logic, while avoiding the risk of presenting project-specific objectives as the official or complete strategic objectives of the cities.

Step 2: Identifying candidate personas from the human layer

The second step focused on identifying the transport personas relevant to each pilot city. In D1.1, personas were developed as qualitative, policy-oriented user profiles. They were not intended to represent statistically fixed population segments. Instead, they were designed to capture typical mobility situations, behavioural constraints, barriers, enablers and sensitivities that matter for mobility-policy assessment.

The persona development process drew on desk research, European mobility literature, project evidence, policy documents, case studies and expert judgement. The aim was to identify user profiles that could help explain how different groups may experience the same mobility solution differently. The resulting personas include, for example, residents, commuters, students, older or less mobile users, families, visitors, business actors and logistics operators.

The following table clarifies how the D1.1 human-layer inputs were collected and translated into candidate personas for D1.4.

Table 6: Traceability of Step 2-Identifying candidate personas

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
Evidence on user needs, behavioural barriers, vulnerabilities, modal dependencies, daily routines, socio-economic characteristics, spatial conditions and personal attitudes.	These inputs were collected through a structured desk-research process using academic studies, European research projects, policy documents, case studies and practical reports. D1.1 used these sources to understand how mobility behaviour is influenced by urban form, transport	The inputs were used to identify the main user groups likely to be affected by each city's GOLIA operational assessment objectives. The purpose was to avoid generic population groups and instead define personas that reflect realistic mobility situations in Antwerp, Florence and Pilsen.	Preliminary persona lists for each pilot city, representing groups such as residents, commuters, students, older or less mobile users, families, visitors, business actors and logistics operators.

	systems, social conditions, governance frameworks and personal constraints.		

For SOMI, this persona layer is essential because it prevents the assessment from collapsing all users into a single "average user". A mobility solution may improve the average score of a city while still leaving some groups underserved. By computing SOMI at persona level before aggregation, D1.4 makes these distributional effects visible.

Step 3: Identifying candidate mobility solutions from the spatial/technical layer

In parallel, candidate mobility solutions were identified from the spatial/technical layer of the D1.1 ecosystem map. D1.1 reviewed a broad range of existing and emerging mobility practices, services, public-space measures, digital tools and governance-related interventions. These included, among others, active-mobility interventions, public-transport improvements, mobility hubs, logistics micro-hubs, digital journey planners, data spaces, traffic-calming measures, road-space redistribution and other measures relevant to socially optimised mobility.

For D1.4, this broad solution catalogue was filtered to identify solutions that met three conditions: they had to be relevant to one or more GOLIA operational assessment objectives; they had to affect clearly identifiable personas or user groups; and they had to be linked to measurable SOMI KPIs, either through available data, official indicators, documented proxies or structured assessment values.

The following table explains how the D1.1 spatial/technical inputs were collected and how they were used to derive candidate mobility solutions for D1.4.

Table 7: Traceability of Step 3 - Identifying candidate mobility solutions

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
Catalogue of mobility practices and solutions; solution clusters and sub-clusters; examples from European mobility initiatives; case studies; specialist sources; internally shortlisted examples; city-relevant solution options.	These inputs were collected through specialised desk research, review of European mobility knowledge bases, previous EU-funded research and innovation initiatives, project reports, academic publications, case studies and practical examples. D1.1 then categorised and clustered the solutions into groups such as spatial/street design, sustainable	The inputs were used to identify mobility solutions relevant to the GOLIA operational assessment objectives. Each solution was screened according to whether it addressed at least one city-specific assessment objective and whether it could be linked to measurable SOMI pillars and KPIs.	Candidate solution lists for the three pilot cities, later narrowed to the solutions assessed in D1.4.

	services, digital planning, governance/regulation and behavioural drivers.		

This filtering step was necessary because the SOMI methodology requires more than conceptual relevance. Each selected solution must also be operationally measurable through the eight SOMI pillars: Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition, Participation, and Safety & Security.

Step 4: Defining behavioural and contextual attributes for personas

The fourth step consisted of describing each persona through behavioural and contextual attributes. These attributes included daily mobility needs, time constraints, cost sensitivity, preference for flexibility, safety concerns, comfort needs, digital skills, reliance on existing services, car dependency, household or work-related constraints, and openness to behavioural change.

This step was important because personas are not only labels. They provide a structured way to understand how mobility solutions may affect different users. For example, a budget-sensitive student may be strongly affected by affordability; an older or less mobile resident may be more sensitive to accessibility, safety and comfort; a suburban commuter may be affected by reliability and multimodal integration; and a logistics operator may be more sensitive to delivery access, time windows and regulatory clarity.

The following table shows how the persona evidence collected in D1.1 was converted into behavioural and contextual attributes usable in the SOMI assessment

Table 8: Traceability of Step 4-Defining behavioural and contextual persona attributes

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
Persona descriptions and evidence on daily mobility needs, trip purposes, cost sensitivity, digital skills, safety concerns, accessibility needs, car dependency, time constraints and openness to change.	These inputs were collected and structured through the D1.1 persona-development process, based on desk research, behavioural theory, mobility-behaviour evidence, policy documents, case studies and expert interpretation.	The inputs were used to make each persona operational for SOMI. Instead of treating personas only as labels, D1.4 used these attributes to understand how each group may experience a mobility solution differently.	Persona attribute profiles used to interpret pillar relevance, distributional impacts and persona-sensitive SOMI results.

By defining these attributes, the persona framework becomes usable for SOMI. The attributes help identify which SOMI pillars are most relevant for each persona and why the same solution may produce different benefits, burdens or risks across user groups.

Step 5: Linking personas to barriers, enablers, nudges and incentives

The fifth step applied the behaviour-change and social-tipping logic developed in D1.1. For each persona, barriers and enablers were identified. Barriers included, for example, lack of perceived safety, limited accessibility, poor connectivity, high costs, strong car-use habits, complex systems, lack of information or digital exclusion. Enablers included improved service reliability, safer infrastructure, clearer information, better intermodality, affordability measures, social support and visible benefits.

Nudges and incentives were also mapped where relevant. Nudges included awareness campaigns, personalised information, visibility of benefits, peer examples, safer street design, signage, digital tools and real-time information. Incentives included discounts, subsidies, mobility credits, priority access, dedicated infrastructure and recognition schemes.

The following table explains how the behavioural evidence from D1.1 was collected and how it was used to support persona-sensitive interpretation in D1.4.

Table 9: Traceability of Step 5 - Linking personas to barriers, enablers, nudges and incentives

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
Behaviour-change evidence; Social Tipping Theory; mapped user barriers and enablers; nudges and incentives linked to different transport modes and persona groups.	These inputs were collected and synthesised through D1.1's behavioural-analysis work, which combined literature review, behavioural theory, Social Tipping Theory and persona-based analysis of barriers, enablers, nudges and incentives.	The inputs were used to explain why a solution may or may not be accepted, used or supported by different personas. They also helped connect each solution to expected behavioural responses, such as modal shift, increased uptake, reduced car dependency or improved trust.	Barrier-enabler-nudge logic used to support persona-sensitive interpretation of SOMI results and to explain why certain pillars matter more for certain personas.

For the solution component, the equivalent step was to identify the expected mechanism through which each solution could contribute to SOMI. For example, 30 km/h traffic-calmed areas act primarily through speed reduction, safer street design and reduced risk for vulnerable road users. Logistics micro-hubs act through consolidation of deliveries, reduced delivery pressure and better management of freight access. Multimodal journey planners act through improved access to integrated mobility information and easier use of sustainable alternatives.

Step 6: Matching personas, solutions and SOMI pillars

The sixth step linked the persona framework and the solution framework. For each city, the analysis clarified which personas are most affected by each selected solution, which barriers the solution addresses, which benefits it may generate, and which SOMI pillars are most relevant.

This matching step created the operational connection between D1.1 and D1.4. D1.1 identifies the user groups, behavioural patterns, mobility modes and possible policy measures. D1.4 then translates this structure into a measurable SOMI configuration by assigning KPIs to the relevant pillars.

The following table shows how the outputs of the previous steps were brought together to create the persona-solution-pillar structure used for SOMI.

Table 10: Traceability of Step 6 -Matching personas, solutions and SOMI pillars

D1.1 input / data used	***How the input was collected in D1.1***	***How the input was used in D1.4***	***What was derived for SOMI***
GOLIA operational assessment objectives, final candidate personas, candidate mobility solutions, D1.1 human and spatial/technical layers, SOMI pillar structure, available KPI evidence and MaaR-related considerations.	These inputs were consolidated from the previous D1.1 steps: city contextual immersion, desk research, persona development, solution mapping, behavioural analysis and validation. The SOMI pillar structure and MaaR considerations were then added in D1.4 to make the D1.1 outputs measurable.	The inputs were combined to identify which personas are most affected by each solution, which barriers each solution addresses, and which SOMI pillars are most relevant. This step created the operational link between D1.1's qualitative ecosystem mapping and D1.4's quantitative SOMI calculation.	Persona-solution-pillar mapping used to structure KPI selection, weighting and persona-level SOMI calculation.

The matching logic can be summarised as follows: persona relevance, barrier relevance, solution mechanism, pillar relevance and KPI feasibility. This approach ensures that the SOMI calculation reflects both technical performance and user-sensitive impacts.

Step 7: Consolidating the final persona and solution sets

The seventh step consolidated the initial long lists of possible personas and solutions into a smaller set of operational inputs for D1.4. Similar personas were grouped into broader user types where this improved clarity and avoided unnecessary duplication. Likewise, the solution list was narrowed to the measures most suitable for SOMI assessment in each city.

The final persona framework retained the city-specific logic developed in D1.1: seven personas for Antwerp, nine personas for Florence and seven personas for Pilsen. These personas reflect the main user groups relevant to the GOLIA pilot contexts.

The final solution selection used in D1.4 reflects the current operational scope of the SOMI calculation. Florence is assessed through three solutions: Zone 30 / 30 km/h traffic-calmed areas, logistics micro-hubs / Spazi di Logistica di Prossimità, and redistribution of road space. Pilsen is assessed through three solutions: cycling, digital-twin-enabled planning and first-/last-mile access. Antwerp is assessed through the multimodal journey planner / Smart Ways to Antwerp scale-up. This selection reflects the solutions for which a coherent SOMI assessment could be developed using the available evidence, KPI structure and pilot-city relevance.

The following table explains how the wider D1.1 persona and solution material was narrowed into the final D1.4 operational set.

Table 11: Traceability of Step 7 - Consolidating final persona and solution sets

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
Grouped personas, city-specific relevance screening, solution relevance to GOLIA operational assessment objectives, available measurable or proxy KPI data and feasibility of applying the SOMI model.	These inputs were collected through the D1.1 synthesis of the persona framework, solution catalogue and city-specific SOs, then refined through internal project review and feasibility screening for D1.4.	The inputs were used to reduce the broader candidate lists into a manageable set of personas and solutions suitable for D1.4. Similar personas were grouped where necessary, and solutions were retained only when they were locally relevant and operationally measurable.	Final D1.4 persona and solution sets: seven personas for Antwerp, nine personas for Florence and seven personas for Pilsen; selected solutions for Florence, Pilsen and Antwerp suitable for SOMI assessment.

Step 8: Validation and refinement

The final step consisted of validation and refinement. In D1.1, the persona framework was validated in several rounds. First, the grouped personas, barriers and enablers were presented during the GOLIA General Assembly, where project partners and city representatives reviewed whether the proposed personas reflected local mobility challenges and policy priorities. A second validation round was carried out directly with the pilot cities to improve local accuracy, feasibility and clarity. Finally, an ICB validation exercise was conducted through an online survey distributed to ICB members and their wider networks, collecting 127 responses and helping validate the identified mobility enablers across persona groups and transport modes.

For D1.4, this validation process is important because it increases confidence that the personas are meaningful for SOMI assessment. The selected solutions were also reviewed through the wider GOLIA process to ensure that they were aligned with the GOLIA operational assessment objectives, relevant for SOMI, and supported by available evidence or measurable KPI values.

The following table summarises how validation inputs were collected and how they supported the final refinement of the D1.4 persona and solution framework.

Table 12: Traceability of Step 8 - Validation and refinement

D1.1 input / data used	How the input was collected in D1.1	How the input was used in D1.4	What was derived for SOMI
GOLIA General Assembly feedback, direct validation with pilot cities, ICB online	These inputs were collected through several validation rounds. The persona	The inputs were used to check whether the personas, barriers, enablers and selected	Validated persona and solution framework used as the basis for SOMI weighting, KPI

survey responses and stakeholder feedback on mobility enablers, barriers and transport modes.	framework was first discussed with project partners and city representatives during the GOLIA General Assembly, then refined through direct validation with the pilot cities. The ICB validation survey was distributed to ICB members and their wider networks and collected 127 responses from public bodies, industry associations, research institutions, private-sector actors, NGOs and other stakeholders.	solutions were realistic, locally relevant and usable for further assessment. The validation process helped refine descriptions, improve clarity and strengthen the link with local mobility challenges.	selection and pilot-city assessment.

In summary, the persona and solution selection process followed a common methodology across the three pilot cities, while allowing each city to retain its own GOLIA-specific assessment focus. The personas capture the main user groups affected by mobility change, while the selected solutions capture the main interventions to be assessed through SOMI. The step-by-step traceability logic presented above ensures that the assessment does not only measure technical KPI performance, but also reflects the mobility needs, barriers, sensitivities and rights-relevant concerns of the people and organisations affected by each solution.

The final persona framework identified 7 personas for Antwerp, 9 personas for Florence and 7 personas for Pilsen. The final solution framework selected three solutions for Florence, one solution for Antwerp and three solutions for Pilsen, reflecting the main mobility priorities of each pilot city.

The table therefore distinguishes between the broader persona logic inherited from D1.1 and the operational selection used in D1.4. This avoids presenting the consolidation step as a black box: the reader can see which personas were retained, which solutions were selected, and how these outputs became the basis for the subsequent SOMI weighting, KPI selection and persona-level calculation.

3.2.5 Persona-pillar significance weight selection process

The derivation of the SOMI significance weights followed a persona-based participatory approach. Within the SOMI framework, the eight pillars, namely Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition, Participation, and Safety & Security, represent the social dimensions through which mobility solutions are assessed.

The purpose of the weighting exercise was to identify how important each SOMI pillar is for each mobility persona in each pilot city, rather than to assign a single universal weight to all users. The weighting process was carried out during the first consortium workshop in Brussels using Mentimeter. For each city, participants were presented with a set of locally relevant personas and asked to assess the suitability or relevance of each SOMI pillar for that persona.

The exercise was implemented through a Likert-type scale ranging from “Strongly disagree” to “Strongly agree”, allowing participants to express the perceived importance of each pillar for each persona in a structured and comparable way (Likert, 1932). The Mentimeter outputs show this process separately for Antwerp, Florence and Pilsen, with one slide per persona and eight scored SOMI pillars on each slide.

To ensure transparency and auditability of the persona–pillar weighting exercise, the meeting and evidence information supporting the Mentimeter scoring process is documented in Table 13. This table clarifies the workshop setting, the expert basis of the scoring, the number of responses, the voting task, the scale used, and the supporting material retained in the appendices.

Table 13: Documentation of the Mentimeter persona–pillar weighting exercise

Element	Information documented for the weighting exercise
Date and setting of the Mentimeter exercise	The Mentimeter exercise was conducted during the first General Assembly meeting in Brussels in January 2026.
Workshop format	In-person consortium workshop, supported by Mentimeter as an interactive scoring tool.
Expert participants / organizations / roles	Participants included project experts and consortium partners, including roles related to pilot cities implementation, urban mobility planning, stakeholder engagement, persona development and SOMI methodology.
Number of experts who voted	9 experts participated in the Mentimeter scoring exercise. The Mentimeter screenshots also report visible response counts for the persona-specific scoring slides.
Cities covered	Antwerp, Florence and Pilsen.
Personas covered	Locally relevant personas were presented separately for each city.
SOMI pillars assessed	Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition, Participation, and Safety & Security.
Description of the voting task	For each persona, participants were asked to assess which SOMI pillars were most suitable / relevant.
Scoring scale	1–5 Likert-type agreement scale, ranging from “Strongly disagree” to “Strongly agree”.
Mentimeter session evidence	Supporting evidence consists of exported Mentimeter outputs showing the scoring questions, SOMI pillars, displayed mean scores and visible response counts.
Appendix reference	The Florence Mentimeter exercise results are included in Appendix I. Equivalent Mentimeter evidence for Antwerp and Pilsen is included in the corresponding appendices / supporting material.
Anonymity clarification	Mentimeter responses were collected anonymously; individual scores are therefore not attributed to named participants.

Use of the data	Displayed Mentimeter average scores were used as mean relevance scores, rescaled using Eq. (16), and normalised across the eight SOMI pillars using Eq. (17).
Interpretation of results	The scores are interpreted as workshop-derived expert / consortium significance judgements, not as statistically representative survey results.

The Mentimeter scores were interpreted as stakeholder-elicited significance judgements. They were not treated as statistically representative survey results, but as structured expert and consortium input collected through a participatory workshop. This approach is consistent with co-design and participatory planning methods, where stakeholders help define priorities, make assumptions explicit, and translate user needs into assessment criteria (Sanders and Stappers, 2008). It is also consistent with multi-criteria decision analysis, where weights are used to express the relative importance of evaluation criteria before combining them into an overall assessment (Belton and Stewart, 2002).

The Mentimeter exercise outputs used for the city-specific calculations are included in the Appendices I,III and V. These appendices provide the documented input evidence for the persona–pillar mean scores used in the subsequent city-by-city weighting results.

For each city c, persona p, and SOMI pillar j, the Mentimeter score was first recorded as a mean relevance score:

$$\bar{x}_{c,p,j} = \frac{1}{n_{c,p,j}} \sum_{i=1}^{n_{c,p,j}} x_{i,c,p,j}, \qquad Eq.\ (12)$$

where (c) is the city, (p) is the persona, (j) is the SOMI pillar, (i) is the individual workshop respondent, and $(n_{c,p,j})$is the number of valid Mentimeter responses for city (c), persona (p), and pillar (j). The value $(\bar{x}_{c,p,j})$represents the displayed Mentimeter average score assigned to pillar (j) for persona (p) in city (c). These displayed averages were used as the input values for the subsequent rescaling and normalisation steps.

Because the Mentimeter scale ranged from low relevance to high relevance, the scores were rescaled before normalisation. The minimum scale value was treated as indicating no or very low relevance, while the maximum scale value represented very high relevance. The adjusted relevance score was therefore calculated as:

$$q_{c,p,j} = \frac{\bar{x}_{c,p,j} - 1}{4}, \qquad Eq.\ (13)$$

where 1 is the minimum possible score and 5 is the maximum possible score. This transformation converts the original 1–5 scale into a 0–1 relevance scale, where 0 indicates the lowest perceived relevance and 1 indicates the highest perceived relevance.

The final persona–pillar significance weight was then obtained by normalising the adjusted relevance scores across the eight SOMI pillars for the same persona:

$$w_{c,p,j} = \frac{q_{c,p,j}}{\sum_{k=1}^{8} q_{c,p,k}}, \qquad Eq.(14)$$

This normalisation ensures that, for each persona in each city, the eight SOMI pillar weights sum to 1:

$$\sum_{j=1}^{8} w_{c,p,j} = 1, \qquad Eq.(15)$$

The resulting value $w_{c,p,j}$ represents the relative importance of SOMI pillar j for persona p in city c. For example,

- if Accessibility receives a high Mentimeter score for an older or less mobile resident, its normalised weight will be higher for that persona.
- Similarly, if Affordability receives a high score for a budget-sensitive student, the Affordability pillar will carry more weight in that persona's SOMI assessment.
- The weights were calculated separately for each city because the same persona type may experience different mobility barriers depending on the local context. For instance, the relevance of Availability, Accessibility or Safety & Security may differ between Antwerp, Florence and Pilsen depending on the transport network, urban form, public-space conditions, and the specific mobility solutions being assessed.
- The final persona-specific SOMI score can then be calculated by combining the normalised pillar performance scores with the corresponding persona–pillar significance weights:

$$SOMI_{c,p} = \sum_{j=1}^{8} w_{c,p,j} \cdot I_{c,j}, \qquad Eq.(16)$$

where $I_{c,j}$ is the normalised performance value of pillar j for the relevant city or solution, and $w_{c,p,j}$ is the significance weight assigned to that pillar for the persona. In this way, the same mobility solution can be evaluated differently for different personas, reflecting the fact that user groups do not value all social mobility dimensions equally.

The methodological advantage of this approach is that it creates a link between personas, SOMI pillars and weighted assessment. The personas define the social lens of analysis; the Mentimeter workshop captures stakeholder judgement on the relative importance of each pillar for each persona; and the normalisation procedure converts these judgements into comparable significance weights. The resulting weights can then be applied in the SOMI calculation to show how each solution performs for different user groups.

Because the Mentimeter exercise was carried out during a consortium workshop, the weights should be interpreted as workshop-derived significance weights. They provide a structured baseline for the deliverable, but they can be refined in later stages through local stakeholder validation, citizen engagement, or sensitivity analysis. This is important because weighting is inherently value-based, and different stakeholder groups may prioritise social mobility dimensions differently (Belton and Stewart, 2002).

Table 14: Nomenclature of persona–pillar Mentimeter weighting methodology

Parameters	Nomenclature
c	City / pilot city
p	Persona
j	SOMI pillar
k	Index used for summation across SOMI pillars
i	Individual workshop respondent
$\boldsymbol{n_{c,p,j}}$	Number of valid Mentimeter responses for city (c), persona (p), and SOMI pillar (j)

$x_{i,c,p,j}$	Mentimeter score assigned by respondent (i) to SOMI pillar (j), for persona (p), in city (c)
$\bar{x}_{c,p,j}$	Mean Mentimeter relevance score for SOMI pillar (j), persona (p), and city (c)
$q_{c,p,j}$	Rescaled 0–1 relevance score for SOMI pillar (j), persona (p), and city (c)
$w_{c,p,j}$	Final persona–pillar significance weight for SOMI pillar (j), persona (p), and city (c)
$\sum_{k=1}^{8} q_{c,p,k}$	Sum of the rescaled relevance scores across all eight SOMI pillars for persona (p) in city (c)
$I_{c,j}$	Normalised performance value of SOMI pillar (j) for city (c), or for the relevant city-level solution assessment
$SOMI_{c,p}$	Persona-specific SOMI score for persona (p) in city (c)
1	Minimum possible Mentimeter score, corresponding to the lowest perceived relevance
5	Maximum possible Mentimeter score, corresponding to the highest perceived relevance
8	Number of SOMI pillars included in the weighting exercise
SOMI pillars	Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition, Participation, and Safety & Security

3.2.6 Solution-specific persona influence weight selection process

This section documents the weighting methodology used to support the Social Optimum Mobility Index. The methodology introduces explicit significance weights at two connected levels: (i) the relative significance of each mobility solution within each pilot city, and (ii) the relative influence of each persona on the successful implementation of each solution.

The same elicitation logic was applied to both weighting levels. For the solution layer, the alternatives were the set of mobility solutions assessed within each pilot city. For the persona layer, the alternatives were the personas relevant to a specific solution. The resulting weights represent structured expert judgement about solution significance and implementation influence. They should not be interpreted as population shares, vulnerability scores, benefit shares or cost shares.

The approach follows a two-round expert-elicitation design. Round 0 used a direct 100-point allocation to create a baseline distribution. Round 1 used the Best-Worst Method (BWM), a structured multi-criteria decision-making method that derives ratio-scale weights from comparisons between the most important and least important alternatives (Rezaei, 2015). The final SOMI-ready weights are based on Round 1 and are aggregated across experts using a normalised geometric mean, consistent with the multiplicative nature of pairwise-comparison judgements (Saaty, 1980; OECD and Joint Research Centre, 2008).

The two-round weighting logic is summarised in Figure 4. The process starts with a direct baseline allocation, then applies the Best-Worst Method to derive ratio-scale weights, checks consistency, aggregates valid expert inputs across ICB organisations and normalises the resulting weights for use in the SOMI calculation.

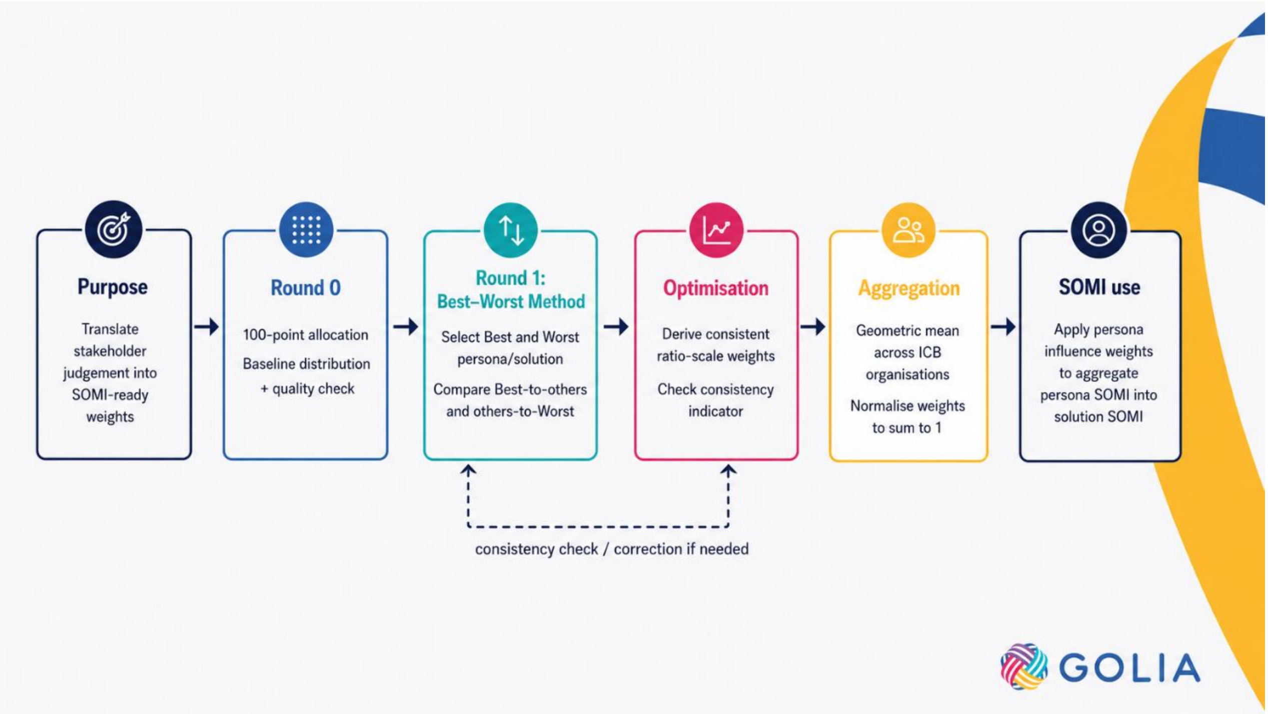

Figure 4: ICB two-round process for deriving SOMI-ready persona influence weights

In D1.4, the operational role of these weights is to support the aggregation of persona-level SOMI scores into solution-level SOMI results. The weights therefore express expert judgement on the relative influence of personas for each assessed solution and should not be interpreted as population shares, benefit shares or vulnerability scores. The collection procedure and supporting evidence are documented in Table 15. The table clarifies the setting of the elicitation exercise, the expert basis of the judgements, the two-round structure, the type of inputs collected, and the supporting material retained for verification.

Table 15: Documentation of the solution-significance and persona-influence weighting exercise

Element	Information documented for the weighting exercise
Date and setting of the elicitation exercise	The ICB weighting consultation was conducted remotely and asynchronously in May 2026 through Excel-based expert elicitation workbooks circulated to the ICB organisations. Inputs were collected by email and/or shared project folders. The Round 1 deadline was set for 15 May 2026, while the final complete input set was received and consolidated by 28 May 2026.
Expert participants / organisations / roles	The consultation involved seven ICB organisations: UITP, ALICE, POLIS, PAVE Europe, EPA, MPACT and TTS Italia. The participating organisations brought expertise related to public transport, logistics, urban mobility policy, parking and curbside management, shared mobility, stakeholder engagement, transport innovation and city implementation.
Number of experts who contributed	Seven expert organisations provided valid inputs for both Round 0 and Round 1. The number of valid responses was recorded separately for each solution and persona set in the consolidated calculation files.
Cities covered	Antwerp, Florence and Pilsen.

Weighting layer covered	The ICB consultation covered the solution-level persona influence layer. For each selected mobility solution, experts assessed the relative influence of the relevant personas on successful implementation.
Alternatives assessed in the persona layer	For each solution s in city c, the alternatives were the personas included in the solution-specific persona set P(c,s). These persona sets were city-specific and solution-specific, reflecting the final GOLIA persona framework for Antwerp, Florence and Pilsen.
Round 0 input collection	In Round 0, experts distributed 100 points across the personas relevant to each solution. Experts also identified the most influential and least influential persona for each solution and could provide a short rationale.
Round 1 input collection	In Round 1, experts applied the Best-Worst Method by selecting the most influential and least influential persona for each solution, then completing Best-to-Others and Others-to-Worst comparisons on a 1–9 scale.
Scoring / comparison scales	Round 0 used a 100-point allocation scale. Round 1 used a 1–9 Best-Worst comparison scale, where 1 indicates equal influence and 9 indicates an extreme difference in influence.
Evidence retained	Supporting evidence includes the completed Round 0 and Round 1 expert workbooks, Round 0 point allocations, Round 1 Best-Worst comparison inputs, QA checks, calculated BWM weights, consistency indicators, aggregation files and final SOMI-ready weight tables.
Anonymity and attribution	Results are reported at aggregated level and, where relevant, by contributing ICB organisation. Individual-level attribution is not required in the main deliverable, while the completed elicitation files are retained in the project evidence file.
Quality-assurance checks	Round 0 checks covered point totals, missing values, Best/Worst selections and any required proportional rescaling. Round 1 checks covered missing ratings, mandatory anchors, Best/Worst consistency, BWM feasibility and positive weights before aggregation.
Use of the data	Round 0 weights were retained for transparency, diagnostics and sensitivity interpretation. Final operational SOMI persona influence weights were based on Round 1 BWM results, aggregated across the seven ICB organisations using a normalised geometric mean.
Interpretation of results	The resulting weights are interpreted as expert-elicited persona influence weights for the successful implementation of each mobility solution. They are not population shares, vulnerability scores, benefit shares, cost shares or general stakeholder-importance scores.
Appendix / evidence reference	The detailed elicitation material is included in Appendix IX. This includes the completed ICB workbooks and the consolidated Round 0 and Round 1 calculation files.

The first weighting layer captures the relative significance of each solution within a city. For each city c, experts considered the active solution set S_c and judged how significant each solution was for the city-level SOMI assessment. The judgement was based on the expected relevance of the solution to the city's mobility transition, its strategic importance, its contribution to SOMI objectives, and its capacity to affect different user groups. The resulting city-specific solution weights are denoted by $V_{c,s}^{R1}$.

The second weighting layer captures the relative influence of each persona on the successful implementation of a solution. For each solution s in city c, experts considered the active persona set $P_{c,s}$ and assessed how strongly each persona could influence implementation success. Influence was interpreted in a policy and behavioural sense: acceptance or opposition, compliance and behavioural response, ability to mobilise other actors, operational leverage, legitimacy of concerns, political salience and potential backlash risk. The resulting final persona-influence weights are denoted by $W_{c,s,p}^{R1}$.

Round 0: Direct 100-point allocation

Round 0 used a direct 100-point allocation. Experts distributed 100 points across the alternatives being assessed. For the solution layer, the alternatives were the solutions in each city. For the persona layer, the alternatives were the personas relevant to each solution. This round provided a baseline and an initial quality check, but it was not used as the final operational weighting input.

For solution significance, let $x_{e,c,s}$ denote the number of points allocated by expert e to solution s in city c. The individual Round 0 solution weight is calculated as follows.

$$v_{e,c,s}^{R0} = \frac{x_{e,c,s}}{\sum_{s \in S_c} x_{e,c,s}}, \qquad Eq.(17)$$

where S_c is the set of solutions assessed for city c. If each expert allocates exactly 100 points, the denominator equals 100; however, the formula is written in normalised form to allow for checking and rescaling if needed.

For persona influence, let $x_{e,c,s,p}$ denote the number of points allocated by expert e to persona p for solution s in city c. The individual Round 0 persona weight is calculated as follows.

$$w_{e,c,s,p}^{R0} = \frac{x_{e,c,s,p}}{\sum_{p \in P_{c,s}} x_{e,c,s,p}}, \qquad Eq.(18)$$

where $P_{c,s}$ is the set of personas assessed for solution s in city c.

The Round 0 weights were aggregated using the arithmetic mean, because the inputs were additive point allocations. For the solution layer, the aggregated Round 0 solution weight is calculated as follows.

$$V_{c,s}^{R0,agg} = \frac{1}{n_c} \sum_{e=1}^{n_c} v_{e,c,s}^{R0}, \qquad Eq.(19)$$

where n_c is the number of valid expert inputs for the solution set in city c. For the persona layer, the aggregated Round 0 persona weight is calculated as follows.

$$W_{c,s,p}^{R0,agg} = \frac{1}{n_{c,s}} \sum_{e=1}^{n_{c,s}} w_{e,c,s,p}^{R0}, \qquad Eq.(20)$$

where $n_{c,s}$ is the number of valid expert inputs for the persona set $P_{c,s}$. Round 0 was retained for transparency, diagnostics and sensitivity interpretation, while the final SOMI-ready weights were derived from the more structured Round 1 BWM exercise (Belton and Stewart, 2002).

Round 1: Best-Worst Method

Round 1 refined the baseline through the Best-Worst Method. For each city-level solution set or solution-level persona set, each expert selected the most significant or influential alternative, called the Best, and the least significant or influential alternative, called the Worst.

Experts then completed two comparison vectors using a 1-9 scale: Best versus each other alternative and each alternative versus the Worst. A value of 1 indicates equal significance or influence, while 9 indicates an extreme difference (Rezaei, 2015). The BWM optimisation finds the non-negative weight vector that best satisfies the comparison statements.

The formulation below is generic. Let A denote the active set of alternatives being assessed. Depending on the weighting layer, A is either the city-specific solution set S_c or the solution-specific persona set $P_{c,s}$. Let z_j denote the weight of alternative j in the active set A. The optimisation problem is formulated as follows.

$$\min \xi \,, \qquad Eq. (21)$$

subject to the Best-to-Others preference-deviation constraints:

$$\left|z_B - a_{Bj} z_j\right| \leq \xi, \quad j \in A, \qquad Eq. (22)$$

the Others-to-Worst preference-deviation constraints:

$$\left|z_j - a_{jW} z_W\right| \leq \xi, \quad j \in A, \qquad Eq. (23)$$

the normalisation constraint:

$$\sum_{j \in A} z_j = 1, \qquad Eq. (24)$$

and the non-negativity constraint:

$$z_j \geq 0, \quad j \in A, \qquad Eq. (25)$$

Constraint (25) ensures that the weight of the best alternative, z_B, is consistent with the stated comparison a_{Bj} between the Best alternative and each alternative j. Constraint (26) ensures that the weight of each alternative j is consistent with the stated comparison a_{jW} between alternative j and the Worst alternative. Constraint (27) ensures that all derived weights sum to one. Constraint (28) ensures that no alternative receives a negative weight.

The optimisation returns one individual expert weight vector for each active set. The value ξ is retained as a consistency indicator: lower values indicate that the expert's Best-Worst comparison statements can be represented more consistently by a single weight vector.

Individual Round 1 BWM weights were aggregated across expert organisations using the geometric mean followed by normalisation. This aggregation approach was selected because BWM weights are derived from ratio-scale comparison judgements. The geometric mean preserves the multiplicative structure of those judgements and reduces the influence of extreme individual responses compared with a purely arithmetic aggregation (Saaty, 1980; OECD and Joint Research Centre, 2008). Because the geometric mean uses logarithms, all individual BWM weights used in the aggregation must be strictly positive. This condition is checked during quality assurance.

For the persona-influence layer, the aggregated geometric mean for persona p in solution s and city c is calculated as follows.

$$\mathrm{GM}_{c,s,p} = \exp\left(\frac{1}{n_{c,s}} \sum_{e=1}^{n_{c,s}} \ln\left(w_{e,c,s,p}^{R1}\right)\right), \qquad Eq. (26)$$

The final persona influence weight used in SOMI is then obtained by normalisation:

$$W_{c,s,p}^{R1} = \frac{\mathrm{GM}_{c,s,p}}{\sum_{p \in P_{c,s}} \mathrm{GM}_{c,s,p}}, \qquad Eq. (27)$$

For the solution-significance layer, the aggregated geometric mean for solution s in city c is calculated as follows.

$$\mathrm{GM}_{c,s} = \exp\left(\frac{1}{n_c}\sum_{e=1}^{n_c} \ln\left(v_{e,c,s}^{R1}\right)\right), \qquad Eq.(28)$$

The final city-specific solution significance weight is calculated as follows.

$$V_{c,s}^{R1} = \frac{\mathrm{GM}_{c,s}}{\sum_{s\in S_c} \mathrm{GM}_{c,s}}, \qquad Eq.(29)$$

Normalization ensures that weights sum to 1 within each active set:

$$\sum_{p\in P_{c,s}} W_{c,s,p}^{R1} = 1\,, \qquad Eq.(30)$$

$$\sum_{s\in S_c} V_{c,s}^{R1} = 1, \qquad Eq.(31)$$

The final Round 1 weights are used as operational weighting inputs in the SOMI calculation presented in the relevant SOMI assessment section. The city-specific solution significance weights $V_{c,s}^{R1}$ indicate the relative importance of each solution within the local city portfolio, while the persona-influence weights $W_{c,s,p}^{R1}$ indicate the relative influence of each persona for the successful implementation of each solution. The present section therefore focuses only on the elicitation, calculation, aggregation and quality assurance of these weights. The subsequent SOMI calculation section explains how the weights are applied to aggregate persona-level, solution-level and city-level SOMI results. Because the elicitation exercise was based on expert judgement, the weights should be interpreted as expert-derived significance and influence weights. They provide a structured operational baseline for the deliverable, but they can be refined in later stages through local stakeholder validation, citizen engagement, or sensitivity analysis.

Table 16: Nomenclature of weighting-solution parameters

Parameter	Nomenclature
c	City / Pilot city
s	Mobility solution
S_c	Set of solutions assessed in city c
p	Persona
$P_{c,s}$	Set of personas assessed for solution s in city c
e	Expert / expert organisation
n_c	Number of valid experts for the city-level solution-significance weighting in city c
$n_{c,s}$	Number of valid experts for the solution-level persona-influence weighting for solution s in city c

$x_{e,c,s}$	Round 0 points allocated by expert e to solution s in city c
$x_{e,c,s,p}$	Round 0 points allocated by expert e to persona p for solution s in city c
$v_{e,c,s}^{R0}$	Individual Round 0 solution-significance weight
$w_{e,c,s,p}^{R0}$	Individual Round 0 persona-influence weight
$V_{c,s}^{R0,agg}$	Aggregated Round 0 solution-significance weight
$W_{c,s,p}^{R0,agg}$	Aggregated Round 0 persona-influence weight
$v_{e,c,s}^{R1}$	Individual Round 1 BWM solution-significance weight
$w_{e,c,s,p}^{R1}$	Individual Round 1 BWM persona-influence weight
$V_{c,s}^{R1}$	Final city-specific solution-significance weight used in SOMI
$W_{c,s,p}^{R1}$	Final solution-specific persona-influence weight used in SOMI
A	Active set of alternatives in the BWM model; either S_c or $P_{c,s}$
j	Generic alternative in active set A
B	Best alternative
W	Worst alternative
a_{Bj}	Best-to-Other comparison value
a_{jW}	Other-to-Worst comparison value
z_j	BWM weight of alternative j in active set A
ξ	BWM deviation / consistency indicator
$\mathrm{GM}_{c,s,p}$	Geometric mean of individual Round 1 persona-influence weights for persona p, solution s, and city c
$\mathrm{GM}_{c,s}$	Geometric mean of individual Round 1 solution-significance weights for solution s in city c
$\mathrm{SOMI}_{c,s,p}$	Persona-level SOMI score for persona p, solution s, and city c
$\mathrm{SOMI}_{c,s}$	Solution-level SOMI score for solution s in city c
SOMI_c	City-level SOMI score for city c

Quality assurance was applied to both rounds of elicitation. Round 0 checks covered point totals, missing values, Best/Worst selections and any required rescaling. Round 1 check covered missing ratings, consistency of mandatory anchors, Best/Worst consistency, BWM feasibility, non-negative weights and positive weights before geometric-mean aggregation. The final Round 1 weights are used as the operational SOMI inputs, while Round 0 is retained for transparency and sensitivity analysis.

3.3 Pilot Use Case Atlas

The data collection process was derived through an iterative KPI-mapping exercise with the three pilot cities. First, the selected mobility solutions for Antwerp, Florence and Pilsen were reviewed against the eight SOMI pillars and the final city-specific persona frameworks. For each solution, a long list of possible indicators was identified and screened according to three criteria. The indicator had to be meaningful for the relevant SOMI pillar, interpretable for the personas affected by the solution, and realistically measurable using data that the city already holds, can provide through official sources, or can access through documented and publicly available evidence.

A key principle of this process was that the values used in the SOMI assessment should, as far as possible, originate from official city sources, city-approved documents, open datasets or other traceable technical documentation. This is important for transparency, but also for the future operationalisation of SOMI within GO-WISDOM. If KPI values are linked to official and accessible data sources, the GO-DATA component can support the dynamic retrieval, updating and management of these inputs, allowing GO-WISDOM to move progressively from a static assessment towards a periodically updated decision-support environment.

This process was translated into city-specific data request tables. For each pilot city and each mobility solution, the tables documented the proposed KPI, its SOMI pillar, the expected unit of measurement, the preferred spatial and temporal scale, the likely data source, and the role of the indicator in the SOMI calculation. The work also distinguished between directly available indicators, indicators requiring minor processing, indicators that could be represented through proxies, and indicators that should be retained as future data needs. The city-specific data request sheets used during the iterative exchanges with the pilot cities are provided in Appendix VIII.

The exercise resulted in a harmonised Pilot Use Case registry for the three pilot cities. For Florence, the KPI mapping focused on measures related to 30 km/h traffic-calmed areas, urban logistics micro-hubs and road-space reallocation. For Pilsen, it focused on cycling and bike-share uptake, public transport and first- and last-mile integration, and connected corridors or smart traffic management readiness. For Antwerp, it focused on the Smart Ways to Antwerp ecosystem, including service-quality improvements and inclusive adaptation for groups that may require clearer information, accessibility support or more tailored guidance.

3.3.1 Florence Use Case

Florence is a medium-sized Italian city with approximately 364,000 inhabitants. It is the capital of Tuscany, located in central Italy. Considered the birthplace of the Renaissance, Florence is one of Italy’s most important tourist destinations, and its historic centre was inscribed on the UNESCO World Heritage List in 1982.

Florence’s economy is characterised by a strong manufacturing base and a large tertiary sector, with tourism representing one of the city’s most important sources of income (Camera di Commercio di Firenze, 2023; Comune di Firenze, 2023). The city receives a high number of daily users, particularly tourists, whose average stay is slightly above three days (Comune di Firenze, 2023). Mobility policies are coordinated between the Municipality of Florence and the Metropolitan City through metropolitan mobility planning, and Florence is recognised as an urban node on the TEN-T Scandinavian–Mediterranean Corridor (Città Metropolitana di Firenze, 2021).

In its SUMP approved in 2021, Florence identified several infrastructure interventions aimed at improving road safety, including actions focused on vulnerable road users such as pedestrians and cyclists. The plan gives priority to reducing individual motorised traffic in favour of more sustainable modes, especially walking, and highlights the need to create safer, more recognisable pedestrian environments and redesign problematic road sections, crossings and intersections (Città Metropolitana di Firenze, 2021).

In 2024, Italy adopted a reform of the Road Code aimed at improving road safety, while also introducing constraints that may affect the scope of municipal road-safety interventions (Repubblica Italiana, 2024; Ministero delle Infrastrutture e dei Trasporti, 2024). Building on the strategic visions set out in Florence's SECAP, Climate City Contract, SUMP and SULP, the redesign of urban spaces will adopt a systems-thinking approach, considering interactions between passenger and freight mobility hubs, sustainable logistics, shared mobility, micromobility and public transport (Comune di Firenze, 2024a; Città Metropolitana di Firenze, 2021, 2022).

3.3.1.1 Selected Solutions and Personas

Applying the methodology summarised in Section 3.2.4 resulted in the selected personas and solutions shown in Table 17:

Table 17: Selected Personas and Solutions in Florence

Selected personas	Solutions
1. **City-centre resident.** 2. **Urban family.** 3. **Older / less mobile resident.** 4. **Business in the city centre.** 5. **Student living away from home to study in Florence.** 6. **Culture visitor.** 7. **Commuter.** 8. **Logistics operator, meaning companies carrying out deliveries.** 9. **Single or couple with no children**	**FLO SOL1:** 30 km/h zones and traffic calming aims to improve road safety by reducing vehicle speeds, lowering the risk and severity of collisions, and creating safer conditions for pedestrians, cyclists, older residents, families and other vulnerable road users. **FLO SOL2**: Urban logistics micro-hubs / proximity logistics spaces aims to improve the efficiency and sustainability of last-mile deliveries by reducing the negative impacts of freight vehicles in the city centre, supporting logistics operators and businesses while limiting congestion, emissions and conflicts with pedestrians and cyclists. **FLO SOL3**: Road-space reallocation toward safer, more sustainable and people-centred mobility aims to redesign urban streets so that more space is dedicated to walking, cycling, public transport, shared mobility and social use, supporting a broader shift from car-oriented streets to safer and more inclusive public spaces.

3.3.1.2 Baseline KPI Values and Acceptable Upper and Lower Limits per Mobility Solution

The first Florence solution concerns the expansion and consolidation of Zone 30 / 30 km/h traffic-calmed areas as a road-safety and liveability intervention. Official City of Florence sources show that the policy is already operational: in February 2025, the City reported that 19 Zone 30 areas were active, covering approximately 45% of the built-up area, and linked the measure to safer streets around schools, hospitals and densely inhabited roads, as well as to lower traffic speeds, lower collision severity, reduced noise and lower emissions (Comune di Firenze, 2025).

For Acceptability, the selected KPI is the share of citizen priority responses supporting Zone-30-relevant road-safety objectives. The value is 71.1%, calculated from the PUMS citizen questionnaire by summing the response share for reducing road-crash risk (44.1%) and the response share for reducing serious crashes involving vulnerable road users (27.0%) (Città Metropolitana di Firenze, 2019a). This remains an indirect acceptability proxy, because it measures support for the safety objectives that Zone 30 measures are designed to achieve, rather than direct approval of a specific Zone 30 intervention.

For Accessibility, the KPI measures the share of the built-up area covered by active Zone 30 areas. The Florence value is 45%, based on the municipal statement that the 19 active Zone 30 areas cover approximately 45% of the built-up area (Comune di Firenze, 2025).

For Affordability, the selected KPI is the expected fuel-consumption reduction from lower and smoother urban speeds. The value is a −7% benchmark from European 30 km/h literature (Yannis & Michelaraki, 2024). This is treated as lower-is-better because lower fuel consumption implies lower vehicle operating costs. However, this is a literature-based affordability proxy, not a Florence-measured cost value. It should be updated if a local Florence estimate of fuel consumption, vehicle operating costs, or household transport-cost effects becomes available.

For Agency, the KPI is the share of trips made on the integrated public-transport network. The value is 17%, derived from the official PUMS monitoring indicator A.2.B, "% di spostamenti sulla rete integrata del TPL" (Città Metropolitana di Firenze, 2025).

For Availability, the KPI is the number of active Zone 30 areas, reported together with the corresponding built-up-area coverage. The current value is 19 active areas (Comune di Firenze, 2025).

For Legal Recognition, the KPI is the number of formally approved Zone 30 regulatory changes. The value is 6, calculated as five newly approved Zone 30 areas in Coverciano, Campo di Marte, San Bartolo a Cintoia, Soffiano and Statuto, plus one expansion of the existing Via di Ripoli Zone 30 area (Comune di Firenze, 2023).

For Participation, the KPI is the number of questionnaire participation inputs in the Florence metropolitan mobility-planning process. The value is 5,100 inputs, calculated as 4,824 citizen questionnaire responses plus 276 stakeholder questionnaire responses (Città Metropolitana di Firenze, 2019a; Città Metropolitana di Firenze, 2019b).

For the Safety & Security pillar, the baseline value is 2,275 injury crashes; lower values indicate better safety performance. Future negative values indicate improvement, while positive values indicate deterioration (Comune di Firenze, 2025). Table 19 summarizes the derived KPI values per pillar for the 30 km/h traffic-calmed areas solution.

Table 18: Summary table- Zone 30 / 30 km/h traffic-calmed areas

SOMI Pillar	Selected KPI	Unit + direction	Value
Acceptability	Share of citizen priority responses supporting Zone-30-relevant road-safety objectives	%; higher is better	71.1%
Accessibility	Share of built-up area covered by active Zone 30 areas	% of built-up area; higher is better	45%

Affordability	Expected fuel-consumption reduction from lower and smoother urban speeds	% reduction; lower operating cost is better	-7%
Agency	Share of trips on the integrated public-transport network	% of trips; higher is better	17%
Availability	Active Zone 30 areas with built-up-area coverage	Count and spatial coverage; higher is better	19 active areas; approx. 45% coverage
Legal Recognition	Number of formally approved Zone 30 regulatory changes	Count; higher is better	6
Participation	Participation inputs in the Florence metropolitan mobility-planning process	Inputs; higher is better	5,100 inputs
Safety & Security	Baseline injury crashes	Count	2,275

Regarding the upper and lower limits for the Acceptability KPI, the lower limit is set at 50%, representing a minimum majority-support threshold. The upper-performance reference is set at the Florence-specific value of 71.1%, derived from the PUMS safety-priority items used for the KPI.

The Accessibility lower-performance reference is the current Florence coverage of 45% of the built-up area. The upper-performance reference is set at 70%, using Bologna "Città 30" as an Italian high-coverage benchmark, where the 30 km/h limit applies to approximately 70% of urban roads (Comune di Bologna, 2024)

The Affordability Limits use the European 30 km/h literature range reported where -3.4% is the lower-performance reference because it represents the smallest documented fuel-consumption reduction, while -11% is the upper-performance reference because it represents the strongest documented reduction (Yannis and Michelaraki 2024).

The Agency Limits have a lower-performance reference of 16.9% and an upper-performance reference of 21.2%, both taken from the official PUMS monitoring indicator "% di spostamenti sulla rete integrata del TPL", reported under Section 7, "Andamento degli indicatori di mobilità del PUMS", macro-objective a.2 "Riequilibrio modale della mobilità", in the table "Indicatori Macrobiettivi DM 4 agosto 2017" of the *Primo Monitoraggio PUMS* (Città Metropolitana di Firenze, 2025).

For Availability, the lower-performance reference is the current documented supply of 19 active Zone 30 areas covering approximately 45% of the built-up area. The upper-performance reference is estimated considering a 100% full built-up-area coverage which corresponds to (19x100)/45 which is equal to approximately 42 active areas.

For Legal Recognition, the lower-performance reference is 0 formally approved regulatory changes and the upper-performance reference is 6, corresponding to the documented Florence package of five new Zone 30 areas plus one expansion.

For Participation, the lower-performance reference is 0 inputs, and the upper-performance reference is 5,100 inputs, matching the documented Florence metropolitan mobility-planning participation base.

For Safety & Security, the lower-performance reference is set at 2,275 injury crashes, corresponding to the baseline value considered. The upper-performance reference is set at approximately 2,070 injury crashes, obtained by applying Florence's most recent approximate 9 % injury-crash reduction to the baseline. Since the KPI is lower-is-better, movement from 2,275 toward 2,070 injury crashes indicates improved safety performance. Table 20 summarizes the KPI upper and lower limits of the Zone 30 / 30 km/h traffic-calmed areas.

Table 19: KPI upper and lower limits of the Zone 30 / 30 km/h traffic-calmed areas

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Share of citizen priority responses supporting Zone-30-relevant road-safety objectives	50%	71.1%
Accessibility	Share of built-up area covered by active Zone 30 areas	45%	70%
Affordability	Expected fuel-consumption reduction from lower and smoother urban speeds	-3.4%	-11%
Agency	Share of trips on the integrated public-transport network	16.9%	21.2%
Availability	Active Zone 30 areas with built-up-area coverage	19	42
Legal Recognition	Number of formally approved Zone 30 regulatory changes	0	6
Participation	Participation inputs in the Florence metropolitan mobility-planning process	0	5,100
Safety & Security	Number of injury crashes	2,275 injury crashes	approx. 2,070 injury crashes

The second Florence solution concerns the development of a trial micro-consolidation centre supported by connected IT services under the UNCHAIN project. In the municipal planning framework, the solution is presented as a laboratory for managing access and delivery-vehicle operations, particularly during peak hours, while creating a trial "micro consolidation centre" and related digital services (Comune di Firenze, 2024b, p. 215). This direction is reinforced in the DUP 2026-2028, which refers to the realisation of "micro-centri di consolidamento (Micro-hub)" and loading/unloading bays as part of Florence's urban logistics strategy (Comune di Firenze, 2026a).

For Acceptability, the KPI is the number of documented stakeholder-engagement sources reporting positive appraisal of the shared micro-hub concept. The current value is 1, because the Firenze per il Clima stakeholder report records that the idea of a shared space close to the centre, with a dedicated area for each operator, was considered "molto interessante" by participating companies and associations (Firenze per il Clima, 2024). This is a planning-stage acceptability proxy, not a large-scale public-acceptance measurement.

For Accessibility, the KPI is the share of ZTL loading/unloading bays equipped with real-time availability sensors. The numerator is 80 smart sensor-equipped loading/unloading bays planned under UNCHAIN, while the denominator is approximately 270 freight loading/unloading bays in the ZTL. The resulting value is 80 / 270 x 100 = 29.6% (Comune di Firenze, 2026b; Città Metropolitana di Firenze, 2019).

For Affordability, the KPI is the number of documented affordability-supporting mechanisms for the micro-hub / proximity-logistics pilot. The value is 2: (i) one mechanism is public/external support through UNCHAIN, and (ii) the second is the proposed rent and management arrangement for the shared hub space. The PAC 2025-2028 action sheets identify “Soluzioni di prossimita” as an action involving urban micro-hubs and link the living lab to the European UNCHAIN project, while the stakeholder report describes a possible arrangement in which each operator rents part of the shared space and an entrusted subject manages the hub to support economic sustainability (Comune di Firenze, 2025-2028, pp. 121-124; Firenze per il Clima, 2024).

For Agency, the KPI is the number of operator-facing delivery-management options available to logistics providers during the pilot. The value is 3: (i) sensor-equipped loading/unloading bays with booking and check-in/check-out services; (i) a cargo-bike routing application allowing flexible and dynamic route selection; (iii) and a micro-hub-based final-mile delivery option using smaller ecological vehicles such as cargo bikes (Comune di Firenze, 2025-2028).

For Availability, the KPI is the number of pilot micro-hub sites to be tested. The value is 1, because the PAC 2025-2028 UNCHAIN action sheet identifies one specific temporary experimental logistics micro-hub site in Piazza Annigoni. This value measures pilot-stage availability only; it does not imply that one hub is sufficient for citywide scale-up (Comune di Firenze, 2025-2028).

For Legal Recognition, the KPI is the number of documented regulatory-readiness mechanisms for ZTL freight / micro-hub logistics. The value is 3: (i) assessment of the digital system for requesting, issuing and managing ZTL access authorisations for freight distribution and collection services; (ii) development of an experimental mobile-app interface for logistics operators; (iii) development of an experimental web app to compare the effects of possible changes to current ZTL access rules through predefined KPIs and KPAs (Comune di Firenze, 2025-2028).

For Participation, the KPI is the number of dedicated participatory tables or processes on urban logistics linked to UNCHAIN. The value is 1, corresponding to the dedicated logistics-operator roundtable documented during the second Firenze per il Clima meeting (Firenze per il Clima, 2024).

For Safety & Security, the selected KPI is the number of injury crashes. The value is 2,275 injury crashes, corresponding to the municipal road-safety baseline. This is a city-wide road-safety monitoring proxy for future assessment, not an observed safety effect of the micro-hub pilot (Comune di Firenze, 2025).

Table 21 summarizes the KPI values Microhub / Spazi di Logistica di Prossimita (SLP) solution.

Table 20: KPI values of the Microhub solution

SOMI Pillar	Selected KPI	Unit-Direction	Value
Acceptability	Documented stakeholder-engagement sources reporting positive appraisal of the shared micro-hub concept	Count; higher is better	1
Accessibility	Share of ZTL loading/unloading bays equipped with real-time availability sensors	% of ZTL freight bays; higher is better	29.6%

Affordability	Documented affordability-supporting mechanisms for the micro-hub / proximity-logistics pilot	Count; higher is better	2
Agency	Operator-facing delivery-management options available to logistics providers during the pilot	Count; higher is better	3
Availability	Pilot micro-hub sites to be tested	Count; higher is better	1
Legal Recognition	Documented regulatory-readiness mechanisms for ZTL micro-hub logistics	Count; higher is better	3
Participation	Dedicated participatory tables or processes on urban logistics linked to UNCHAIN	Count per year; higher is better	1
Safety & Security	Number of injury crashes	injury crashes; lower is better	2,275 injury crashes

Regarding the Pillar KPI limits, the Acceptability lower-performance reference is 0 documented sources and the upper-performance reference is 3 documented sources. The value of 3 reflects the main evidence categories needed for a robust shared micro-hub solution: (i) logistics operators and delivery companies; (ii) the Municipality or public authority responsible for mobility and ZTL management; and (iii) local businesses or receivers affected by freight deliveries.

For Accessibility, the lower-performance reference is 0% and the upper-performance reference is 100%, representing no digitally visible ZTL loading/unloading bays and full sensor coverage of the relevant ZTL loading/unloading bay stock, respectively. The Florence value of 29.6% is therefore a partial pilot-stage coverage value.

For Affordability, the lower-performance reference is set at 0 documented affordability-supporting mechanisms, representing the absence of any identified mechanism to reduce, share or structure the economic burden of implementing and operating the micro-hub / proximity-logistics pilot. The upper-performance reference is set at 2 documented mechanisms, corresponding to the two mechanisms currently identified in the Florence evidence base: first, the public/external funding support through the UNCHAIN project, including the Horizon Europe funding allocated to the Comune di Firenze; and second, the proposed rent and management arrangement for the shared hub space, whereby operators may rent part of the shared space and an entrusted managing body may coordinate the hub to support its economic sustainability.

For Agency, the lower-performance reference is set at 0 operator-facing delivery-management options, representing a condition in which the pilot provides no additional operational choice to logistics providers. The upper-performance reference is set at 3 documented options, corresponding to the three operator-facing options identified in the UNCHAIN action sheet: first, the use of sensor-equipped loading/unloading bays supported by digital booking and check-in/check-out services; second, the cargo-bike routing application, allowing operators to select routes dynamically according to criteria such as shortest, safest or most comfortable route; and third, the micro-hub-based final-mile delivery option, where goods can be transferred from conventional vans or trucks to smaller ecological vehicles such as cargo bikes.

For Availability, the lower-performance reference is set at 0 pilot micro-hub sites, representing the absence of a physical site available for operational testing. The upper-performance reference is set at 1 pilot micro-hub site, reflecting the current pilot-stage scope documented for Florence, where one temporary experimental micro-logistics hub is planned in Piazza Annigoni. This Limit does not represent the maximum number of hubs that would be needed in a future citywide system; it only reflects the documented availability of the current pilot site.

For Legal Recognition, the lower-performance reference is set at 0 regulatory-readiness mechanisms, representing the absence of documented legal or administrative preparation for ZTL freight and micro-hub logistics. The upper-performance reference is set at 3 regulatory-readiness mechanisms, corresponding to the three mechanisms documented in the UNCHAIN action sheet: first, the assessment of the digital system for requesting, issuing and managing ZTL access authorizations for freight distribution and collection services; second, the development of an experimental mobile-app interface for logistics operators carrying out deliveries or collections; and third, the development of an experimental web app to compare the effects of possible changes to current ZTL access rules using predefined KPIs and KPAs.

For Participation, the lower-performance reference is set at 0 public events or participatory processes on urban logistics per year, representing the absence of documented stakeholder involvement in the design, testing or refinement of the micro-hub / proximity-logistics solution. The upper-performance reference is set at 2 public events or participatory processes per year. This upper reference represents a basic but complete annual engagement cycle: one moment dedicated to consultation or co-design, where logistics operators, public authorities, local businesses and other relevant stakeholders can identify needs, constraints and operational expectations; and one follow-up moment dedicated to validation, feedback or refinement, where stakeholders can review the proposed solution, comment on implementation arrangements and help adjust the pilot before or during testing.

For Safety & Security, the lower-performance reference is set at 2,275 injury crashes, corresponding to the baseline value considered. The upper-performance reference is set at approximately 2,070 injury crashes, obtained by applying Florence's most recent approximate 9 % injury-crash reduction to the baseline. Since the KPI is lower-is-better, movement from 2,275 toward 2,070 injury crashes indicates improved safety performance. Table 22 summarizes the KPI upper and lower limits.

Table 21: KPI upper and lower limits of the Microhub solution

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Documented stakeholder-engagement sources reporting positive appraisal of the shared micro-hub concept	0	3
Accessibility	Share of ZTL loading/unloading bays equipped with real-time availability sensors	0%	100%
Affordability	Documented affordability-supporting mechanisms for the micro-hub / proximity-logistics pilot	0	2
Agency	Operator-facing delivery-management options available to logistics providers during the pilot	0	3
Availability	Pilot micro-hub sites to be tested	0	1

Legal Recognition	Documented regulatory-readiness mechanisms for ZTL micro-hub logistics	0	3
Participation	Dedicated participatory tables or processes on urban logistics linked to UNCHAIN	0	2
Safety & Security	Number of injury crashes	2,275 injury crashes	approx. 2,070 injury crashes

The third Florence solution involves the re-distribution of road space in favour of more people-centred, accessible, safe and sustainable urban mobility. The solution is consistent with international road-space and Complete Streets principles, which frame streets as public spaces that should support safe access for all users, including pedestrians, cyclists, public transport users and motor-vehicle users, rather than allocating most space primarily to private cars (OECD/ITF, 2022). In the Florence context, the selected SOMI KPIs therefore focus on citizen priorities for sustainable mobility and public-space quality, cycling infrastructure, pedestrianised space, regulatory recognition of pedestrian areas, participation in mobility planning, and safety outcomes.

For Acceptability, the KPI is the share of citizen priority responses supporting road-space reallocation toward sustainable modes and better public space. The value is 35.8%, calculated by summing 28.0% of citizen responses supporting the reduction of private-car use in favour of more sustainable alternatives and 7.8% supporting the improvement of the physical quality, usability and pedestrian safety of streets and squares (Città Metropolitana di Firenze, 2019a).

For Accessibility, the KPI is the length of the cycle network available in Florence. The value is 113 km. The Florence mobility portal reports that the city's cycle network extends for 113 km, including 84 km in the urban context and 62 km forming part of the Bicipolitana, and identifies 120 km as the municipal objective (Comune di Firenze, Mobilita ciclistica).

For Affordability, the KPI is the share of citizen priority responses supporting lower private-vehicle costs through more convenient shared, bicycle and pedestrian mobility. The value is 13.8%. This is a citizen-priority affordability proxy, not a direct household-cost measure, but it is linked to reduced dependence on private-car use (Città Metropolitana di Firenze, 2019a).

For Agency, the selected KPI is the share of PUMS citizen respondents who use the bicycle. The value is 42%. This KPI measures baseline mobility agency because it captures the proportion of respondents who already use cycling as a practical mobility option. Road-space redistribution can strengthen this agency by making cycling safer, more continuous and more attractive. The PUMS participation questionnaire reports that 42% of citizen respondents answered "Sì" (Yes) to the question "Usi la bicicletta?" (Do you cycle) Città Metropolitana di Firenze, 2019a).

For Availability, the selected KPI is the pedestrianised circulation area in Florence's historic centre. The value is 420,000 m^2. This KPI measures the amount of road and public space already made available primarily for pedestrians rather than general motor traffic. It is directly relevant to road-space redistribution because it captures the physical availability of pedestrian-priority space. The City of Florence document on new pedestrian areas reports 420,000 m^2 of pedestrian areas in the historic centre, equivalent to 1.14 m^2 per inhabitant (Comune di Firenze, 2020).

For Legal Recognition, the selected KPI is the number of formal pedestrian-area regulatory typologies. The value is 6 typologies. This KPI measures the extent to which redistributed pedestrian space is legally and administratively recognised. Florence Open Data states that pedestrianised urban circulation areas are mapped as polygons and divided by type according to municipal ordinances. The same dataset classifies pedestrian areas into six typologies, identified by the letters A, B, C, D, E and F (Comune di Firenze Open Data, 2026).

For Participation, the selected KPI is the number of participation inputs in the Florence metropolitan mobility-planning process. The value is 5,100 inputs, calculated as 4,824 citizen questionnaire responses, 276 stakeholder responses. This KPI measures the participation base behind mobility and road-space planning decisions. It can improve if more citizens and stakeholders contribute to future mobility-planning or road-space consultations (Città Metropolitana di Firenze, 2019a, p. 3; Città Metropolitana di Firenze, 2019b).

For Safety & Security, the selected KPI is the number of injury crashes. The value is 2,275 injury crashes, corresponding to the municipal road-safety baseline. This is used as a city-wide monitoring proxy for the safety context within which future road-space redistribution impacts can be assessed (Comune di Firenze, 2025). Table 22 summarizes the KPI values of the Re-distribution of road space solution.

Table 22: Summary table- Re-distribution of road space

SOMI Pillar	Selected KPI	Unit + direction	Value
Acceptability	Share of citizen priority responses supporting road-space reallocation toward sustainable modes and better public space	%; higher is better	35.8%
Accessibility	Length of cycle network available in Florence	km; higher is better	113 km
Affordability	Share of citizen priority responses supporting lower private-vehicle costs and more convenient shared / cycle-pedestrian mobility	%; higher is better	13.8%
Agency	Share of PUMS citizen respondents who use the bicycle	%; higher is better	42%
Availability	Pedestrianised circulation area in Florence's historic centre	m^2; higher is better	420,000 m^2
Legal Recognition	Number of formal pedestrian-area regulatory typologies	Count; higher is better	6 typologies
Participation	Participation inputs in the Florence metropolitan mobility-planning process	Inputs; higher is better	5,100 inputs
Safety & Security	Number of injury crashes	injury crashes; lower is better	2,275 injury crashes

Regarding the values of the lower and upper limits of the Acceptability KPI, the lower limit is set at 0%, representing the absence of documented citizen-priority support for road-space reallocation objectives. The upper-performance reference is 35.8%, matching the same PUMS items used to calculate the KPI.

For Accessibility, the lower-performance reference is 0 km and the upper-performance reference is 120 km. The upper reference is the official municipal cycle-network objective reported by the Florence mobility portal (Comune di Firenze, Mobilita ciclistica), while the current KPI value is 113 km.

For the Affordability KPI, the lower limit is set at 0%, while the upper reference limit is set at 13.8%. This KPI is a citizen-priority affordability proxy, not a direct household-cost measure. The lower limit represents no documented citizen priority for reducing private-vehicle costs through more convenient shared, bicycle and pedestrian mobility. The upper reference limit corresponds to the official PUMS questionnaire result, where 13.8% of citizen responses selected the objective of reducing costs linked to private-vehicle use by making shared cars, shared bikes and cycle-pedestrian mobility more convenient (Città Metropolitana di Firenze, 2019a).

For the Agency KPI, the lower limit is set at 0%, while the upper reference limit is set at 42%. The lower limit represents a condition in which no surveyed citizens report using the bicycle as a mobility option. The upper reference limit corresponds to the PUMS citizen questionnaire result, where 42% of respondents answered “Sì” to the question “Usi la bicicletta?” (Città Metropolitana di Firenze, 2019a).

For Availability, the lower-performance reference is 0 m^2 and the upper-performance reference is 420,000 m^2, corresponding to the documented pedestrianised circulation area in Florence’s historic centre. (Comune di Firenze, 2020).

For the Legal Recognition KPI, the lower limit is set at 0 typologies, while the upper reference limit is set at 6 typologies. The lower limit represents no formal typological or regulatory classification of pedestrian areas. The upper reference limit corresponds to the City of Florence classification system, which groups pedestrian areas into six regulatory typologies, identified by the letters A, B, C, D, E and F matching the documented formal classification of pedestrian areas (Comune di Firenze Open Data, Aree pedonali).

For the Participation KPI, the lower limit is set at 0 inputs, while the upper reference limit is set at 5,100 inputs. The lower limit represents the absence of documented public or stakeholder input. The upper reference limit corresponds to the documented Florence metropolitan mobility-planning participation base used for this KPI (Città Metropolitana di Firenze, 2019a, Città Metropolitana di Firenze, 2019b).

For Safety & Security, the lower-performance reference is set at 2,275 injury crashes, corresponding to the municipal baseline. The upper-performance reference is set at approximately 2,070 injury crashes, corresponding to the level that would be reached if the recent approximate 9% improvement rate were reproduced from the baseline (Comune di Firenze, 2025a).

Table 23: KPI upper and lower limits of the Re-distribution of road space

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Share of citizen priority responses supporting road-space reallocation toward sustainable modes and better public space	0%	35.8%
Accessibility	Length of cycle network available in Florence	0 km	120 km

Affordability	Share of citizen priority responses supporting lower private-vehicle costs and more convenient shared / cycle-pedestrian mobility	0%	13.8%
Agency	Share of PUMS citizen respondents who use the bicycle	0%	42%
Availability	Pedestrianised circulation area in Florence's historic centre	0 m^2	420,000 m^2
Legal Recognition	Number of formal pedestrian-area regulatory typologies	0 typologies	6 typologies
Participation	Participation inputs in the Florence metropolitan mobility-planning process	0 inputs	5,100 inputs
Safety & Security	Number of injury crashes	2,275	2,070

3.3.1.3 Derived Significance Weights per Pillar KPI, Persona

Following the persona–pillar weighting methodology, the Florence Mentimeter results were used to derive significance weights for each SOMI pillar and persona. The Mentimeter exercise was implemented as part of the Florence project consultation and expert-scoring process, with participants asked to assess the relevance of each SOMI pillar for each Florence persona. For each persona, the Mentimeter question asked which SOMI pillars were most suitable, using a 1–5 agreement scale ranging from "Strongly disagree" to "Strongly agree".

For the calculation, the displayed Mentimeter values were treated as the mean relevance scores $x_{c,p,j}$.These mean scores were then rescaled from the 1–5 Likert scale to a 0–1 relevance score using Eq. (16) and normalised across the eight SOMI pillars for each persona using Eq. (17). This ensures that the eight pillar weights sum to 1 for each Florence persona. The calculation therefore follows the methodology described in the SOMI significance-weighting section and uses the Florence Mentimeter outputs included in the Appendix as the documented input evidence.

Since the Mentimeter exercise responses were collected anonymously, individual scores are not attributed to named participants. However, the appended Mentimeter evidence verifies the scoring task, the scale used, the persona-specific SOMI pillar questions, the displayed mean values and the number of responses visible for each scoring slide. The derived weights presented in Table 24 are therefore traceable to the documented Florence Mentimeter exercise outputs.

Table 24: Florence Mentimeter mean scores by persona and SOMI pillar

Persona	Accept.	Access.	Afford.	Agen.	Avail.	Legal Reco.	Partic.	Safety & Sec.

City-centre resident	3.2	3.8	2.7	2.7	3.3	2.8	4.0	4.3
Urban family	4.2	4.7	4.8	3.2	4.2	3.0	3.2	5.0
Older / less mobile resident	4.2	4.3	4.0	3.2	4.5	3.3	3.0	4.8
Business in the city centre	3.6	3.6	3.9	3.7	4.1	3.0	3.1	3.3
Student living away from home to study in Florence	2.7	3.4	5.0	3.3	4.1	3.0	3.1	4.0
Culture visitor	3.1	4.0	2.9	2.3	4.3	1.9	1.3	4.4
Commuter	4.0	4.0	4.2	4.3	4.3	2.8	3.5	4.2
Logistics operator, companies carrying out deliveries	3.6	3.6	3.9	3.7	4.1	3.0	3.1	3.3
Single or couple with no children	3.2	3.8	2.7	2.7	3.3	2.8	4.0	4.3

Table 25: Derived Florence persona–pillar significance weights

Persona	Accept.	Access	Afford	Agen	Avail.	Legal Rec	Partic.	Safety & Sec.
City-centre resident	0.117	0.149	0.090	0.090	0.122	0.096	0.160	0.176
Urban family	0.132	0.152	0.156	0.091	0.132	0.082	0.091	0.165
Older / less mobile resident	0.136	0.140	0.128	0.094	0.149	0.106	0.085	0.162
Business in the city centre	0.128	0.128	0.143	0.133	0.153	0.099	0.103	0.113
Student living away from home to study in Florence	0.083	0.117	0.194	0.112	0.150	0.097	0.102	0.146

Culture visitor	0.130	0.185	0.117	0.080	0.204	0.056	0.019	0.210
Commuter	0.129	0.129	0.137	0.142	0.142	0.077	0.107	0.137
Logistics operator, companies carrying out deliveries	0.128	0.128	0.143	0.133	0.153	0.099	0.103	0.113
Single or couple with no children	0.117	0.149	0.090	0.090	0.122	0.096	0.160	0.176

Table 26: Highest weighted SOMI pillars by Florence persona

Persona	Highest weighted SOMI pillars
City-centre resident	Safety & Security (0.176), Participation (0.160), Accessibility (0.149)
Urban family	Safety & Security (0.165), Affordability (0.156), Accessibility (0.152)
Older / less mobile resident	Safety & Security (0.163), Availability (0.150), Accessibility (0.142)
Business in the city centre	Availability (0.153), Affordability (0.143), Agency (0.133)
Student living away from home to study in Florence	Affordability (0.194), Availability (0.150), Safety & Security (0.146)
Culture visitor	Safety & Security (0.210), Availability (0.204), Accessibility (0.185)
Commuter	Agency (0.142), Availability (0.142), Affordability / Safety & Security (0.137)
Logistics operator, companies carrying out deliveries	Availability (0.153), Affordability (0.143), Agency (0.133)
Single or couple with no children	Safety & Security (0.176), Participation (0.160), Accessibility (0.149)

The highest-weighted SOMI pillars show that Florence personas attach different levels of importance to the eight SOMI dimensions. For the city-centre resident, Safety & Security, Participation and Accessibility are the dominant pillars. This reflects the relevance of safe streets, involvement in mobility planning and access to everyday destinations in the dense urban core. For the urban family, Safety & Security, Affordability and Accessibility are the most important pillars, which is consistent with household mobility needs, school-related trips, exposure to traffic risks and the cost of daily mobility. For the older / less mobile resident, Safety & Security, Availability and Accessibility receive the highest weights, showing the importance of usable, safe and available mobility options for people with reduced mobility or higher vulnerability in public space.

For the business in the city centre, the most important pillars are Availability, Affordability and Agency. This reflects the practical need for reliable access, economically viable mobility and logistics arrangements, and sufficient operational choice. The same logic applies to the logistics operator, whose mobility needs are closely linked to delivery access, loading/unloading conditions, final-mile options and operational flexibility. For the student living away from home to study in Florence, Affordability is the dominant pillar, followed by Availability and Safety & Security. This profile is consistent with the cost sensitivity of students and their dependence on affordable and available mobility options for education, services and social activities.

For the culture visitor, Safety & Security, Availability and Accessibility receive the highest weights. This is coherent with the visitor profile, because visitors need safe, legible and available access to cultural destinations, especially in a historic and tourism-intensive city such as Florence. For the commuter, Agency and Availability are the most important pillars, followed by Affordability and Safety & Security. This shows that commuters are particularly affected by the availability of practical travel options, the ability to choose between modes and routes, the cost of repeated travel and the reliability and safety of everyday trips. Finally, the single or couple with no children has the same weighting profile as the city-centre resident, indicating that this persona is mainly shaped by safe, accessible and participatory urban mobility conditions.

Overall, the persona–pillar weighting results show that the Florence SOMI calculation avoids an average-user approach. Safety & Security is particularly important for residents, families, older users, visitors and single/couple households; Affordability is especially important for students and business-related personas; and Availability and Agency are more prominent for business, logistics and commuter profiles. These differences are important because they ensure that each Florence solution is evaluated according to the needs and priorities of the personas most affected by it.

3.3.1.4 Personas Significance for Solution Implementation

For Florence, the ICB implementation-influence weighting exercise covered three solutions: SOL1 – 30 km/h zones and traffic calming, SOL2 – urban logistics micro-hubs, and SOL3 – road-space reallocation. The Florence persona set contains nine personas: city-centre resident, urban family, older / less mobile resident, business in the city centre, student living away from home to study in Florence, culture visitor, commuter, logistics operator carrying out deliveries, and single or couple with no children. The results show that persona significance varies substantially by solution. This confirms the need to use solution-specific persona weights rather than applying a single citywide persona hierarchy. Appendix II provides the ICB implementation workflow results for the city of Florence.

Table 27: Persona significance weights for Florence.

Persona ID	Persona	SOL1 – 30 km/h zones & traffic calming	SOL2 – Urban logistics micro-hubs	SOL3 – Road space reallocation
F-P1	City-centre resident	0.122	0.081	0.154
F-P2	Urban family	0.251	0.110	0.179
F-P3	Older / less mobile resident	0.149	0.078	0.129
F-P4	Business in the city centre	0.137	0.168	0.141

F-P5	Student living away from home to study in Florence	0.058	0.066	0.070
F-P6	Culture visitor	0.058	0.042	0.053
F-P7	Commuter	0.075	0.070	0.049
F-P8	Logistics operator, companies carrying out deliveries	0.097	0.351	0.159
F-P9	Single or couple with no children	0.052	0.035	0.066

The persona significance weights show that each Florence solution has a distinct implementation-influence profile. For SOL1 – 30 km/h zones and traffic calming, the highest weight is assigned to the urban family. This is consistent with the road-safety and liveability focus of the solution, because urban families are directly affected by vehicle speeds, school-related mobility, pedestrian safety, cycling conditions and the quality of everyday neighbourhood streets. The older / less mobile resident also receives a high weight, reflecting the importance of traffic calming for vulnerable road users. The business in the city centre also remains relevant because changes in speed limits, traffic circulation and street design can influence access to local commercial activities.

For SOL2 – urban logistics micro-hubs, the logistics operator is the dominant implementation persona. This is expected because the success of an urban logistics micro-hub depends strongly on the participation, acceptance and operational adaptation of delivery companies and logistics service providers. Businesses in the city centre also receive a high weight, because they are directly affected by delivery reliability, loading/unloading conditions, ZTL access rules and final-mile logistics arrangements. The urban family also remains relevant because micro-hub implementation can influence local traffic, pedestrian safety, public-space use and the intensity of freight vehicles in residential and mixed-use areas.

For SOL3 – road-space reallocation, the highest weights are assigned to the urban family, the logistics operator and the city-centre resident. This is coherent with the broad effects of reallocating road space. The solution affects household mobility, pedestrian and cycling conditions, local access, logistics operations and the use of streets as public spaces. The city-centre resident is particularly relevant because road-space redistribution directly changes the everyday mobility environment in dense urban areas. The logistics operator remains important because changes in road space, loading areas, access rules and street priorities can affect delivery operations and final-mile logistics.

Table 28: Highest-weighted personas for Florence

Solution	Persona ID	Most significant persona	Final weight
SOL1 – 30 km/h zones & traffic calming	F-P2	Urban family	0.251

SOL2 – Urban logistics micro-hubs	F-P8	Logistics operator, companies carrying out deliveries	0.351
SOL3 – Road space reallocation	F-P2	Urban family	0.179

The highest-weighted persona results confirm that the Florence implementation-influence structure is solution-sensitive. The urban family is the most significant persona for SOL1, because traffic calming is closely linked to everyday household mobility, school-related trips, pedestrian safety and the protection of vulnerable road users. The logistics operator is the most significant persona for SOL2, because the micro-hub solution depends on the practical uptake and operational adaptation of delivery companies and logistics providers. The urban family is again the most significant persona for SOL3, reflecting the strong relevance of road-space reallocation for household mobility, safer streets, cycling, walking and access to everyday services.

These results show that the same persona does not dominate all solutions. Instead, the most influential persona changes according to the implementation logic of each solution. This supports the use of solution-specific persona weights in the Florence SOMI calculation. A single citywide persona hierarchy would not capture the different implementation pathways of traffic calming, urban logistics micro-hubs and road-space reallocation.

3.3.1.4.1 Estimated SOMI per Persona and Solution

The persona-level SOMI values were calculated by combining the normalised KPI performance of each solution with the persona-specific SOMI pillar weights. For each persona and solution, the eight normalised pillar scores were multiplied by the corresponding persona–pillar weights and then summed. The result is a persona-level SOMI value between 0 and 1, where higher values indicate stronger performance from the perspective of that persona.

Table 29: Persona-level SOMI estimates for Florence.

Persona	SOL1: 30 km/h zones and traffic calming	SOL2: Urban logistics micro-hubs	SOL3: Road-space reallocation
City-centre resident	0.417	0.562	0.816
Urban family	0.381	0.595	0.827
Older / less mobile resident	0.385	0.603	0.829
Business in the city centre	0.401	0.659	0.879
Student living away from home to study in Florence	0.376	0.666	0.848

Culture visitor	0.261	0.564	0.779
Commuter	0.382	0.633	0.855
Logistics operator, companies carrying out deliveries	0.401	0.659	0.879
Single or couple with no children	0.417	0.562	0.816

The persona-level SOMI estimates show that SOL3 – road-space reallocation achieves the highest score for every Florence persona. The strongest values are observed for the business in the city centre and the logistics operator, both at 0.879, followed by the commuter at 0.855 and the student living away from home at 0.848. These high values reflect the strong performance of SOL3 across most SOMI pillars, especially Acceptability, Accessibility, Affordability, Agency, Availability, Legal Recognition and Participation. The only pillar that remains weak is Safety & Security, because the current injury-crash baseline is used as the observed value and no additional improvement is yet captured in the normalised score.

SOL2 – urban logistics micro-hubs produces intermediate SOMI values across the personas. The highest values are recorded for the student living away from home, the business in the city centre and the logistics operator. This reflects the strong performance of SOL2 in Affordability, Agency, Availability and Legal Recognition. The solution also provides operational value for business and logistics-related personas because it directly addresses delivery-management options, micro-hub availability, ZTL freight readiness and the economic organisation of last-mile logistics. However, its overall performance remains moderated by partial scores in Acceptability, Accessibility and Participation, as well as the absence of a measured safety improvement.

SOL1 – 30 km/h zones and traffic calming produces the lowest persona-level SOMI values among the three Florence solutions. The highest values are observed for the city-centre resident and the single or couple with no children, both at 0.417, followed by the business in the city centre and the logistics operator, both at 0.401. The lowest value is observed for the culture visitor, at 0.261. These results do not mean that traffic calming is a weak policy concept. Rather, they reflect the current KPI and normalisation structure: SOL1 performs strongly in Acceptability, Legal Recognition and Participation, but the current Zone 30 coverage, active-area count and injury-crash baseline are treated as lower-performance references. Therefore, the SOL1 result should be interpreted as a current-state assessment that can improve if wider Zone 30 coverage and measurable safety improvements are achieved.

3.3.1.4.2 Estimated Solution SOMI

The solution-level SOMI values were calculated by aggregating persona-level SOMI scores using the solution-specific persona implementation weights. This means that the final solution value reflects both the KPI performance of the solution and the relative implementation influence of the personas most relevant to that solution.

Table 30: Solution SOMI estimates for Florence.

Solution	Aggregation method	Solution-level SOMI

SOL1 – 30 km/h zones and traffic calming	Persona-level SOMI weighted by solution-specific persona implementation weights	0.385
SOL2 – Urban logistics micro-hubs	Persona-level SOMI weighted by solution-specific persona implementation weights	0.631
SOL3 – Road-space reallocation	Persona-level SOMI weighted by solution-specific persona implementation weights	0.841

The solution-level results confirm the ranking already visible in the persona-level values. SOL3 – road-space reallocation achieves the highest solution-level SOMI, with a value of 0.841. This is because it performs strongly across most SOMI pillars and is also highly relevant for influential personas such as the urban family, logistics operator and city-centre resident. SOL2 – urban logistics micro-hubs achieves an intermediate SOMI value of 0.631. Its performance is driven by strong scores in Affordability, Agency, Availability and Legal Recognition, together with the high implementation weight assigned to logistics operators and city-centre businesses. SOL1 – 30 km/h zones and traffic calming records a lower SOMI value of 0.385, mainly because its current spatial coverage, active-area count and injury-crash baseline remain close to the lower-performance references used in the calculation.

3.3.1.4.3 Estimated City SOMI

To obtain the Florence city-level SOMI, the three assessed solution-level SOMI values were aggregated using equal solution weights. Equal weighting is used because the three Florence solutions are treated as parallel assessed interventions within the same use case and no alternative strategic, budgetary, territorial-impact or stakeholder-defined solution weighting is introduced at this stage.

The estimated Florence city-level SOMI is 0.619. This value represents the combined social-optimum mobility performance of the three Florence solutions assessed in the use case. It should be interpreted as a synthetic evaluation of the current evidence base rather than as a permanent city score. The value is mainly shaped by the high performance of road-space reallocation, the intermediate performance of the urban logistics micro-hub solution and the lower current-state score of the Zone 30 / traffic-calming solution.

The city-level result also shows the usefulness of the SOMI structure. It does not only provide a single score, but also allows the analysis to identify where performance is strong and where further improvement is needed. In Florence, the strongest contribution comes from road-space reallocation, which performs well across most SOMI pillars and personas. The micro-hub solution shows good potential, especially for logistics and business-related personas, but remains partly constrained by its pilot-stage status. The Zone 30 solution has strong institutional and participation foundations, but its SOMI score can increase if future implementation expands coverage and produces measurable safety improvements. Hence, the Florence SOMI result provides a basis for comparing the three selected solutions and for identifying which pillars and personas should be prioritised in future monitoring and policy refinement.

3.3.2 Pilsen Use Case

Pilsen is a technologically advanced small city with around 188,000 inhabitants and is an urban node on the Rhine–Danube TEN-T Corridor (Czech Statistical Office, 2024; European Parliament and Council, 2024). The city has a strong focus on high-value innovation, research and development, including testing infrastructure for connected, cooperative and automated vehicles and the deployment of advanced 5G connectivity (Smart City Pilsen, 2026). Pilsen has also developed a Digital Twin infrastructure, including modules that integrate technical and social data for urban planning, traffic forecasting, scenario testing and decision support (DUET Project Partners, 2022; Digital Urban Twins, 2022; Smart City Pilsen, 2026). However, these initiatives have mainly focused on the City of Pilsen itself, while complex, data-based planning across policy sectors remains limited. Therefore, the city aims to connect separate data streams into a more cohesive strategy and extend their use to the wider Integrated Territorial Investment area of the Pilsen agglomeration (Útvar koncepce a rozvoje města Plzně, 2022). The ITI strategy identifies six strategic areas requiring an integrated approach: innovation, education, economy, environment, mobility, and sustainable development of cities and towns (Útvar koncepce a rozvoje města Plzně, 2022). Key challenges include applying R&D outputs in the local economy, better aligning education with labour-market needs, reducing dependence on the automotive sector, improving energy efficiency, introducing new technologies for transport management, strengthening walking and cycling connections, improving tourism infrastructure, revitalising public spaces, and supporting civic amenities and public-service facilities in rural and suburban municipalities of the Pilsen agglomeration (Útvar koncepce a rozvoje města Plzně, 2022; Útvar koncepce a rozvoje města Plzně, 2025).

3.3.2.1 Baseline KPI Values and Acceptable Upper and Lower Limits per Mobility Solution

For Acceptability, the selected KPI is the share of residents prioritising safer and more comfortable cycling-relevant routes. The observed value is 48% of survey respondents. The value is supported by the PUMP 2026-2035 questionnaire evaluation and the official City of Plzen communication, which report that almost half of respondents wanted safe and comfortable routes through the city for active mobility (City of Plzen, 2025a; Utvar koncepce a rozvoje mesta Plzne, 2025).

For Accessibility, the selected KPI is the length of dedicated bicycle lanes. The observed value is 0.18 km. This value is taken from the indicator workbook of the Strategie udrzitelne mobility Plzenske aglomerace, sheet “Indikatory”, where the indicator “Delka vyhrazenych jizdnich pruhu pro cyklisty” is linked to Specific Objective 1.3 and reports a baseline of 0.18 km. The accompanying SUMP summary defines the indicator as the total length of reserved bicycle lanes, counted one-way, and identifies SVS mesta Plzne, usek dopravniho inzenyrstvi as the monitoring authority (Strategie udrzitelne mobility Plzenske aglomerace, 2022a, sheet “Indikatory”, row 19; 2022b, PDF viewer p. 39 / printed p. 33).

For Affordability, the selected KPI is the cost of a 30-minute Pilsen Bike trip. The observed standard value is EUR 1.23, calculated from the tariff basis of CZK 1 per minute, giving CZK 30 for a 30-minute ride. Using the ECB daily EUR/CZK reference exchange rate of 24.324 CZK per EUR for 12 May 2026, the calculation is 30 / 24.324 = EUR 1.23 (PMDP, 2026a; Narodna banka Slovenska / ECB, 2026).

For Agency, the selected KPI is residents mainly moving around Plzeň by bicycle. The value is 13% of survey respondents. This KPI captures the degree to which cycling is already used as a practical everyday mobility option. The Plzeň mobility survey reported that 41% of respondents mainly use a car, 33% use public transport, 13% cycle and 12% walk (City of Plzeň, 2025; Útvar koncepce a rozvoje města Plzně, 2025).

For Availability, the selected KPI is bike-share stations per 1,000 residents. The observed value is 0.83 stations per 1,000 residents, calculated from 156 Pilsen Bike stations and a Plzen population of 187,928 residents: 156 / 187,928 x 1,000 = 0.83. The station count is drawn from the City of Plzen / Pilsen Bike evidence base, while the population denominator is taken from Czech Statistical Office data (City of Plzen, 2025a; Český statistický úřad, 2025).

For Legal Recognition, the selected KPI is cycling included in the approved mobility plan. The value is 1, coded as a binary indicator where 1 means that cycling is formally recognised in an approved mobility-planning document. The updated Plán udržitelné mobility Plzně 2026–2035 was approved by the City Assembly of Plzeň through ZMP Resolution No. 391 on 11 December 2025. The plan and its approval resolution are available through the official Mobilita Plzeň download page (Mobilita Plzeň, 2025.; Zastupitelstvo města Plzně, 2025).

For Participation, the selected KPI is respondents in the city mobility survey. The value is 1,069 respondents. This KPI measures the participation base behind the cycling and mobility-planning priorities used in the KPI set. The Plán udržitelné mobility Plzně 2026–2035 questionnaire evaluation reports that the survey ran from 1 September 2025 to 30 September 2025 and involved 1,069 respondents (City of Plzeň, 2025; Útvar koncepce a rozvoje města Plzně, 2025).

For Safety & Security, the selected KPI is reported traffic accidents in Plzen-mesto. The observed value is 1,894 traffic accidents in 2024. This is a lower-is-better KPI because fewer reported traffic accidents indicate safer mobility conditions. The value is taken from the Czech Statistical Office regional accident report based on Police Presidium data, which reports 1,894 traffic accidents in Plzen-mesto in 2024, including 382 accidents with consequences for life or health, 8 fatalities and 475 injured persons (Český statistický úřad, 2025). Table 31 summarizes the cycling solution KPI values.

Table 31: Cycling solution KPI Values

SOMI Pillar	Selected KPI	Unit + direction	Value
Acceptability	Residents prioritising safer and more comfortable cycling routes	%; higher better	48%
Accessibility	Length of dedicated bicycle lanes	km; higher better	0.18 km
Affordability	Cost of a 30-minute Pilsen Bike trip	EUR; lower better	EUR 1.23
Agency	Residents mainly moving around Plzen by bicycle	%; higher better	13%
Availability	Bike-share stations per 1,000 residents	stations / 1,000 residents; higher better	0.83
Legal Recognition	Cycling included in approved mobility plan	0-1 score; higher better	1
Participation	Respondents in the city mobility survey	count; higher better	1,069
Safety & Security	Reported traffic accidents in Plzen-mesto	accidents; lower better	1,894

For the definition of the lower and upper limits, and specifically for Acceptability, the lower-performance reference is set at 0%, representing no documented resident priority for safer and more comfortable cycling routes. The upper-performance reference is set at 100%, representing the theoretical maximum of a percentage-based public-support indicator. The observed value of 48% is therefore treated as the current Pilsen baseline, not as the maximum possible level of acceptability.

For Accessibility, the lower-performance reference is set at 0 km, representing the absence of dedicated bicycle-lane infrastructure. The upper-performance reference is set at 375.86 km, calculated by applying the TUMI benchmark of 2 km of high-quality segregated cycling lanes per 1,000 inhabitants to the Plzen population of 187,928 residents: 187,928 / 1,000 x 2 = 375.86 km. This benchmark is used because the KPI measures the physical extent of dedicated cycling infrastructure and the TUMI benchmark provides an external reference for a high-quality cycling network (Moser & Wagner, 2021, pp. 7-9; Český statistický úřad, 2026).

For Affordability, the lower-performance reference is set at EUR 1.23, representing the standard 30-minute Pilsen Bike trip cost. The upper-performance reference is set at EUR 0.62, representing the reduced-cost condition for eligible PMDP or IDPK monthly-pass users who receive up to 15 minutes free twice per day. Under this condition, a 30-minute ride requires payment for only 15 minutes, equal to CZK 15, or approximately EUR 0.62 using the same exchange-rate basis. Because the KPI is lower-is-better, the reduced cost represents stronger affordability performance (PMDP, 2026a; PMDP, 2026b; Narodna banka Slovenska / ECB, 2026).

For Agency, the lower-performance reference is set at 0%, representing no surveyed residents mainly using the bicycle for mobility in Plzen. The upper-performance reference is set at 25%, based on the Czech cycling-policy benchmark VISION 25, which aimed for bicycle transport to reach at least 25% modal split for short trips up to 5 km in plains. The observed 13% value remains the current Pilsen baseline, while 25% provides a relevant national policy reference for higher cycling uptake (Utvar koncepce a rozvoje mesta Plzne, 2025, p. 2; Ministry of Transport of the Czech Republic, 2013).

For Availability, the lower-performance reference is set at 0 stations per 1,000 residents, representing no bike-share station availability. The upper-performance reference is set at 0.83 stations per 1,000 residents, representing the documented Pilsen Bike deployment of 156 stations for 187,928 residents. This is used as a local best-performance reference because no higher formal Pilsen target for stations per 1,000 residents is available, and the documented Pilsen station density already exceeds the older OBIS European bike-sharing benchmark maximum of 6.7 stations per 10,000 inhabitants, equivalent to 0.67 stations per 1,000 inhabitants (City of Plzen, 2025b; Český statistický úřad, 2026; Buttner et al., 2011).

For Legal Recognition, the lower-performance reference is set at 0, meaning that cycling is not formally recognised in an approved mobility-planning document. The upper-performance reference is set at 1, meaning that cycling is formally included in the approved Plan udrzitelne mobility Plzne 2026-2035. The observed value is 1 because the plan was approved by ZMP Resolution No. 391 on 11 December 2025. The binary scale is appropriate because the KPI measures the presence or absence of formal planning recognition, not the intensity of implementation (Mobilita Plzen, 2025; Zastupitelstvo mesta Plzne, 2025).

For Participation, the lower-performance reference is set at 0 respondents, representing no documented public input. The upper-performance reference is set at 1,069 respondents, representing the actual participation base of the PUMP 2026-2035 mobility survey. This value is methodologically defensible because Cochran's standard sample-size formula gives approximately 1,068 respondents for a 95% confidence level and a +/-3 percentage-point margin of error under the conservative p = 0.5 assumption. The Pilsen sample of 1,069 respondents therefore reaches this participation-quality threshold and can be used as the upper-performance reference for this survey-based participation KPI (Utvar koncepce a rozvoje mesta Plzne, 2025; Cochran, 1977).

For Safety & Security, the lower-performance reference is set at 1,894 reported traffic accidents, representing the documented 2024 baseline for Plzen-mesto. The upper-performance reference is set at 947 reported traffic accidents, representing a 50% reduction from the 2024 baseline: 1,894 x 0.50 = 947. Because the KPI is lower-is-better, the numerically lower value represents stronger safety performance. The 50% reduction logic is aligned with the EU and UN road-safety policy objective of reducing deaths and serious injuries by 50% by 2030, applied here as a accident-reduction benchmark for normalisation (Český statistický úřad, 2025; European Commission, 2021; WHO, 2021). Table 32 summarizes the upper and lower limits of the cycling solution's KPIs.

Table 32: KPI upper and lower limits of the Cycling Solution

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Residents prioritising safer and more comfortable cycling routes	0%	100%
Accessibility	Length of dedicated bicycle lanes	0 km	375.86 km
Affordability	Cost of a 30-minute Pilsen Bike trip	EUR 1.23 standard 30-minute ride	EUR 0.62 eligible reduced-cost condition
Agency	Residents mainly moving around Plzen by bicycle	0%	25%
Availability	Bike-share stations per 1,000 residents	0 stations / 1,000 residents	0.83 stations / 1,000 residents
Legal Recognition	Cycling included in approved mobility plan	0	1
Participation	Respondents in the city mobility survey	0 respondents	1,069 respondents
Safety & Security	Reported traffic accidents in Plzen-mesto	1,894 accidents	947 accidents

The Pilsen Digital Twin solution concerns the use of integrated urban data, spatial layers, traffic models, stakeholder feedback and scenario-testing functionality to support evidence-based mobility planning and decision-making. The KPI set uses documented pilot values, binary presence indicators and source-based reference limits where no formal city target or maturity benchmark is available.

For Acceptability, the selected KPI is documented positive stakeholder appraisal of the Pilsen Digital Twin after local testing. The value is 1 on a 0-1 binary scale. The DUET evaluation material reports high overall acceptance of the DUET solution and states that the Pilsen application was perceived as a suitable solution for cities because it complements existing tools, does not require installation and enables easier work with 3D and 2D data than robust desktop GIS systems (DUET Project Partners, 2022c).

For Accessibility, the selected KPI is the number of Pilsen Digital Twin public-transport spatial dataset types documented for the pilot. The value is 2, corresponding to the two public-transport spatial dataset types documented in DUET D2.5: public-transport routes and public-transport stops. These layers are relevant because routes and stops are basic spatial inputs for assessing access to public transport, interchange possibilities and multimodal connectivity (DUET Project Partners, 2022a).

For Affordability, the selected KPI is the documented EU financial contribution to Pilsen-based DUET participants supporting the Digital Twin pilot. The value is EUR 252,500, calculated as EUR 93,750 for Zapadoceska univerzita v Plzni plus EUR 158,750 for Sprava informacnich technologii mesta Plzne. This is a financial-feasibility proxy because it documents external EU support for local implementation and reduces direct reliance on municipal funding resources. It is not a full life-cycle cost or annual operating-cost estimate (European Commission, CORDIS, 2023).

For Agency, the selected KPI is whether the Pilsen Digital Twin focus groups included an explicit channel for participants to provide suggestions and remarks. The value is 1 on a 0-1 binary scale. DUET D6.5 reports three Pilsen focus groups with 34 participants and states that participants were invited to contribute suggestions and remarks after the platform introduction and presentation. The report also lists recommendations arising from this process, including adding a complete legend, map snapping and user information during model calculations (DUET Project Partners, 2022b).

For Availability, the selected KPI is the number of operational mobility data/model inputs explicitly documented as implemented in the Pilsen DUET pilot. The value is 3, corresponding to traffic detector data, traffic model data and floating car data. DUET D2.5 describes traffic detector data from 1,000 magnetic loop detectors, traffic model data supported by a modeller backend and web application, and floating-car speed data updated every five minutes and covering 1,100 km of Pilsen streets (DUET Project Partners, 2022a).

For Legal Recognition, the selected KPI is formal city support for DUET documented in project material. The value is 1 on a 0-1 binary scale. DUET D2.5 states that the City of Pilsen signed a statement of support and remained continuously engaged in project activities. This is used as a conservative legal-recognition and governance proxy; it confirms formal municipal backing, but does not imply that the Digital Twin is embedded in a statutory planning obligation or permanent regulation (DUET Project Partners, 2022a).

For Participation, the selected KPI is the number of Pilsen DUET co-creation, consultation and testing sessions documented in the pilot evaluation. The value is 17 sessions. DUET D6.6 reports "PILSEN - 17 sessions" and lists consultations, workshops, testing, meetings, presentations and co-creation activities involving local technical and policy stakeholders (DUET Project Partners, 2022c).

For Safety & Security, the selected KPI is whether the official Pilsen Digital Twin project scope includes crisis-scenario prediction, countermeasures and modelling of their effectiveness. The value is 1 on a 0-1 binary scale. The Smart City Pilsen DUET project page states that DUET focuses on creating a 3D model of the city and modelling conditions that might occur in the city, including crisis scenarios, prediction, countermeasures and modelling of their effectiveness (Smart City Pilsen, 2025). Table 33 summarizes the Digital Twin KPI values.

Table 33: Digital Twin KPI Values

SOMI Pillar	Selected KPI	Unit + direction	Value
Acceptability	Documented positive stakeholder appraisal after local testing	0-1 score; higher better	1
Accessibility	Public-transport spatial dataset types documented for the pilot	dataset types; higher better	2
Affordability	EU financial contribution to Pilsen-based DUET participants	EUR; higher better	EUR 252,500

Agency	Focus groups included a channel for suggestions and remarks	0-1 score; higher better	1
Availability	Operational mobility data/model inputs implemented in the pilot	inputs; higher better	3
Legal Recognition	Formal city statement of support for DUET documented	0-1 score; higher better	1
Participation	Co-creation / consultation / testing sessions in pilot evaluation	sessions; higher better	17
Safety & Security	Project scope includes crisis-scenario prediction and countermeasure modelling	0-1 score; higher better	1

For the definition of the lower and upper limits, and specifically for acceptability KPI the lower-performance reference is set at 0, representing no documented positive appraisal after local testing. The upper-performance reference is set at 1, representing documented positive appraisal. The 0-2 range is source-based, because the available evidence documents these two specific public-transport accessibility layers and does not provide a formal Pilsen target for additional Digital Twin transport layers (DUET Project Partners, 2022c).

For Accessibility, the lower-performance reference is set at 0 public-transport spatial dataset types, representing the absence of public-transport spatial layers in the Digital Twin environment. The upper-performance reference is set at 2 dataset types, corresponding to the two documented Pilsen pilot layers: public-transport routes and public-transport stops. This 0-2 range is more auditable than an unsupported higher target that was used during the first iterations of the KPI value ranges definition process, because the available evidence documents two specific public-transport accessibility layers and no formal Pilsen target for additional Digital Twin transport layers is provided in the reference set (DUET Project Partners, 2022a).

For Affordability, the lower-performance reference is set at EUR 0, representing no documented external EU financial support for Pilsen-based Digital Twin implementation actors. The upper-performance reference is set at EUR 252,500, corresponding to the documented net EU contribution to the two Pilsen-based DUET participants. The indicator remains a financial-feasibility proxy, not a full project-cost or cost-benefit indicator (European Commission, CORDIS, 2023).

For Agency, the lower-performance reference is set at 0, representing no explicit participant channel for suggestions or remarks during the focus-group process. The upper-performance reference is set at 1, representing documented existence of such a feedback channel. The binary scale is appropriate because the KPI measures a procedural condition: whether participants were given a documented role in identifying issues and shaping improvements to the Digital Twin tool (DUET Project Partners, 2022b).

For Availability, the lower-performance reference is set at 0 operational mobility data/model inputs, representing no documented mobility-operational inputs implemented in the Digital Twin pilot. The upper-performance reference is set at 3 inputs, corresponding to the three documented Pilsen mobility inputs: traffic detector data, traffic model data and floating car data. The 0-3 range is based on the implemented mobility input categories documented in the available evidence (DUET Project Partners, 2022a).

For Legal Recognition, the lower-performance reference is set at 0, representing no formal city support or governance recognition documented for the Digital Twin pilot. The upper-performance reference is set at 1, representing the documented City of Pilsen statement of support and continued engagement in the

DUET project. This binary legal-recognition proxy is conservative as it confirms formal municipal backing within the project framework, while avoiding overstatement that the Digital Twin has become a statutory or permanent regulatory instrument (DUET Project Partners, 2022a).

For Participation, the lower-performance reference is set at 0 documented co-creation, consultation or testing sessions. The upper-performance reference is set at 17 documented sessions, corresponding to the full number of Pilsen pilot engagement activities reported in DUET D6.6. This reference limit is tied to the documented pilot evidence. The 17 sessions cover a broad engagement process, including consultations with municipal and technical actors, workshops, release testing, data-storage discussions, traffic-model presentations, noise-sensor discussions and co-creation of new use cases (DUET Project Partners, 2022c).

For Safety & Security, the lower-performance reference is set at 0, representing no documented Digital Twin capability for crisis-scenario prediction, countermeasures or effectiveness modelling. The upper-performance reference is set at 1, representing explicit inclusion of these safety/security modelling capabilities in the official Pilsen DUET project scope. The binary scale is appropriate because the KPI measures documented presence or absence of capability, not a quantified reduction in crashes, incidents or emergency-response time (Smart City Pilsen, 2025).

Table 34: KPI upper and lower limits of the Digital Twin Solution

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Documented positive stakeholder appraisal after local testing	0	1
Accessibility	Public-transport spatial dataset types documented for the pilot	0 dataset types	2 dataset types
Affordability	EU financial contribution to Pilsen-based DUET participants	EUR 0	EUR 252,500
Agency	Focus groups included a channel for suggestions and remarks	0	1
Availability	Operational mobility data/model inputs implemented in the pilot	0 inputs	3 inputs
Legal Recognition	Formal city statement of support for DUET documented	0	1
Participation	Co-creation / consultation / testing sessions in pilot evaluation	0 sessions	17 sessions
Safety & Security	Project scope includes crisis-scenario prediction and countermeasure modelling	0	1

The Pilsen public transport and first-/last-mile access solution concerns strengthening public transport by improving access to and from stops, interchanges and peripheral areas through better links with walking, cycling, bike-sharing and station or stop accessibility. The validated KPI set focuses on public support for continued tram development, the scale of the public-transport network, the affordability of a monthly public-transport pass, the availability of bike-sharing as a first-/last-mile option, the formal recognition of public transport and active mobility in the city's sustainable mobility planning, participation in the PUMP survey process, and the accessibility of tram stops and stations.

For Acceptability, the selected KPI is the share of respondents supporting or prioritising continued tram network development. The observed value is 49%. The PUMP 2026-2035 questionnaire evaluation states that 49% of respondents considered it important to continue developing tram lines, including to Na Vinice and the Kasarna Bory residential area (Utvar koncepce a rozvoje mesta Plzne, 2025).

For Accessibility, the selected KPI is the number of public-transport stops available. The observed value is 339 stops. This replaces the repeated use of "49 lines" for both Accessibility and Availability and gives the Accessibility pillar a more direct network-access proxy. UITP documents the PMDP Pilsen network as having 339 stops, alongside bus, tram and trolleybus services, 49 lines, coverage of 220 km2 and 107 million passengers per year (UITP, 2018).

For Affordability, the selected KPI is the monthly public-transport pass cost as a share of median monthly income. The observed value is 1.44%. This is calculated from the adult 31-day pass for Zone 001 Plzen, costing CZK 570, and the Czech Statistical Office median monthly wage of CZK 39,685: 570 / 39,685 x 100 = 1.436%, rounded to 1.44%. This is a lower-is-better KPI because a smaller share of income indicates greater affordability (PMDP, 2025; Český statistický úřad, 2024).

For Agency, the selected KPI is the number of bike-sharing stations or locations across the city. The observed value is more than 150 locations. PMDP states that Pilsen Bike is a shared e-bike service with 300 e-bikes and that users can rent and return bikes at more than 150 locations throughout the city. The KPI is relevant to Agency because it captures an additional user-controlled first-/last-mile option that can complement public transport (PMDP, 2026a).

For Availability, the selected KPI is the number of public-transport lines available. The observed value is 49 lines. UITP documents the PMDP Pilsen network as consisting of 49 lines across bus, tram and trolleybus modes. This value is used for Availability because it reflects the breadth of the operating public-transport service offer (UITP, 2018).

For Legal Recognition, the selected KPI is whether public-transport and first-/last-mile access improvement are formally recognised in the city's sustainable mobility-planning framework. The observed value is 1 on a 0-1 binary scale. The updated Plan udrzitelne mobility Plzne 2026-2035 was formally approved through ZMP Resolution No. 391 on 11 December 2025, and the PUMP questionnaire evaluation confirms that the plan is a comprehensive development document covering all transport modes used in Plzen (Mobilita Plzen, 2025; Zastupitelstvo mesta Plzne, 2025; Utvar koncepce a rozvoje mesta Plzne, 2025).

For Participation, the selected KPI is the number of respondents in the PUMP 2026-2035 mobility survey. The observed value is 1,069 respondents, documented in the questionnaire evaluation, which states that the survey ran from 1 September 2025 to 30 September 2025 and provided relevant public-opinion evidence for confirming principles and proposed solutions (Utvar koncepce a rozvoje mesta Plzne, 2025).

For Safety & Security, the selected KPI is the share of tram stops and stations with accessible boarding and access conditions. The observed value is 75%. This is a safe-access and universal-access infrastructure proxy, not a direct crime or crash indicator. UITP reports that 75% of tram stops and stations in the PMDP Pilsen network are accessible and that 50% of the bus and trolleybus network is accessible (UITP, 2018).

Table 35: First/last-mile access solution KPI Values

SOMI Pillar	Selected KPI	Unit + direction	Value

Acceptability	Respondents supporting / prioritising continued tram network development	%; higher better	49%
Accessibility	Public-transport stops available	count; higher better	339 stops
Affordability	Monthly PT pass cost as share of median monthly income	%; lower better	1.44%
Agency	Bike-sharing stations / locations across the city	count; higher better	150+ locations
Availability	Public-transport lines available	count; higher better	49 lines
Legal Recognition	PT and first-/last-mile access recognised in approved mobility plan	0-1 score; higher better	1
Participation	Respondents in the PUMP 2026-2035 mobility survey	count; higher better	1,069 respondents
Safety & Security	Tram stops and stations with accessible boarding and access conditions	%; higher better	75%

For the definition of the lower and upper limits, and for Acceptability, the lower-performance reference is set at 0%, representing no documented respondent support for continued tram network development. The upper-performance reference is set at 100%, representing the theoretical maximum of a percentage-based public-support indicator. The observed 49% value is the current Pilsen baseline, not the upper limit (Utvar koncepce a rozvoje mesta Plzne, 2025).

For Accessibility, the lower-performance reference is set at 0 public-transport stops, representing the absence of stop-level access points. The upper-performance reference is set at 339 stops, corresponding to the documented PMDP network stop count. This local reference is appropriate because the KPI measures the actual stop-based accessibility infrastructure available in the Pilsen public-transport network, and no higher formal stop-count target is provided in the reference set (UITP, 2018).

For Affordability, the lower-performance reference is set at 1.44% of median monthly income, representing the documented current monthly-pass affordability condition for the adult 31-day Zone 001 Plzen pass. The upper-performance reference is set at 0% of median monthly income, representing a theoretical free-pass condition in which the monthly public-transport pass imposes no direct cost on the user. Because the KPI is lower-is-better, the 0% condition represents stronger affordability performance (PMDP, 2025; Český statistický úřad, 2024).

For Agency, the lower-performance reference is set at 0 bike-sharing locations, representing no first-/last-mile bike-sharing option available to public-transport users. The upper-performance reference is set at 150+ locations, corresponding to the documented Pilsen Bike deployment across the city. This value is used as a local upper-performance reference because no higher formal Pilsen target for bike-sharing locations is available, and the documented service already provides a citywide complementary mobility option with 300 e-bikes (PMDP, 2026a).

For Availability, the lower-performance reference is set at 0 public-transport lines, representing no public-transport service availability. The upper-performance reference is set at 49 lines, corresponding to the documented PMDP network scale across tram, trolleybus and bus modes. This is distinct from Accessibility: the stop count captures access points to the network, while the line count captures the breadth of the operating service offer (UITP, 2018).

For Legal Recognition, the lower-performance reference is set at 0, representing no formal recognition of public transport and first-/last-mile access improvement in an approved mobility-planning framework. The upper-performance reference is set at 1, representing formal embedding of these policy areas in the approved Plan udrzitelne mobility Plzne 2026-2035. The observed value is 1 because the plan was formally approved through ZMP Resolution No. 391 on 11 December 2025 and is available through the official Mobilita Plzen repository. The binary scale is appropriate because the KPI measures formal planning recognition rather than implementation intensity (Mobilita Plzen, 2025; Zastupitelstvo mesta Plzne, 2025).

For Participation, the lower-performance reference is set at 0 respondents, representing no documented public input into the PUMP process. The upper-performance reference is set at 1,069 respondents, corresponding to the documented survey participation base. The PUMP questionnaire evaluation explicitly states that the number of respondents allowed the survey to serve as a relevant basis for documenting public opinion and for confirming the suitability of selected principles and proposed solutions, which supports using the actual participation base as the upper-performance reference for this pilot-stage participation KPI (Utvar koncepce a rozvoje mesta Plzne, 2025).

For Safety & Security, the lower-performance reference is set at 0%, representing no documented accessible tram stops or stations. The upper-performance reference is set at 100%, representing full accessibility of tram stops and stations. The observed value of 75% is therefore treated as the current documented condition, not as the best possible performance level. This is more robust than setting the upper reference at 75%, because universal accessibility is naturally Limited at 100% and represents the normative safe-access condition for tram stops and stations (UITP, 2018). Table 36 summarizes the KPI upper and lower limits of the First/last-mile access solution KPI Values.

Table 36: KPI upper and lower limits of the First/last-mile access solution KPI Values

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Respondents supporting / prioritising continued tram network development	0%	100%
Accessibility	Public-transport stops available	0 stops	339 stops
Affordability	Monthly PT pass cost as share of median monthly income	1.44% of median monthly income	0% of median monthly income
Agency	Bike-sharing stations / locations across the city	0 locations	150+ locations
Availability	Public-transport lines available	0 lines	49 lines
Legal Recognition	PT and first-/last-mile access recognised in approved mobility plan	0	1

Participation	Respondents in the PUMP 2026-2035 mobility survey	0 respondents	1,069 respondents
Safety & Security	Tram stops and stations with accessible boarding and access conditions	0%	100%

3.3.2.2 Selected Personas

Employing the proposed methodology of D1.1 summarized in Subsection 3.2.4 resulted on the following selected personas and solutions as summarized in Table 37 below:

Table 37: Selected Personas and Solutions in Pilsen

Selected personas	Solutions
• **City / urban resident, occasional car user.** • **Budget-sensitive student.** • **Industrial-zone shift commuter.** • **Suburban family.** • **Older / less mobile resident.** • **Leisure and culture visitor.** • **Regional commuter family**	PIL SOL1: Cycling infrastructure and bike-share uptake: aims to increase the role of active mobility in Pilsen by improving access to cycling infrastructure, safe and comfortable cycling routes, shared-bike options and short-distance sustainable mobility. The solution supports the D1.1 objective of promoting active modes of travel and contributes to multimodal access by connecting cycling and bike-sharing with everyday urban trips, public transport and peripheral areas. PIL SOL2: Digital twin / smart-city mobility data integration: aims to improve data-driven mobility planning by using digital and smart-city tools to integrate mobility data, support scenario assessment, improve data sharing across stakeholders and strengthen decision-making across the city and wider functional urban area. The solution supports the D1.1 objectives of better exploiting existing digital assets, improving data sharing, integrating multisectoral data exchange, producing new open-data outputs from the current digital twin and preparing Pilsen for connected and digital mobility infrastructure. PIL SOL3: Public transport and first-/last-mile access improvement: aims to improve access to public transport by strengthening connections between homes, employment areas, services, public-transport stops and interchange points through better links with walking, cycling, bike-sharing and accessible stop or station infrastructure. The solution supports the D1.1 objectives of enhancing and extending multimodal transport, including peripheral areas of the city, promoting active modes of travel, complementing the existing transport offer with more flexible access options and improving mobility for suburban families, older or less mobile residents, budget-sensitive users, industrial-zone shift commuters and regional commuters.

3.3.2.3 Derived Significance Weights per Pillar KPI, Persona

Following the persona–pillar weighting methodology, the Pilsen Mentimeter results were used to derive significance weights for each SOMI pillar and persona. The Pilsen calculation follows the seven-persona structure used in the Pilsen use case, namely: city / urban resident, occasional car user; budget-sensitive student; industrial-zone shift commuter; suburban family; older / less mobile resident; leisure and culture visitor; and regional commuter family. This ensures that the numerical SOMI weighting layer captures both everyday urban mobility profiles and broader commuter, household and regional access needs.

Since the Mentimeter exercise responses (Appendix I) were collected anonymously, individual scores are not attributed to named participants. However, the appended Mentimeter evidence verifies the scoring task, the scale used, the persona-specific SOMI pillar questions, the displayed mean values and the number of responses visible for each scoring slide.

Table 38: Mentimeter mean scores by persona and SOMI pillar.

Pilsen persona	Accept.	Access.	Afford.	Agen.	Avail.	Legal Reco.	Partic.	Safety & Sec.
City/urban resident, occasional car user	3.0	4.6	4.0	2.8	3.4	2.6	3.8	4.4
Budget-sensitive student	2.7	4.7	4.5	3.3	3.7	2.0	3.0	3.8
Industrial-zone shift commuter	3.5	4.5	4.5	3.0	4.7	1.8	2.8	2.5
Suburban family	4.8	4.8	4.6	4.2	4.6	2.0	3.8	5.0
Older / less mobile resident	3.4	4.9	3.4	2.6	4.1	2.9	3.6	4.6
Leisure and culture visitor	3.4	3.7	3.6	3.0	4.6	1.4	1.6	4.4
Regional commuter family	3.4	4.1	4.0	2.8	4.1	1.0	2.5	2.9

Table 39: Persona–pillar significance weights after rescaling and normalisation.

Persona	Accept.	Access.	Afford.	Agen.	Avail.	Legal Reco.	Partic.	Safety & Sec.
City/urban resident,	0.097	0.175	0.146	0.087	0.117	0.078	0.136	0.165

occasional car user								
Budget-sensitive student	0.086	0.188	0.178	0.117	0.137	0.051	0.102	0.142
Industrial-zone shift commuter	0.130	0.181	0.181	0.104	0.192	0.041	0.093	0.078
Suburban family	0.147	0.147	0.140	0.124	0.140	0.039	0.109	0.155
Older / less mobile resident	0.112	0.181	0.112	0.074	0.144	0.088	0.121	0.167
Leisure and culture visitor	0.136	0.153	0.147	0.113	0.203	0.023	0.034	0.192
Regional commuter family	0.138	0.164	0.160	0.114	0.166	0.040	0.101	0.116

Table 40: Highest weighted SOMI pillars by Pilsen persona

Persona	Highest weighted SOMI pillars
City / urban resident, occasional car user	Accessibility (0.175), Safety & Security (0.165), Affordability (0.146)
Budget-sensitive student	Accessibility (0.188), Affordability (0.178), Safety & Security (0.142)
Industrial-zone shift commuter	Availability (0.192), Accessibility (0.181), Affordability (0.181)
Suburban family	Safety & Security (0.155), Acceptability (0.147), Accessibility (0.147)
Older / less mobile resident	Accessibility (0.181), Safety & Security (0.167), Availability (0.144)
Leisure and culture visitor	Availability (0.203), Safety & Security (0.192), Accessibility (0.153)
Regional commuter family	Availability (0.166), Accessibility (0.164), Affordability (0.160)

The highest weighted SOMI pillars show that the Pilsen personas have distinct mobility priorities, even though Accessibility, Availability, Affordability and Safety & Security appear repeatedly across the persona profiles. For the city / urban resident, occasional car user, Accessibility is the most important pillar, followed by Safety & Security and Affordability. This indicates that this persona is mainly concerned with whether daily destinations can be reached easily, safely and at reasonable cost. The occasional car-use characteristic suggests that this persona may be open to alternatives to car travel, but only if those alternatives are accessible, safe and practically affordable.

For the budget-sensitive student, Accessibility and Affordability are the two dominant pillars, followed by Safety & Security. This is consistent with the student profile, because students depend on affordable and accessible mobility for education, social activities, services and everyday trips. The high Affordability weight confirms that cost is a key constraint for this persona, while the high Accessibility weight shows that the availability of affordable transport alone is not sufficient unless it also provides practical access to relevant destinations.

For the industrial-zone shift commuter, Availability is the highest weighted pillar, while Accessibility and Affordability have equal second-highest importance. This is a coherent result because shift commuters depend heavily on mobility services being available at the right times and in the right locations, including outside standard peak-hour periods. Accessibility is also important because industrial zones are often located outside the city centre, and Affordability matters because commuting is a repeated cost. This profile indicates that solutions targeting this persona should focus on reliable service availability, corridor access and cost-effective commuting options.

For the suburban family, Safety & Security is the most important SOMI pillar, followed by Acceptability and Accessibility, which have equal weights. This reflects the multidimensional character of family mobility. Suburban families are concerned with safe travel conditions for all household members, but they also need mobility solutions that are acceptable in daily family routines and provide access to schools, work, services, leisure activities and public transport connections. The balance between these pillars indicates that family mobility depends on more than one factor and that successful interventions should combine safety, access and practical social acceptability.

For the older / less mobile resident, Accessibility is the highest weighted pillar, followed by Safety & Security and Availability. This is methodologically and socially coherent because older and less mobile residents are strongly affected by whether mobility options are physically accessible, safe to use and actually available. For this persona, mobility improvements must not only increase the number of options but must also ensure that those options can be used safely and comfortably by people with reduced mobility or higher vulnerability in public space.

For the leisure and culture visitor, Availability is the highest weighted pillar, followed by Safety & Security and Accessibility. This reflects the needs of visitors who depend on available, legible and safe mobility options to access cultural, leisure and tourism destinations. Visitors may be less familiar with the local mobility system, so the availability of services and the safety and accessibility of routes become particularly important. This profile is relevant for solutions connected to public transport, first-/last-mile access, wayfinding, cycling routes and visitor-friendly mobility information.

For the regional commuter family, Availability, Accessibility and Affordability are the three highest weighted pillars, with very close values. This confirms that the regional commuter family combines household-based mobility needs with regional commuting constraints. The persona depends on services being available across the wider urban and regional area, on accessible connections between peripheral settlements and the city, and on affordable options for repeated commuting and family trips. The closeness of the three weights indicates that these dimensions should be treated together rather than separately when assessing solutions for this persona.

Overall, the results show that the Pilsen weighting structure is strongly oriented toward practical mobility performance. Accessibility is central for residents, students, older / less mobile users and regional commuter families. Availability is especially important for shift commuters, leisure and culture visitors and regional commuter families. Affordability is particularly important for students, industrial-zone shift commuters and regional commuter families. Safety & Security is especially important for suburban families, older / less mobile residents, leisure and culture visitors and city / urban residents. These differences confirm the usefulness of the persona-based SOMI approach, because the same mobility solution may perform differently depending on the user group considered. The table therefore provides an important interpretation layer for the subsequent persona-level SOMI estimates.

3.3.2.4 Persona Significance for Solution Implementation

For Pilsen, the ICB implementation-influence weighting exercise covered three operational solution tabs: SOL7 – cycling and bike-share uptake, SOL8 – public transport and first-/last-mile integration, and SOL9 – connected corridors and smart traffic management readiness. In the Pilsen use-case narrative, these correspond respectively to PIL SOL1 – cycling infrastructure and bike-share uptake, PIL SOL3 – public transport and first-/last-mile access improvement, and PIL SOL2 – digital twin / smart-city mobility data integration. More specifically, PIL SOL1 corresponds to SOL7, PIL SOL2 corresponds to SOL9, and PIL SOL3 corresponds to SOL8. This mapping is retained to ensure consistency between the report solution codes and the ICB workbook solution tabs.

The ICB weights are interpreted as solution-specific implementation-influence weights. They express the extent to which each persona is expected to influence the successful implementation of a specific Pilsen solution through acceptance or opposition, behavioural uptake, operational relevance, political salience, legitimacy of concerns and potential implementation risk. They are not population shares, vulnerability weights, benefit shares or general stakeholder-importance scores.

The Pilsen implementation-influence weighting uses seven personas: city / urban resident, occasional car user; budget-sensitive student; industrial-zone shift commuter; suburban family; older / less mobile resident; leisure and culture visitor; and regional commuter family. This structure enables the Pilsen use case to capture both individual everyday mobility needs and more complex household, regional and commuter-oriented mobility patterns.

Table 41: Persona significance weights for Pilsen.

Persona ID	Persona	SOL1 – Cycling infrastructure and bike-share uptake	SOL2 – Digital twin / smart-city mobility data integration	SOL3 – Public transport and first-/last-mile access improvement
P-P1	City / urban resident, occasional car user	0.236	0.202	0.158
P-P2	Budget-sensitive student	0.341	0.125	0.203
P-P3	Industrial-zone shift commuter	0.122	0.293	0.137
P-P4	Suburban family	0.072	0.099	0.142
P-P5	Older / less mobile resident	0.051	0.102	0.124
P-P6	Leisure and culture visitor	0.106	0.079	0.095

P-P7	Regional commuter family	0.072	0.099	0.142

The results show that implementation influence varies substantially by solution. For PIL SOL1 / SOL7, cycling infrastructure and bike-share uptake, the highest implementation weight is assigned to the budget-sensitive student, with a final weight of 0.341. This is consistent with the expected uptake logic of bike-share and cycling-support measures, where affordability, flexibility, short-distance access and everyday urban travel behaviour are central. The city / urban resident, occasional car user also receives a relatively high weight of 0.236, indicating that cycling and bike-share measures may influence occasional car users if they provide a practical alternative for short urban trips.

For PIL SOL2 / SOL9, digital twin / smart-city mobility data integration, the highest weight is assigned to the industrial-zone shift commuter, with a final weight of 0.293. This distribution is coherent with the implementation logic of connected corridors and smart traffic management readiness. The solution is particularly relevant to users affected by commuting reliability, corridor performance, peripheral employment access, travel-time predictability and time-sensitive trips. The city / urban resident, occasional car user also receives a meaningful weight of 0.202, while the budget-sensitive student, older / less mobile resident, suburban family and regional commuter family remain relevant but less dominant.

For PIL SOL3 / SOL8, public transport and first-/last-mile access improvement, the highest weight is assigned to the budget-sensitive student, with a final weight of 0.203. This result is consistent with the solution's focus on improving the usability, affordability and practical accessibility of public transport and the quality of access to and from stops, stations and interchanges. The city / urban resident, occasional car user follows with a weight of 0.158, while the suburban family and regional commuter family both receive weights of 0.142. This shows that household trip chaining, regional commuting and first-/last-mile connectivity remain important, but they do not dominate the weighting structure.

Across the three Pilsen solutions, the results confirm that no single persona dominates all interventions. The budget-sensitive student is most influential for cycling and bike-share uptake and for public transport / first-/last-mile access improvement, while the industrial-zone shift commuter is most influential for digital twin / smart-city mobility data integration. This confirms the methodological need for solution-specific persona weights rather than a single citywide persona hierarchy. It also supports the persona-sensitive logic of SOMI, because different solutions generate different implementation pathways and affect different user groups in different ways.

The regional commuter family plays an important cross-cutting role in the seven-persona Pilsen structure. It is not the highest-weighted persona in any of the three solutions, but it receives meaningful weights especially for public transport / first-/last-mile access improvement. Including this persona separately improves the interpretability of the Pilsen SOMI results and ensures that regional household commuting needs are represented explicitly.

Table 42: Highest-weighted personas for Pilsen

Solution	Persona ID	Most significant persona	Final weight
PIL SOL1 – Cycling infrastructure and bike-share uptake	P-P2	Budget-sensitive student	0.341

PIL SOL2 – Digital twin / smart-city mobility data integration	P-P3	Industrial-zone shift commuter	0.293
PIL SOL3 – Public transport and first-/last-mile access improvement	P-P2	Budget-sensitive student	0.203

The highest-weighted persona results show that each Pilsen solution is associated with a distinct implementation-influence profile. For PIL SOL1 – cycling infrastructure and bike-share uptake, the most significant persona is the budget-sensitive student, with a final weight of 0.341. This result is coherent with the nature of cycling and bike-share interventions, because students are typically highly sensitive to affordability, flexible access, short-distance travel options and low-cost alternatives to private car use. The success of this solution therefore depends strongly on whether cycling infrastructure and bike-share services are accessible, affordable, safe and convenient for student users and other cost-sensitive groups.

For PIL SOL2 – digital twin / smart-city mobility data integration, corresponding to the ICB tab SOL9 – connected corridors and smart traffic management readiness, the most significant persona is the industrial-zone shift commuter, with a final weight of 0.293. This reflects the relevance of connected-corridor management, traffic prediction and digital mobility integration for users whose daily travel depends on reliable corridor performance and predictable journey times. Industrial-zone shift commuters are particularly affected by peripheral employment locations, time-sensitive trips and non-standard working hours. Their high implementation weight indicates that this solution is strongly linked to improving travel reliability and operational predictability for commuter flows connected to industrial and employment areas.

For PIL SOL3 – public transport and first-/last-mile access improvement, corresponding to the ICB tab SOL8 – public transport and first-/last-mile integration, the most significant persona is the budget-sensitive student, with a final weight of 0.203. This is consistent with the solution's focus on improving the usability, affordability and practical accessibility of public transport and the quality of access to and from stops, stations and interchanges. Budget-sensitive students are strongly affected because public transport integration and first-/last-mile improvements directly influence affordability, accessibility and everyday mobility independence. The city / urban resident, occasional car user follows with a weight of 0.158, while the suburban family and the regional commuter family both receive weights of 0.142. This shows that household trip chaining, regional commuting and first-/last-mile connectivity remain important, but they do not dominate the weighting structure.

Overall, the results confirm that the Pilsen implementation-influence structure is solution-sensitive. The budget-sensitive student is the most influential persona for both cycling and bike-share uptake and public transport / first-/last-mile access improvement, while the industrial-zone shift commuter is the most influential persona for digital twin / smart-city mobility data integration. This confirms that a single citywide persona hierarchy would not adequately represent the Pilsen use case. Instead, each solution requires its own persona-influence weighting, because different interventions depend on different user groups, behavioural responses, operational constraints and implementation pathways.

3.3.2.4.1 Estimated City SOMI per Persona and Solution

The persona-level SOMI values were calculated by combining the normalised KPI performance of each solution with the persona-specific SOMI pillar weights. For each persona and solution, the eight normalised pillar scores were multiplied by the corresponding persona–pillar weights and then summed.

The result is a persona-level SOMI value between 0 and 1, where higher values indicate stronger performance from the perspective of that persona.

Table 43: Persona-level SOMI estimates

Persona	SOL1: Cycling and bike-share uptake	SOL2: Digital Twin / smart corridor readiness	SOL3: PT and first-/last-mile integration
City / urban resident, occasional car user	0.423	1.000	0.764
Budget-sensitive student	0.392	1.000	0.744
Industrial-zone shift commuter	0.443	1.000	0.733
Suburban family	0.423	1.000	0.747
Older / less mobile resident	0.445	1.000	0.788
Leisure and culture visitor	0.384	1.000	0.737
Regional commuter family	0.433	1.000	0.740

The solution-level SOMI results show that PIL SOL2 – digital twin / smart-city mobility data integration has the highest performance, with a value of 1.000. This reflects the fact that the selected KPI values reach the documented upper-performance references across all SOMI pillars. The Digital Twin solution is therefore strongly positioned within the current pilot-evidence framework, particularly as a data-driven planning, scenario-testing and decision-support intervention.

PIL SOL3 – public transport and first-/last-mile access improvement achieves a solution-level SOMI of 0.749. This indicates strong but not complete performance. The solution performs well in Accessibility, Agency, Availability, Legal Recognition, Participation and Safety & Security, but its overall score is moderated by the current acceptability level and the affordability structure of the monthly public-transport pass. The result confirms that public transport and first-/last-mile integration is a strong Pilsen solution, especially for suburban families, older / less mobile residents and regional commuter families.

PIL SOL1 – cycling infrastructure and bike-share uptake records a solution-level SOMI of 0.414. This lower score is mainly driven by the current baseline conditions for dedicated bicycle lanes, affordability and traffic accidents. At the same time, the solution performs strongly in Availability, Legal Recognition and Participation, indicating that Pilsen already has an important institutional and service base for cycling and bike-share development. The SOMI result therefore highlights where further improvement would have the greatest effect: expanding dedicated cycling infrastructure, improving effective affordability for users and reducing safety risks.

3.3.2.4.2 Estimated SOMI per solution

The solution-level SOMI values were calculated by aggregating the persona-level SOMI scores using the solution-specific persona implementation-influence weights. This means that each solution-level result reflects both the normalised KPI performance of the solution and the relative implementation influence of the personas most relevant to that solution.

Table 44: Solution-level SOMI estimates

Persona	Aggregation method	Solution-level SOMI
SOL1: Cycling and bike-share uptake	Persona-level SOMI weighted by solution-specific persona implementation weights	0.413
SOL2: Digital Twin / smart corridor readiness	Persona-level SOMI weighted by solution-specific persona implementation weights	1.000
SOL3: PT and first-/last-mile integration	Persona-level SOMI weighted by solution-specific persona implementation weights	0.751

The solution-level SOMI results show that PIL SOL2 – digital twin / smart-city mobility data integration has the highest performance, with a value of 1.000. This reflects the fact that the selected KPI values reach the documented upper-performance references across all SOMI pillars. The Digital Twin solution is therefore strongly positioned within the current pilot-evidence framework, particularly as a data-driven planning, scenario-testing and decision-support intervention.

PIL SOL3 – public transport and first-/last-mile access improvement achieves a solution-level SOMI of 0.751. This indicates strong but not complete performance. The solution performs well in Accessibility, Agency, Availability, Legal Recognition, Participation and Safety & Security, but its overall score is moderated by the current acceptability level and the affordability structure of the monthly public-transport pass. The result confirms that public transport and first-/last-mile integration is a strong Pilsen solution, especially for suburban families, older / less mobile residents and regional commuter families.

PIL SOL1 – cycling infrastructure and bike-share uptake records a solution-level SOMI of 0.413. This lower score is mainly driven by the current baseline conditions for dedicated bicycle lanes, affordability and traffic accidents. At the same time, the solution performs strongly in Availability, Legal Recognition and Participation, indicating that Pilsen already has an important institutional and service base for cycling and bike-share development. The SOMI result therefore highlights where further improvement would have the greatest effect: expanding dedicated cycling infrastructure, improving effective affordability for users and reducing safety risks.

3.3.2.4.3 Estimated City SOMI

To obtain the Pilsen city-level SOMI, the three assessed solution-level SOMI values were aggregated using equal solution weights. Equal weighting is used because the three Pilsen solutions are treated as parallel assessed interventions within the same use case and no alternative strategic, budgetary, territorial-impact or stakeholder-defined solution weighting is introduced at this stage.

The estimated Pilsen city-level SOMI is 0.721. This value represents the combined social-optimum mobility performance of the three Pilsen solutions assessed in the use case. The city-level score is strongly supported by the high performance of the Digital Twin / smart-city mobility data integration solution and the strong performance of public transport and first-/last-mile access improvement. The cycling and bike-share solution contributes positively, but its current score is more moderate because several KPIs remain close to their lower-performance references.

The city-level result shows the usefulness of the SOMI structure as a diagnostic tool. It does not only provide a single aggregate score, but also identifies where performance is already strong and where future improvement could produce the greatest gains. In Pilsen, the strongest current contribution comes from digital and smart-city mobility data integration, followed by public transport and first-/last-mile access improvement. The cycling and bike-share solution has a solid foundation in participation, availability and legal recognition, but its future SOMI performance would increase if dedicated cycling infrastructure expands, bike-share affordability improves and safety outcomes improve. Hence, the Pilsen SOMI result provides a basis for comparing the three selected solutions and for identifying which pillars and personas should be prioritised in future monitoring and policy refinement.

3.3.3 Antwerp Use Case

Antwerp is the largest city in Flanders, Belgium, and one of the country's main urban and economic centres. It is a historic city known for fashion, art, architecture, gastronomy and its long-established role in the diamond trade (Visit Antwerp, 2024; Encyclopaedia Britannica, 2024). Antwerp is also a major European port city. The Port of Antwerp-Bruges is one of Europe's largest seaports and plays a central role in shipping, logistics, petrochemicals and wider port-related industrial activity (Port of Antwerp-Bruges, 2024).

Antwerp is a crucial urban node in the Trans-European Transport Network. Under the revised TEN-T framework, urban nodes are expected to support the integration of long-distance, regional and urban transport and to contribute to multimodal, sustainable mobility planning (European Parliament and Council, 2024). Antwerp is strategically located on the European core network and is connected to major European transport corridors, including the Rhine-Alpine corridor and the North Sea–Rhine–Mediterranean / North Sea corridor framework, depending on the TEN-T corridor classification used (European Commission, 2024a; European Commission, 2024b).

The wider Antwerp functional urban and transport area has a population of around 1.1 million inhabitants, while more than half a million people live in the municipality of Antwerp itself (Statbel, 2024; Vlaamse Overheid, 2024). The city and its surrounding region have experienced sustained population growth over the past decade, increasing pressure on transport networks, urban accessibility and public-space management (Statbel, 2024).

The City of Antwerp has been at the forefront of multimodal journey planning and smart mobility scale-up through the **Smart Ways to Antwerp** initiative. Smart Ways to Antwerp was launched in 2016 to help maintain accessibility in and around the city during major infrastructure works in the Antwerp area. Its scope subsequently expanded beyond temporary traffic management to become part of Antwerp's wider sustainable urban mobility strategy, supporting modal shift, multimodal travel information and cooperation between public and private mobility actors (Smart Ways to Antwerp, 2024; City of Antwerp, 2024).

Rather than relying only on small, isolated MaaS pilots, Antwerp has positioned itself as a living lab for scalable mobility services. The city invites mobility-service providers to deploy solutions in real urban conditions and periodically uses open calls to support projects that can help reduce congestion and improve sustainable accessibility. This approach allows potentially viable mobility concepts to be tested at a larger operational scale and encourages cooperation between the municipality, public-transport actors, private providers and regional authorities (Smart Ways to Antwerp, 2024; POLIS Network, 2020).

As Antwerp is part of a wider Flemish transport region, there is further potential to improve integration between public transport, shared mobility, demand-responsive transport and digital journey-planning services across the functional urban area. For this reason, Antwerp aims to upscale its digital mobility tools beyond the municipal Limitary and towards the broader Antwerp transport region, supporting more coordinated multimodal mobility management at metropolitan scale (Vlaamse Overheid, 2024; Smart Ways to Antwerp, 2024).

3.3.3.1 Selected Personas

Employing the proposed methodology of D1.1, summarised in Subsection 3.2.4, resulted in the following operational persona set and solution for the Antwerp SOMI assessment. The selected solution is aligned with the D1.1 Antwerp operational assessment objectives, namely: reducing car dependency, improving the adoption, functionality and coverage of Smart Ways to Antwerp, strengthening multimodal alternatives, supporting metropolitan-scale planning and data sharing, improving communication with target audiences, and supporting more inclusive mobility-policy making for diverse user groups.

Table 45: Selected Personas and Solutions in Antwerp

Selected personas	Solutions
1. City-centre resident, occasional car user **2. Port worker, car-dependent** **3. Sub-urban commuter** **4. Cost-conscious/Multimodal Student** **5. Young urban family** **6. Older resident and resident with reduced mobility** **7. Visitor**	**SOL4:** Multimodal journey planner / Smart Ways scale-up: aims to improve the adoption, functionality and territorial coverage of the Smart Ways to Antwerp digital mobility ecosystem. The solution supports users in comparing and combining walking, cycling, public transport, shared mobility, park-and-ride, car and other mobility options through an integrated multimodal journey-planning environment. It is intended to reduce dependence on private motorised travel, strengthen multimodal alternatives, improve access to real-time and user-relevant mobility information, and support the extension of Smart Ways to Antwerp from a city-focused tool toward a broader metropolitan / Functional Urban Area mobility-planning instrument.

The Antwerp assessment focuses on SOL4, Smart Ways to Antwerp scale-up. The selected personas reflect the main user groups for which the solution can influence route choice, multimodal accessibility, information quality, perceived usability and inclusion. The same solution may therefore create different SOMI outcomes depending on each persona's mobility constraints, digital capability, affordability sensitivity, accessibility needs and dependence on reliable multimodal guidance.

3.3.3.2 Baseline KPI Values and Acceptable Upper and Lower Limits per Mobility Solution

The Antwerp KPI set follows the same SOMI structure used for Pilsen: one KPI is selected for each SOMI pillar and then normalised using lower and upper limits. The Antwerp solution concerns the upgrade of the Smart Ways to Antwerp intermodal / multimodal journey planner. In SPINE, this measure is identified as ANT_MS3, the multimodal journey planner app, which builds on the Smart Ways to Antwerp route planner and mobility map. SPINE D2.3 explains that Smart Ways to Antwerp has developed a multimodal route planner and a mobility map with practical information for travellers, including routing combinations, mobility-map layers, shared-vehicle locations, parking zones, low-emission-zone information and public-transport stops. The route planner and mobility map are being redesigned and integrated in a more user-friendly way within the Antwerp SPINE Living Lab.

For Acceptability, the selected KPI is the number of registered users of the multimodal journey-planner app. The observed value is 48,740 registered users. Registered users are used as an uptake and adoption indicator for a user-facing digital mobility platform. SPINE D2.3 Annex A, indicator IND58, defines the metric as the number of users of the multimodal journey-planner app, assigns it to ANTW_MS3 and reports a 2022 baseline value of 48.740 users, interpreted as 48,740 users in European thousands notation. The same indicator reports a target of 56,051 users, which is retained below as the upper-performance reference (SPINE, 2024, Annex A).

For Accessibility, the selected KPI is the presence of a dedicated accessibility map in the route planner / mobility map. The observed value is 1. This binary KPI records whether accessibility-oriented information is already incorporated in the platform. SPINE D2.3 documents a dedicated accessibility map with additional information on parking, public-transport stops and toilets, and also shows detailed information for accessible toilets. The value is therefore coded as 1 because the function is documented as present (SPINE, 2024, Figures 17–18).

For Affordability, the selected KPI is the city-funded development model for the website, route planner and app. The observed value is 1. This is a platform-affordability proxy, because the available evidence does not provide a direct end-user price, subscription fee or household transport-cost indicator for using the route planner. SPINE D2.3 states that the full development cost of the website, route planner and app is covered by the City of Antwerp. The value is therefore coded as 1 because development costs are publicly covered rather than directly transferred to users through a paid-access model (SPINE, 2024).

For Agency, the selected KPI is the number of distinct transport mode / service categories explicitly represented in the route planner. The observed value is 10 categories. This KPI is used as an Agency indicator because it captures the breadth of practical travel choices presented to users. The Smart Ways to Antwerp / POLIS presentation lists the following mode and service families: on foot; bicycle, e-bike and foldable bike; shared bike; bus and tram; train; car and taxi; boat; shared scooter; shared moped; and shared car. Counting these explicitly listed categories gives 10 categories. The official Smart Ways to Antwerp route-planner page also supports this interpretation by describing the platform as covering more than 10 different transport modes (Penne, 2023; Smart Ways to Antwerp, 2025).

For Availability, the selected KPI is the coverage of mobility providers integrated in the multimodal app. The observed value is 90% shared-provider coverage, with 11 shared mobility providers and 100% public-transport-operator coverage. Availability is measured through provider integration because a digital journey planner is operationally useful only if real mobility providers and services are represented. SPINE D2.3 Annex A, indicator IND56, reports 11 shared mobility providers, corresponding to 90% shared-provider coverage, and 100% public-transport-operator coverage. The same indicator defines the target as 100% of mobility providers active in Antwerp for more than six months (SPINE, 2024, Annex A).

For Legal Recognition, the selected KPI is formal institutional recognition of the route planner as an Antwerp SPINE Living Lab measure. The observed value is 1. This binary KPI records whether the solution is formally embedded in a recognised implementation and monitoring framework. SPINE D2.3 explicitly identifies ANT_MS3 as the Antwerp multimodal journey-planner app and assigns monitoring indicators to this measure in Annex A, including IND56, IND57 and IND58. The value is therefore coded as 1 because the route planner is formally recognised as a monitored SPINE Living Lab measure (SPINE, 2024, Section 4.3 and Annex A).

For Participation, the selected KPI is the number of target-group validation workshops conducted for WCAG / inclusive route-planner development. The observed value is 5 workshops. This KPI captures direct target-group involvement in testing and validating the inclusiveness of the web interface. SPINE D2.3 reports five workshops with target groups under the WCAG check and validation activity and states that analyses were made to ensure WCAG compliance of the web interface. The value is therefore directly reported rather than estimated (SPINE, 2024, Section 4.3.3).

For Safety & Security, the selected KPI is whether road-safety support is explicitly included in multimodal turn-by-turn app navigation. The observed value is 1. This binary KPI is used as a conservative safety/security proxy because the available evidence documents the presence of road-safety support, but not a quantified crash-reduction effect attributable to the route planner. The Smart Ways to Antwerp / POLIS presentation identifies multimodal turn-by-turn navigation and lists support for every transfer, including alerts, popups, real-time information, platform information and road safety. The value is therefore coded as 1 because road-safety support is explicitly documented (Penne, 2023).

Table 46: Multimodal journey planner solution KPI Values

SOMI Pillar	Selected KPI	Unit + direction	Value
Acceptability	Registered users of the multimodal journey-planner app	users; higher is better	48,740 users
Accessibility	Dedicated accessibility map incorporated in the route planner / mobility map	coded 0-1; higher is better	1
Affordability	City-funded development model for the website, route planner and app	coded 0-1; higher is better	1
Agency	Distinct transport mode / service categories explicitly represented in the route planner	count; higher is better	10 categories
Availability	Mobility providers integrated in the multimodal app	% provider coverage; higher is better	90% shared-provider coverage; 100% PTO coverage
Legal Recognition	Formal institutional recognition of the route planner as an Antwerp SPINE Living Lab measure	coded 0-1; higher is better	1
Participation	Target-group validation workshops conducted for WCAG / inclusive route-planner development	workshops; higher is better	5 workshops
Safety & Security	Road-safety support explicitly included in multimodal turn-by-turn app navigation	coded 0-1; higher is better	1

The Antwerp KPI limits follow a source-based min-max normalisation logic. For higher-is-better KPIs, the lower-performance reference represents the weakest documented or theoretical condition and the upper-performance reference represents the best documented, target or full-presence condition. Where formal SPINE targets are available, they are used as upper-performance references. Where no quantified target is available, the limit is defined from the documented measurement scale or from the observed presence of the relevant function.

For Acceptability, the lower-performance reference is set at 0 registered users, representing no documented uptake of the multimodal journey-planner app. The upper-performance reference is set at 56,051 registered users, corresponding to the formal target reported for SPINE Annex A indicator IND58. The observed value of 48,740 users is therefore assessed against the source-reported SPINE target.

For Accessibility, the lower-performance reference is set at 0, meaning that no dedicated accessibility-map function is documented. The upper-performance reference is set at 1, meaning that the accessibility-map function is documented as present. This binary 0-1 scale is appropriate because the selected KPI measures the presence of a dedicated accessibility map in the route planner / mobility map, not the future maturity or quality of accessibility routing. SPINE D2.3 documents the accessibility map and detailed information for accessible toilets, so the observed value is 1.

For Affordability, the lower-performance reference is set at 0, representing the absence of a documented public funding model for the route planner, website and app. The upper-performance reference is set at 1, representing the condition documented in SPINE D2.3, where the City of Antwerp covers the full development cost of the website, route planner and app. This is a conservative affordability proxy as it does not measure the user cost of public transport or shared mobility, but it confirms that the digital platform itself is publicly funded and does not depend on charging end users for access.

For Agency, the lower-performance reference is set at 0 transport mode / service categories, representing no documented travel choices in the route planner. The upper-performance reference is set at 10 documented categories, corresponding to the transport mode and service families explicitly identified in the Smart Ways to Antwerp / POLIS route-planner evidence: walking; bicycle, e-bike and foldable bike; shared bike; bus and tram; train; car and taxi; boat; shared scooter; shared moped; and shared car. The 0-10 scale avoids introducing an arbitrary upper value such as 15 categories unless additional evidence is added.

For Availability, the lower-performance reference is set at 0% provider coverage, representing no documented integration of mobility providers in the multimodal app. The upper-performance reference is set at 100% provider coverage, which is directly supported by the SPINE Annex A target for IND56: 100% of mobility providers active in Antwerp for more than six months. The observed Antwerp value is 90% shared-provider coverage, based on 11 shared mobility providers, with 100% public-transport-operator coverage. For normalisation, the percentage coverage component is used because it is directly comparable against the 100% target.

For Legal Recognition, the lower-performance reference is set at 0, representing no formal embedding of the route planner in a recognised project, municipal or implementation framework. The upper-performance reference is set at 1, representing formal institutional recognition of the route planner as a monitored Antwerp SPINE Living Lab measure. This binary scale is appropriate because the source confirms the presence of formal recognition: ANT_MS3 is explicitly identified as the multimodal journey-planner app and is linked to monitoring indicators in SPINE Annex A. Stronger forms of long-term institutionalisation, such as permanent procurement or regulatory obligations, would require a different KPI or an additional source.

For Participation, the lower-performance reference is set at 0 workshops, representing no documented target-group validation for inclusive route-planner development. The upper-performance reference is set at 5 workshops, corresponding to the five target-group validation workshops reported in SPINE D2.3 under the WCAG check and validation activity. This keeps the normalisation reference aligned with the documented implementation evidence. A broader reference such as 10 workshop-equivalent activities could be used only as a methodological maturity benchmark if the assessment explicitly aims to go beyond the documented SPINE activity.

For Safety & Security, the lower-performance reference is set at 0, representing no documented road-safety support in multimodal turn-by-turn app navigation. The upper-performance reference is set at 1, representing the documented presence of road-safety support. This is a conservative safety/security proxy because the evidence confirms a safety-related platform function but does not quantify accident reduction, perceived safety improvement or risk reduction attributable to the app. The KPI should therefore be interpreted as a documented safety-support capability, not as an observed safety outcome.

Table 47: KPI upper and lower limits of the Multimodal journey planner

SOMI Pillar	Selected KPI	Lower Limit	Upper Limit
Acceptability	Registered users of the multimodal journey-planner app	0 registered users	56,051 registered users
Accessibility	Dedicated accessibility map incorporated in the route planner / mobility map	0 - no documented accessibility-map function	1 - accessibility-map function documented
Affordability	City-funded development model for the website, route planner and app	0 - no documented public funding model	1 - full development cost covered by City of Antwerp
Agency	Distinct transport mode / service categories explicitly represented in the route planner	0 categories	10 documented categories
Availability	Mobility providers integrated in the multimodal app	0% provider coverage	100% provider coverage
Legal Recognition	Formal institutional recognition of the route planner as an Antwerp SPINE Living Lab measure	0 - not formally recognised as monitored measure	1 - formally recognised as ANT_MS3 SPINE measure
Participation	Target-group validation workshops conducted for WCAG / inclusive route-planner development	0 workshops	5 workshops
Safety & Security	Road-safety support explicitly included in multimodal turn-by-turn app navigation	0 - no documented road-safety support	1 - road-safety support documented

3.3.3.3 Significance Weights per Pillar KPI, Persona

The Antwerp Mentimeter evidence covers seven operational personas: city-centre resident / occasional car user, port worker / car-dependent user, sub-urban commuter, cost-conscious / multimodal student, young urban family, older resident and resident with reduced mobility, and visitor. These personas are used for the persona–pillar significance-weighting calculation because they are the personas for which Mentimeter scoring evidence is available. The Antwerp SOMI assessment focuses on SOL4: Multimodal journey planner / Smart Ways to Antwerp scale-up. Therefore, the persona–pillar weighting layer is used to calculate persona-level SOMI values for SOL4.

Since the Mentimeter exercise responses (Appendix III) were collected anonymously, individual scores are not attributed to named participants. However, the appended Mentimeter evidence verifies the scoring task, the scale used, the persona-specific SOMI pillar questions, the displayed mean values and the number of responses visible for each scoring slide.

Table 48: Mentimeter mean scores by persona and SOMI pillar

Persona	Accept.	Access.	Afford.	Agen.	Avail.	Legal Reco.	Partic.	Safety & Sec.
City-centre resident, occasional car user	3.8	4.5	4.3	3.6	4.1	2.6	2.9	4.3
Port worker, car-dependent	3.8	4.5	4.3	3.4	4.7	3.2	2.6	4.2
Sub-urban commuter	3.4	4.2	4.2	3.2	4.8	2.4	2.0	4.8
Cost-conscious/Multimodal Student	3.3	4.0	4.9	3.4	4.3	1.7	1.9	4.7
Young urban family	4.1	4.9	3.7	3.9	4.7	2.0	2.1	4.9
Older resident and resident with reduced mobility	4.0	5.0	3.7	3.7	4.0	2.6	2.5	4.7
Visitor	3.3	4.2	3.3	2.4	5.0	1.0	1.0	5.0

Table 49: Derived Antwerp persona–pillar significance weights

Persona	Accept.	Access.	Afford.	Agen.	Avail.	Legal Reco.	Partic.	Safety & Sec.
City-centre resident, occasional car user	0.127	0.158	0.149	0.118	0.140	0.072	0.086	0.149
Port worker, car-dependent	0.123	0.154	0.145	0.106	0.163	0.097	0.070	0.141
Sub-urban commuter	0.114	0.152	0.152	0.105	0.181	0.067	0.048	0.181
Cost-conscious/Multimodal Student	0.114	0.149	0.193	0.119	0.163	0.035	0.045	0.183
Young urban family	0.139	0.175	0.121	0.130	0.166	0.045	0.049	0.175

Older resident and resident with reduced mobility	0.135	0.180	0.122	0.122	0.135	0.072	0.068	0.167
Visitor	0.133	0.169	0.132	0.097	0.204	0.039	0.026	0.201

Table 50: Highest weighted SOMI pillars by Antwerp persona

PERSONA	HIGHEST WEIGHTED SOMI PILLARS
City-centre resident, occasional car user	Accessibility (0.158), Affordability (0.149), Safety & Security (0.149)
Port worker, car-dependent	Availability (0.163), Accessibility (0.154), Affordability (0.145)
Sub-urban commuter	Availability (0.181), Safety & Security (0.181), Accessibility / Affordability (0.152)
Cost-conscious/Multimodal Student	Affordability (0.193), Safety & Security (0.183), Availability (0.163)
Young urban family	Accessibility (0.175), Safety & Security (0.175), Availability (0.166)
Older resident and resident with reduced mobility	Accessibility (0.180), Safety & Security (0.167), Acceptability / Availability (0.135)
Visitor	Availability (0.204), Safety & Security (0.201), Accessibility (0.169)

The persona–pillar weighting results show that the Antwerp SOMI assessment is strongly shaped by practical access, service availability, affordability and safety. For the city-centre resident, occasional car user, Accessibility is the highest-weighted pillar, followed by Affordability and Safety & Security. This indicates that the Smart Ways to Antwerp scale-up is especially relevant if it helps residents compare practical alternatives to car use, identify accessible routes and reduce uncertainty around travel cost and safety.

For the port worker, car-dependent persona, Availability receives the highest weight, followed by Accessibility and Affordability. This is consistent with the mobility constraints of port and industrial workers, who often depend on reliable travel options across dispersed employment locations and may face limited alternatives to the car. For this persona, a multimodal journey planner is valuable when it makes real mobility options visible, available and usable in relation to work schedules and employment geography.

For the sub-urban commuter, Availability and Safety & Security are jointly the highest-weighted pillars, followed by Accessibility and Affordability. This profile reflects the importance of reliable metropolitan-scale mobility options, safe transfers and clear route information for commuters travelling between

Antwerp and surrounding areas. The weighting structure also shows that cost and access remain relevant, but that the availability of realistic options and safe multimodal journeys are central.

For the cost-conscious / multimodal student, Affordability is the dominant pillar, followed by Safety & Security and Availability. This is coherent with the student profile, because students are generally more sensitive to travel costs and depend on affordable multimodal options for education, social activities and daily access. The high Safety & Security weight also shows that cost-effective mobility must remain safe and reliable to be considered socially optimal.

For the young urban family, Accessibility and Safety & Security are jointly the highest-weighted pillars, followed by Availability. This reflects the household-based nature of family mobility, where users need safe and accessible routes for children, school trips, services, leisure and everyday errands. The Smart Ways to Antwerp scale-up can support this persona when it provides clear, family-relevant, safe and multimodal route options.

For the older resident and resident with reduced mobility, Accessibility is the highest-weighted pillar, followed by Safety & Security. Acceptability and Availability form the next most important layer. This profile is highly relevant to an inclusive journey-planning tool, because older residents and people with reduced mobility need accessible routes, safe transfers, reliable information and practical confidence that a proposed journey can actually be completed.

For the visitor persona, Availability and Safety & Security are the dominant pillars, followed by Accessibility. This reflects the needs of visitors who may be unfamiliar with Antwerp's mobility system and therefore depend on clear information about available services, safe navigation and accessible connections to cultural, commercial and tourism destinations. Overall, the persona–pillar weights confirm that Smart Ways to Antwerp is not only a route-planning tool, but also a mechanism for improving users' ability to understand, compare and use multimodal mobility options across the city and wider functional urban area.

3.3.3.4 Personas Significance for Solution Implementation

For Antwerp, the implementation-influence weighting is applied to SOL4: MaaS / Smart Ways to Antwerp scale-up. This solution focuses on improving the adoption, functionality and territorial coverage of the Smart Ways to Antwerp digital mobility ecosystem. The implementation-persona set used for SOL4 is aligned with the seven operational personas used in the Antwerp SOMI calculation: city-centre resident, occasional car user; port worker, car-dependent; sub-urban commuter; cost-conscious / multimodal student; young urban family; older resident and resident with reduced mobility; and visitor.

The ICB weights are interpreted as solution-specific implementation-influence weights. They express the extent to which each persona is expected to influence the successful implementation and uptake of Smart Ways to Antwerp through acceptance, behavioural response, operational relevance, legitimacy of concerns, political salience and implementation risk. They are not population shares, vulnerability weights, benefit shares or general stakeholder-importance scores.

Table 51: Full persona significance weights for Antwerp.

Persona ID	Persona	SOL4 – MaaS / Smart Ways to Antwerp scale-up
A-P1	City-centre resident, occasional car user	0.132
A-P2	Port worker, car-dependent	0.067

A-P3	Sub-urban commuter	0.199
A-P4	Cost-conscious/Multimodal Student	0.152
A-P5	Young urban family	0.141
A-P6	Older resident and resident with reduced mobility	0.155
A-P7	Visitor	0.155

The implementation-influence weights show that the sub-urban commuter is the most significant persona for SOL4, with a final weight of 0.199. This is coherent with the Smart Ways to Antwerp scale-up logic, because the solution is strongly linked to metropolitan travel, multimodal commuting and the reduction of car dependency for trips between Antwerp and its surrounding areas. Sub-urban commuters are highly relevant because they are likely to benefit from better information on public transport, cycling, shared mobility, park-and-ride, parking and multimodal combinations.

The older resident and resident with reduced mobility and the visitor persona both receive meaningful weights of 0.155. This indicates that the inclusive and informational dimensions of the journey planner are also important for implementation. Older users and people with reduced mobility depend on accessible route information, reliable transfer details and confidence in the usability of proposed mobility options. Visitors depend on legible, safe and available mobility information because they are less familiar with the local system. Their relatively high weights therefore reflect the importance of accessibility, usability and trust in the platform.

The cost-conscious / multimodal student also receives a high weight of 0.152, reflecting the importance of affordability, flexibility and multimodal choice for younger and cost-sensitive users. The young urban family receives a weight of 0.141, indicating that Smart Ways to Antwerp is also relevant for household mobility, school-related trips, service access and family trip-chaining. The city-centre resident, occasional car user receives a weight of 0.132, showing that the platform is relevant for reducing occasional car dependency by making alternatives more visible and easier to compare. The port worker, car-dependent persona receives a lower weight of 0.067, not because this group is irrelevant, but because the specific SOL4 journey-planner scale-up is less directly able to overcome the structural constraints of port-related employment locations and shift patterns without complementary service improvements.

Table 52: Highest-weighted personas for Antwerp.

Solution	Persona ID	Most significant persona	Final weight
SOL4 – MaaS / Smart Ways to Antwerp scale-up	A-P3	Sub-urban commuter	0.199

The highest-weighted persona for SOL4 is the sub-urban commuter. This result confirms that Smart Ways to Antwerp scale-up is especially relevant as a metropolitan and Functional Urban Area mobility tool. The sub-urban commuter represents users who travel across municipal municipal boundaries, compare several possible mobility combinations and may shift away from private car use if reliable, practical and well-integrated alternatives are visible. The result also supports the strategic logic of extending Smart Ways to Antwerp beyond a city-focused route planner toward a broader mobility-planning instrument for the Antwerp transport region.

3.3.3.5 Estimated SOMI per Persona

The Antwerp persona-level SOMI values were calculated by combining the normalised KPI performance of SOL4 with the persona-specific SOMI pillar weights. For each persona, the eight normalised pillar scores were multiplied by the corresponding persona–pillar weights and then summed. The result is a persona-level SOMI value between 0 and 1, where higher values indicate stronger performance from the perspective of that persona.

The normalised SOL4 KPI scores used in the calculation are: 0.870 for Acceptability, based on 48,740 registered users against the 56,051-user target; 1.000 for Accessibility, based on the documented accessibility map; 1.000 for Affordability, based on the city-funded development model; 1.000 for Agency, based on the 10 documented mode / service categories; 0.900 for Availability, based on 90% provider coverage; 1.000 for Legal Recognition; 1.000 for Participation; and 1.000 for Safety & Security.

Table 53: Persona-level SOMI estimates for Antwerp

Persona	SOL4: Multimodal journey planner / Smart Ways to Antwerp scale-up
City-centre resident, occasional car user	0.968
Port worker, car-dependent	0.967
Sub-urban commuter	0.967
Cost-conscious/Multimodal Student	0.970
Young urban family	0.965
Older resident and resident with reduced mobility	0.970
Visitor	0.963

The persona-level SOMI estimates show that SOL4 performs strongly for all Antwerp personas, with values ranging from 0.963 for the visitor to 0.970 for the cost-conscious / multimodal student and the older resident and resident with reduced mobility. The high values are explained by the strong KPI profile of the Smart Ways to Antwerp scale-up: most KPIs reach their upper-performance reference, including Accessibility, Affordability, Agency, Legal Recognition, Participation and Safety & Security. The two dimensions that remain below full performance are Acceptability, where the current number of registered users remains below the SPINE target, and Availability, where shared-provider coverage is 90% against a 100% reference.

The cost-conscious / multimodal student receives one of the highest persona-level SOMI scores because this persona gives strong weight to Affordability, Safety & Security and Availability. Since SOL4 performs very strongly on these pillars, the resulting SOMI value is high. The older resident and resident with reduced mobility also receives a high score because Accessibility and Safety & Security are heavily weighted for this persona, and the route planner includes a documented accessibility-map function and road-safety support.

The visitor receives the lowest, although still very strong, persona-level SOMI score. This is because the visitor persona gives the highest weight to Availability and Safety & Security, and Availability is one of the two SOL4 KPI dimensions that does not yet reach full performance. This indicates that extending provider coverage toward the full 100% target would be especially relevant for visitor-oriented mobility. Similarly, improving registered user uptake would increase the SOL4 SOMI score across all personas, especially those that attach greater importance to Acceptability.

Overall, the results show that the multimodal journey planner / Smart Ways to Antwerp scale-up performs as a mature and broadly beneficial digital mobility solution within the current SOMI framework. Its strongest contribution lies in making multimodal travel options more visible, accessible, understandable and usable across user groups. The remaining performance gap is mainly linked to further uptake and complete provider integration rather than to the absence of core platform functions.

3.3.3.6 Estimated City SOMI

The solution-level SOMI for Antwerp was calculated by aggregating the persona-level SOMI values using the SOL4 persona implementation-influence weights. Since the Antwerp SOMI assessment includes one assessed solution, SOL4, the solution-level SOMI and the city-level SOMI are the same under the current scope.

The estimated Antwerp city-level SOMI is 0.967. This value represents the social-optimum mobility performance of the assessed Antwerp solution under the current evidence base. The high score reflects the strong maturity of the Smart Ways to Antwerp scale-up across the SOMI pillars. The platform has documented user uptake, an accessibility map, a publicly funded development model, broad mode representation, high provider integration, formal recognition as a monitored SPINE Living Lab measure, target-group validation workshops and documented road-safety support in multimodal navigation.

The result should be interpreted as the SOMI score of the assessed digital mobility solution, not as a complete assessment of the whole Antwerp mobility system. The current Antwerp SOMI calculation focuses on SOL4 only. Therefore, the city-level value reflects the performance of the multimodal journey planner / Smart Ways to Antwerp scale-up, rather than a weighted portfolio of several Antwerp mobility interventions. If additional Antwerp solutions are later assessed with their own KPI values, persona weights and solution-level SOMI scores, the city-level SOMI can be recalculated as a multi-solution aggregate.

The main improvement potential for SOL4 lies in increasing user uptake and completing provider integration. Acceptability is strong but not yet at the SPINE target, while Availability remains at 90% shared-provider coverage against a 100% reference. Improvements in these two dimensions would further strengthen the SOMI score, especially for personas that place high weight on Availability, such as visitors, sub-urban commuters and port workers. Overall, the Antwerp SOMI result indicates that Smart Ways to Antwerp provides a robust digital basis for multimodal mobility support, with particularly strong relevance for metropolitan commuting, inclusive route information and user-facing multimodal decision support.

4 Atlas of Accessibility

The Atlas of Accessibility is used in D1.4 as a spatial baseline and interpretive layer. It maps current walking-based access to key destination categories and supports persona-oriented interpretation. It does not, at this stage, estimate the direct causal effects of the selected pilot-city mobility solutions.

The Atlas of Accessibility is used in D1.4 as a spatial baseline and interpretive layer. It maps current walking-based access to key destination categories and supports persona-oriented interpretation of accessibility conditions across the three pilot cities. It does not, at this stage, estimate the direct causal effects of the selected pilot-city mobility solutions. Instead, it identifies the spatial distribution of accessibility opportunities and gaps that can inform future GO-WISDOM scenarios and support subsequent dynamic updating.

The Atlas should therefore be understood as the spatial companion of SOMI. SOMI answers how selected mobility solutions perform across the eight SOMI Pillars and across relevant personas. The Atlas answers where accessibility conditions are stronger or weaker, and how these spatial patterns may support or constrain different types of users. This is particularly relevant because accessibility is not evenly distributed across urban space. Some areas combine public transport, education, healthcare, parks, daily services and cultural destinations within walking distance, while other areas remain more dependent on motorised travel or on longer first-/last-mile connections.

The Atlas supports three levels of interpretation as presented below.

First, it provides a place-based accessibility diagnosis by showing how many destinations are reachable from each H3 hexagon within 15 minutes of walking. This helps identify areas with strong, moderate or weak local accessibility.

Second, it provides a category-based interpretation. Different destination categories reveal different spatial structures. For example, bus stops may be more widely distributed than cultural attractions, while schools, healthcare facilities, parks and daily needs may follow different neighbourhood patterns. This makes it possible to identify which types of opportunities are spatially concentrated and which are more evenly distributed.

Third, it provides a persona-oriented interpretation. By combining the destination categories that are more relevant for different user profiles, the Atlas translates category-based accessibility into user-oriented accessibility profiles. These profiles do not predict individual behaviour, but they provide an exploratory spatial proxy of how well different areas support the everyday accessibility needs of residents, students, families, older users and visitors.

The Atlas does not model the ex-post impact of each selected mobility solution. Instead, it provides a current accessibility baseline against which the relevance of the pilot-city mobility solutions can be interpreted. For example, mobility-accessibility layers are relevant for Antwerp's multimodal route-planner scale-up, Pilsen's first-/last-mile integration and cycling uptake, and Florence's road-space reallocation, 30 km/h traffic-calming and proximity-logistics measures. The Atlas therefore strengthens the location-dependent dimension of SOMI and supports the identification of spatial inequalities, priority areas and potential intervention needs.

4.1 Methodological approach

4.1.1 Overall workflow

The Atlas is based on a network-based cumulative accessibility approach. The objective is to estimate, for each small spatial unit of analysis, how many destinations of a selected type can be reached within a predefined walking-time threshold. The methodological workflow followed for the Atlas of Accessibility is summarised in Figure 5.

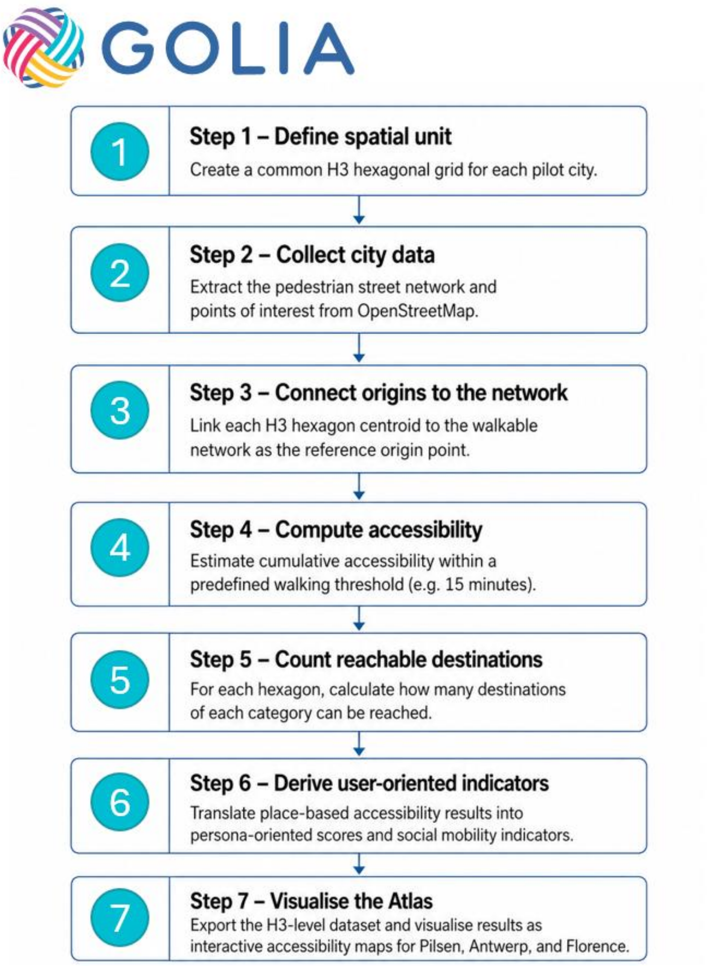

Figure 5: Methodological workflow for developing the Atlas

The workflow starts from the definition of a common spatial unit of analysis for each pilot city. H3 hexagons are used as the common spatial grid, allowing the results to be visualised and compared through a consistent spatial structure. OpenStreetMap data are then used to extract the pedestrian network and points of interest. Each hexagon is connected to the nearest accessible node of the pedestrian network, and each point of interest is also connected to the walking network. Shortest walking times are then calculated between each hexagon and the relevant destinations. The resulting cumulative accessibility values are joined back to the H3 grid and visualised as thematic map layers.

The same workflow is applied consistently across Pilsen, Antwerp and Florence. This allows the Atlas to provide a harmonised spatial diagnosis across the three pilot cities, while still reflecting the different urban structures, land-use patterns and service distributions of each city.

4.1.2 Spatial unit and pedestrian network representation

The spatial unit of analysis is the H3 hexagonal grid. For each city, the study area is divided into H3 hexagons. Each hexagon is represented by its centroid, which acts as the origin point for the accessibility calculation. The pedestrian street network is extracted from OpenStreetMap and represented as a walkable network graph. Each edge of the network is assigned a walking travel time based on its length and the assumed walking speed. The analysis applies the following travel-time logic:

$$\boldsymbol{t_e} = \frac{\boldsymbol{l_e}}{\boldsymbol{V_w}} Eq. (32)$$

where $\boldsymbol{t_e}$ is the walking time on network edge $\boldsymbol{e}$, $\boldsymbol{l_e}$ is the length of edge $\boldsymbol{e}$, and $\boldsymbol{V_w}$ is the assumed walking speed. Accessibility is therefore calculated along the pedestrian network rather than as straight-line distance. This is essential because real walking accessibility depends on street connectivity, pedestrian routes, barriers and network structure, not only on geographic proximity

4.1.3 Points of interest and destination categories

Points of interest are extracted from OpenStreetMap and grouped into destination categories relevant for everyday accessibility, mobility planning and persona-oriented interpretation. The Atlas uses six core destination categories:

1. Culture & tourism;
2. Mobility;
3. Education & childcare;
4. Health & care;
5. Parks & playgrounds;
6. Supermarkets & daily needs.

These categories represent different types of urban opportunities. Health & care, Education & childcare, Parks & playgrounds, and Supermarkets & daily needs represent everyday services and local opportunities. Mobility represents access to public-transport and mobility nodes. Culture & tourism represents visitor-oriented and cultural destinations, which are particularly important in cities with strong tourism, leisure or heritage functions. The classification logic is summarised in the table below.

Table 54: Atlas destination category classification

Atlas category	Destination types included in the interpretation
Culture & tourism	Attractions, museums, monuments, artworks and other visitor-related destinations
Mobility	Bus stops, public-transport stops, stations, mobility access points and similar transport nodes
Education & childcare	Schools, universities, kindergartens, childcare facilities and related education services
Health & care	Pharmacies, doctors, clinics, hospitals and related healthcare services

Parks & playgrounds	Parks, playgrounds, gardens, recreation grounds and similar open-space destinations
Supermarkets & daily needs	Supermarkets, convenience stores, grocery shops and other daily-service destinations

This classification links the raw geospatial data to the Atlas outputs. The Atlas measures the accessibility of mapped destinations. It does not measure destination quality, capacity, affordability, opening hours or user satisfaction.

4.1.4 Cumulative accessibility indicators and map classification

The Atlas applies a cumulative-opportunity accessibility measure. For each H3 hexagon, the indicator counts how many destinations of a selected category are reachable within 15 minutes of walking along the pedestrian network.

The category-based accessibility indicator is:

$$\boldsymbol{A_{h,q}^{15}} = \sum_{\boldsymbol{p \in P_q}} \boldsymbol{I}\left(\boldsymbol{T_{h,p}} \leq \mathbf{15}\right) \quad Eq.(33)$$

Where:

- $A_{h,q}^{15}$ is the number of destinations of type q accessible from hexagon h within walking-time threshold 15,
- $P_{c,q}$ is the set of points of interest of type q in city c,
- and $I(\cdot)$ indicator function equal to 1 when the destination is reachable within 15 minutes and 0 otherwise

In practical terms, if an H3 hexagon has 12 bus stops within a 15-minute walking catchment, its mobility-accessibility count is 12. If it has 3 healthcare facilities within the same walking threshold, its health-and-care accessibility count is 3.

The category-based maps classify the number of reachable destinations as follows.

Table 55: Number of reachable destinations classification

ACCESSIBILITY CLASS	NUMBER OF REACHABLE DESTINATIONS WITHIN 15 MINUTES
LOW	0–5
MEDIUM	5–10
HIGH	10+

This classification provides a clear and comparable interpretation across cities and destination categories. It also aligns with the visual logic of the Atlas maps, where each H3 hexagon is coloured according to the number of reachable destinations in the selected category.

4.1.5 Persona-oriented accessibility scores

The persona-oriented Atlas layer translates category-based accessibility into composite user-oriented profiles. The calculation uses the same H3-level accessibility dataset as the category maps, but combines the destination categories according to their relevance for each persona profile.

First, the raw accessibility count for each destination category is normalised to a 0–1 scale. Since the category maps use 10 or more reachable destinations as the highest class, the normalised category score is calculated as:

$$N_{h,q} = \min(1, \frac{A_{h,q}^{15}}{10}) \quad Eq.(34)$$

where:

- $N_{h,q}$ = normalised accessibility score of hexagon h for destination category q;
- $A_{h,q}^{15}$ = number of destinations of category q reachable within 15 minutes;
- 10 = threshold corresponding to the highest map class.

Second, persona-oriented accessibility is calculated as a weighted sum of the normalised category scores:

$$PAI_{h,r} = \sum_{q \in Q} (\beta_{r,q} \times N_{h,q}) \quad Eq.(35)$$

where:

- $PAI_{h,r}$ = persona-oriented accessibility score for hexagon h and persona profile r;
- $\beta_{r,q}$ = relevance weight of destination category q for persona profile r;
- $N_{h,q}$ = normalised accessibility score for destination category q;
- $\Sigma\beta_{r,q}$ = 1 for each persona profile.

The resulting score ranges from 0 to 1. Higher values indicate that a hexagon provides stronger 15-minute walking access to the combination of destination categories considered relevant for the selected persona profile. For cartographic presentation, the persona-oriented score is classified into five fixed classes.

Table 56: Persona-oriented score classification

Persona score class	Score interval
Very low	0.00–0.20
Low	0.20–0.40
Medium	0.40–0.60
High	0.60–0.80
Very high	0.80–1.00

The persona-oriented scores are analytical accessibility profiles. They are not observed travel behaviour, individual preference models or statistically validated behavioural predictions. They do not measure whether a specific person will walk to a destination. They indicate how well each hexagon performs against a literature-informed combination of destination categories associated with each user profile.

4.2 Category-based Atlas outputs and interpretation

This section presents the category-based Atlas outputs for the three pilot cities. The maps show how many destinations of each selected category are accessible within 15 minutes of walking from each H3 hexagon. The interpretation focuses on the spatial distribution of accessibility, the concentration or dispersion of accessible destinations, and the relevance of these patterns for the GOLIA pilot-city use cases.

The maps are current accessibility baselines. They do not show the direct impact of a future mobility intervention. They provide the spatial context within which the selected solutions are interpreted. Areas with high accessibility already combine multiple nearby opportunities, while areas with low accessibility indicate locations where improved mobility links, better first-/last-mile integration, new local services or complementary public-space interventions are most relevant.

4.2.1 Pilsen

For Pilsen, the Atlas visualises walking accessibility across the city and surrounding area. The maps show an uneven spatial pattern. Higher accessibility values are concentrated in and around the urban core and in selected neighbourhood nodes, while large peripheral and lower-density areas show lower counts. Pilsen therefore presents a node-based accessibility structure: access to destinations is strongest where urban services are clustered and weaker across more dispersed areas.

This spatial pattern is relevant for the Pilsen use cases, which focus on cycling uptake, first-/last-mile integration and digital mobility planning. Mobility-related accessibility, especially access to bus stops and public-transport nodes, helps interpret whether active-mobility and public-transport measures can support wider access beyond the central area. Daily-service categories such as education, healthcare, parks and supermarkets identify where different user groups experience stronger or weaker walking-based access to everyday opportunities.

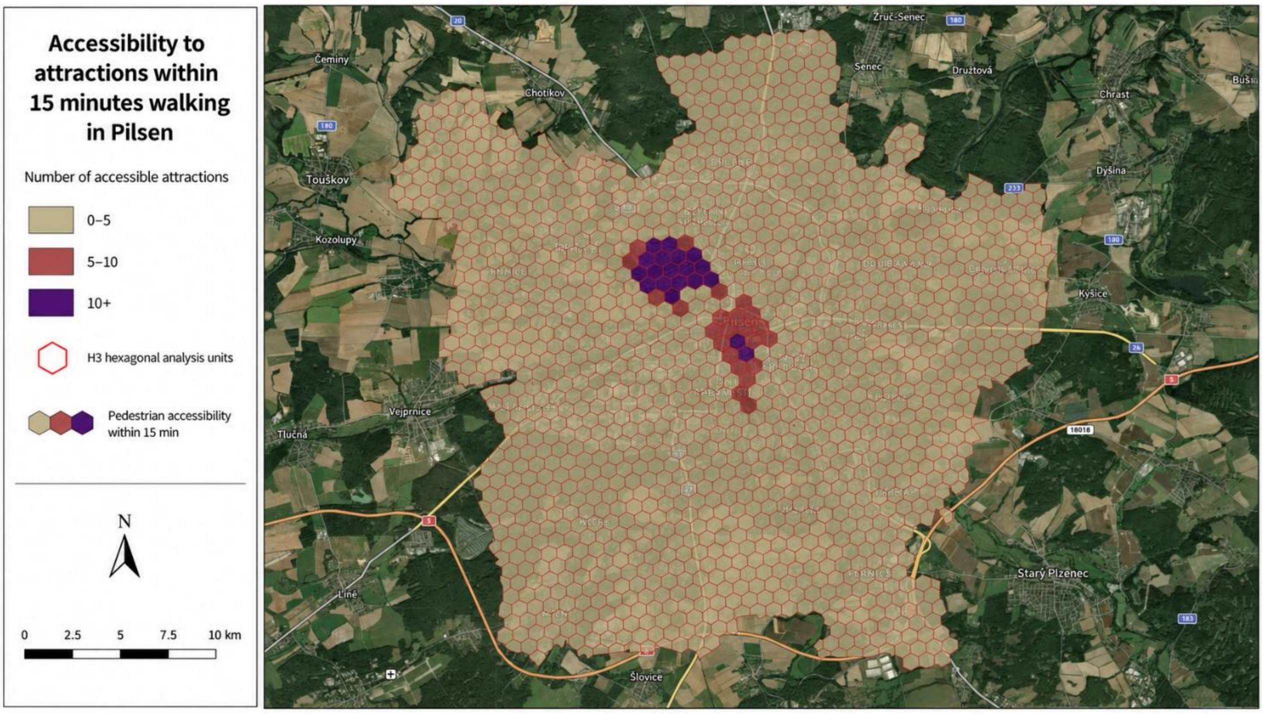

Figure 6: Pilsen - H3-level walking accessibility to Culture & tourism destinations within 15 minutes

The Pilsen Culture & tourism map shows a highly concentrated pattern. High accessibility is mainly located around the central urban area, where visitor-oriented destinations are clustered. Outside this core, most hexagons remain in the lowest class, indicating that attractions and tourism-related destinations are not evenly distributed across the wider study area. Visitor-oriented walking accessibility in Pilsen is therefore strongly anchored to the city centre.

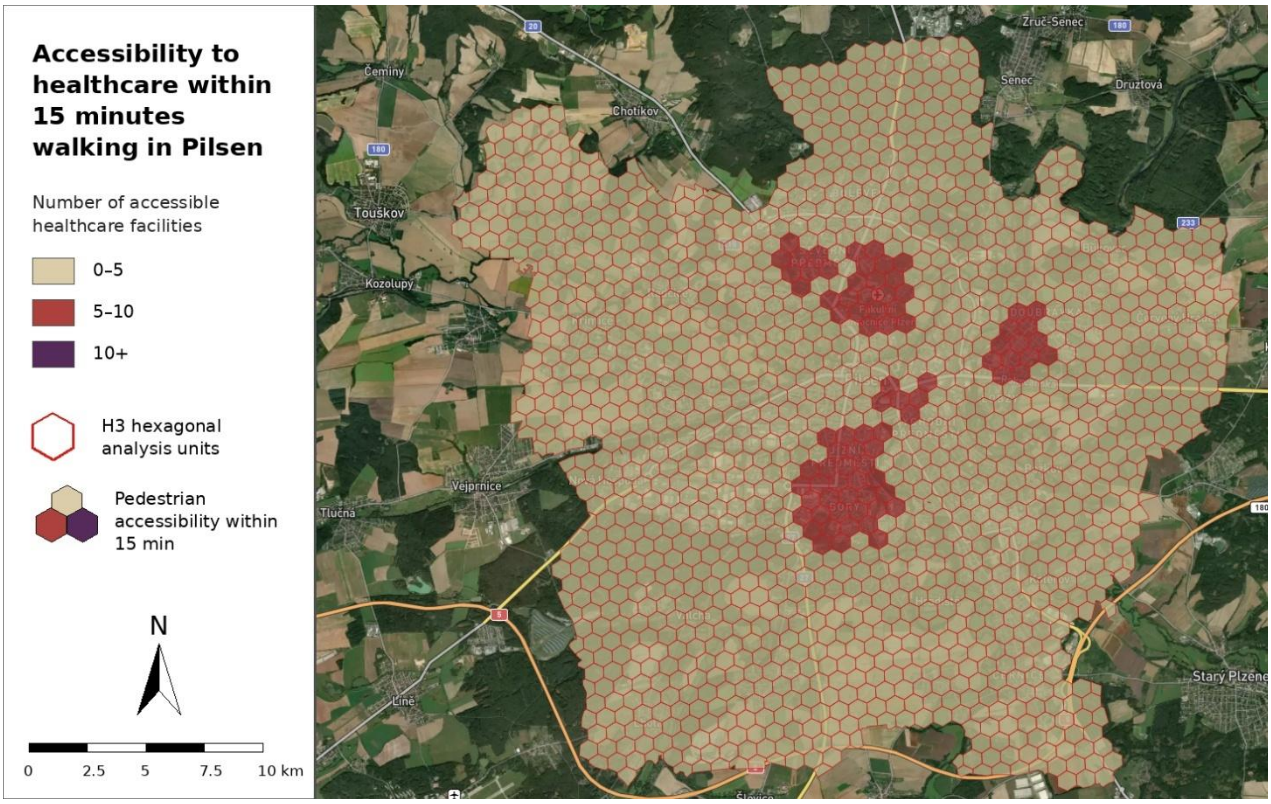

Figure 7: Pilsen - H3-level walking accessibility to Health & care destinations within 15 minutes

The health & care map shows several clusters of medium accessibility, mainly around the central urban area and selected neighbourhoods. Compared with Culture & tourism, healthcare accessibility is less concentrated in a single core, but it remains spatially uneven. Peripheral areas remain mostly in the low class, indicating weaker walking access to healthcare facilities. This is particularly relevant for older or less mobile users, for whom proximity to healthcare and public transport strongly affects independent daily mobility.

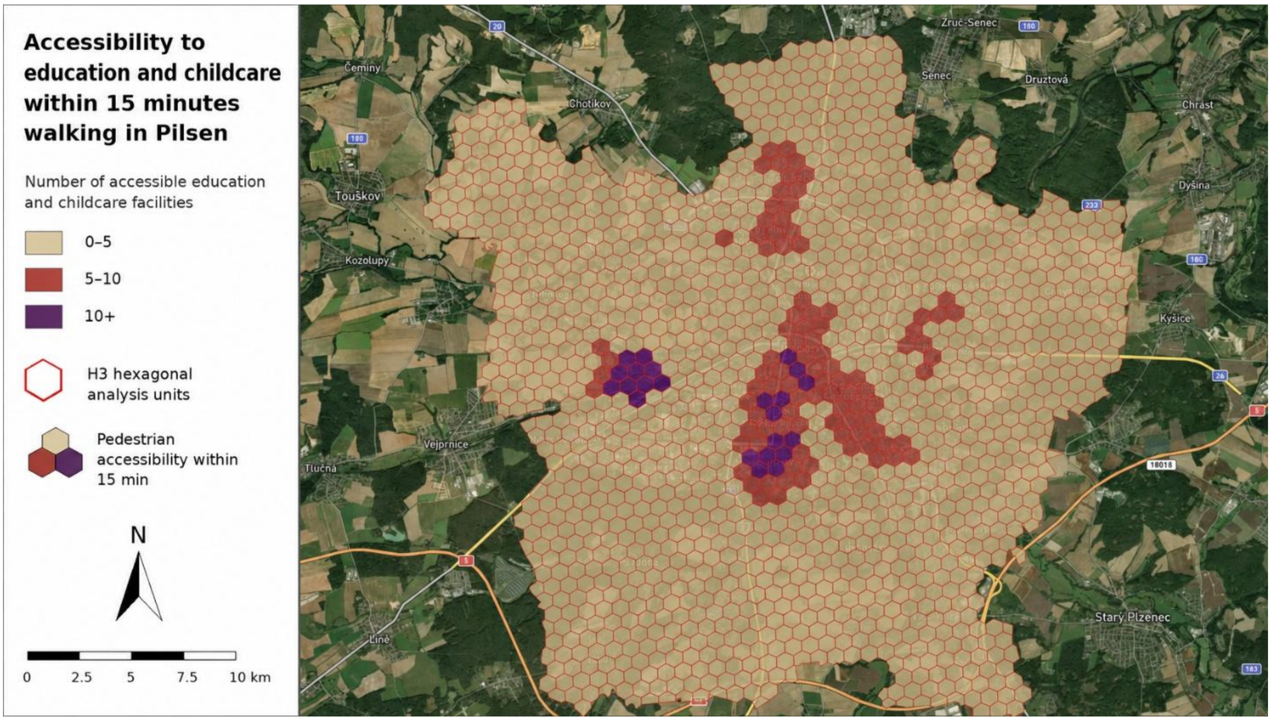

Figure 8: Pilsen - H3-level walking accessibility to education and childcare destinations within 15 minutes

The Education & childcare map shows a more dispersed structure than the Culture & tourism layer. Several clusters of higher accessibility appear in and around residential neighbourhoods, reflecting the distribution of schools, childcare facilities and related education services. The map also shows clear spatial gaps across the wider study area. Family-oriented accessibility is therefore strongest in selected local nodes and weaker in lower-density or peripheral zones where education and childcare facilities are less reachable on foot.

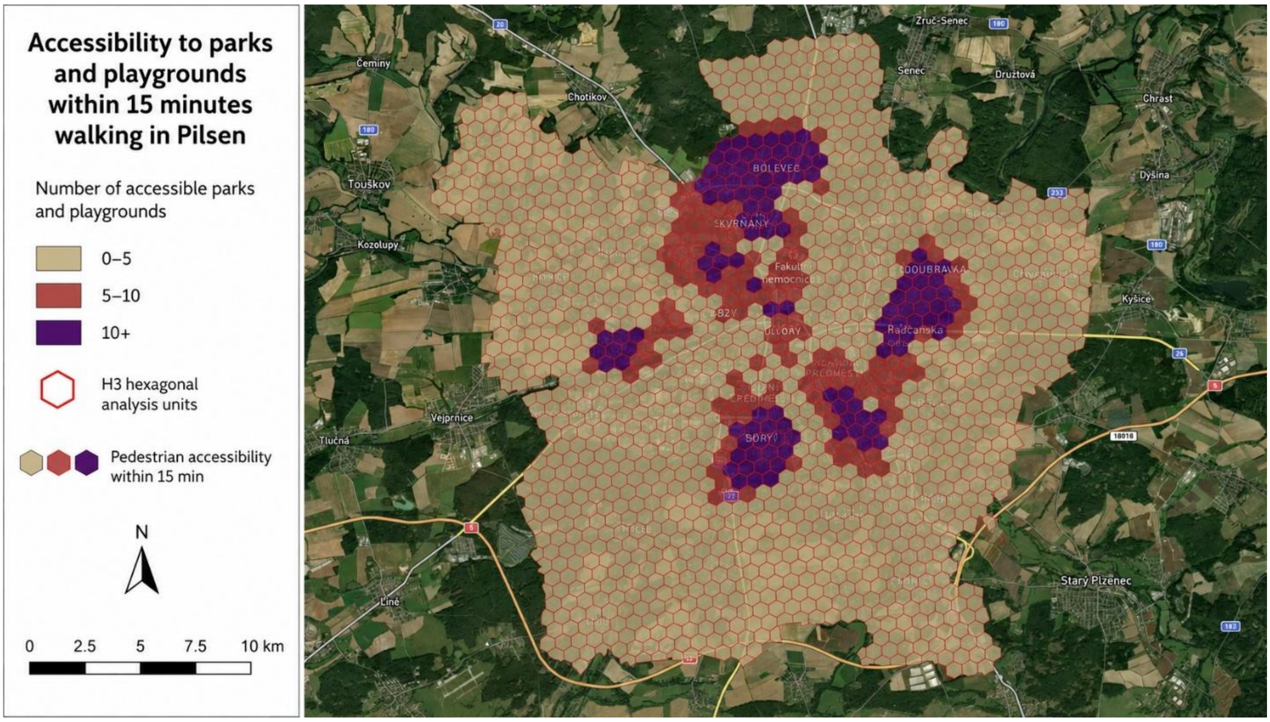

Figure 9: Pilsen - H3-level walking accessibility to parks and playgrounds within 15 minutes

The Parks & playgrounds map shows a more polycentric pattern, with several medium and high accessibility clusters distributed across different parts of the city. Access to green and recreational spaces is not limited to the central area. However, large parts of the outer study area remain in the low class, indicating that recreational accessibility is still uneven. For families, older residents and general residents, this layer is important because parks and playgrounds contribute to everyday liveability, public-space quality and local well-being.

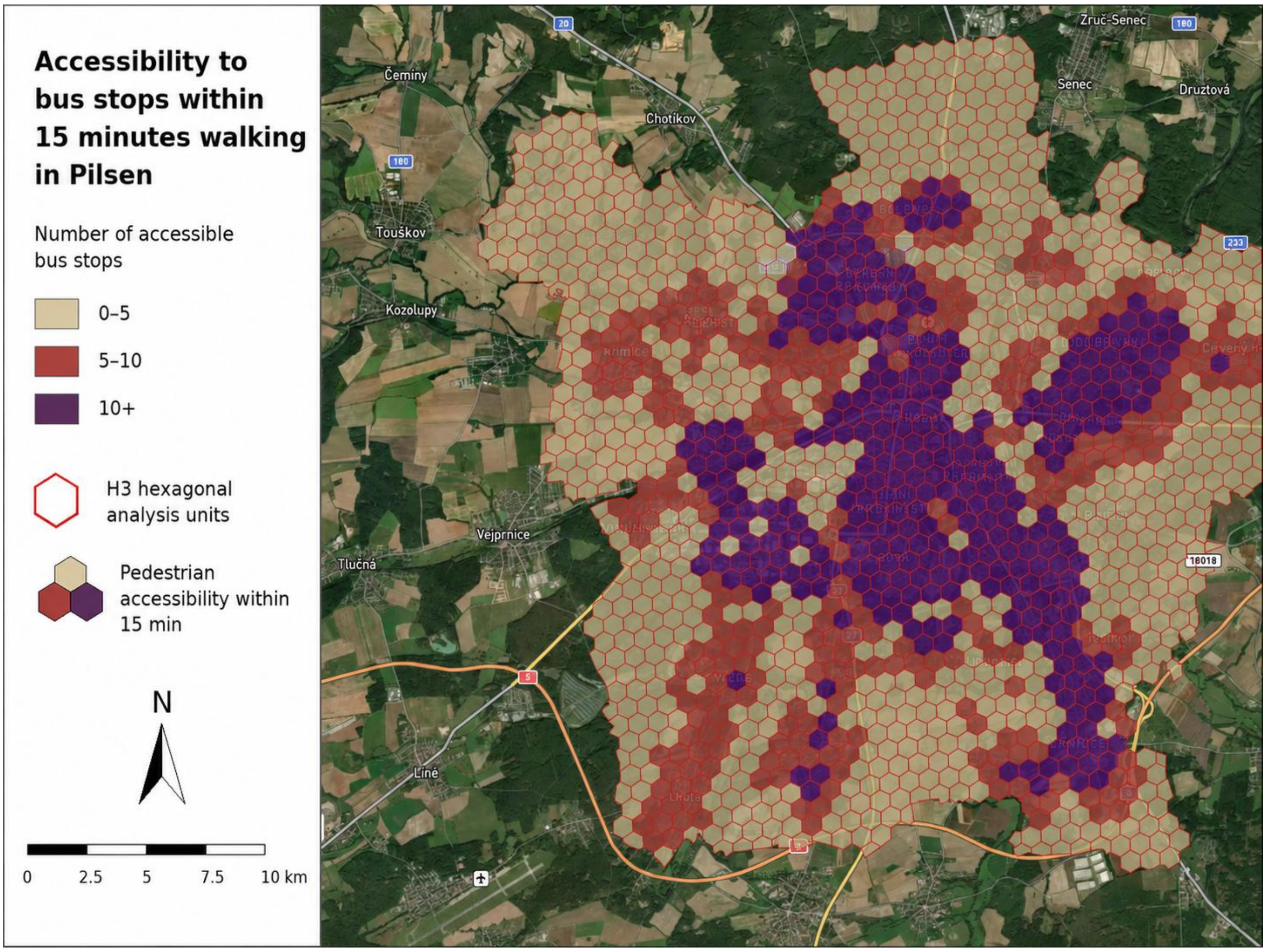

Figure 10: Pilsen - H3-level walking accessibility to Mobility destinations within 15 minutes

The bus-stop accessibility map shows the most extensive accessibility pattern among the Pilsen categories. Large parts of the urban core and several surrounding corridors display medium or high accessibility values, indicating that multiple bus stops can be reached within 15 minutes of walking from many H3 cells. This suggests relatively broad physical access to public-transport stops. However, this indicator measures only the number of reachable stops; it does not capture service frequency, operating hours, reliability, route directness or interchange quality. It should therefore be interpreted as a measure of physical proximity to public-transport access points, rather than as a complete public-transport performance indicator.

Figure 11: Pilsen - H3-level walking accessibility to Supermarkets and daily needs destinations within 15 minutes

The Supermarkets & daily needs map shows clear local clusters, with stronger accessibility in central and selected neighbourhood areas. The pattern is less extensive than the Mobility layer and more dispersed than the Culture & tourism layer. Access to everyday retail and daily services is therefore available in several local nodes, but not evenly across the study area. For residents, families and older users, these gaps are important because daily-needs access is one of the basic conditions for proximity-based everyday mobility.

Overall, the Pilsen Atlas outputs reveal a centrality-periphery gradient. Bus-stop accessibility appears comparatively strong and spatially extensive, while attractions, healthcare and daily needs are more concentrated. Education and childcare, as well as parks and playgrounds, show a more neighbourhood-based distribution, although peripheral gaps remain visible. These maps support the interpretation of accessibility conditions for different user groups, while also highlighting that destination availability differs substantially by category.

4.2.2 Antwerp

For Antwerp, the Atlas shows a broader and more complex accessibility structure. High accessibility values are mainly concentrated in the central and southern urban neighbourhoods, while northern and port-related areas show weaker access for most destination categories. This reflects Antwerp’s mixed metropolitan structure, where dense urban neighbourhoods, port and industrial areas, water barriers and lower-density peripheral zones coexist within the same study area.

The Antwerp maps are relevant for interpreting the scale-up of Smart Ways to Antwerp and the wider multimodal route-planning logic. Digital journey planning and multimodal information tools improve user knowledge, route choice and modal integration, but they operate on top of an uneven geography of physical opportunities. The Atlas distinguishes between areas where information and multimodal routing can unlock existing accessibility potential and areas where the underlying distribution of destinations remains sparse.

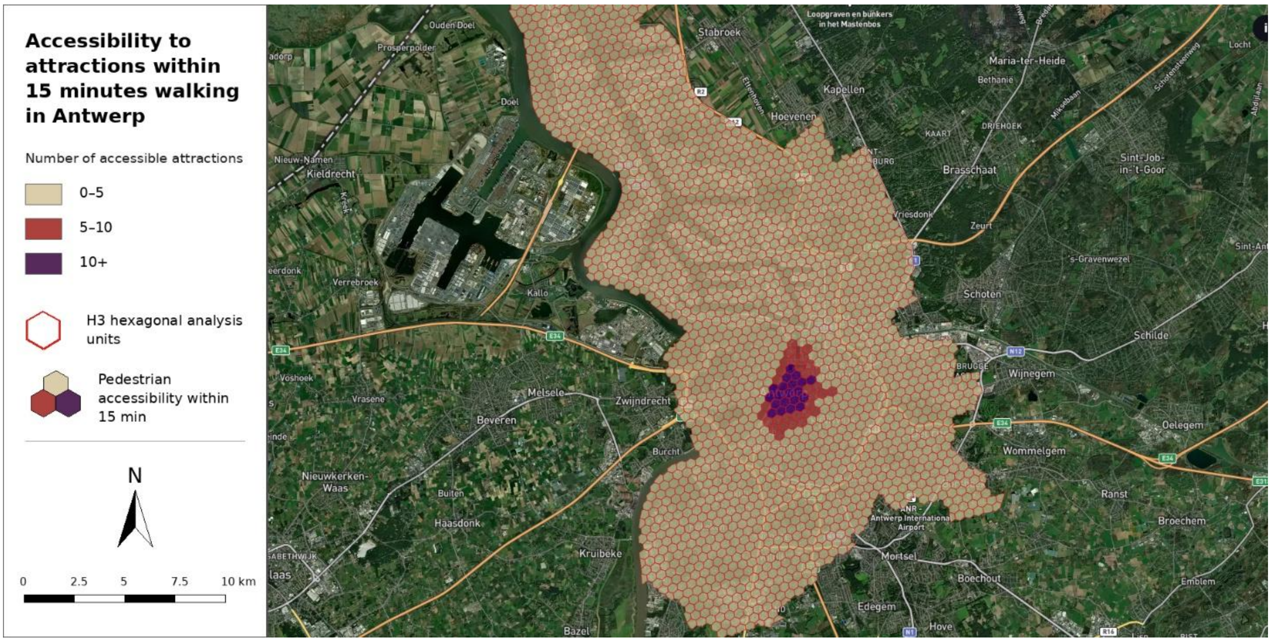

Figure 12: Antwerp - H3-level walking accessibility to Culture & tourism destinations within 15 minutes

The Antwerp Culture & tourism map shows a highly concentrated pattern, with high accessibility focused around the central urban area. Attractions and visitor-oriented destinations are strongly clustered, while the wider study area, including northern and port-related zones, remains mostly in the low accessibility class. The central city is therefore the main cultural and visitor accessibility node.

Figure 13: Antwerp - H3-level walking accessibility to mobility destinations within 15 minutes

The mobility map shows a much wider and more continuous accessibility pattern than the Culture & tourism layer. High access to bus stops and mobility nodes extends across central and southern Antwerp and into several surrounding neighbourhoods. Northern and port-related areas remain less well covered.

This indicates that the public-transport access structure is relatively strong in consolidated urban areas and weaker in industrial or lower-density zones.

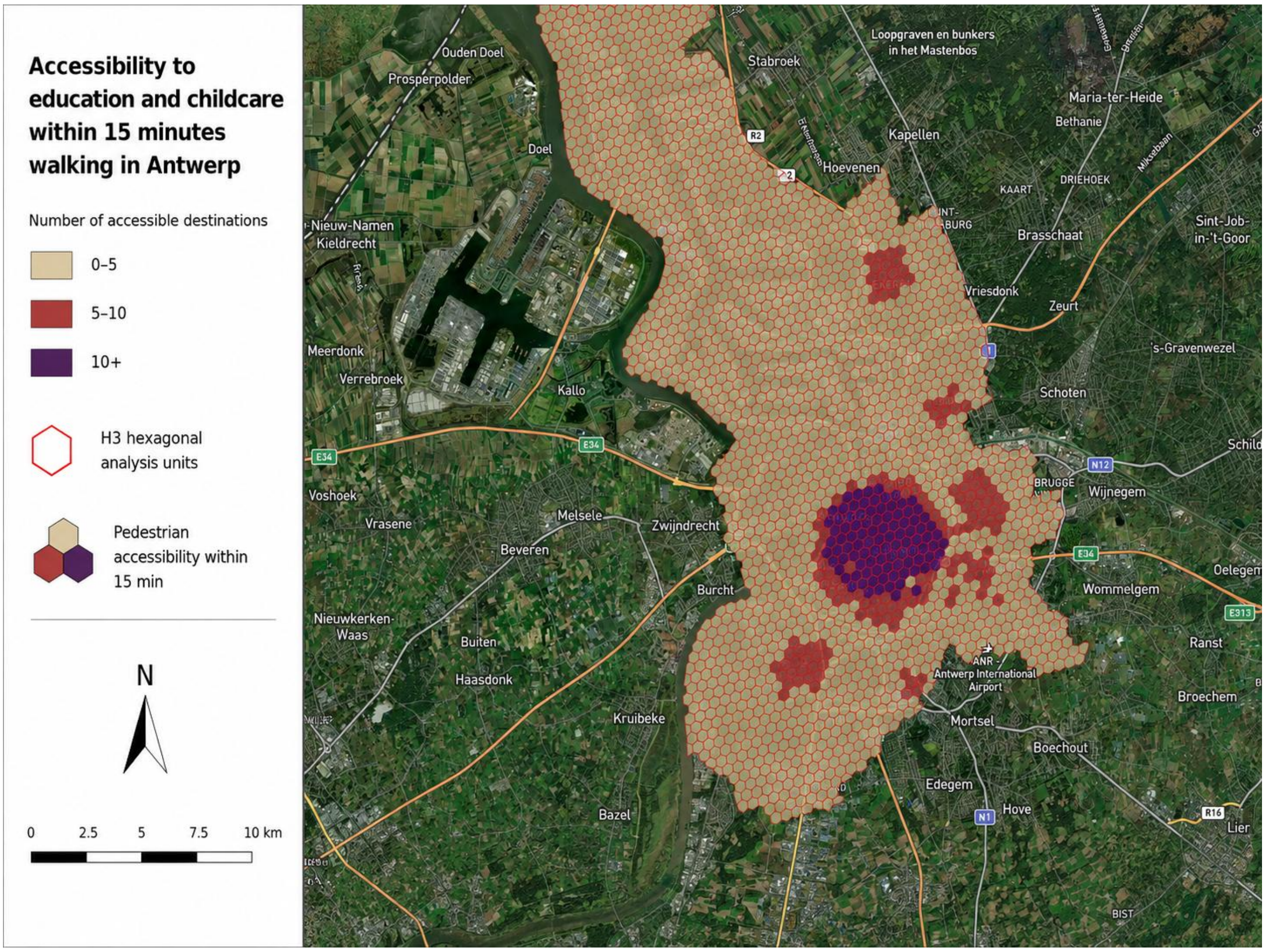

Figure 14: Antwerp - H3-level walking accessibility to education and childcare destinations within 15 minutes

The Education & childcare map shows a strong concentration in central and southern urban neighbourhoods, with additional smaller clusters in selected residential areas. The pattern is less continuous than the Mobility layer but less centralised than Culture & tourism. Education and childcare accessibility is therefore closely linked to residential neighbourhood structure. Peripheral and port-related areas show weaker walking access, indicating spatially uneven family-oriented accessibility across the wider Antwerp area.

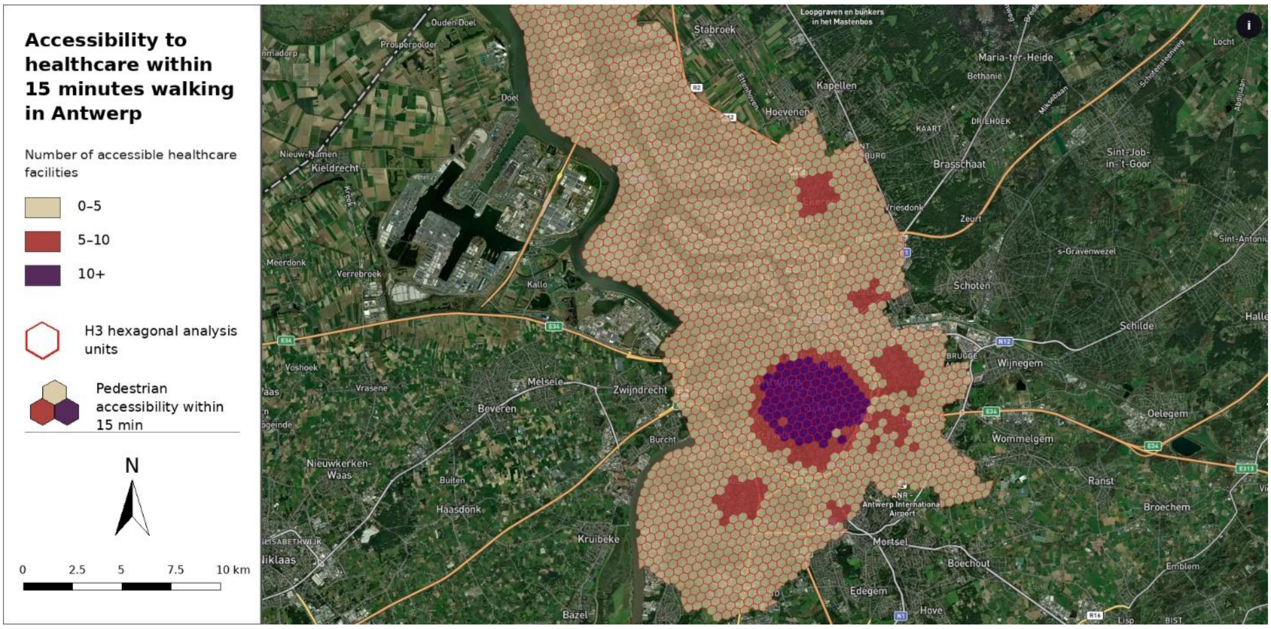

Figure 15: Antwerp - H3-level walking accessibility to healthcare destinations within 15 minutes

The Health & care map shows a pronounced high-accessibility cluster in the central and southern urban area, supported by smaller medium-accessibility pockets elsewhere. Access to healthcare facilities is more concentrated than public-transport access and less evenly distributed across the wider study area. For older users and residents with regular care needs, walkable healthcare access is strongest in consolidated urban neighbourhoods and weaker in peripheral or port-related areas.

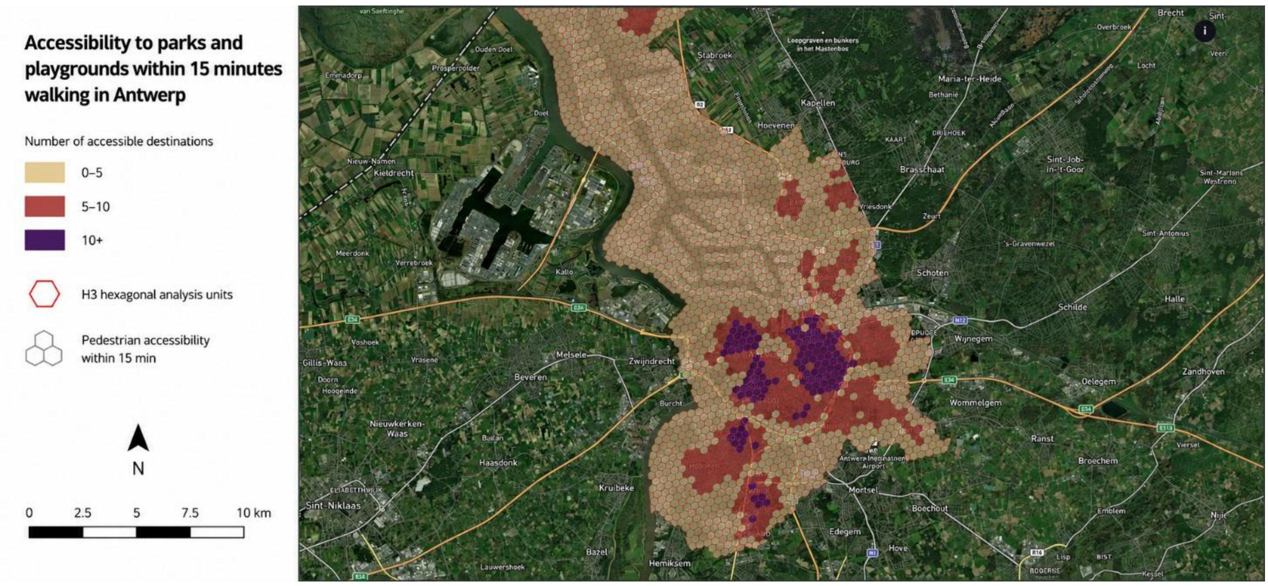

Figure 16: Antwerp - H3-level walking accessibility to parks and playgrounds destinations within 15 minutes

he Parks & playgrounds map shows a broader spatial distribution than Health & care or Culture & tourism. Medium and high accessibility areas appear across several neighbourhoods, including parts of the central, southern and eastern urban fabric. Access to recreational and green-space destinations is therefore relatively distributed, although not uniform. For families, residents and older users, this category contributes to everyday liveability and supports non-motorised local activity.

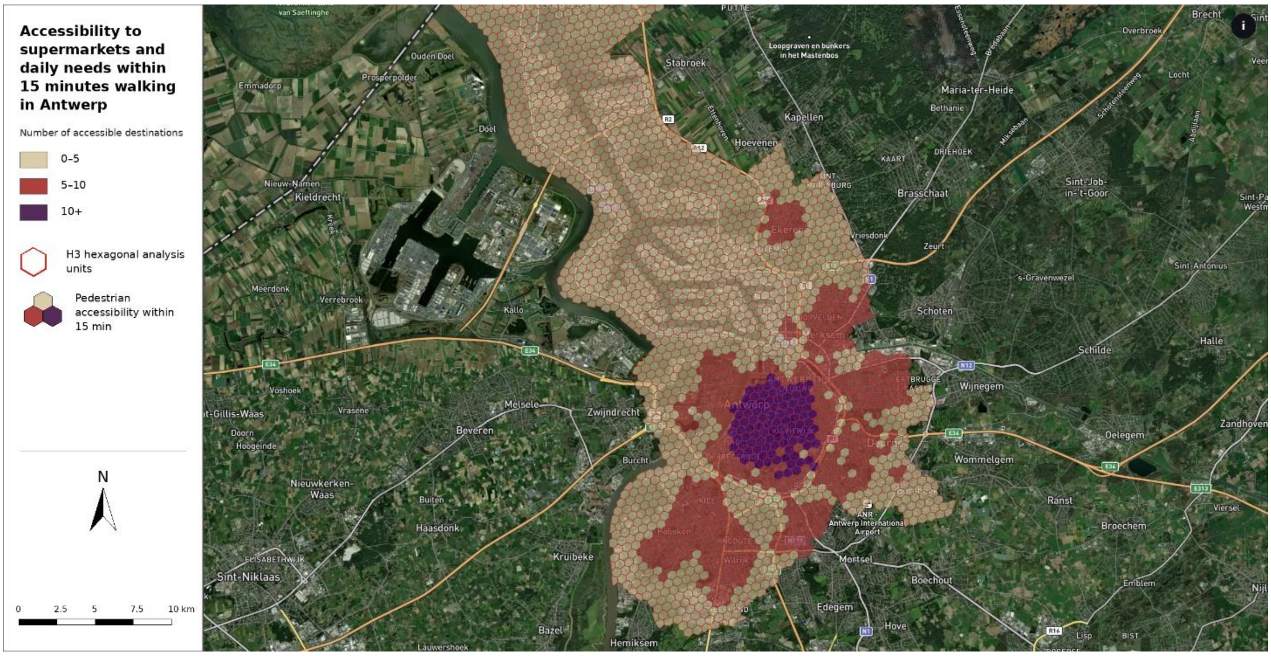

Figure 17: Antwerp - H3-level walking accessibility to supermarkets and daily needs destinations within 15 minutes

The Supermarkets & daily needs map shows strong accessibility in central and southern urban neighbourhoods, with additional medium-accessibility areas in surrounding districts. Everyday retail access is more spatially extended than Culture & tourism, but remains weaker in northern and port-related parts of the study area. For resident-oriented accessibility, this layer is central because daily-needs destinations shape whether everyday activities can be completed locally and on foot.

Overall, the Antwerp category maps show a strong contrast between dense urban neighbourhoods and lower-accessibility port or peripheral areas. Mobility and daily-needs accessibility are more widely distributed, while Culture & tourism, Health & care and Education & childcare remain more spatially concentrated. This reinforces the relevance of Antwerp's multimodal and digital mobility tools, while also showing that information provision alone does not remove spatial gaps where destination density is low.

4.2.3 Florence

For Florence, the Atlas shows a compact and strongly centralised accessibility structure. High accessibility values are mainly concentrated in the historic and inner urban area, especially for Culture & tourism, Health & care, Education & childcare and Supermarkets & daily needs. The surrounding hills and more peripheral areas show weaker values, reflecting the combined influence of land-use concentration, urban morphology and service distribution.

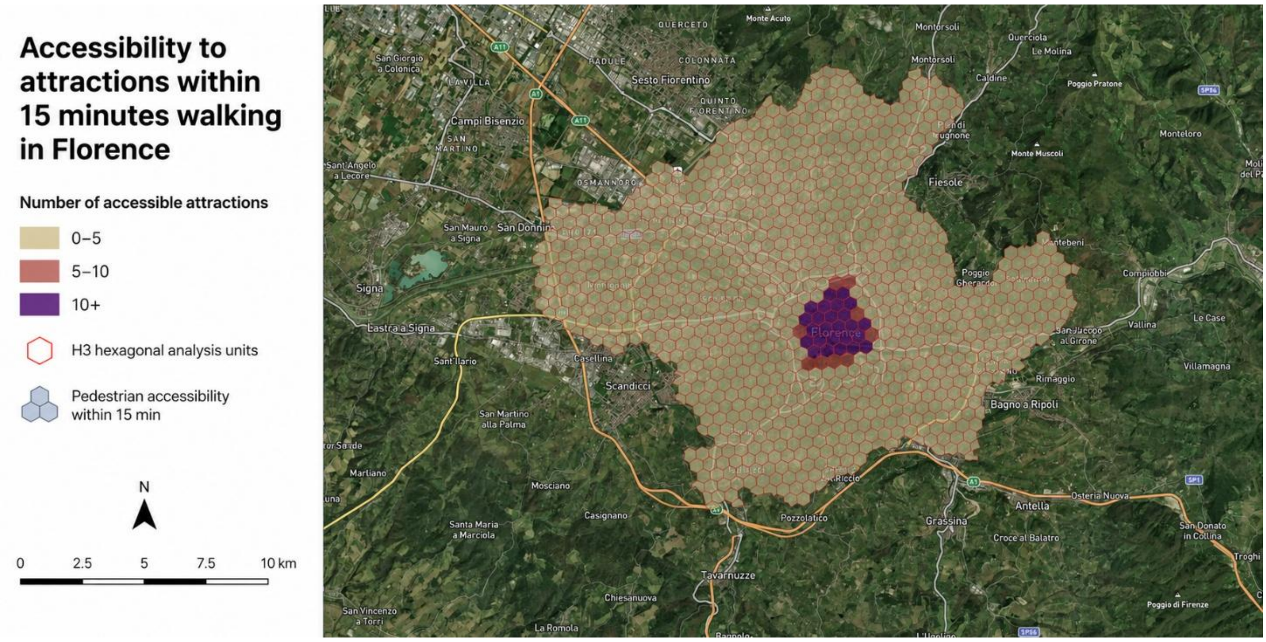

Figure 18: Florence - H3-level walking accessibility to Culture & tourism destinations within 15 minutes

The Mobility map shows a broad and extensive accessibility pattern across much of the urban area. High access to bus stops and mobility access points extends beyond the historic centre and covers a large part of the built-up area. Mobility access is therefore more spatially distributed than cultural destinations. The layer measures access to mobility nodes, not full public-transport performance. It does not measure service frequency, reliability, directness, vehicle accessibility or fare integration.

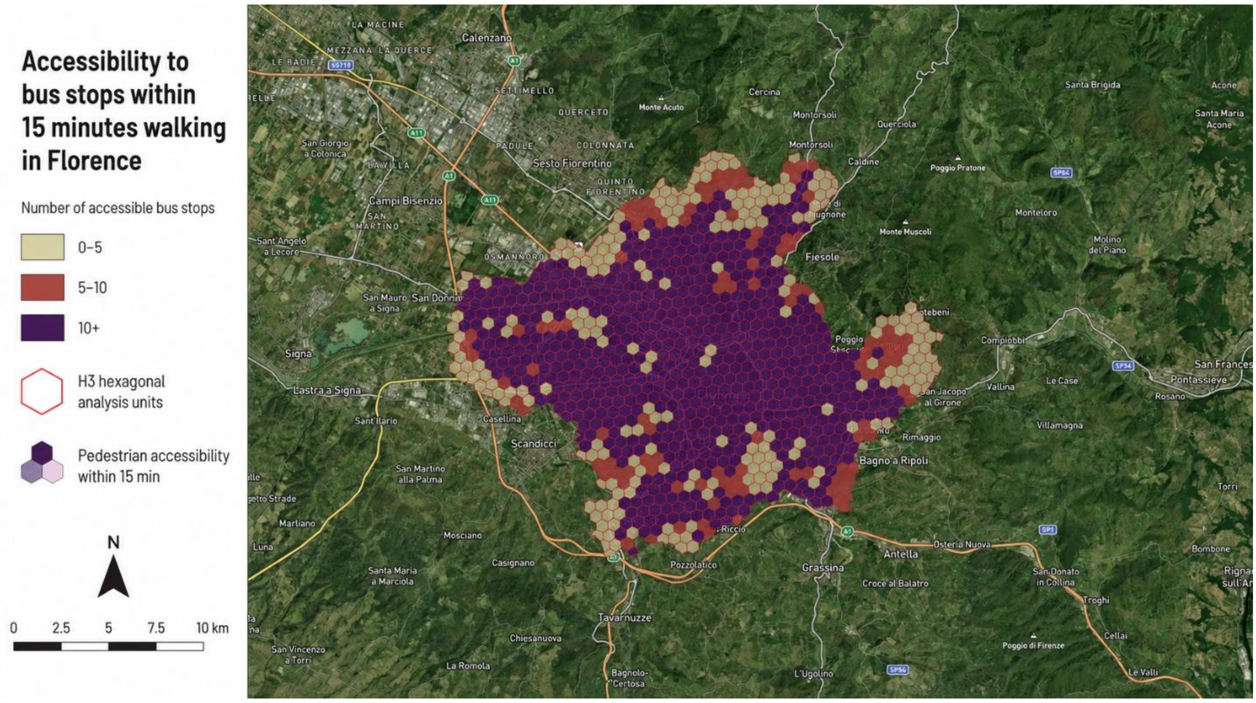

Figure 19: Florence - H3-level walking accessibility to mobility destinations within 15 minutes

The Education & childcare map shows a central and inner-urban concentration, with medium accessibility extending into some surrounding neighbourhoods. Education-related destinations are more distributed than cultural attractions but remain strongly associated with the consolidated urban fabric. This is relevant for family-oriented accessibility, because schools and childcare facilities are core everyday destinations. Peripheral and hillside areas show lower values, indicating weaker walking access to education and childcare services.

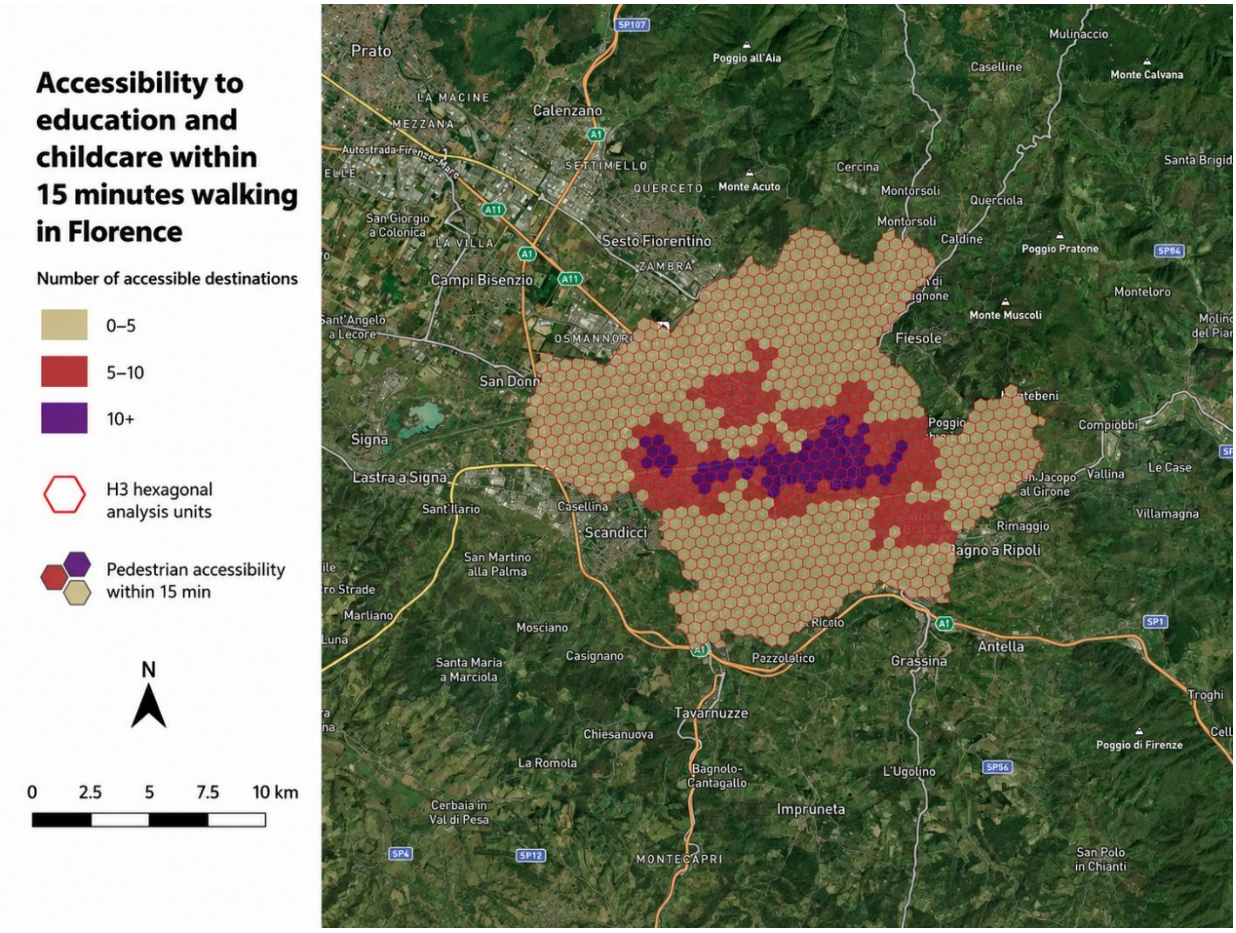

Figure 20: Florence - H3-level walking accessibility to education and childcare destinations within 15 minutes

The Health & care map shows high accessibility in and around the central urban area, with medium values extending into nearby neighbourhoods. Healthcare access is relatively centralised but not confined only to the historic core. For older users and residents, this layer is important because healthcare proximity supports independent mobility and reduces reliance on longer or more complex trips. Lower-accessibility areas around the edges of the study area indicate weaker walking access to this category.

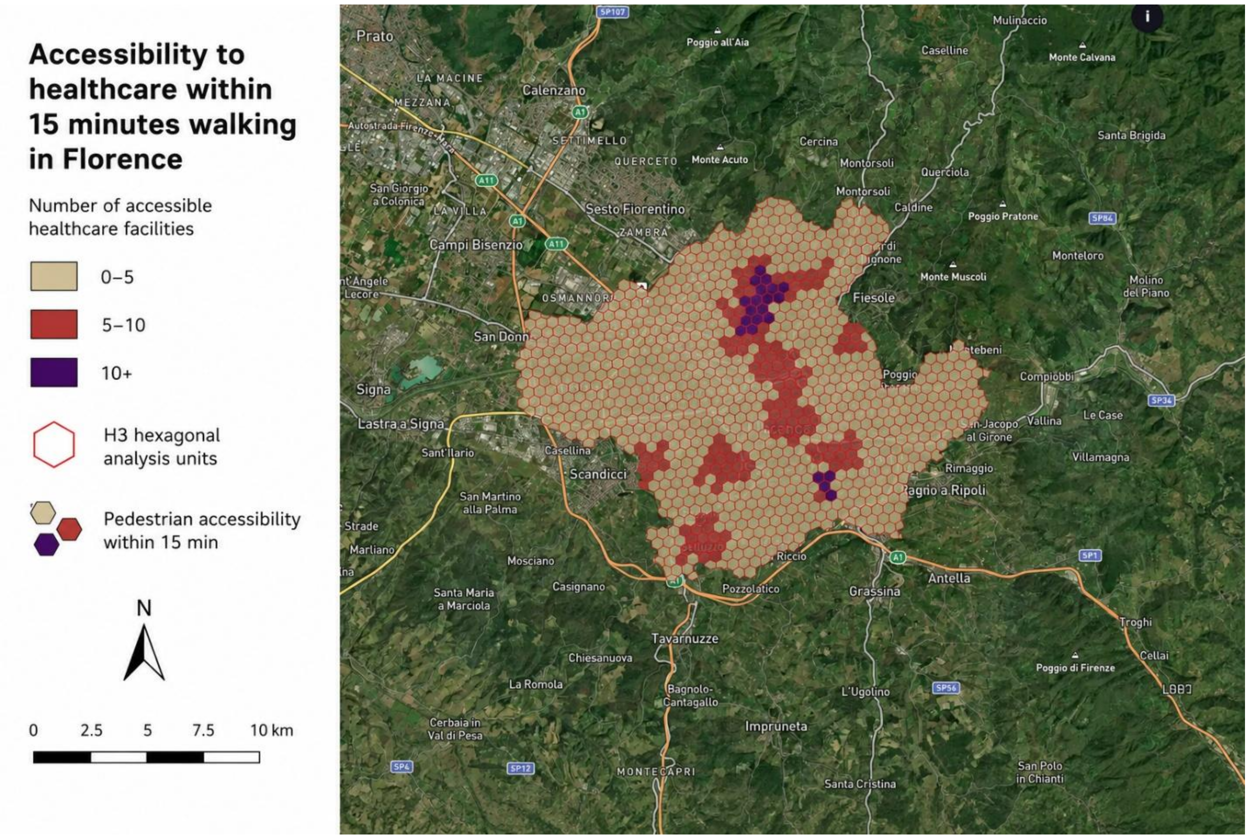

Figure 21: Florence - H3-level walking accessibility to healthcare destinations within 15 minutes

The Supermarkets & daily needs map shows a clear central and inner-urban concentration, with several additional medium-accessibility areas. Everyday retail access is strongest in the compact urban fabric and weaker in peripheral or less dense areas. For residents, families and older users, this pattern is important because daily needs are among the most frequent trip purposes and are central to proximity-based urban living.

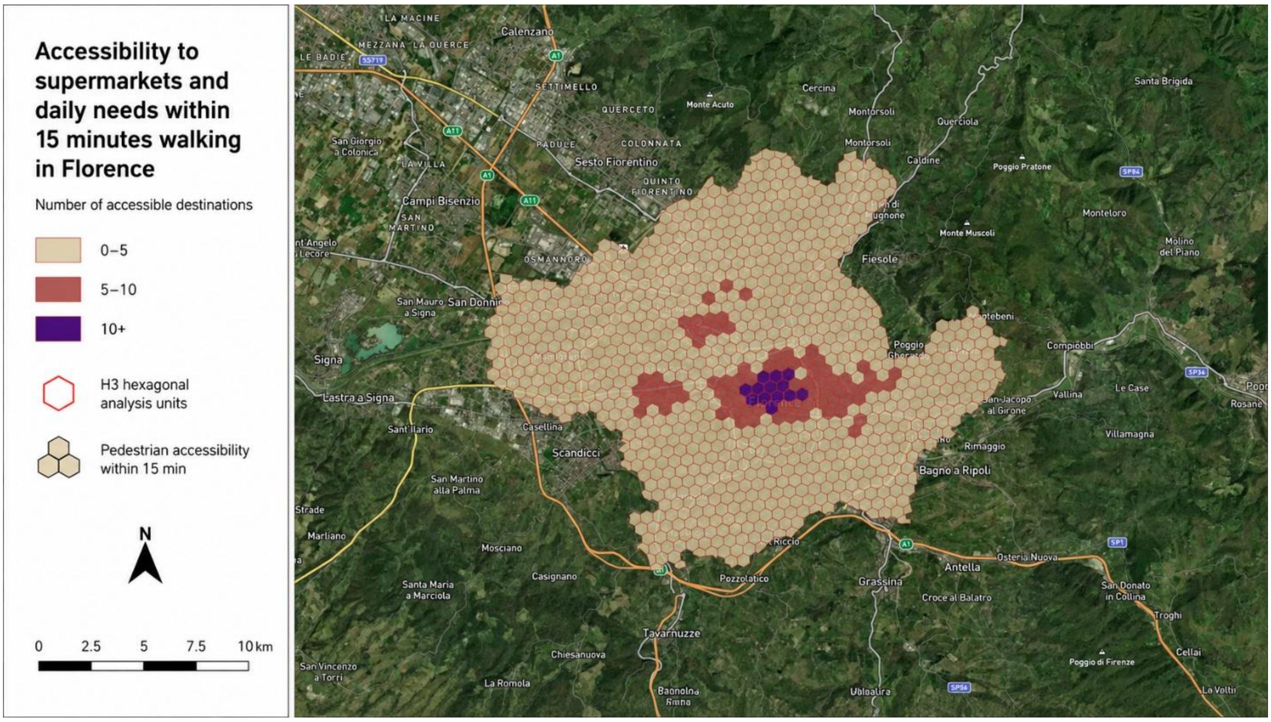

Figure 22: Florence - H3-level walking accessibility to supermarkets and daily needs destinations within 15 minutes

The Parks & playgrounds map shows a more dispersed pattern than Culture & tourism, with several areas of high accessibility across the urban fabric. Access to recreational and green-space destinations is not limited to the historic centre. However, lower-accessibility areas remain visible around parts of the urban edge. For families, residents and older users, this layer supports everyday liveability, active mobility and public-space quality.

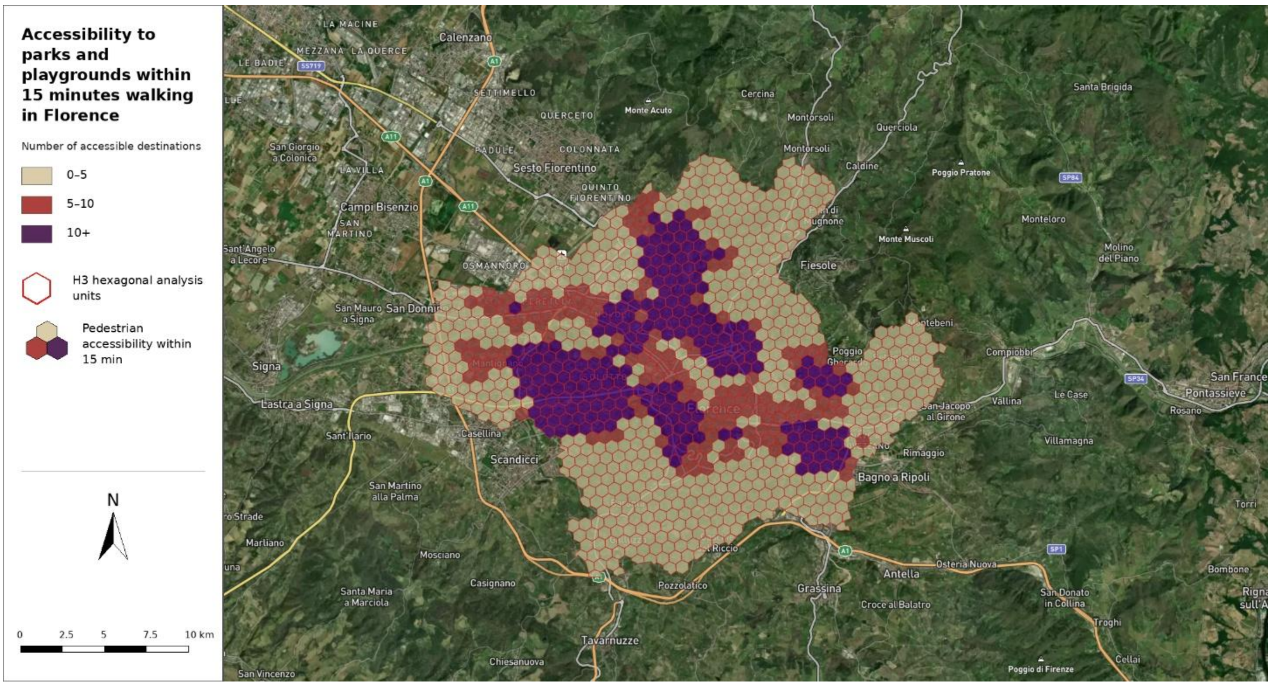

Figure 23: Florence - H3-level walking accessibility to parks and playgrounds destinations within 15 minutes

Overall, the Florence category maps show a compact accessibility structure with a strong central core. Culture & tourism is highly concentrated in the historic centre, while Mobility access is more widely distributed. Health & care, Education & childcare, Parks & playgrounds and Supermarkets & daily needs show intermediate patterns, with strong inner-urban accessibility and weaker edge conditions. This confirms the importance of managing public space, walking conditions, traffic calming and logistics access in the central and inner urban areas, where multiple accessibility demands overlap.

4.2.4 Cross-city interpretation

Across the three pilot cities, the category-based maps show that accessibility is shaped by both urban structure and destination type. Mobility access is generally the most spatially extensive category, especially where bus stops and public-transport nodes are widely distributed. Culture & tourism is the most centralised category, particularly in Florence and Pilsen, where visitor-oriented destinations are strongly concentrated in the urban core. Health & care, Education & childcare, Parks & playgrounds and Supermarkets & daily needs show mixed patterns, often linked to residential neighbourhoods and local service centres.

Pilsen presents a node-based accessibility structure. High accessibility is concentrated around the centre and selected neighbourhood clusters, while peripheral areas remain weaker. Antwerp presents a metropolitan and uneven structure, with strong accessibility in central and southern urban neighbourhoods and weaker access in northern and port-related areas. Florence presents the most compact and centralised structure, with strong accessibility around the historic and inner urban area.

These differences matter for SOMI because the same type of mobility solution operates under different spatial conditions. In Florence, public-space and logistics measures respond to a highly concentrated central accessibility environment. In Antwerp, multimodal route-planning and MaaR-oriented digital tools operate across a larger and more uneven metropolitan structure. In Pilsen, cycling, first-/last-mile and Digital Twin-supported planning are particularly relevant for connecting the central city with surrounding neighbourhood and peripheral nodes.

4.3 Persona-oriented accessibility interpretation

4.3.1 Methodological basis for persona-oriented scores

The persona-oriented Atlas layer builds on the category-based accessibility maps. It combines them into simplified user-oriented accessibility profiles. This approach was followed in order to have the same spatial accessibility data interpreted differently according to the proximity needs of different types of users, in line with accessibility-based planning, proximity planning and equity-sensitive accessibility analysis (Geurs & van Wee, 2004; Moreno et al., 2021; Pereira et al., 2017; Willberg et al., 2023). The five Atlas persona profiles that were used are:

1. Resident;
2. Student;
3. Family;
4. Older user;
5. Visitor.

These were used as simplified cross-city interpretation profiles. They are not identical to the full city-specific SOMI personas used in Chapter 3. They are common Atlas profiles designed to enable comparable spatial interpretation across Pilsen, Antwerp and Florence. The relationship between the Atlas profiles and the broader SOMI persona logic is shown below.

Table 57: Atlas persona profile descriptions

Atlas persona profile	Related SOMI persona examples	Main interpretation
Resident	City-centre resident, urban resident, occasional car user	Everyday neighbourhood accessibility
Student	Budget-sensitive student, student living away from home	Access to education, mobility and everyday services
Family	Young urban family, suburban family	Access to education, childcare, parks, healthcare and daily needs
Older user	Older or less mobile resident	Access to healthcare, mobility, parks and daily needs
Visitor	Culture visitor, leisure and culture visitor	Access to attractions, mobility and visitor-related urban opportunities

The persona scores are calculated by combining normalised category scores using persona-destination relevance weights. For each H3 hexagon, the Atlas first calculates cumulative walking accessibility to each destination category. Cumulative-opportunity accessibility is widely used in transport and land-use planning because it provides a communicable measure of the number of opportunities reachable within a defined travel-time threshold (Geurs & van Wee, 2004; Kapatsila et al., 2023; Pajares et al., 2021). The base category indicator is defined as:

$$A_{h,q}^{15} = \sum_{p \in P_{c,q}} I\left(T_{h,p} \leq 15\right) \quad Eq. (36)$$

where:

- h is an H3 hexagon;
- q is a destination category;
- $P_{c,q}$ is the set of destinations of category q in city c;
- $T_{h,p}$ is the pedestrian-network walking time from hexagon h to destination p;
- $I(\cdot)$ is an indicator function equal to 1 if the condition is true and 0 otherwise;
- $A_{h,q}^{15}$ is the number of reachable destinations of category q within the 15-minute walking threshold.

To make the category scores comparable, raw accessibility counts are normalised to a 0-1 scale. Since the Atlas legends classify accessibility counts using the ranges 0-5, 5-10 and 10 or more reachable destinations, a capped linear normalisation is used:

$$\tilde{A}_{h,q} = \min\left(1, \frac{A_{h,q}^{15}}{10}\right) \quad Eq. (37)$$

where:

- $\tilde{A}_{h,q}$ is the normalised accessibility score for hexagon h and destination category q;
- a value of 0 means that no relevant destinations are reachable within 15 minutes;
- a value of 1 means that 10 or more destinations of the selected category are reachable within 15 minutes.

The persona-oriented accessibility score is then calculated as a weighted combination of the normalised category scores:

$$PAI_{h,r} = \sum_{q \in Q} \beta_{r,q} \cdot \tilde{A}_{h,q} \qquad Eq. (38)$$

where:

- $PAI_{h,r}$ is the Persona Accessibility Indicator for hexagon h and persona r;
- $\beta_{r,q}$ is the relevance weight of destination category q for persona r;
- $\tilde{A}_{h,q}$ is the normalised accessibility score for destination category q;
- Q is the set of destination categories included in the persona score.

For each persona, the relevance weights sum to 1.00:

$$\sum_{q \in Q} \beta_{r,q} = 1 \quad Eq. (39)$$

The score therefore expresses how well each H3 hexagon supports the accessibility needs of a specific persona, based on the destination categories that are considered most relevant for that persona:

- For the resident profile, higher importance is assigned to supermarkets and daily needs, mobility access and general neighbourhood services, reflecting the role of routine services and public transport in everyday neighbourhood accessibility (Moreno et al., 2021; OECD, 2020; ITF, 2024).
- or the student profile, mobility access, education-related destinations and daily services receive higher relevance because student accessibility is strongly shaped by access to education, public transport, active travel and everyday urban opportunities (Zannat et al., 2020; de Alba-Martinez et al., 2021; Moreno et al., 2023).
- For the family profile, education and childcare, parks and playgrounds, healthcare and daily needs receive higher relevance, reflecting child-friendly and family-oriented accessibility requirements (UNICEF, 2018; UNICEF, 2022; Zhou et al., 2022; Martin et al., 2023).
- For the older-user profile, healthcare, public transport, daily needs and parks receive higher relevance because age-friendly city guidance and empirical studies identify nearby health services, transport access and walkable everyday destinations as central to ageing in place (WHO, 2007; WHO, 2015; Lowen et al., 2015; Hasselder et al., 2022; Twardzik et al., 2023).
- For the visitor profile, attractions / culture and tourism and mobility access receive the highest relevance because visitor accessibility is primarily shaped by the ability to reach tourism destinations and move between them within the city (Coppola et al., 2020; Zientara et al., 2024; UN Tourism, n.d.).

The final persona score is classified into five fixed qualitative classes. This fixed classification scheme is used because it preserves comparability across personas, cities and maps, following the principle that composite indicators should use stable normalisation and classification rules when outputs are compared across cases (OECD & Joint Research Centre, 2008). A “High” score therefore has the same meaning across the Atlas, rather than depending on the distribution of values in each individual map.

Table 58: Classification scheme for persona-oriented accessibility scores

PERSONA SCORE RANGE	CLASS
0.00-0.20	Very low
0.20-0.40	Low
0.40-0.60	Medium
0.60-0.80	High
0.80-1.00	Very high

The persona weights used in the Atlas are literature-informed methodological proxies. They are based on accessibility planning, proximity planning, transport equity, age-friendly city guidance, child-friendly city guidance, student mobility literature and visitor/tourist accessibility research (Pereira et al., 2017; Moreno et al., 2021; OECD, 2020; ITF, 2024; WHO, 2007; UNICEF, 2018; Coppola et al., 2020; Zientara et al., 2024). The full persona-destination category relevance matrix and supporting literature are provided in Appendix VII. The weights are methodological proxies derived from accessibility, proximity-planning and transport-equity literature.

Table 59: Planning assumptions used for spatial interpretation for the Atlas

Persona profile	Mobility	Health & care	Education & childcare	Parks & playgrounds	Supermarkets & daily needs	Culture & tourism	Sum
Resident	0.20	0.15	0.10	0.15	0.30	0.10	1.00
Student	0.25	0.10	0.25	0.10	0.20	0.10	1.00
Family	0.15	0.15	0.30	0.20	0.15	0.05	1.00
Older user	0.20	0.30	0.05	0.15	0.20	0.10	1.00
Visitor	0.30	0.05	0.00	0.10	0.10	0.45	1.00

The interpretation of each weight is direct. A higher value means that the destination category contributes more strongly to the persona score. Health & care receives the highest weight for older users. Education & childcare receives the highest weight for families. Culture & tourism receives the highest weight for visitors.

The persona-oriented scores do not represent observed travel behaviour, individual preferences or actual destination choice. They do not measure whether a specific person walks to a destination, nor do they capture affordability, opening hours, service quality, perceived safety, disability access or capacity. They provide an exploratory spatial proxy of how well each area supports the accessibility needs associated with each persona profile.

4.3.2 Persona-oriented heatmap results

The persona-oriented accessibility maps translate the category-based Atlas indicators into composite user-oriented scores. While the previous maps focused on individual destination categories, the following maps combine the accessibility conditions that are most relevant for each persona profile. The results therefore do not represent a single destination type, but a composite 15-minute walking accessibility score reflecting how well different areas support the everyday needs, mobility options and urban opportunities associated with each persona.

Overall, the persona-oriented maps show that accessibility is strongly shaped by the spatial concentration of services, public transport, education, healthcare, green spaces and visitor-related destinations. In all three cities, the highest scores tend to appear in consolidated urban areas where multiple destination categories overlap within walking distance. Peripheral, low-density or mono-functional areas generally show lower scores, even when they may perform well for one specific category.

4.3.2.1 Pilsen

In Pilsen, the persona-oriented maps show a concentrated and node-based accessibility structure. Higher values are mainly found around the urban core and selected neighbourhood centres, while large parts of the wider study area remain in lower accessibility classes. This reflects the spatial structure of Pilsen, where services and opportunities are clustered in the central city and in specific local nodes rather than evenly distributed across the wider area.

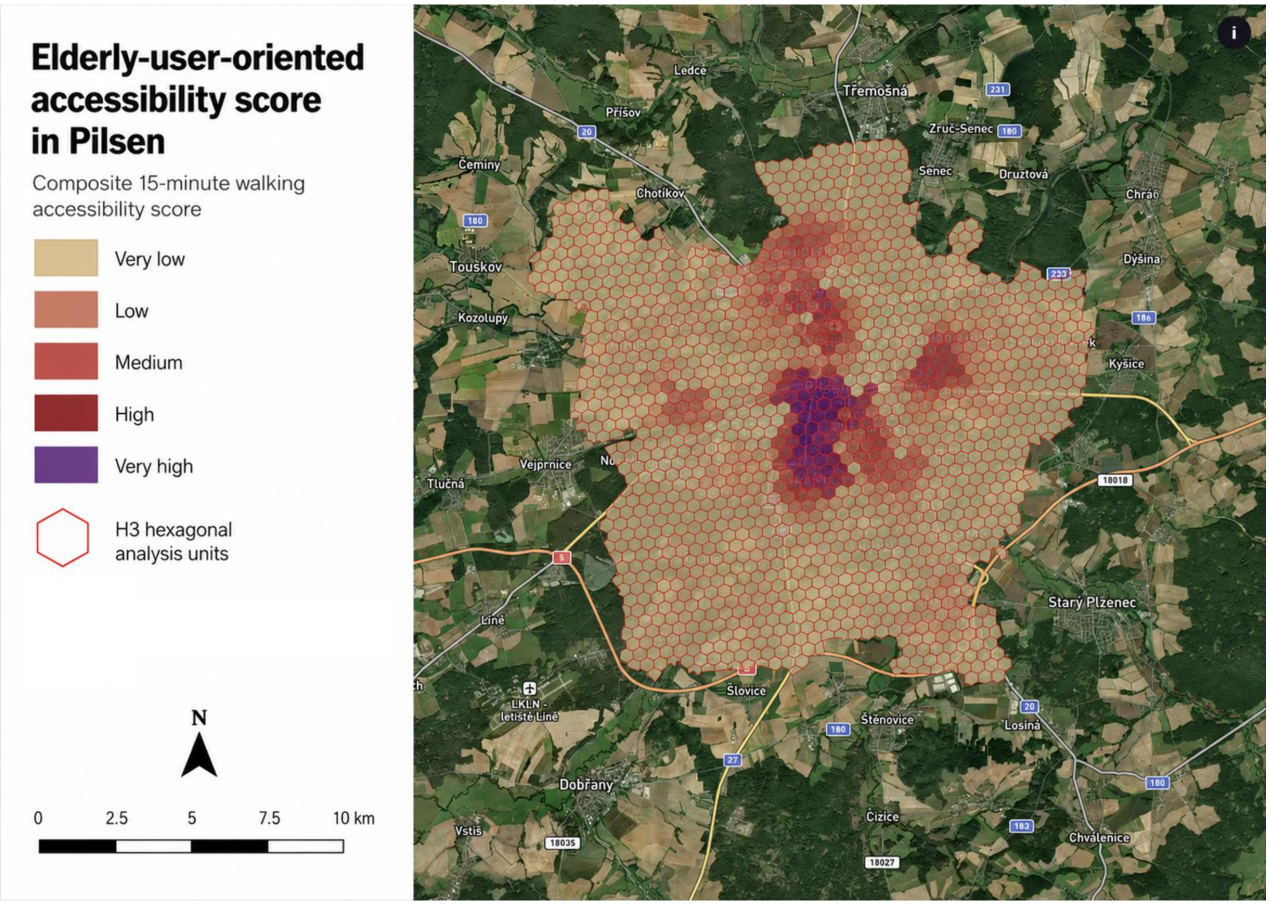

Figure 24: Pilsen - Elderly-user-oriented accessibility score

The older-user-oriented accessibility score in Pilsen is concentrated around the central urban area, with smaller pockets of medium and high accessibility in nearby neighbourhoods. The strongest values appear where healthcare, public transport, daily services and accessible public spaces overlap. Most peripheral areas remain in very low or low classes, indicating limited walking access to the combination of services that are most relevant for older users. This points to a clear dependence on central and neighbourhood-level service provision.

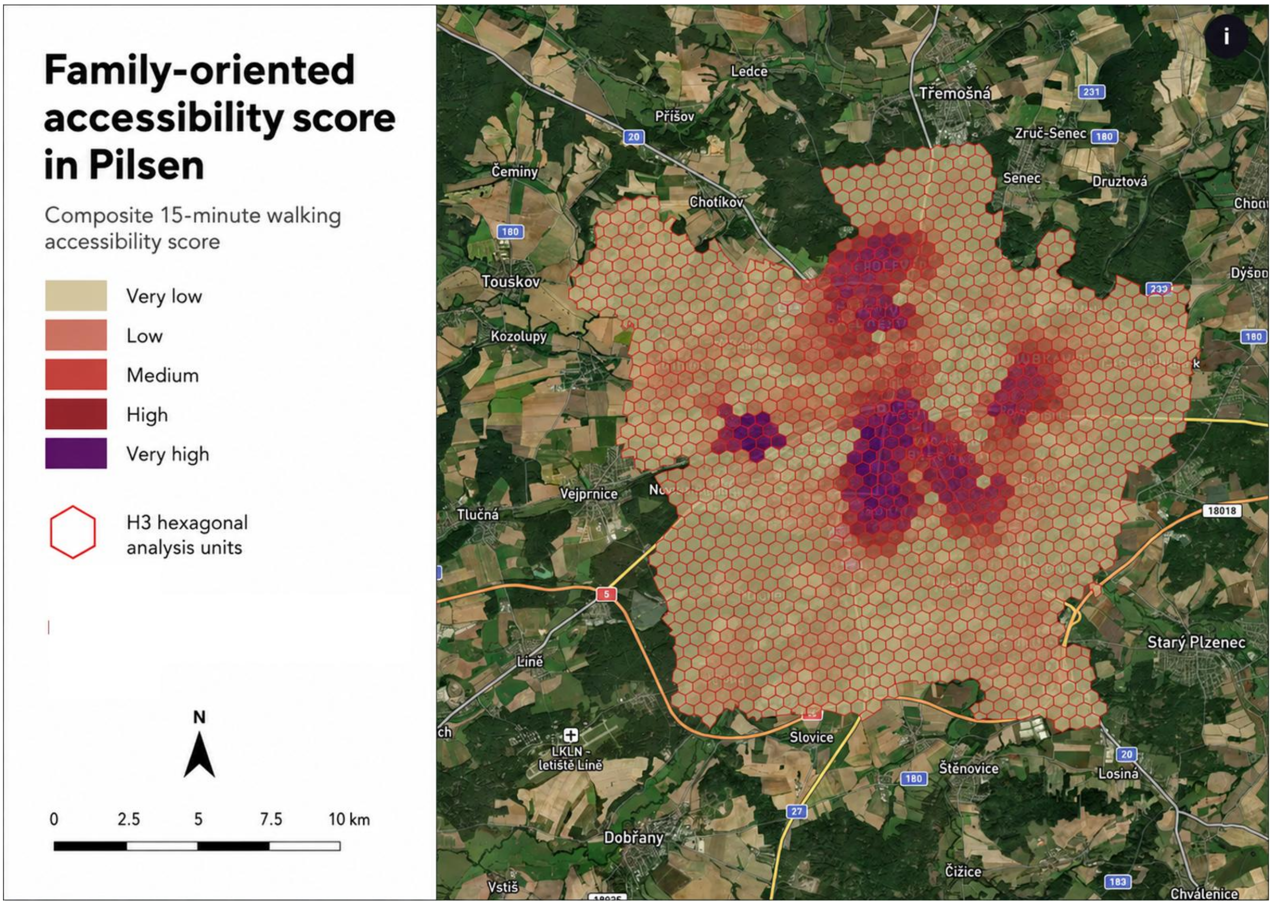

Figure 25: Pilsen - Family-oriented accessibility score

The family-oriented accessibility score shows several distinct clusters of higher accessibility, rather than one continuous high-accessibility zone. These clusters reflect areas where schools, childcare, parks, daily services and public transport are available within walking distance. The central area performs well, while additional neighbourhood-level concentrations are also visible. Large peripheral parts of the study area remain low, indicating that family-oriented walking accessibility is uneven and strongly tied to local service nodes.

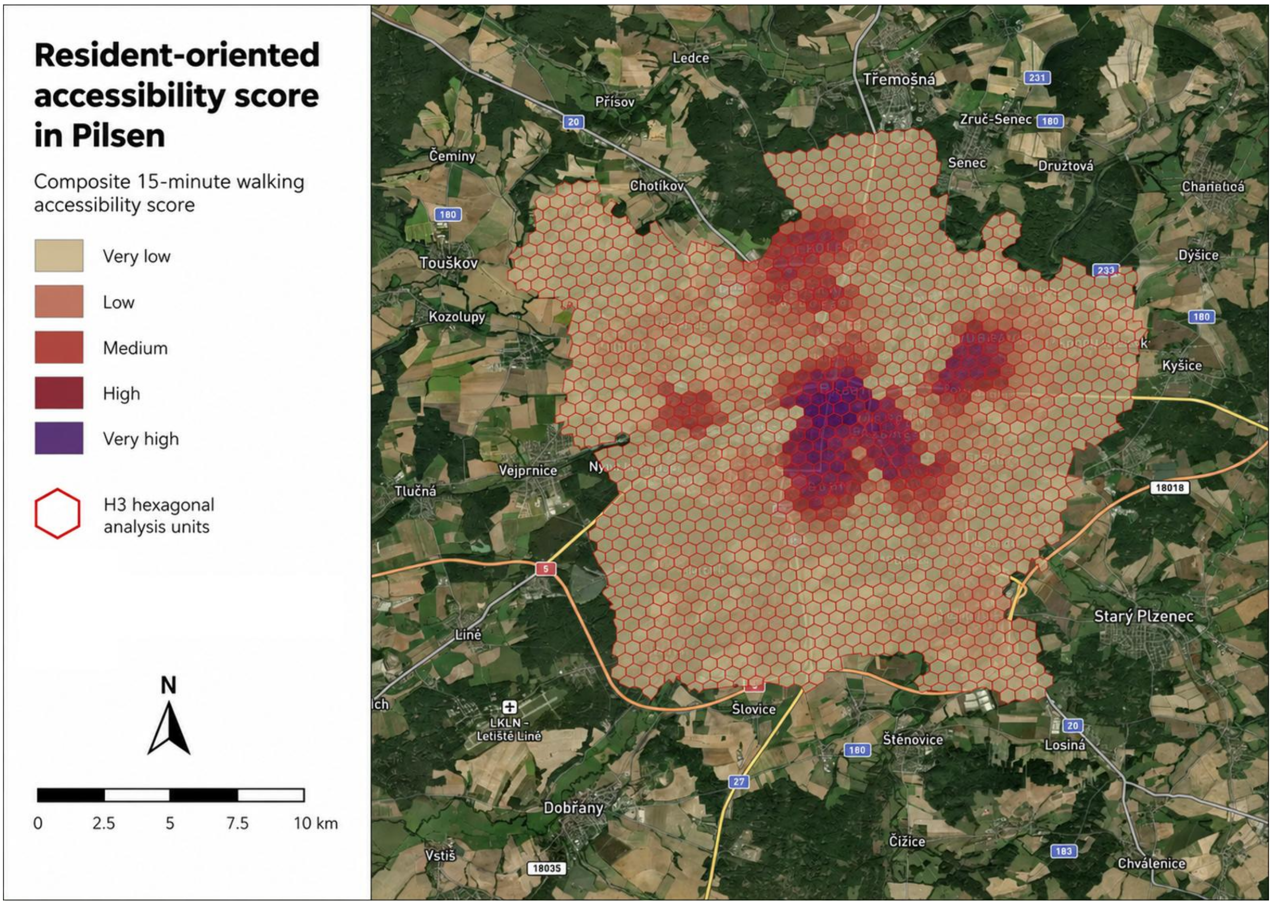

Figure 26: Pilsen - Resident-oriented accessibility score

The resident-oriented accessibility score in Pilsen shows a central concentration of higher values, supported by additional medium-accessibility areas in selected surrounding neighbourhoods. Everyday services and public transport access are strongest around the urban core and weaker in peripheral or sparsely served areas. Compared with the family-oriented map, the resident profile is slightly more general, but it still shows a clear centre-periphery contrast.

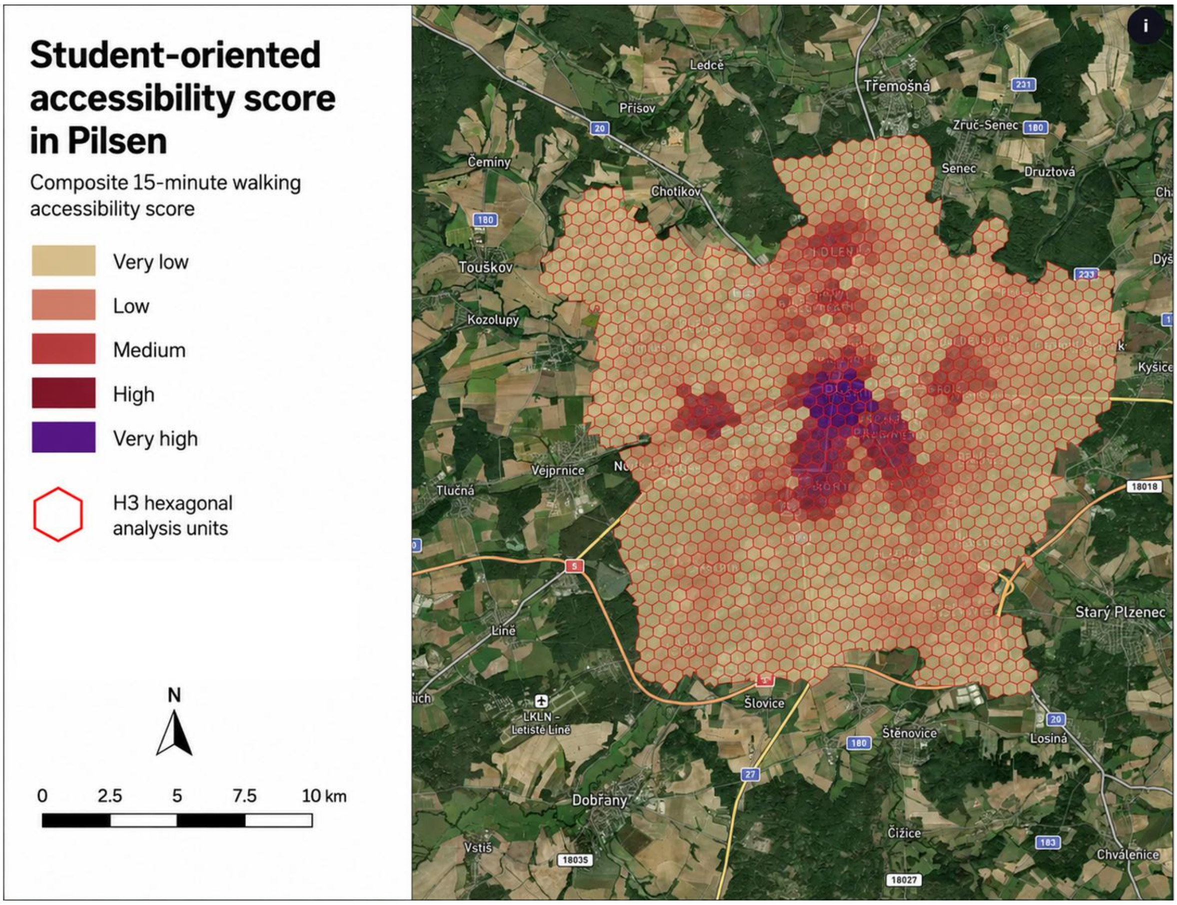

Figure 27: Pilsen - Student-oriented accessibility score

The student-oriented accessibility score is mainly concentrated around the central area and a few secondary clusters. High values appear where education-related destinations, public transport and food or daily-service opportunities overlap. Student-oriented accessibility is therefore not evenly distributed across the city, but depends on the proximity of educational facilities and supporting urban functions. Peripheral areas show mostly low scores, indicating weaker walking-based support for student daily mobility.

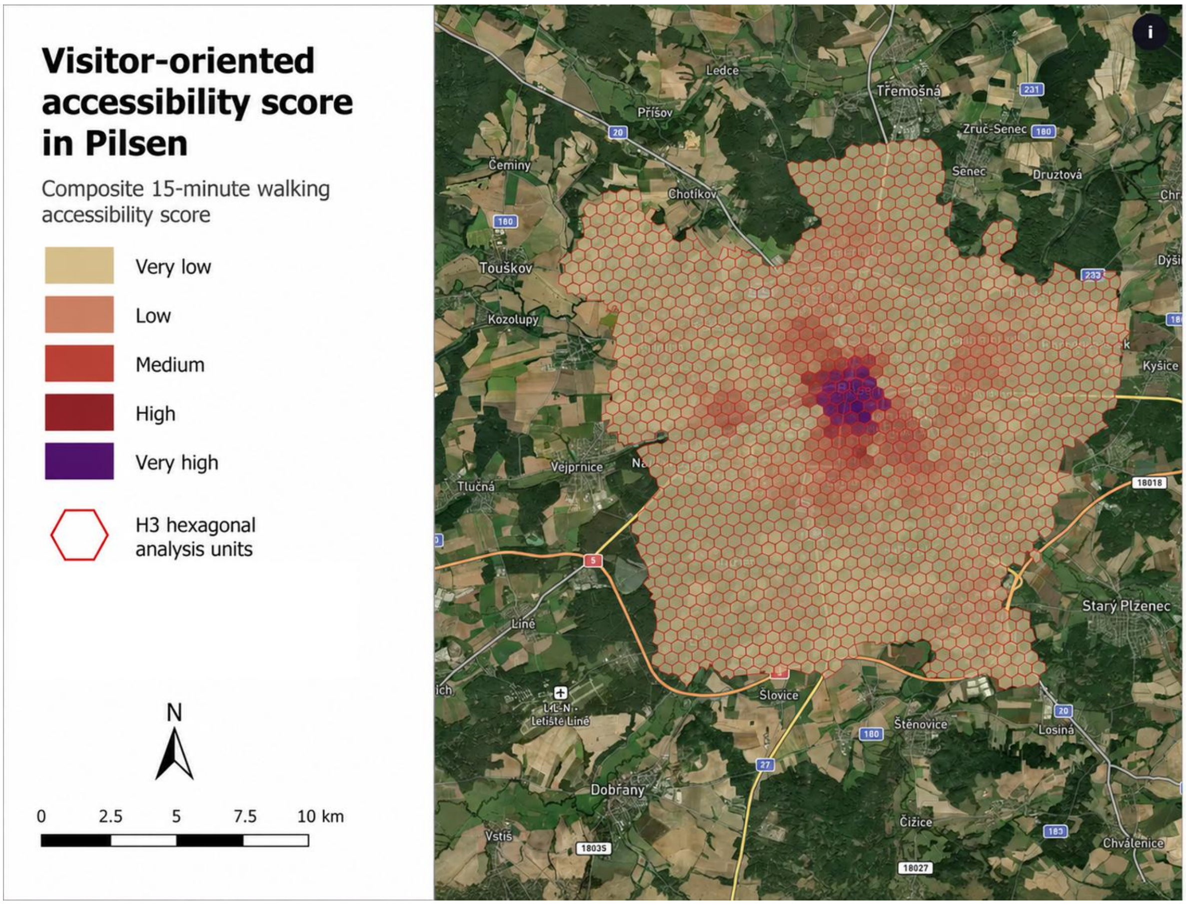

Figure 28: Pilsen - Visitor-oriented accessibility score

The visitor-oriented accessibility score in Pilsen is the most spatially concentrated among the persona maps. High and very high values are focused around the central area, where attractions, cultural destinations, food and drink opportunities and public transport are clustered. Outside the centre, the score decreases sharply, with most of the wider study area showing low or very low visitor-oriented accessibility. Visitor experience by walking is therefore strongly anchored to the urban core.

Overall, Pilsen presents a node-based persona-accessibility structure. The highest scores are concentrated in the city centre and in selected neighbourhood clusters, while peripheral areas show consistently lower values. Visitor accessibility is highly centralised, whereas family and resident accessibility show additional local centres. Older-user and student accessibility depend strongly on the overlap between relevant services and public transport.

4.3.2.2 Antwerp

In Antwerp, the persona-oriented maps show a broader but more uneven accessibility structure than Pilsen. Higher scores are concentrated in central and southern urban neighbourhoods, while northern and port-related areas generally perform less strongly. This reflects Antwerp's metropolitan structure, where dense urban neighbourhoods, industrial and port areas, water barriers and lower-density peripheral zones coexist within the study area.

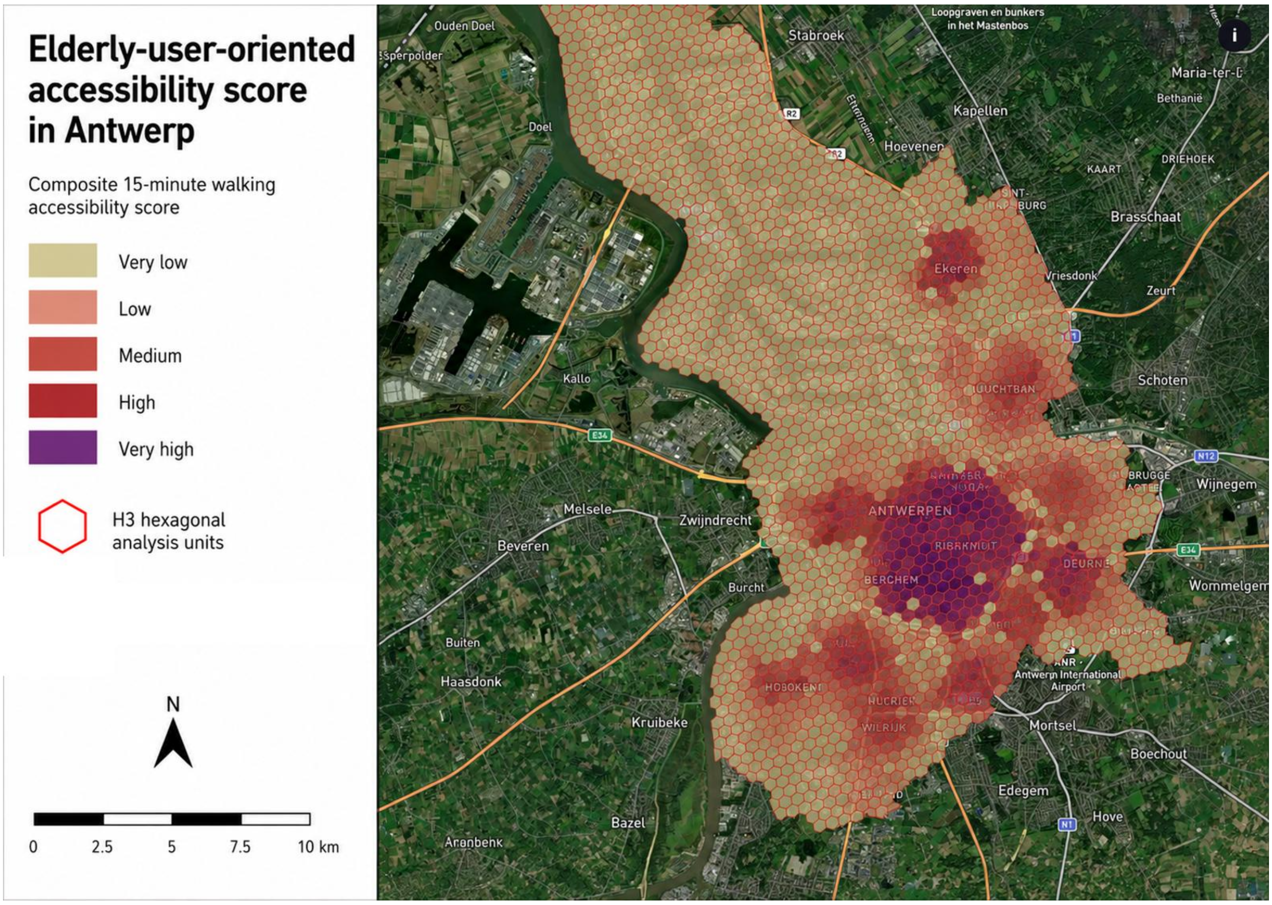

Figure 29: Antwerp - Elderly-user -oriented accessibility score

The older-user-oriented accessibility score in Antwerp is strongest in the central and southern urban neighbourhoods, where healthcare, public transport, daily services and parks overlap. The map shows a relatively broad high-accessibility area compared with Pilsen, but also clear gaps toward the northern and port-related parts of the study area. Older-user accessibility is therefore spatially uneven and strongly linked to the concentration of everyday services and mobility access in the consolidated urban fabric.

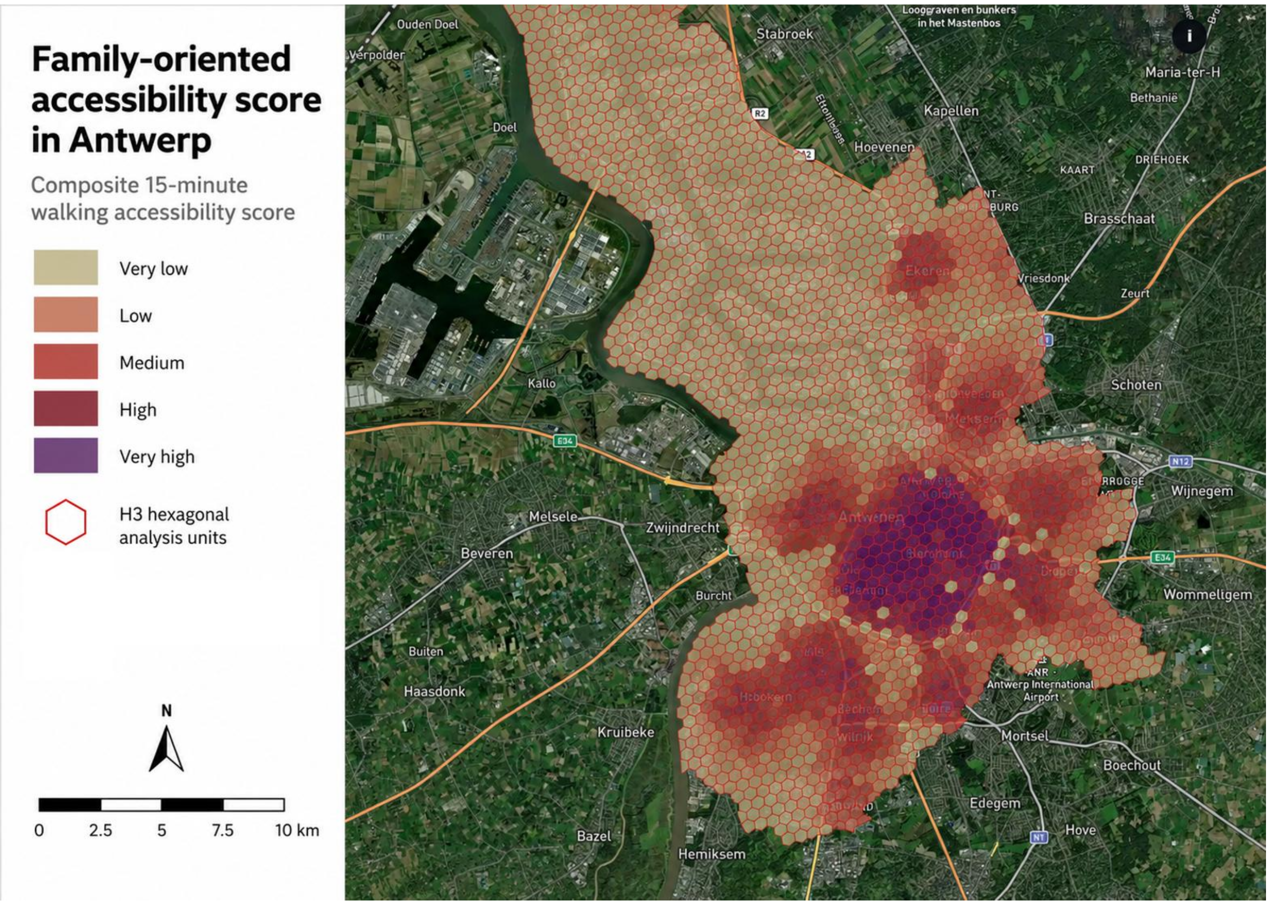

Figure 30: Antwerp - Family -oriented accessibility score

The family-oriented accessibility score shows high values across central and southern Antwerp, with additional medium-accessibility areas in surrounding neighbourhoods. This indicates that the combination of education and childcare, parks, daily needs, healthcare and mobility access is strongest in residential urban areas. Northern and port-related areas remain mostly low, indicating weaker walking-based support for family-oriented daily mobility. The map highlights the importance of neighbourhood-level service distribution for family accessibility.

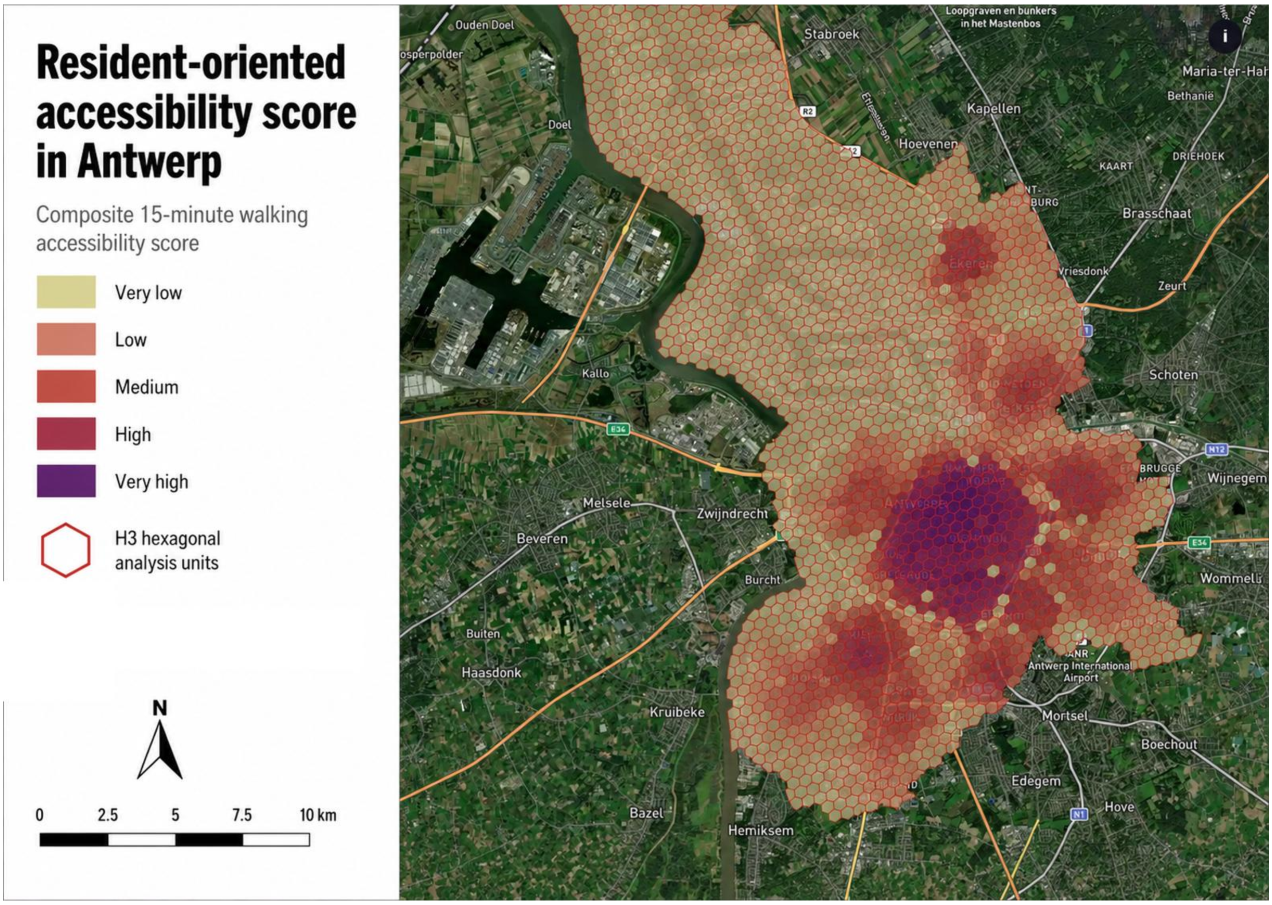

Figure 31: Antwerp - Resident -oriented accessibility score

The resident-oriented accessibility score shows a strong central and southern concentration, reflecting the overlap of daily needs, public transport, healthcare and local services. Compared with the visitor-oriented map, the resident profile is more spatially extended because it depends on everyday services distributed across several neighbourhoods. The map still shows a clear contrast between consolidated urban areas and lower-accessibility peripheral or port-related zones.

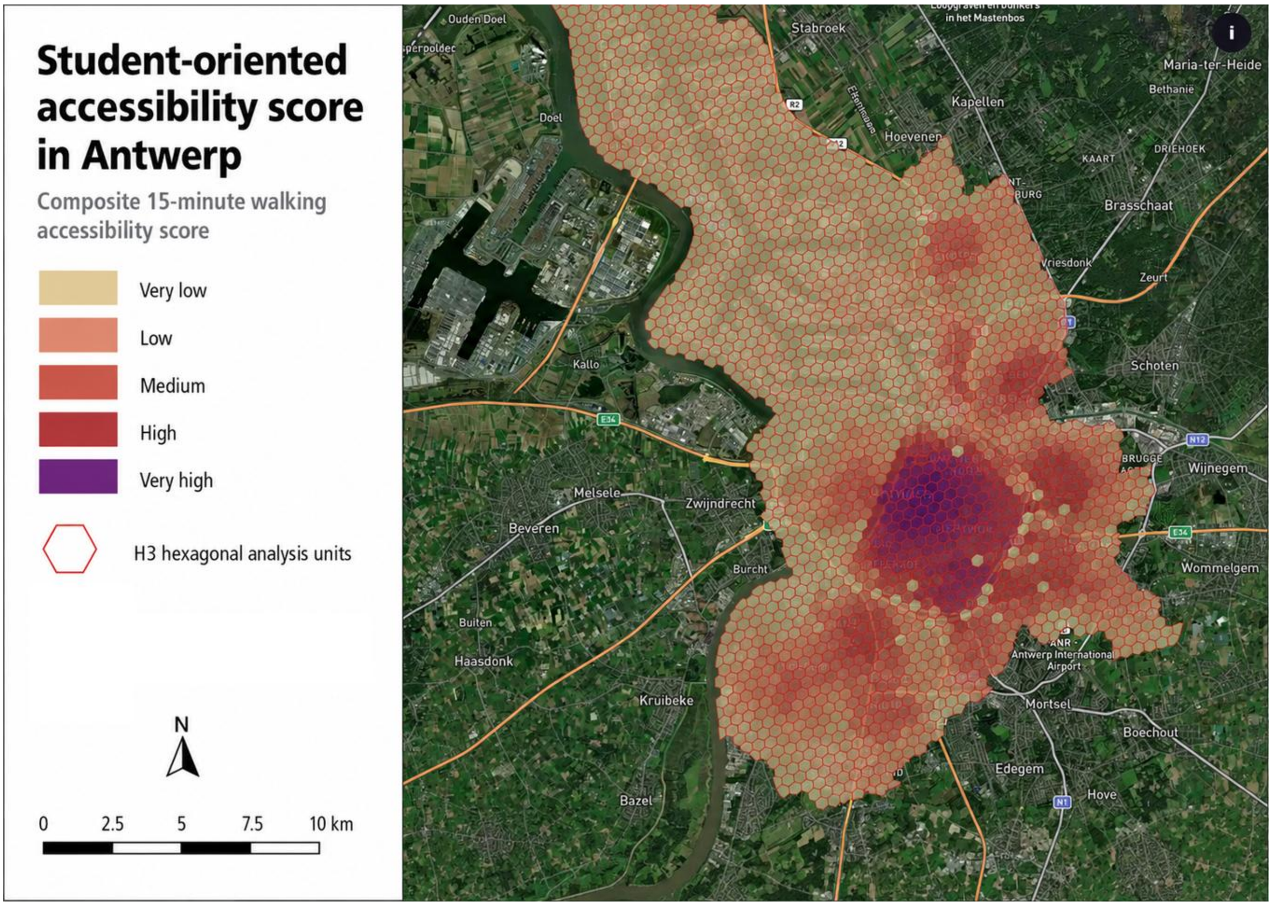

Figure 32: Antwerp - Student -oriented accessibility score

The student-oriented accessibility score is concentrated around central and southern Antwerp, with medium values extending into some surrounding neighbourhoods. The pattern reflects the spatial overlap between education-related destinations, mobility access and everyday services. Student-oriented accessibility is relatively strong where public transport and urban services are dense, but weaker in northern and industrial areas. This is relevant for interpreting whether multimodal information and route-planning tools support student mobility across a wider urban area.

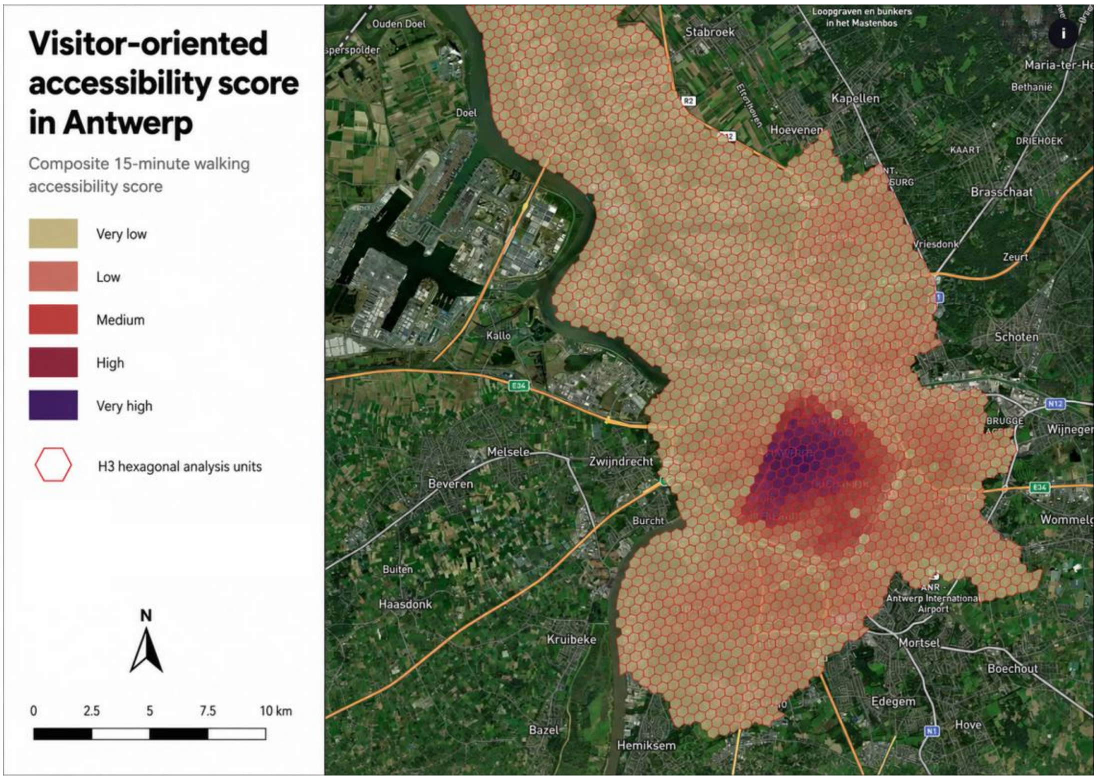

Figure 33: Antwerp - Visitor -oriented accessibility score

The visitor-oriented accessibility score is strongly concentrated around the central urban area. This reflects the clustering of culture, tourism and mobility access in the city centre. The score decreases sharply outside the core, especially toward northern, industrial and port-related areas. Visitor-oriented walking accessibility in Antwerp is therefore much more centralised than resident or family accessibility.

Overall, Antwerp shows a relatively broad but uneven persona-accessibility structure. Resident, family, student and older-user profiles perform well in central and southern urban neighbourhoods, while visitor accessibility is more strongly concentrated in the city centre. The lower scores in northern and port-related areas underline that Antwerp's accessibility challenges are not only about mobility information, but also about the underlying geography of services and opportunities.

4.3.2.3 Florence

In Florence, the persona-oriented maps show a compact and strongly centralised accessibility structure. Higher values are mainly found in the historic and inner urban area, where multiple destination categories overlap within walking distance. Compared with Antwerp, the high-accessibility zone is more compact. Compared with Pilsen, it is more continuous around the central urban area. Peripheral and hillside areas generally show lower scores.

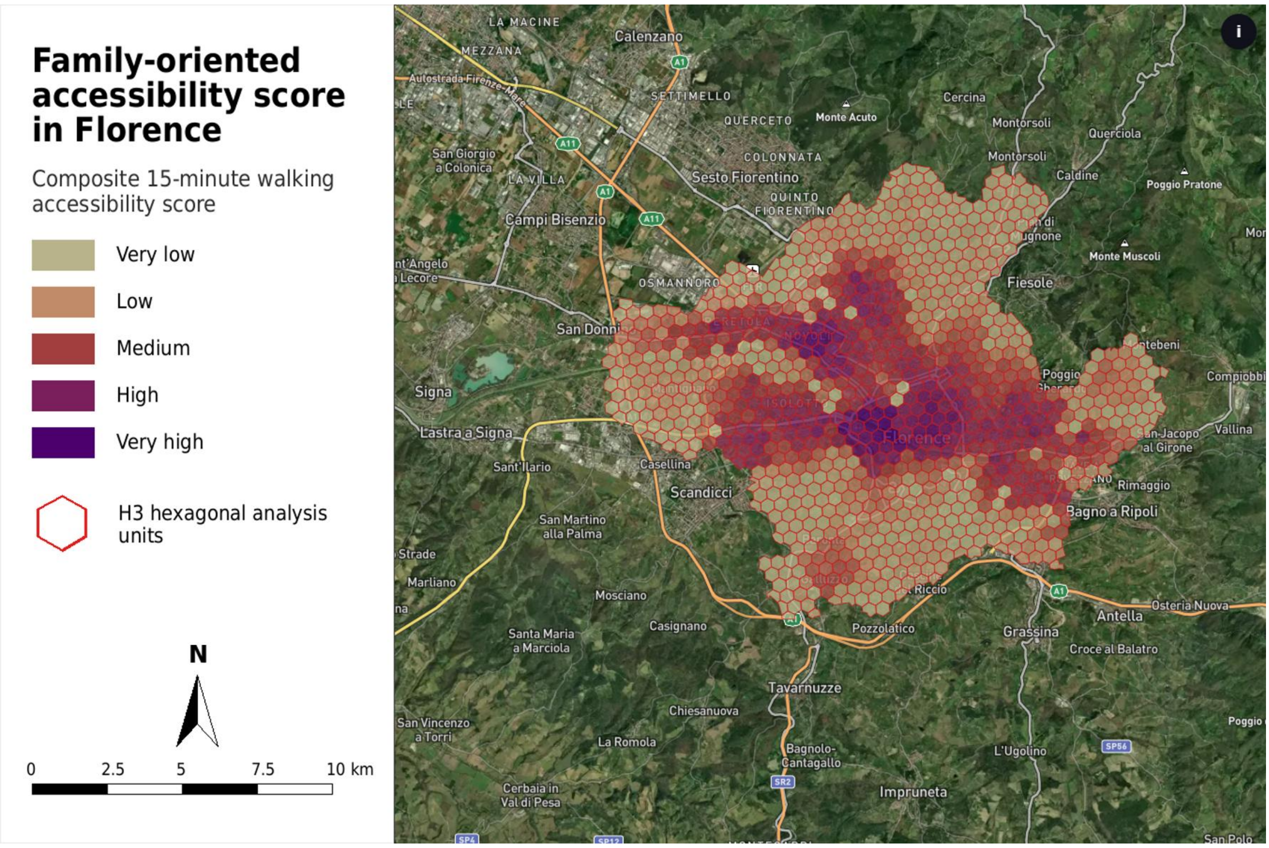

Figure 34: Florence - Family -oriented accessibility score

The family-oriented accessibility score in Florence is highest in the central and inner urban area, where education and childcare, parks, healthcare, daily needs and mobility access overlap. The map shows a relatively continuous zone of medium to high accessibility around the urban core, with weaker values toward the edges of the study area. Family-oriented walking accessibility is therefore strongest in the consolidated city, while more peripheral areas show weaker access to the combined set of family-relevant destinations.

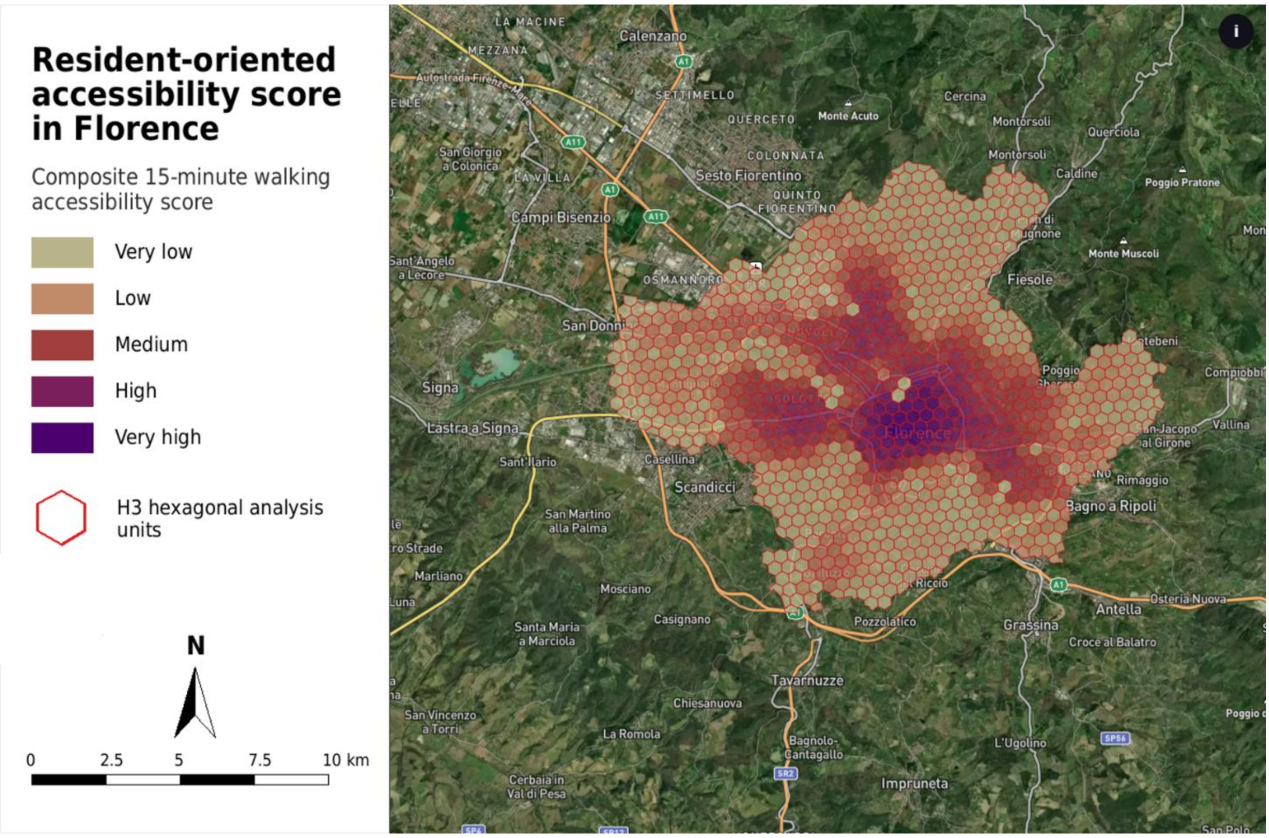

Figure 35: Florence - Resident -oriented accessibility score

The resident-oriented accessibility score shows a strong central and inner-urban concentration. High values appear where daily needs, mobility access, healthcare and local services are clustered. Florence's compact urban structure supports strong resident-oriented accessibility in the centre and nearby neighbourhoods. Accessibility decreases toward peripheral and hillside areas, highlighting a spatial contrast between the walkable inner city and less service-dense outer areas.

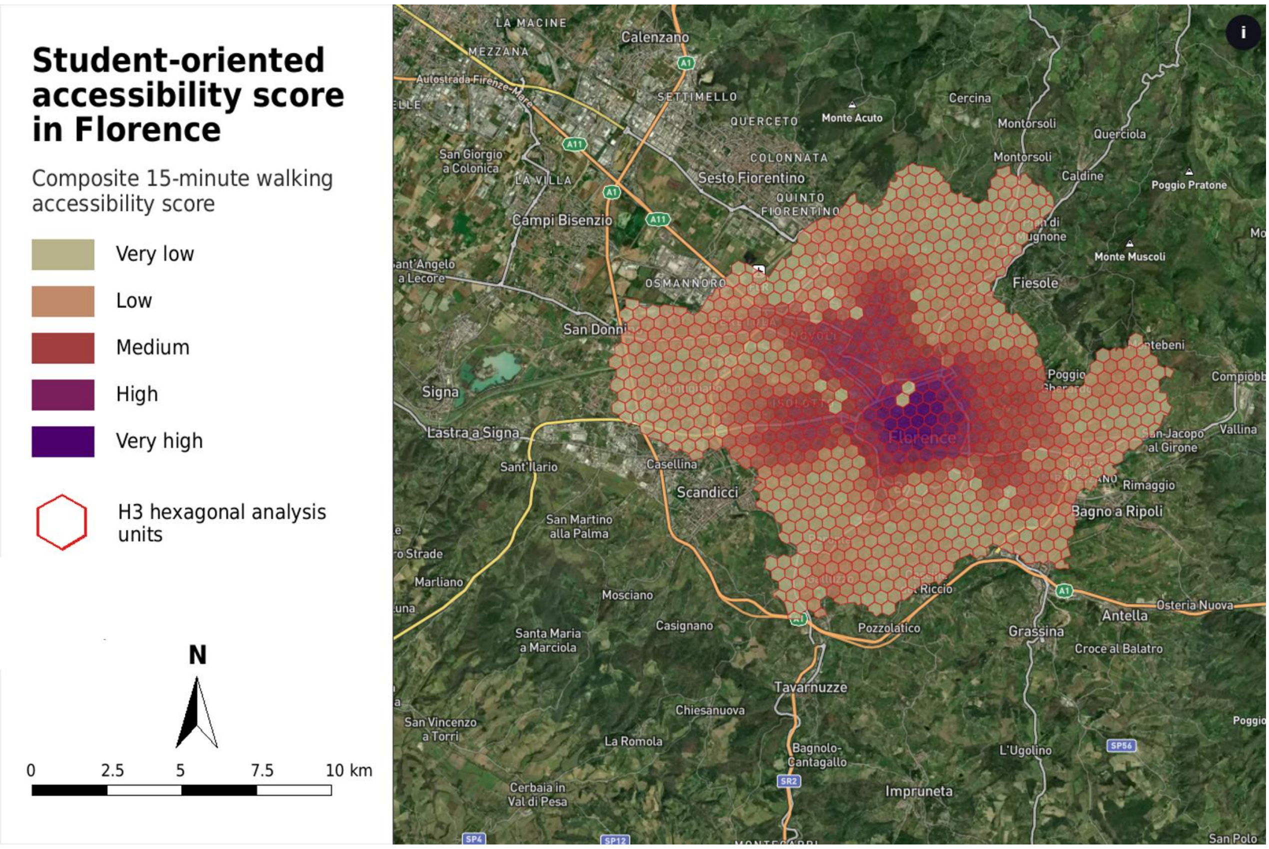

Figure 36: Florence - Student -oriented accessibility score

The student-oriented accessibility score is concentrated in and around the central urban area, with medium values extending into selected surrounding neighbourhoods. The pattern reflects the overlap between education-related destinations, public transport access, daily services and urban opportunities. Student accessibility is strongest where education and urban services are close together. Peripheral areas show weaker values, indicating lower walking-based support for student daily mobility outside the consolidated urban fabric.

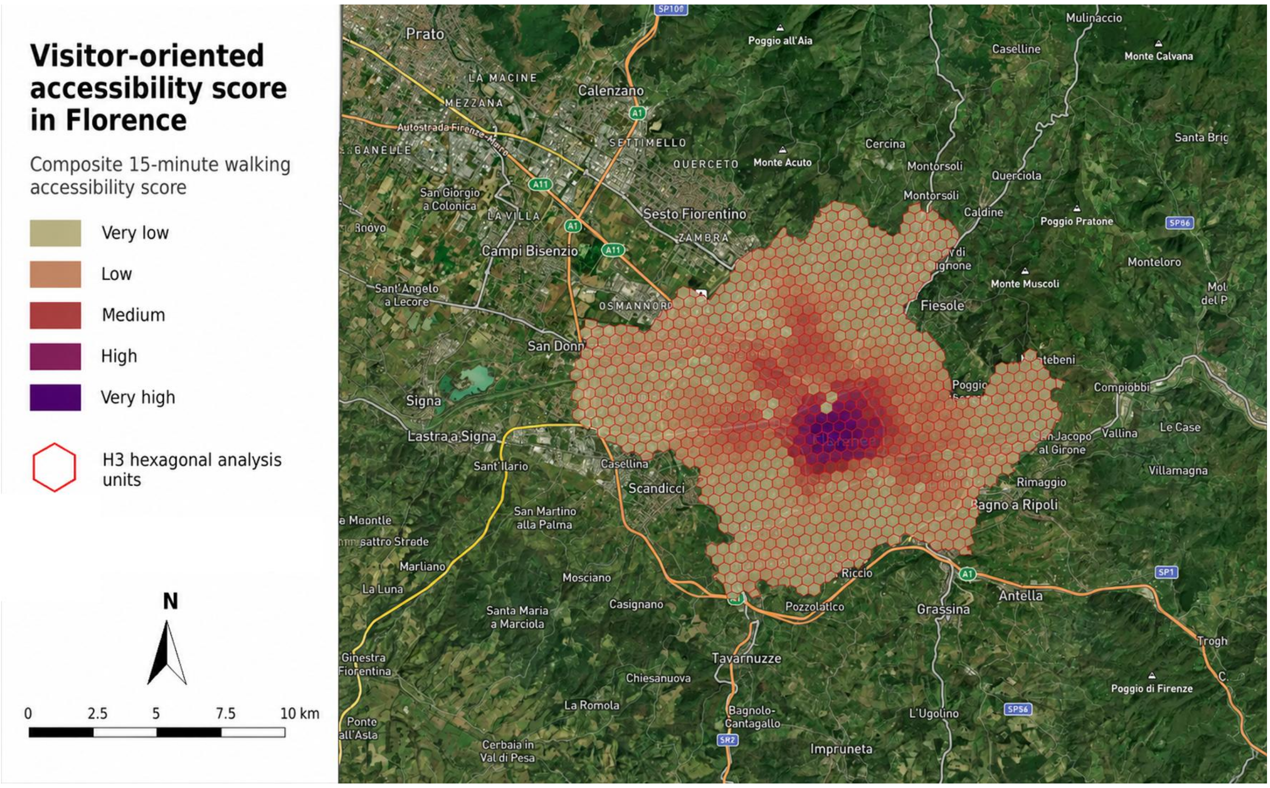

Figure 37: Florence - Visitor-oriented accessibility score

The visitor-oriented accessibility score is highly concentrated in the historic centre. This reflects the strong clustering of attractions, cultural destinations, mobility access and visitor-related urban opportunities in the core of Florence. The score decreases sharply outside the central area, confirming that visitor accessibility is spatially narrower than resident, family or student accessibility. This result is important for Florence because it shows where tourism-related accessibility demand overlaps with public-space pressures, pedestrian flows and urban logistics constraints.

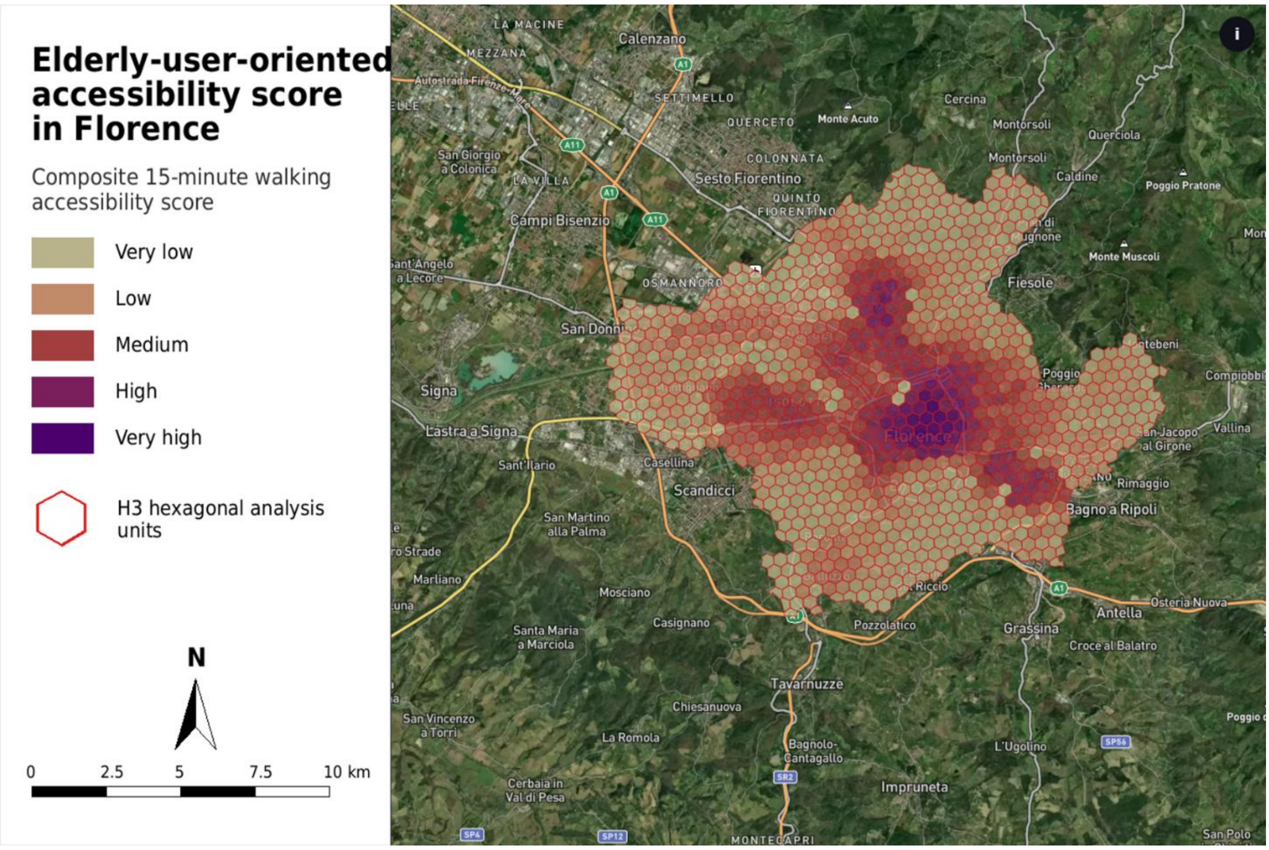

Figure 38: Florence - Elderly-oriented accessibility score

The older-user-oriented accessibility score shows high values around the central and inner urban area, where healthcare, daily needs, parks and mobility access overlap. The compact city structure supports strong older-user accessibility in central areas. Peripheral and hillside areas show lower scores, indicating that walking-based access to the combination of services most relevant for older users is weaker outside the consolidated urban fabric. This reinforces the importance of interpreting accessibility through both proximity and the usability of walking routes, public transport access and public-space conditions.

Overall, Florence shows the most compact and centralised persona-accessibility structure among the three pilot cities. Most persona profiles perform well in the central and inner urban area, while peripheral areas show weaker accessibility. Visitor accessibility is especially concentrated in the historic centre, while resident, family, student and older-user accessibility extend somewhat further into the surrounding urban fabric. This pattern is highly relevant for Florence's road-space reallocation, 30 km/h and urban logistics measures, because many user needs overlap in a spatially constrained central area.

4.3.3 Cross-city persona interpretation

Across the three pilot cities, the persona-oriented maps confirm that accessibility is not only a question of how many destinations are present, but also of which combinations of destinations are relevant for different user profiles. A hexagon performs well for visitors when it has strong access to culture and tourism destinations, but it performs less strongly for families when it lacks schools, parks or daily services. Similarly, an area performs well for mobility access when many stops are reachable, but it scores lower for older users when healthcare and daily needs are not nearby.

Florence shows the strongest compact central accessibility structure. Most persona scores are highest in and around the historic and inner urban area. Antwerp shows a broader but more uneven structure, with strong accessibility in central and southern neighbourhoods and weaker values in northern and port-related areas. Pilsen shows a more selective node-based structure, where high persona scores are concentrated in the city centre and selected neighbourhood clusters.

The comparison also shows that different personas reveal different spatial problems. Visitor-oriented accessibility is consistently the most centralised, especially in Florence and Pilsen. Resident and family-oriented accessibility are more spatially extended because they rely on everyday services distributed across residential areas. Student-oriented accessibility follows the overlap between education, public transport and urban services. Older-user accessibility is particularly sensitive to the combined availability of healthcare, mobility, parks and daily needs.

These results demonstrate the added value of the persona-oriented Atlas layer. The category-based maps identify where specific destinations are reachable within 15 minutes, while the persona maps translate these destination patterns into user-oriented accessibility profiles. This makes it possible to identify not only where accessibility is high or low, but also which types of users benefit from existing spatial conditions and which areas require targeted mobility, service or public-space interventions.

4.4 Link between Atlas outputs and selected mobility solutions

The Atlas provides a current accessibility baseline that supports the interpretation of the selected pilot-city mobility solutions. It does not estimate the direct impact of each solution. It identifies the spatial context in which the solutions operate and the areas where accessibility gaps or opportunities are most relevant.

For Pilsen, the Atlas is particularly relevant for interpreting cycling, first-/last-mile access and Digital Twin-supported mobility planning. The mobility-accessibility map shows where public-transport access points are already available within walking distance, while the daily-needs, education, healthcare and parks layers show where local service access remains more uneven. This supports the identification of areas where cycling links, bike-share expansion, public-transport integration or Digital Twin-supported monitoring are most relevant.

For Antwerp, the Atlas provides spatial context for the scale-up of multimodal route planning and Smart Ways to Antwerp. The maps show that mobility access is relatively broad in consolidated urban areas, while destination accessibility varies substantially across the metropolitan structure. This distinction is important because digital information tools improve route choice and multimodal awareness, but they do not fully compensate for areas where physical destination density or service availability is low.

For Florence, the Atlas supports the interpretation of road-space reallocation, 30 km/h traffic calming and urban logistics micro-hubs. The maps show a strong overlap of visitor, resident, family, student and older-user accessibility in the compact central area. This confirms that the central and inner urban fabric is where multiple user needs, public-space pressures and mobility conflicts coincide. The Atlas therefore explains why public-space management, pedestrian accessibility, safe streets and logistics organisation are central to the Florence SOMI use case.

In this sense, the Atlas strengthens the place-based dimension of SOMI. It makes the spatial distribution of accessibility visible and provides a baseline for discussing where selected mobility solutions are most relevant, where trade-offs arise and where further local validation adds value.

4.5 Limitations and future refinement

The current Atlas is an initial spatial demonstrator of walking-based accessibility across the three GOLIA pilot cities. Its interpretation is based on the following methodological limitations.

First, the analysis relies on OpenStreetMap data. OpenStreetMap is a rich and widely used geospatial source, but its completeness and accuracy vary across cities, neighbourhoods and destination categories. Some points of interest are missing, outdated or inconsistently classified. The quality of the Atlas therefore depends partly on the quality and completeness of the underlying OSM data.

Second, the accessibility calculation uses a 15-minute walking threshold. The 15-minute walking threshold reflects the proximity-planning logic used in the Atlas, where everyday accessibility is assessed through the availability of relevant destinations within short walking distance rather than only through motorised travel-time performance (Moreno et al., 2021; Pajares et al., 2021; Willberg et al., 2023). This threshold is intuitive and consistent with proximity-based planning approaches, but it remains a fixed analytical assumption. Different users walk at different speeds, and people with reduced mobility experience smaller effective walking catchments. The current Atlas applies a common walking threshold to all users.

Third, the H3 centroid is used as the representative origin point for each hexagon. This enables consistent and efficient calculation, but it simplifies within-hexagon variation, especially where the street network is fragmented, where pedestrian barriers exist, or where the centroid is not representative of actual residential or activity locations.

Fourth, the Atlas measures the number of reachable destinations, not their quality, affordability, opening hours, capacity, universal accessibility, perceived safety or reliability. Access to a bus stop does not mean access to frequent, affordable, direct or barrier-free public transport. Access to healthcare facilities does not indicate appointment availability, service capacity or suitability for specific user needs.

Fifth, the analysis focuses on walking accessibility and does not include full multimodal accessibility. Public transport, cycling, shared mobility and car-based travel are not modelled as travel-time networks in the current Atlas. The Atlas is therefore most useful for interpreting local proximity and walking-based accessibility, while broader regional accessibility requires complementary analysis.

Sixth, persona-oriented accessibility scores are derived indicators. They translate spatial accessibility into user-oriented profiles, but they are not direct survey-based measures of behaviour. The weights used in the persona profiles are methodological assumptions informed by accessibility and user-needs logic.

Seventh, the Atlas does not classify neighbourhoods as socially optimal or socially excluded in a complete sense. It describes one specific dimension of urban opportunity: walkable access to selected destination categories within 15 minutes. It is interpreted together with other evidence on housing, affordability, environmental quality, safety, disability access, service quality and local knowledge.

Future refinements include the integration of authoritative local datasets, validation of OpenStreetMap points of interest, alternative walking speeds by persona, public-transport and cycling travel-time accessibility, time-of-day accessibility, service quality indicators, opening-hours constraints, sidewalk and crossing quality, and stronger linkage between Atlas outputs and SOMI pillar scores. Further validation with pilot cities, local stakeholders and user representatives strengthens the interpretation of persona-oriented accessibility profiles.

Overall, the Atlas of Accessibility provides a structured and visually communicable spatial baseline for D1.4. It complements the SOMI calculation model by showing where accessibility opportunities and gaps are located, how different destination categories are distributed, and how these patterns are interpreted through simplified user-oriented profiles. The Atlas therefore contributes to the wider GOLIA objective of supporting socially optimised, inclusive and place-sensitive mobility planning.

5 Conclusions

D1.4 has developed a structured methodology for assessing mobility solutions through the Social Optimum Mobility Index and the Atlas of Accessibility. The deliverable translates GOLIA's Mobility as a Right ambition into a practical assessment framework that can be used to compare mobility solutions across social, spatial, technical and governance dimensions. Its main contribution is the creation of an auditable calculation logic that links KPIs, SOMI pillars, transport personas, expert-derived weights, pilot-city use cases and spatial accessibility evidence within a common decision-support structure.

The pilot-city applications show that SOMI can be applied as a shared assessment logic while still respecting the specific mobility context of each city. In Florence, the methodology is applied to 30 km/h traffic-calmed areas, urban logistics micro-hubs and road-space reallocation. These solutions highlight how safety, liveability, accessibility, affordability and operational needs can affect different personas in different ways. In Pilsen, the assessment of cycling and bike-share uptake, public transport and first- and last-mile integration, and connected corridor readiness shows the relevance of SOMI for everyday accessibility, multimodality and implementation readiness. In Antwerp, the Smart Ways to Antwerp applications show how a mature multimodal mobility ecosystem can be assessed both as a service-quality improvement and as an inclusion challenge for groups that may otherwise remain underserved.

Across the three cities, the value of SOMI is not limited to the final index value. Its strength lies in making assumptions, trade-offs and distributional effects visible. The methodology shows how a mobility solution may perform well for some personas while creating weaker outcomes for others. It also shows how different SOMI pillars may pull in different directions. A solution may improve accessibility but raise affordability concerns, improve safety but create operational constraints, or improve service availability while still leaving gaps in acceptability, agency or participation. SOMI therefore provides a structured way to discuss these trade-offs rather than hiding them behind a single average indicator.

5.1 From pilot-city findings to new-generation transport model components

The pilot-city findings presented in Chapter 3 are relevant for the development of new-generation transport model components because they show how conventional transport outputs can be interpreted through a broader social-optimum lens. SOMI does not replace transport modelling, accessibility modelling or scenario analysis. Instead, it provides an interpretation layer that connects technical model outputs with accessibility, personas, SOMI pillars, distributional effects and spatial context.

In conventional transport modelling, trip generation estimates how many trips are produced or attracted by different zones, households, land uses or activities. This is a necessary starting point, but it can be socially incomplete if observed trips are treated as equivalent to real mobility needs. A low number of trips in a disadvantaged area does not necessarily mean that residents or city users have fewer needs. It may indicate suppressed demand caused by poor accessibility, high costs, unsafe conditions, limited service availability or digital exclusion. For this reason, new-generation modelling increasingly connects trip generation with accessibility and spatial context. Krasić and Novačko (2015) show that public transport network accessibility can improve trip generation modelling, while Wu et al. (2012) and Kröger et al. (2018) also demonstrate the importance of linking trip rates to accessibility conditions.

SOMI can build on these developments by interpreting trip generation outputs through a social-optimum lens. Instead of asking only how many trips are generated, SOMI asks whether trip generation reflects real participation opportunities. For example, trip generation outputs can be differentiated by persona, income group, age, disability status, residential location or access to public transport. These differentiated outputs can then support SOMI indicators related to Accessibility, Availability and Agency. If a peripheral or low-income neighbourhood generates fewer work, education or healthcare trips than expected, SOMI can help interpret this as a potential sign of unmet mobility need rather than simply as low demand. In this way, trip generation becomes more than a demand-estimation step. It becomes an entry point for detecting mobility deprivation.

The same logic applies to urban freight and last-mile logistics. Fried et al. (2024) show that freight trip generation and last-mile delivery can also be evaluated through an equity lens. This is relevant for SOMI because freight flows affect neighbourhood liveability, curb-space use, emissions, safety and access to services. Therefore, trip generation outputs for both passenger and freight mobility can feed SOMI by revealing where mobility demand is socially necessary, where it is excessive, and where it creates external burdens for specific territories or user groups.

Trip distribution models estimate where generated trips are likely to go. Traditional gravity-based approaches often allocate trips according to distance, travel cost or generalised impedance. However, this can hide important social differences. Two people may face the same modelled travel time but very different real constraints due to income, care responsibilities, disability, shift work, safety concerns or limited modal options. Chacon-Hurtado et al. (2019) argue that traditional trip distribution processes relying heavily on gravity models may fail to capture how individual characteristics and workplace attributes influence job accessibility and journey-to-work patterns. Similarly, Zhang et al. (2019) show that place of residence and place of work decisions are deeply connected to daily travel behaviour and mode choice.

SOMI can use trip distribution outputs to move from a purely spatial interpretation of origin-destination flows to a territorial justice interpretation. Origin-destination matrices can be transformed into indicators showing whether different personas can reach key opportunities such as jobs, schools, health services, public administration, cultural facilities and green spaces. In this sense, the trip distribution component can directly support the SOMI Accessibility pillar. It can also support Affordability when travel costs are attached to origin-destination pairs, Availability when service frequency and temporal coverage are included, and Safety and Security when exposure to risky routes or unsafe waiting environments is spatially represented.

Integrated land-use and transport models are particularly important here. An and Chen (2012) demonstrate how land-use outputs and transport model outputs can be connected through accessibility measures. This is highly compatible with SOMI, because social optimum depends not only on movement but also on the spatial arrangement of opportunities. A transport system may appear efficient from a network perspective but still be socially weak if essential services remain concentrated in areas that are difficult or expensive for vulnerable groups to reach. SOMI therefore allows trip distribution outputs to be assessed not only according to the amount of movement they produce, but also according to whether they improve balanced and fair access across territories.

Mode choice models estimate whether users select car, public transport, walking, cycling, shared mobility or other modes. Traditional mode choice models usually rely on variables such as travel time, cost, distance, transfers and vehicle availability. These variables remain essential, but they are not sufficient to explain socially optimal mobility. The newer literature shows that mode choice is influenced by tour structure, access and egress distances, individual mobility attributes, social norms, built environment, perceived safety and availability of alternatives. Bastarianto et al. (2019), for example, develop a tour-based mode choice model, showing that mode choice is influenced by the structure of daily activities rather than isolated trips. Wang et al. (2025) show that access and egress distances strongly affect public transport commute mode choices, while Vovsha et al. (2013) highlight the importance of individual mobility attributes such as car ownership, driving licence, parking availability and transit pass ownership.

SOMI can enrich mode choice outputs by interpreting them through pillars such as Agency, Affordability, Acceptability and Safety and Security. A high car share, for example, may not simply indicate a preference for private vehicles. It may reflect the absence of reliable alternatives. Similarly, a low cycling share may not indicate lack of willingness to cycle, but rather poor perceived safety, lack of infrastructure, long access distances or social norms that discourage cycling. Wang et al. (2018) show that mode choice should be understood through a multi-choice perspective in which different transport options may substitute or complement one another. This fits well with SOMI's Agency pillar, because socially optimal mobility requires meaningful choice rather than forced dependence on a single mode.

SOMI can therefore transform mode choice probabilities into socially relevant outputs. For each persona, mode choice results can be assessed according to whether the chosen or available modes are affordable, accessible, safe and acceptable. A policy scenario that increases public transport mode share but makes trips more expensive for low-income users would not automatically be socially optimal. Likewise, a scenario that increases cycling but exposes users to higher safety risk would require careful evaluation. Through SOMI, mode choice outputs become part of a broader assessment of whether users have real, fair and dignified modal options.

Traffic assignment models allocate trips to routes and network links. Their traditional function is to estimate congestion, travel times, link flows, route costs and network performance. New-generation transport models increasingly combine assignment with simulation, dynamic traffic modelling, agent-based modelling and resilience analysis. Azevedo et al. (2016) show how agent-based models can combine activity-based demand with detailed network dynamics and dynamic traffic assignment. Jiang et al. (2022) use activity-based modelling and traffic assignment to assess connected and automated vehicle impacts on VMT, emissions and equity. Taghizadeh and Mahsuli (2026) also demonstrate how network and agent-based models can support risk and resilience analysis of transport systems.

SOMI can use traffic assignment outputs to evaluate not only whether the network is efficient, but also whether it is socially acceptable. Link-level speeds, congestion, delays and route flows can be translated into indicators of Availability and Accessibility. Crash exposure, pedestrian conflict risk, unsafe crossings and emergency routing performance can feed Safety and Security. Emissions, noise and congestion burdens can be spatially allocated to identify whether specific communities bear disproportionate negative impacts. Di Ciommo and Lucas (2014), for instance, show that road-pricing policies may have different spatial and social equity impacts across user groups. This type of analysis is directly relevant to SOMI because assignment outputs can reveal who benefits from network optimisation and who pays the cost.

Assignment outputs can also support resilience-oriented SOMI assessment. Vichiensan et al. (2025) show that flood adaptation measures can be assessed by linking flood simulation with a travel demand model to evaluate congestion and mode shift. In a SOMI framework, such outputs would not only indicate increased travel time or disrupted routes. They would also show which personas lose access to essential services, which areas become isolated, and whether alternative modes remain available. This allows traffic assignment to contribute to socially optimal mobility planning under disruption, climate stress or emergency conditions.

The main contribution of SOMI is that it can connect the outputs of each transport model component into a coherent social evaluation framework. Trip generation can reveal mobility needs and suppressed demand. Trip distribution can reveal territorial accessibility and spatial inequality. Mode choice can reveal whether users have meaningful and affordable options. Traffic assignment can reveal exposure to congestion, delay, emissions, risk and insecurity. Activity-based and agent-based models can further strengthen this process because they produce disaggregated outputs at the level of individuals, households, tours and daily activity patterns. Bills and Walker (2017) argue that activity-based travel demand models are especially useful for equity analysis because they can generate disaggregate transport measures and support analysis beyond average impacts.

This is highly compatible with the SOMI logic. SOMI can receive outputs from conventional or advanced transport models and convert them into normalised pillar scores by persona, city and solution. It can therefore transform model results from technical forecasts into policy-relevant social-optimum evidence. For example, an agent-based simulation of demand-responsive transport may show changes in waiting time, coverage and vehicle utilisation. SOMI can evaluate whether those changes improve access to jobs, education and healthcare for people without cars, as discussed in agent-based analyses of demand-responsive transport and social exclusion (Inturri et al., 2021; Giuffrida et al., 2020). Similarly, activity-based accessibility analysis of automated vehicles can be interpreted not only in terms of travel demand change, but also in terms of who gains or loses accessibility (Luo et al., 2022).

The pilot-city applications illustrate how this modelling logic can become operational in GOLIA. In Florence, the 30 km/h traffic-calming example shows how a safety-oriented measure can affect personas differently, depending on their everyday mobility needs and on the relative importance of safety, accessibility, affordability and liveability. In Pilsen, the cycling, bike-sharing and public transport integration examples show how SOMI can capture differences between students, commuters, families, older users and visitors, especially where the success of a solution depends on practical everyday access and first- and last-mile connectivity. In Antwerp, the Smart Ways to Antwerp examples show how a mature multimodal mobility ecosystem can be assessed both as a service-quality improvement and as an inclusion challenge for groups that may need clearer information, accessibility support or more tailored guidance.

The Atlas of Accessibility adds a spatial dimension to this logic. It shows that mobility conditions are not evenly distributed within cities and that accessibility outcomes depend on where people live, where services are located and how the walking network connects origins to opportunities. By combining spatial accessibility outputs with persona-oriented interpretation, the Atlas supports a more place-sensitive reading of the SOMI framework. It helps identify where specific interventions may be most relevant and where complementary measures may be required.

In this way, the new generation of transport models becomes more useful for governance. Their value is not only that they are more detailed or computationally advanced, but that they can be connected to a evaluative framework. SOMI provides this framework by translating model outputs into a structured assessment of social optimum. The result is a modelling chain in which technical performance, accessibility, equity, well-being and rights are evaluated together. This allows GOLIA to move from transport modelling as prediction toward transport modelling as social decision support.

5.2 SOMI-driven planning use and the connection with GO-WISDOM

SOMI-driven planning refers to the use of the Social Optimum Mobility Index not only as an evaluation score, but as a practical decision-support logic for mobility governance. Its role is to help authorities understand whether a proposed intervention improves the mobility system in a socially meaningful way, rather than only improving technical performance indicators such as speed, flow, capacity or average travel time. This is consistent with the broader shift from conventional transport appraisal toward accessibility, equity, capability, well-being and justice-oriented evaluation, where the relevant question is not only whether the system works efficiently, but whether it enables different groups to access opportunities under fair, safe and dignified conditions (Beyazit, 2011; Lucas et al., 2016; Pereira et al., 2017; Vecchio and Martens, 2021).

Within GOLIA, SOMI can be used in planning in three complementary ways, as an objective, as a constraint and as a monitoring metric. As an objective, SOMI allows authorities to prioritise policy scenarios that maximise overall social value across the selected pillars, namely Accessibility, Availability, Affordability, Acceptability, Agency, Participation, Legal Recognition and Safety and Security. In this sense, a mobility intervention is not preferred simply because it improves traffic conditions or increases modal efficiency. It is preferred when it improves the combined social performance of the mobility system, especially for the personas, territories and user groups that are most dependent on fair and reliable access.

As a constraint, SOMI acts as a Mobility as a Right safeguard. This means that an intervention should not be considered socially acceptable if it improves the average score while undermining minimum equity, accessibility, affordability or safety conditions for vulnerable groups. For example, a measure that reduces congestion but increases the cost burden for low-income users, worsens access for older people, or reduces delivery reliability for small businesses would need to be reconsidered or complemented by mitigation measures. This reflects the core logic of transport justice research. Aggregate improvements are not sufficient if they conceal unequal impacts or deepen social exclusion (Stanley et al., 2011; Di Ciommo and Lucas, 2014; Martens, 2017; Oliveira Soares and Glaser, 2025).

As a monitoring metric, SOMI supports continuous and adaptive planning. Instead of being calculated once at the end of a project, it can be used before, during and after implementation. At the baseline stage, it helps identify existing mobility deficits across personas and territories. During scenario appraisal, it helps compare alternative interventions or packages. During implementation, it can monitor whether expected benefits are actually emerging. After implementation, it can support policy learning by showing whether the intervention remains socially beneficial over time. This is important because mobility systems are dynamic. Daily modal patterns, service reliability, affordability conditions, safety perceptions and user priorities may change. The pilot-city SOMI applications presented in Chapter 3 provide useful examples of how this planning role can work in practice across different mobility solutions and urban contexts.

The connection with GO-WISDOM is therefore central. GO-WISDOM can be understood as the digital planning environment where SOMI becomes operational for decision-making. While GO-DATA provides the data inputs, GO-INFO supports visualisation and communication, and GO-KNOW structures the reusable knowledge base, GO-WISDOM uses SOMI to compare policy scenarios, reveal trade-offs and support the selection of interventions that improve social outcomes. D1.4 positions GO-WISDOM as the module that supports implementation by maximising SOMI, highlighting conflicts between policy goals, and identifying incentives or nudges for disadvantaged groups.

Conceptually, GO-WISDOM does not replace political judgement or stakeholder deliberation. Instead, it makes the consequences of different planning choices more visible and transparent. It can show, for example, that one scenario improves average accessibility but weakens affordability, while another improves safety but creates operational difficulties for delivery users. This is important because socially optimal mobility rarely means that every group benefits in exactly the same way. The planning challenge is to identify policy packages that improve the overall system while avoiding unacceptable harm to specific groups. This connects SOMI directly to the literature on composite indicators, multi-criteria appraisal and distributional equity, which stresses that planning tools should make assumptions, weights and trade-offs explicit rather than hiding them behind a single average score (Thomopoulos and Grant-Muller, 2013; Danielis et al., 2017; Ayadi et al., 2024).

The pilot-city SOMI applications provide useful examples of this planning role. In Florence, the 30 km/h traffic-calming example shows how a safety-oriented measure can generate different outcomes for city-centre residents, urban families, students, commuters and logistics-related users, depending on their daily mobility needs and on the relative importance of safety, accessibility, affordability and liveability. In Pilsen, the cycling, bike-sharing and public transport integration examples show how SOMI can capture differences between students, commuters, families, older users and visitors, especially where the success of a solution depends on practical everyday access and first- and last-mile connectivity. In Antwerp, the Smart Ways to Antwerp examples show how a mature multimodal mobility ecosystem can be assessed both as a service-quality improvement and as an inclusion challenge for groups that may need clearer information, accessibility support or more tailored guidance.

In practical planning terms, SOMI-driven GO-WISDOM use can follow a clear policy cycle. First, authorities define the problem and establish a baseline SOMI profile for each relevant solution, persona and territory. Second, alternative interventions are translated into expected changes in the SOMI pillars. Third, GO-WISDOM compares the scenarios and identifies which options improve the overall social optimum. Fourth, the system checks whether any MaaR-sensitive pillar or vulnerable persona falls below an acceptable threshold. Fifth, where trade-offs appear, authorities can redesign the policy package by adding compensatory or corrective measures. Finally, after implementation, SOMI is recalculated periodically so that planning remains adaptive rather than fixed.

This approach also strengthens the link between transport modelling and governance. Outputs from trip generation, distribution, mode choice and assignment models can feed GO-WISDOM, but SOMI changes how those outputs are interpreted. A change in mode share is not only a behavioural result. It becomes evidence about affordability, agency or acceptability. A change in network delay is not only an efficiency result. It becomes evidence about accessibility and availability. A change in route exposure is not only a technical assignment result. It becomes evidence about safety, environmental burden and territorial fairness. In this way, GO-WISDOM transforms model outputs into social decision-support information, consistent with new-generation transport modelling approaches that emphasise activity patterns, agent heterogeneity, accessibility, distributional impacts and equity-sensitive appraisal (Azevedo et al., 2016; Bills and Walker, 2017; Jiang et al., 2022; Luo et al., 2022).

Overall, SOMI-driven planning provides the evaluative logic through which GO-WISDOM can support socially responsible mobility governance. It enables public authorities to move beyond asking which intervention performs best for the network and toward asking which intervention produces the most acceptable balance between efficiency, equity, accessibility, safety, agency and rights. Its added value is not only that it produces a score, but that it structures the discussion around who benefits, who may be disadvantaged, which minimum conditions must be protected, and which complementary measures are needed to make a mobility intervention socially optimal.

5.3 Limitations and future research

The SOMI methodology developed in D1.4 provides a structured and transferable way to assess mobility solutions from a social-optimum perspective. At the same time, the present application should be interpreted as a methodological and pilot-city implementation step, rather than as a fully mature monitoring system. Several limitations therefore need to be acknowledged.

First, the calculation depends on the availability, quality and spatial resolution of city-level data. Although the methodology defines a common logic for KPI selection, normalisation and aggregation, not all pilot cities currently provide the same level of detail for all indicators. In some cases, proxy indicators or simplified assumptions are required in order to preserve comparability across solutions and personas. Future applications should progressively replace these proxies with more direct measurements, especially where operational, behavioural or accessibility data become available through city systems, GO-DATA, GO-X modules or other local data sources.

Second, the persona-based approach necessarily simplifies the diversity of real urban users. The final persona framework makes the SOMI calculation more human-centred and easier to interpret, but each persona still represents a broad group of people or organisations with different needs, capabilities and constraints. Future research should therefore test the persona assumptions with additional local evidence, stakeholder feedback and, where possible, observed behavioural data. This would help refine the way different groups experience mobility solutions and improve the robustness of persona-level SOMI results.

Third, the weighting process introduces expert judgement into the calculation. The ICB exercise provided a structured way to derive persona influence weights, while the pillar weights helped reflect the relative importance of SOMI dimensions for different personas. However, these weights should not be understood as fixed or universal values. They are context-specific inputs that reflect the knowledge available at this stage of the project. Future work should include sensitivity testing, additional expert validation and, where appropriate, direct engagement with local user groups in order to assess how changes in weights affect the final SOMI results.

Fourth, SOMI is not intended to replace detailed transport modelling, accessibility modelling or cost-benefit analysis. Its role is to complement these approaches by making social-optimum effects more visible. The results should therefore be read as decision-support outputs, showing how different solutions perform across personas and pillars, rather than as deterministic predictions of future mobility behaviour. Future integration with GO-WISDOM can strengthen this role by linking SOMI with dynamic data inputs, scenario comparison, visualisation tools and monitoring functions.

The Atlas of Accessibility developed in D1.4 should also be seen as a first version of a spatial decision-support layer that can be further enriched through GO-INFO. In its current form, the Atlas helps visualise selected accessibility conditions and identify areas where opportunities, constraints or potential mobility disadvantages are concentrated. In future iterations, this spatial layer can become more interactive and dynamic, allowing users of the GO-INFO environment to explore different combinations of mobility solutions, persona assumptions, SOMI pillars and spatial indicators. This would make it possible to test how alternative policy choices or implementation packages may affect different parts of the city and different user groups.

As part of GO-INFO, the Atlas could therefore evolve from a static mapping output into an exploratory interface for scenario testing and policy learning. Users could compare accessibility patterns before and after selected interventions, examine how results change when different personas or SOMI pillars are prioritised, and identify where complementary measures may be needed. This would strengthen the practical value of the Atlas by linking spatial evidence with the broader SOMI assessment logic and by supporting more targeted and adaptive decision-making.

Overall, future research should focus on moving SOMI from a pilot-city methodological application towards a more operational decision-support framework. This includes improving data pipelines, validating assumptions with cities and stakeholders, testing sensitivity to alternative weights and indicators, and embedding the methodology more fully within the GO-X and GO-WISDOM environment. These steps would increase the reliability, transparency and practical value of SOMI as a tool for assessing Mobility as a Right in different urban contexts.

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APPENDIX I

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

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Author(s):

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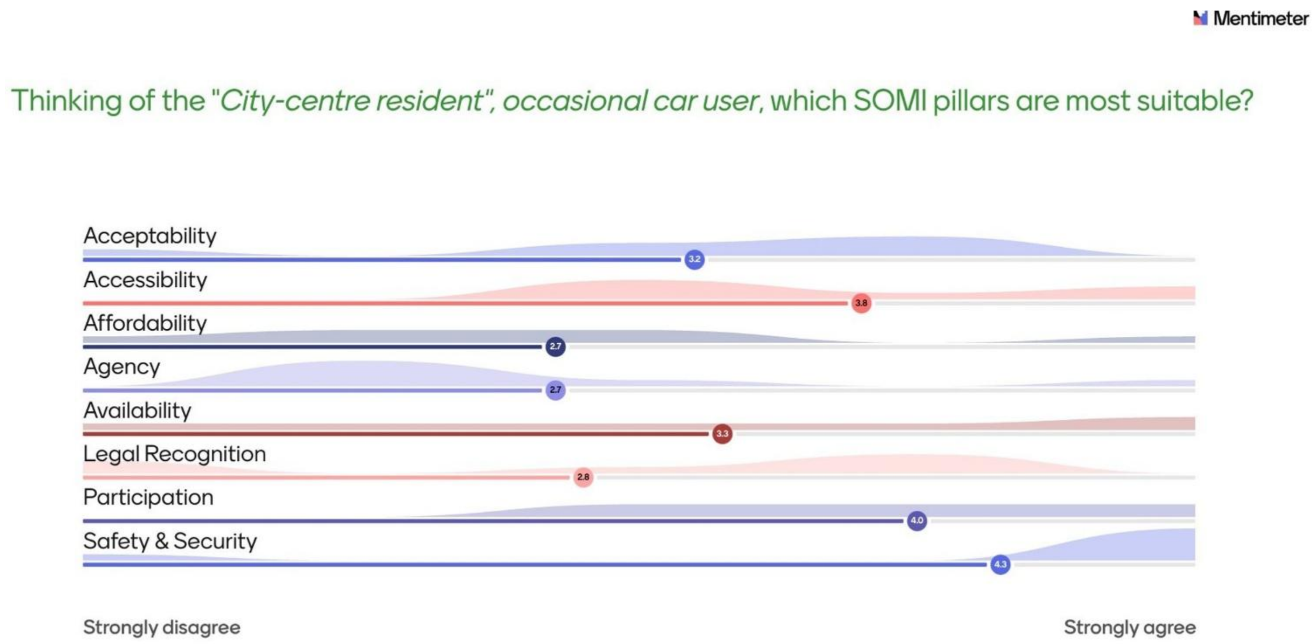
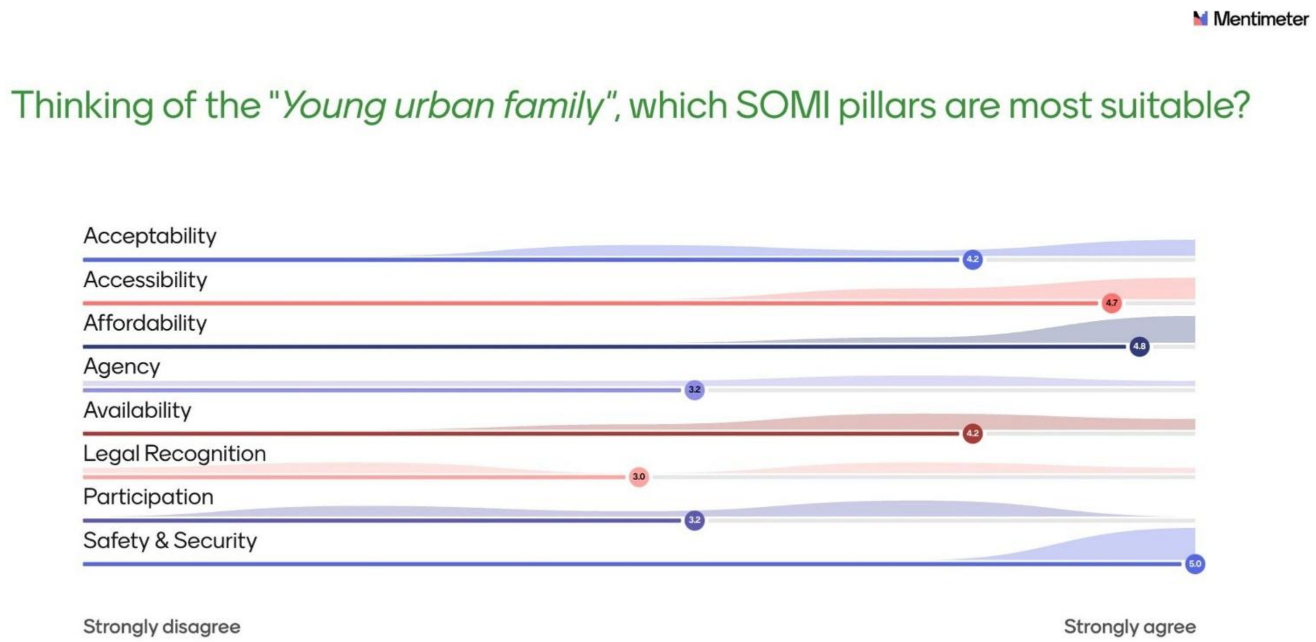
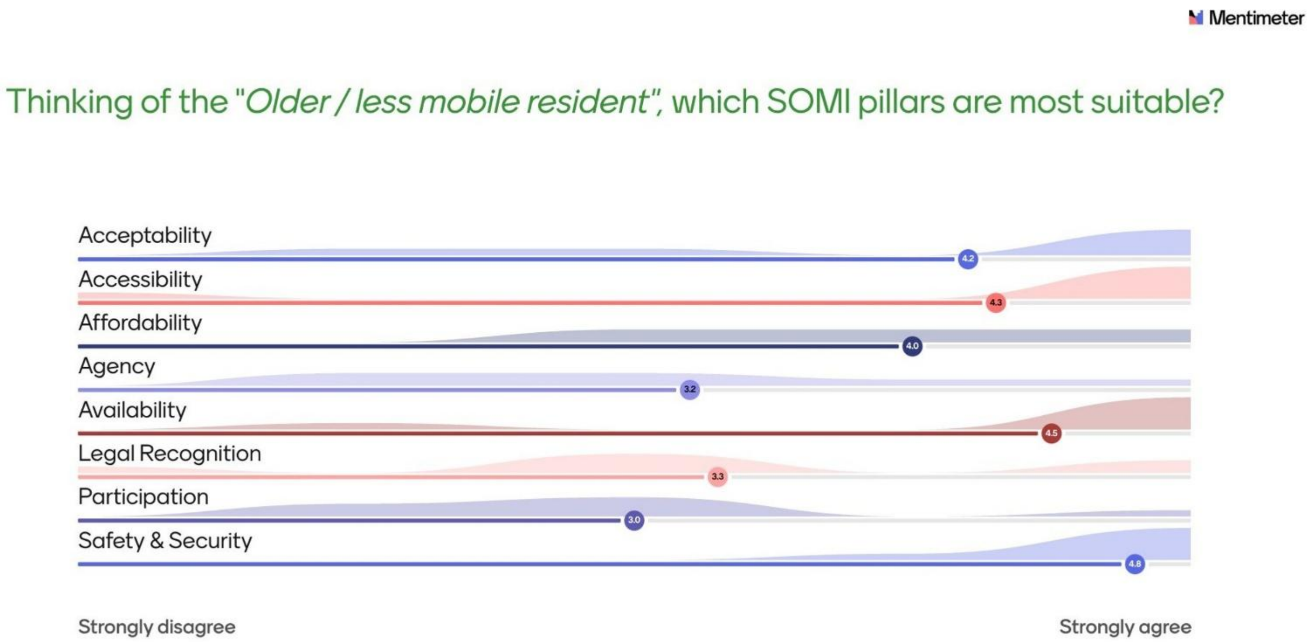
APPENDIX I: Florence Mentimeter Score exercise

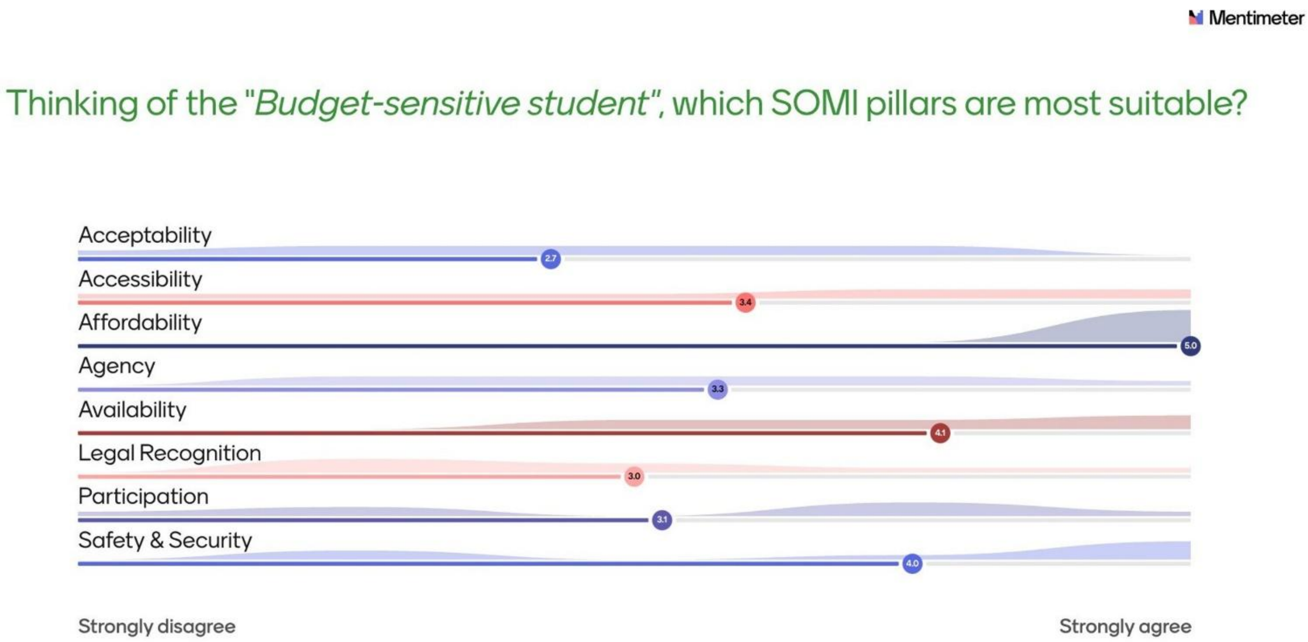
This appendix presents the Mentimeter scoring outputs used to support the Florence persona-pillar significance weights. The screenshots document how the SOMI pillars were assessed in relation to the Florence personas and provide traceable evidence for the weighting inputs used in the SOMI calculation. The material is retained as supporting evidence for the elicitation process and should be read together with the final persona framework, the normalisation logic and the SOMI methodology described in the main deliverable.

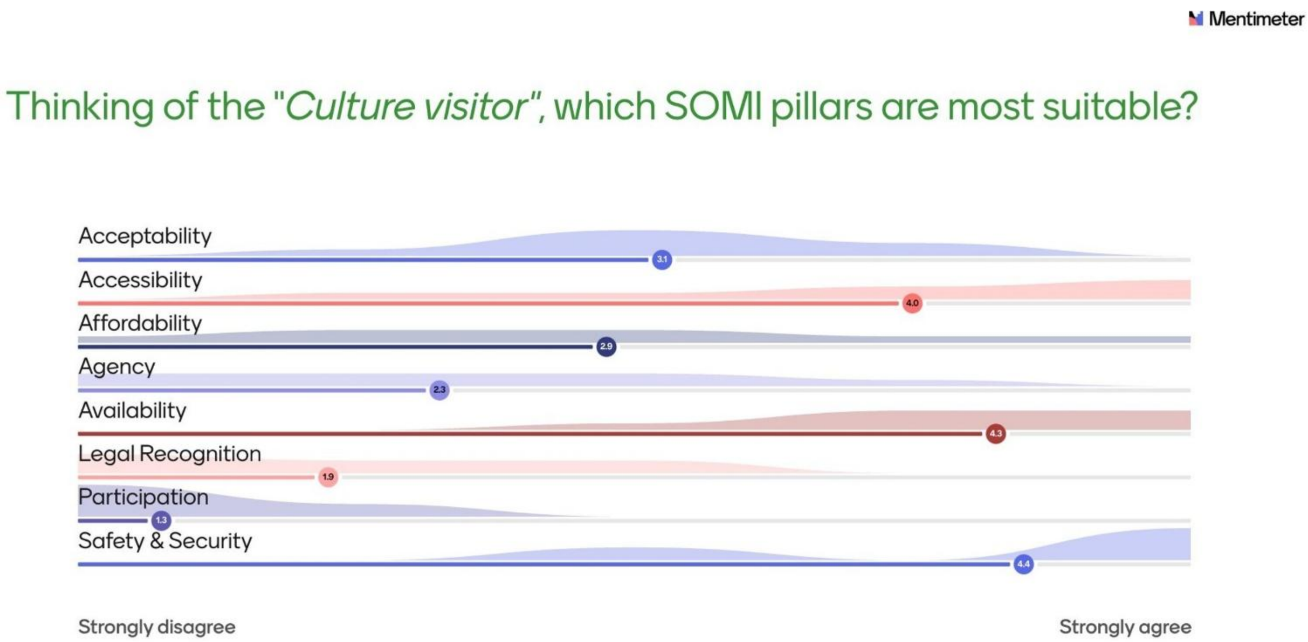


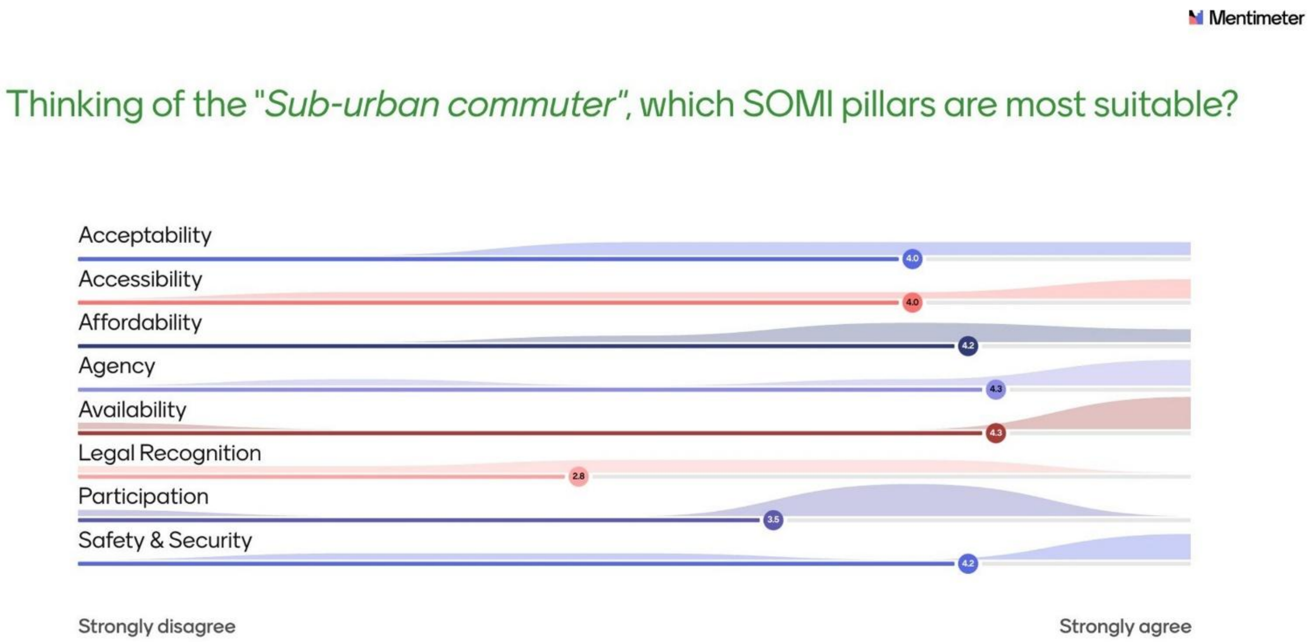


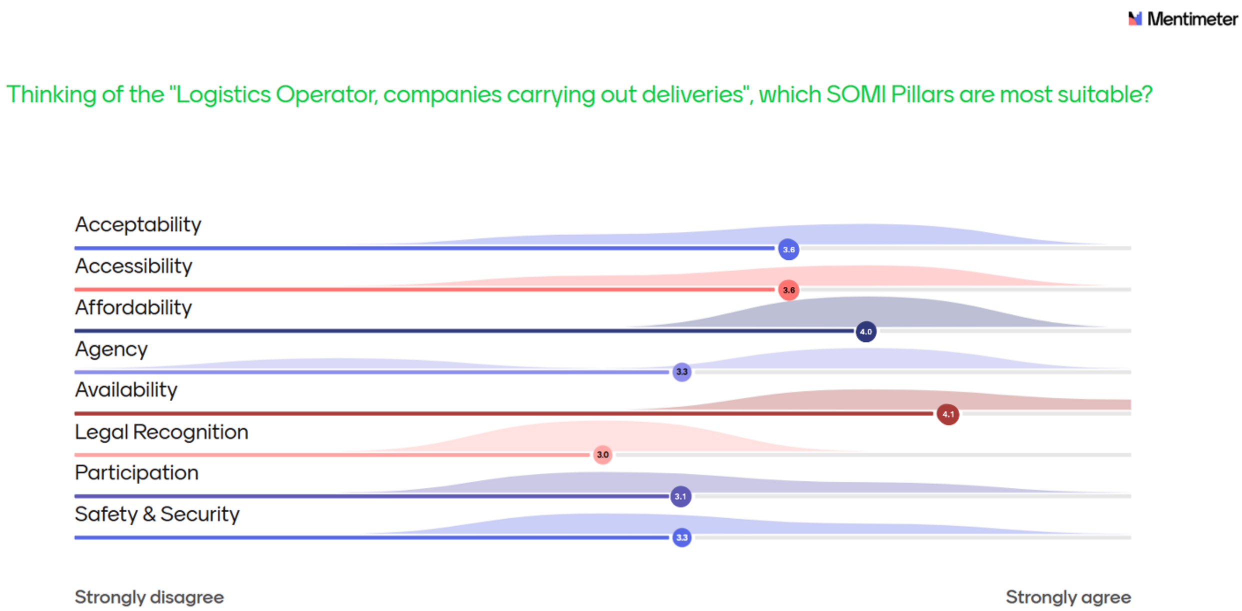

Mentimeter
Thinking of the "*Older / less mobile resident*", which SOMI pillars are most suitable?
Acceptability
4.2
Accessibility
4.3
Affordability
4.0
Agency
3.2
Availability
4.5
Legal Recognition
3.3
Participation
3.0
Safety & Security
4.8
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "*Shop owner with deliveries*", which SOMI pillars are most suitable?
Acceptability
3.6
Accessibility
3.6
Affordability
3.9
Agency
3.7
Availability
4.1
Legal Recognition
3.0
Participation
3.1
Safety & Security
3.3
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "*Budget-sensitive student*", which SOMI pillars are most suitable?
Acceptability
2.7
Accessibility
3.4
Affordability
5.0
Agency
3.3
Availability
4.1
Legal Recognition
3.0
Participation
3.1
Safety & Security
4.0
Strongly disagree
Strongly agree

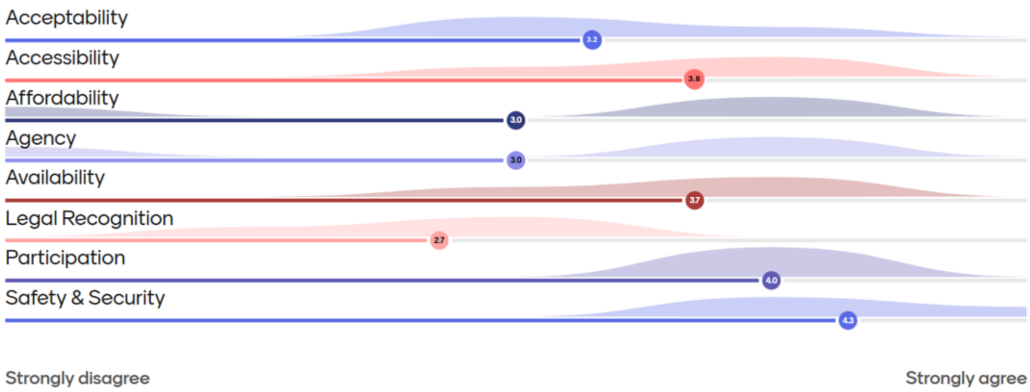

Mentimeter
Thinking of the "*Culture visitor*", which SOMI pillars are most suitable?
Acceptability
3.1
Accessibility
4.0
Affordability
2.9
Agency
2.3
Availability
4.3
Legal Recognition
1.9
Participation
1.3
Safety & Security
4.4
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Sub-urban commuter", which SOMI pillars are most suitable?
Acceptability
4.0
Accessibility
4.0
Affordability
4.2
Agency
4.3
Availability
4.3
Legal Recognition
2.8
Participation
3.5
Safety & Security
4.2
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Logistics Operator, companies carrying out deliveries", which SOMI Pillars are most suitable?
Acceptability
3.6
Accessibility
3.6
Affordability
4.0
Agency
3.3
Availability
4.1
Legal Recognition
3.0
Participation
3.1
Safety & Security
3.3
Strongly disagree
Strongly agree

Mentimeter

Thinking of the "Single or couple with no children", which SOMI Pillars are most suitable?



APPENDIX II

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

Version number: **V2.0 - Final**

Date for release: **29/06/2026**

Author(s):

CERTH I Mallidis, V Giannoudis, S Dais

APPENDIX II: ICB implementation workflow results for Florence

II.1 Purpose and evidentiary role of this appendix

This appendix documents the route through which the Impact Creation Board (ICB) persona-influence weighting methodology was implemented for the Florence case study. The appendix focuses on the implementation evidence for the three Florence solutions: SOL1 - 30 km/h zones and traffic calming; SOL2 - urban logistics micro-hubs; and SOL3 - road-space reallocation. For each solution, the appendix reports the ICB response coverage, the Round 1 Best-Worst Method results, the final persona weights used for SOMI, the highest-weighted personas, the consistency indicators, and the comparison between the Round 0 baseline and the Round 1 final weights.

The weights reported here are implementation-influence weights. They express how strongly each persona is expected to influence the successful implementation of a specific Florence solution through acceptance or opposition, behavioural response, operational leverage, legitimacy of concerns, political salience and potential backlash risk. They are not population shares, expected benefit shares, vulnerability weights or general stakeholder-importance scores.

II.2 ICB organisations involved in the Florence implementation-weighting process

The Florence implementation used the same consolidated ICB expert group as the wider GOLIA weighting exercise. The organisations and their relevance to the weighting exercise are summarised below.

ICB organisation	Full name / participant name	Domain used in ICB	Relevance to Florence weighting
UITP	Union Internationale des Transports Publics	Public transport; MaaR	Public-transport operations, user accessibility, modal integration and Mobility as a Right.
ALICE	Alliance for Logistics Innovation through Collaboration in Europe	Logistics	Freight, urban deliveries, operational feasibility and logistics-related implementation.
POLIS	POLIS AISBL	Cities	City and regional authority perspective, policy transferability and implementation feasibility.
PAVE Europe	Partners for Automated Vehicle Education Europe AISBL	CCAM	Connected, cooperative and automated mobility acceptance, readiness and public understanding.
EPA	European Parking Association AISBL	Parking and curbside management	Parking, curbside allocation, access management and impacts on urban space.
MPACT	Mpact vzw	Mobility hubs; MaaR	Mobility hubs, shared mobility, multimodality and inclusion-oriented mobility services.

ICB organisation	Full name / participant name	Domain used in ICB	Relevance to Florence weighting
TTS Italia	TTS Italia	ITS promotion; smart city	Intelligent Transport Systems, traffic management, digitalisation and smart-city applications.

II.3 Florence solution scope and response coverage

The Florence ICB implementation covered three active solution tabs. Each Florence solution received seven valid Round 0 inputs and seven valid Round 1 inputs, confirming complete response coverage across the ICB organisations for the Florence weighting exercise.

Solution	City	Florence solution title	R0 n	R1 n	R1 top persona	R1 top weight
SOL1	Florence	30 km/h zones and traffic calming	7	7	P2 - Urban family	0.251
SOL2	Florence	Urban logistics micro-hubs	7	7	P8 - Logistics operator, companies carrying out deliveries	0.351
SOL3	Florence	Road-space reallocation	7	7	P2 - Urban family	0.179

II.4 Florence ICB implementation workflow

Step	Implementation stage	Florence-specific implementation evidence
1	ICB expert inputs collected	ICB organisations submitted Round 0 and Round 1 workbooks covering the active Florence solution tabs.
2	Round 0 baseline allocation	Experts distributed 100 points across the nine final Florence personas for each Florence solution.
3	Round 0 processing	Point totals, missing values, Best/Worst selections and rationales were checked; valid values were converted into normalised baseline weights.
4	Round 1 Best-Worst elicitation	Experts selected the most and least influential personas for each Florence solution and completed Best-to-Others and Others-to-Worst comparisons on a 1-9 scale.
5	BWM optimisation	For each ICB organisation and Florence solution, the BWM model generated an individual persona-weight vector and consistency indicator.
6	Aggregation across ICB organisations	Individual Round 1 BWM weights were aggregated using the normalised geometric mean.

Step	Implementation stage	Florence-specific implementation evidence
7	QA and consistency check	The Florence results were checked for response coverage, mandatory anchors, BWM feasibility, positive weights and consistency indicator values.
8	Operational SOMI input	The final Florence weights are stored in the consolidated Round 1 final-weights workbook and merged with persona-level SOMI scores using solution, city and persona ID.

II.5 Highest-weighted personas for Florence

Florence solution	Persona ID	Most significant persona	Final R1 weight	Implementation interpretation
SOL1 - 30 km/h zones and traffic calming	P2	Urban family	0.251	Traffic-calming implementation is strongly shaped by family safety, school access, neighbourhood liveability and acceptance of lower-speed streets.
SOL2 - Urban logistics micro-hubs	P8	Logistics operator, companies carrying out deliveries	0.351	Micro-hub implementation depends strongly on logistics operators and delivery companies adopting, using and integrating the solution into delivery operations.
SOL3 - Road-space reallocation	P2	Urban family	0.179	Road-space reallocation is strongly shaped by urban families because everyday street use, school access, safety and liveability are directly affected by the redistribution of space.

II.6 Final Florence persona-influence weights used for SOMI

The following table reproduces the final Round 1 weights used as operational SOMI inputs for Florence. For each solution, the persona weights sum to 1.000 after rounding differences are taken into account.

PERSONA ID	PERSONA	SOL1 30 KM/H ZONES AND TRAFFIC CALMING	SOL2 URBAN LOGISTICS MICRO-HUBS	SOL3 ROAD-SPACE REALLOCATION
P1	City-centre resident	0.122	0.081	0.154
P2	Urban family	0.251	0.110	0.179
P3	Older / less mobile resident	0.149	0.078	0.129

P4	Business in the city centre	0.137	0.168	0.141
P5	Student living away from home to study in Florence	0.058	0.066	0.070
P6	Culture visitor	0.058	0.042	0.053
P7	Commuter	0.075	0.070	0.049
P8	Logistics operator, companies carrying out deliveries	0.097	0.351	0.159
P9	Single or couple with no children	0.052	0.035	0.066

II.7 BWM consistency and quality assurance for Florence

The BWM consistency indicators show that the Round 1 comparison judgements for the Florence solutions were feasible and internally coherent enough to be retained as operational inputs. Lower values of xi indicate stronger consistency between the Best-to-Others and Others-to-Worst comparison vectors.

Solution	City	Solution title	Mean xi	Max xi	Valid R1 experts
SOL1	Florence	30 km/h zones and traffic calming	0.057	0.087	7
SOL2	Florence	Urban logistics micro-hubs	0.068	0.094	7
SOL3	Florence	Road-space reallocation	0.051	0.072	7

II.8 Round 0 baseline vs Round 1 final weights for Florence

Round 0 remains useful as a transparency and sensitivity layer. The comparison below shows how the direct 100-point baseline allocation changed after the more structured Round 1 BWM elicitation and aggregation. Positive delta values indicate personas whose implementation influence increased in the final Round 1 weights; negative delta values indicate personas whose influence decreased relative to the baseline allocation.

SOL1: 30 km/h zones and traffic calming

Solution	Persona ID	Persona	R0 baseline	R1 final	Delta
SOL1	P1	City-centre resident	0.086	0.122	+0.036
SOL1	P2	Urban family	0.229	0.251	+0.022
SOL1	P3	Older / less mobile resident	0.154	0.149	-0.005
SOL1	P4	Business in the city centre	0.134	0.137	+0.003
SOL1	P5	Student living away from	0.060	0.058	-0.002

		home to study in Florence			
SOL1	P6	Culture visitor	0.070	0.058	-0.012
SOL1	P7	Commuter	0.113	0.075	-0.038
SOL1	P8	Logistics operator, companies carrying out deliveries	0.117	0.097	-0.020
SOL1	P9	Single or couple with no children	0.037	0.052	+0.015

SOL2: Urban logistics micro-hubs

Solution	Persona ID	Persona	R0 baseline	R1 final	Delta
SOL2	P1	City-centre resident	0.067	0.081	+0.014
SOL2	P2	Urban family	0.113	0.110	-0.003
SOL2	P3	Older / less mobile resident	0.057	0.078	+0.021
SOL2	P4	Business in the city centre	0.233	0.168	-0.065
SOL2	P5	Student living away from home to study in Florence	0.063	0.066	+0.003
SOL2	P6	Culture visitor	0.034	0.042	+0.008
SOL2	P7	Commuter	0.060	0.070	+0.010
SOL2	P8	Logistics operator, companies carrying out deliveries	0.344	0.351	+0.007
SOL2	P9	Single or couple with no children	0.029	0.035	+0.006

SOL3: Road-space reallocation

Solution	Persona ID	Persona	R0 baseline	R1 final	Delta
SOL3	P1	City-centre resident	0.121	0.154	+0.033
SOL3	P2	Urban family	0.226	0.179	-0.047
SOL3	P3	Older / less mobile resident	0.119	0.129	+0.010
SOL3	P4	Business in the city centre	0.146	0.141	-0.005
SOL3	P5	Student living away from home to study in Florence	0.074	0.070	-0.004
SOL3	P6	Culture visitor	0.061	0.053	-0.008
SOL3	P7	Commuter	0.071	0.049	-0.022

SOL3	P8	Logistics operator, companies carrying out deliveries	0.130	0.159	+0.029
SOL3	P9	Single or couple with no children	0.052	0.066	+0.014

II.9 Evidence tracking table for Appendix II

The following tracking table aims is to make the route from ICB input to SOMI-ready weights auditable without overloading the main report body.

Core ICB evidence and consolidated processing files

Evidence item	Description / file or sheet
ICB participant list and domain table	List of UITP, ALICE, POLIS, PAVE Europe, EPA, MPACT and TTS Italia with their GOLIA domains.
Round 0 submitted workbooks	ICB_T1.4_Round0_ALICE.xlsx; ICB_T1.4_Round0_EPA.xlsx; ICB_T1.4_Round0_MPACT.xlsx; ICB_T1.4_Round0_PAVE.xlsx; ICB_ICB_ID_POLIS_Initials_Round0.xlsx; ICB_T1.4_Round0_TTSItalia.xlsx; ICB_T1.4_Round0_UITP.xlsx.
Round 1 submitted workbooks	ICB_ALICE_Round1.xlsx; ICB_ICB_ID_EPA_Round1.xlsx; ICB_ICB_ID_POLIS_Round1.xlsx; ICB_ICB_PAVE Europe_NH_Round1.xlsx; ICB_T1.4_Round1_MPACT.xlsx; ICB_T1.4_Round1_TTSItalia.xlsx; ICB_T1.4_Round1_UITP.xlsx.
Consolidated Round 0 workbook	GOLIA_ICB_R0_Consolidated_Results_v2.xlsx, including Response_Coverage, QA_by_Org_Solution, Processed_R0_Responses, Aggregated_R0_Weights, Best_Worst_Counts and Solution_Summary.
Consolidated Round 1 workbook	GOLIA_ICB_R1_Consolidated_Final_Weights_v2.xlsx, especially the consolidated Round 1 final-weights workbook, QA_R1_by_Org_Sol, Processed_R1_Ratings, BWM_Consistency and R0_R1_Comparison.

Florence-specific extracts and implementation checks

EVIDENCE ITEM	DESCRIPTION / FILE OR SHEET
FLORENCE SOLUTION-SCOPE TABLE	SOL1, SOL2 and SOL3, each with R0 n = 7 and R1 n = 7. This proves complete Florence response coverage for the three implemented solutions.
FLORENCE BWM CONSISTENCY TABLE	Mean and maximum xi values for SOL1, SOL2 and SOL3. This proves feasibility and internal consistency of the Round 1 BWM calculations.
FLORENCE FINAL WEIGHTS TABLE	Final persona-influence weights for P1-P9 across SOL1, SOL2 and SOL3. These are the

	operational weights used in the SOMI calculation.
FLORENCE R0 VS R1 COMPARISON TABLES	R0 baseline, R1 final and delta for each solution-persona combination using the final Florence persona framework. This supports transparency and sensitivity interpretation.
ANALYST / FACILITATOR NOTES	Notes on corrections, missing values, rescaling or quality-assurance decisions. Retain as project evidence and include if requested by the evaluator.

APPENDIX III

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

Version number: **V2.0 - Final**

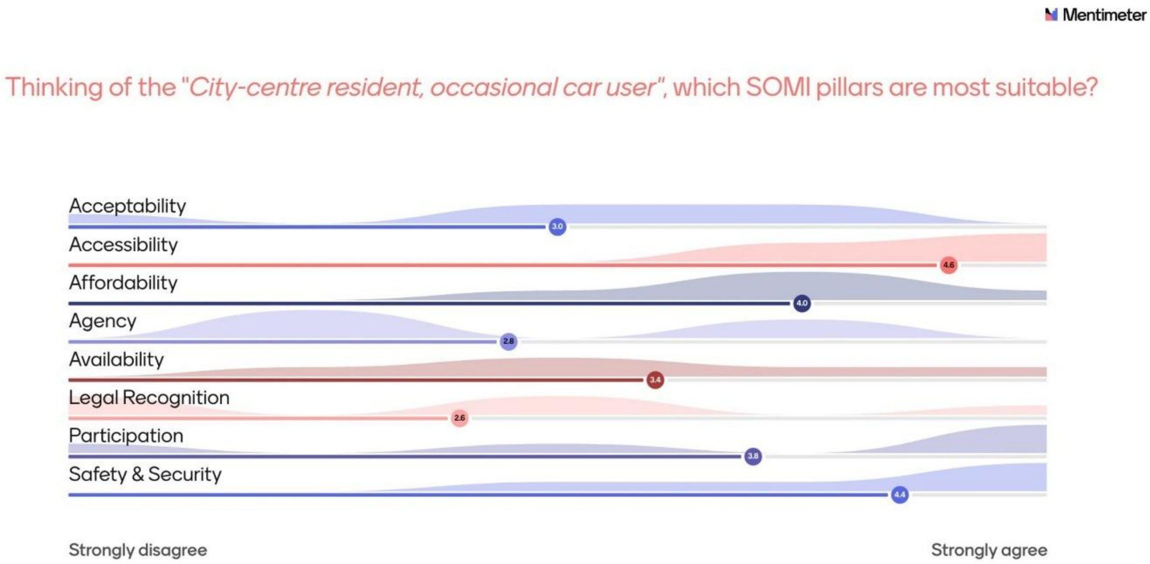
Date for release: **29/06/2026**

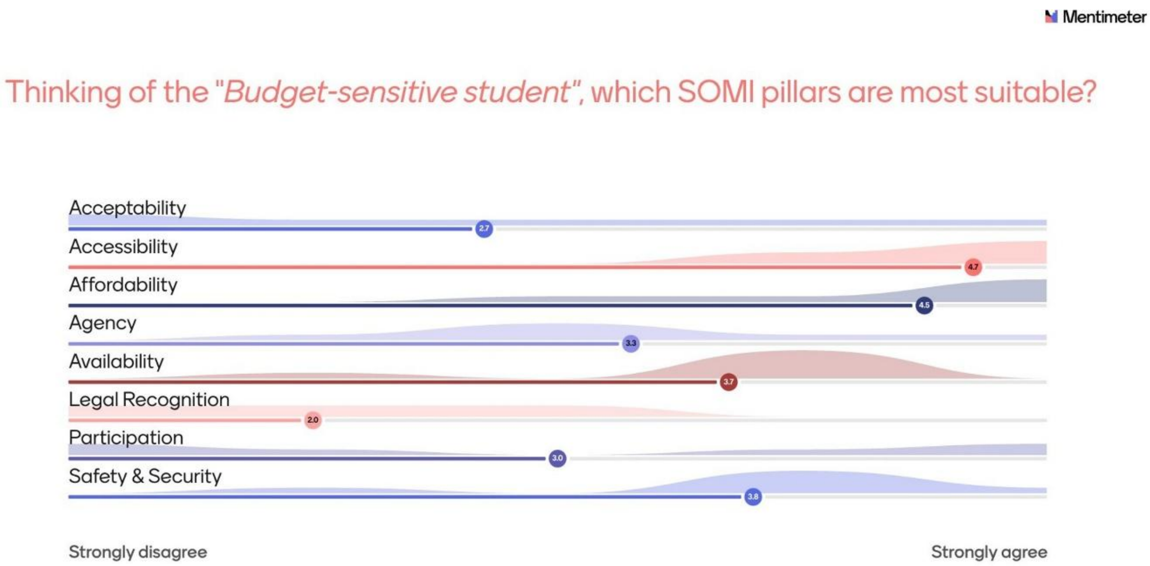
Author(s):

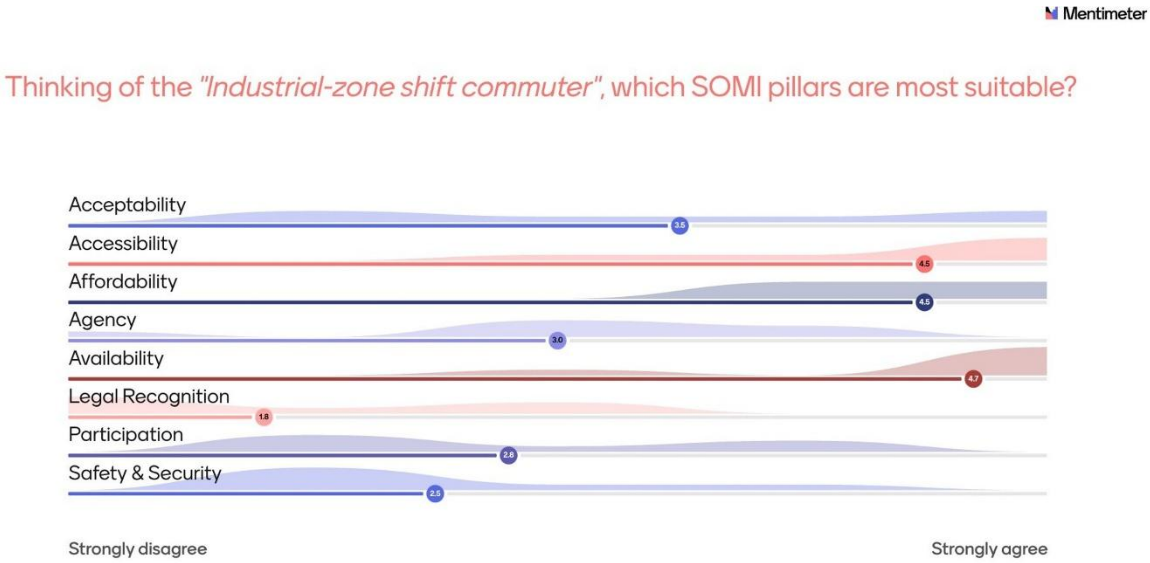
CERTH I Mallidis, V Giannoudis, S Dais

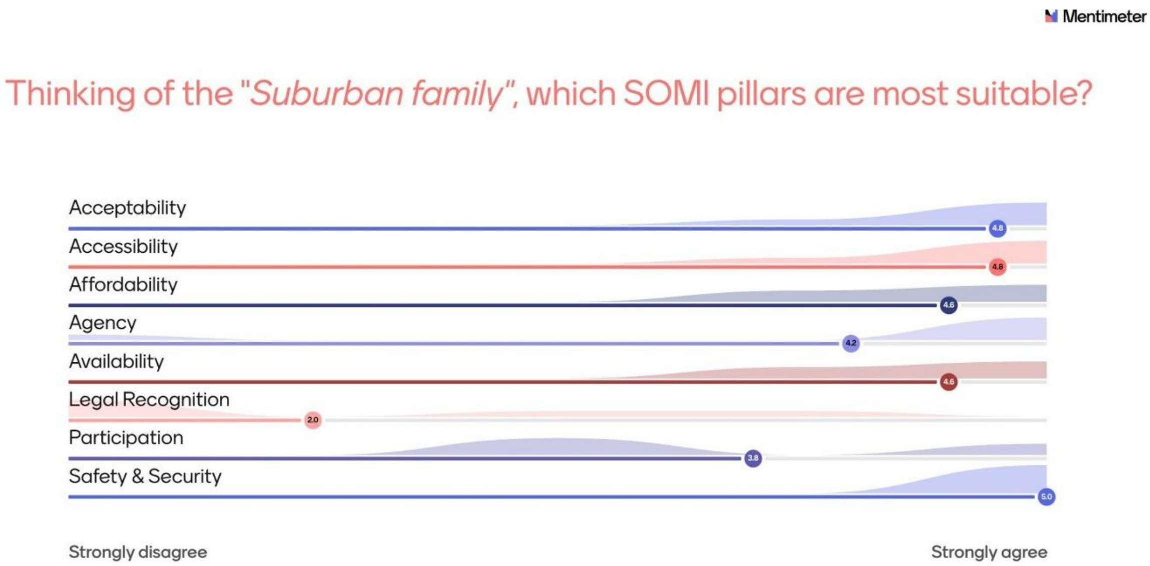
APPENDIX III: Pilsen Mentimeter Score exercise

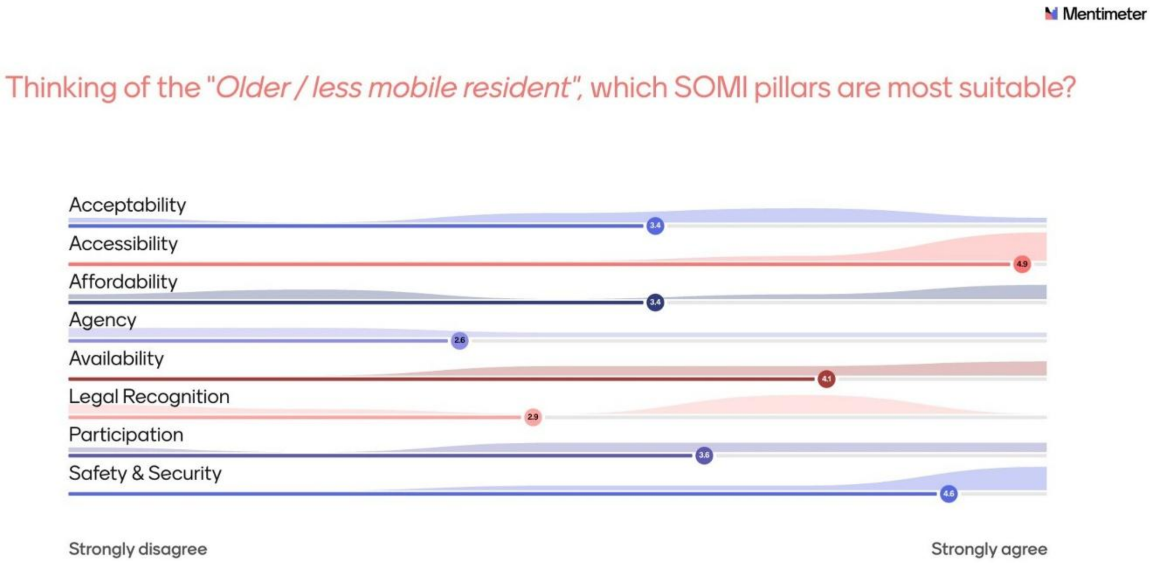
This appendix presents the Mentimeter scoring outputs used to support the Pilsen persona-pillar significance weights. The screenshots show the pillar-level scoring exercise carried out for the Pilsen personas and provide evidence for the inputs used in the SOMI weighting structure. The appendix therefore supports the transparency of the persona-based assessment by documenting the original elicitation material behind the normalised pillar weights applied in the Pilsen SOMI calculations.

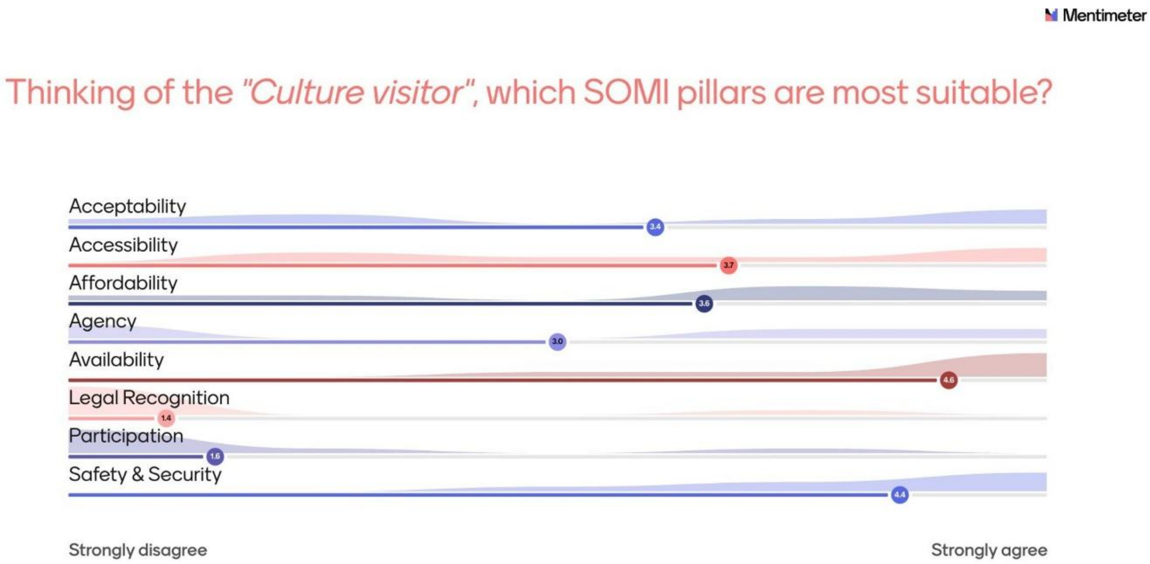


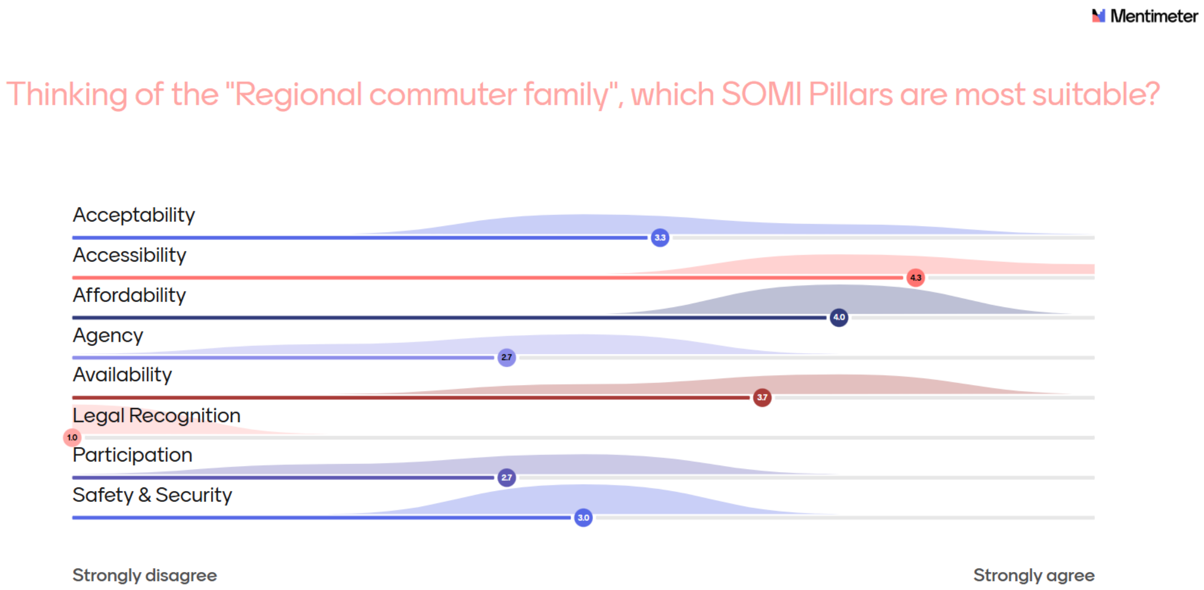



Mentimeter
Thinking of the "Industrial-zone shift commuter", which SOMI pillars are most suitable?
Acceptability
3.5
Accessibility
4.5
Affordability
4.5
Agency
3.0
Availability
4.7
Legal Recognition
1.8
Participation
2.8
Safety & Security
2.5
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Suburban family", which SOMI pillars are most suitable?
Acceptability
4.8
Accessibility
4.8
Affordability
4.6
Agency
4.2
Availability
4.6
Legal Recognition
2.0
Participation
3.8
Safety & Security
5.0
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "*Older / less mobile resident*", which SOMI pillars are most suitable?
Acceptability
3.4
Accessibility
4.9
Affordability
3.4
Agency
2.6
Availability
4.1
Legal Recognition
2.9
Participation
3.6
Safety & Security
4.6
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "*Culture visitor*", which SOMI pillars are most suitable?
Acceptability
3.4
Accessibility
3.7
Affordability
3.6
Agency
3.0
Availability
4.6
Legal Recognition
1.4
Participation
1.6
Safety & Security
4.4
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Regional commuter family", which SOMI Pillars are most suitable?
Acceptability
3.3
Accessibility
4.3
Affordability
4.0
Agency
2.7
Availability
3.7
Legal Recognition
1.0
Participation
2.7
Safety & Security
3.0
Strongly disagree
Strongly agree

APPENDIX IV

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

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Date for release: **29/06/2026**

Author(s):

CERTH I Mallidis, V Giannoudis, S Dais

APPENDIX IV: ICB implementation workflow results for Pilsen

IV.1 Purpose and evidentiary role of this appendix

This appendix documents the route through which the Impact Creation Board (ICB) persona-influence weighting methodology was implemented for the Pilsen case study. It provides a trail from the ICB expert inputs to the final persona-influence weights used in the Pilsen SOMI implementation.

The appendix focuses on the implementation evidence for the three Pilsen solutions: PIL SOL1 – cycling infrastructure and bike-share uptake; PIL SOL2 – connected corridors and smart traffic management readiness; and PIL SOL3 – public transport and first-/last-mile access improvement. The ICB workbook uses the operational solution tabs SOL7, SOL8 and SOL9. Therefore, this appendix explicitly maps the report solution codes to the ICB solution codes.

The weights reported here are implementation-influence weights. They express how strongly each persona is expected to influence the successful implementation of a specific Pilsen solution through acceptance or opposition, behavioural response, operational leverage, legitimacy of concerns, political salience and potential backlash risk. They are not population shares, expected benefit shares, vulnerability weights or general stakeholder-importance scores.

IV.2 ICB organisations involved in the Pilsen implementation-weighting process

The Pilsen implementation used the same consolidated ICB expert group as the wider GOLIA weighting exercise.

ICB organisation	Domain used in ICB	Relevance to Pilsen weighting
UITP	Public transport; MaaR	Public transport operations, accessibility, multimodal integration and Mobility as a Right.
ALICE	Logistics	Freight, logistics innovation and operational feasibility.
POLIS	Cities	City and regional authority perspective, policy transferability and implementation feasibility.
PAVE Europe	CCAM	Connected and automated mobility acceptance, readiness and public understanding.
EPA	Parking and curbside management	Parking, curbside allocation, access management and impacts on urban space.
MPACT	Mobility hubs; MaaR	Mobility hubs, shared mobility, multimodality and inclusion-oriented mobility services.
TTS Italia	ITS promotion; smart city	Intelligent Transport Systems, traffic management, digitalisation and smart-city applications.

IV.3 Pilsen solution-code alignment

The Pilsen report uses PIL SOL1, PIL SOL2 and PIL SOL3, while the ICB weighting workbook uses SOL7, SOL8 and SOL9. The alignment is as follows.

Report solution code	ICB solution tab	Solution title used in weighting
PIL SOL1	SOL7	Cycling and bike-share uptake
PIL SOL2	SOL9	Connected corridors and smart traffic management readiness
PIL SOL3	SOL8	Public transport and first-/last-mile integration

This mapping should be retained in the appendix to avoid confusion between the report numbering and the ICB workbook numbering.

IV.4 Pilsen solution scope and response coverage

Each Pilsen solution received seven valid Round 0 inputs and seven valid Round 1 inputs, confirming complete response coverage across the ICB organisations for the Pilsen weighting exercise.

Report solution	ICB tab	Pilsen solution title	R0 n	R1 n	R1 top persona	R1 top weight
PIL SOL1	SOL7	Cycling and bike-share uptake	7	7	P2 - Budget-sensitive student	0.341
PIL SOL2	SOL9	Connected corridors and smart traffic management readiness	7	7	P3 - Industrial-zone shift commuter	0.293
PIL SOL3	SOL8	Public transport and first-/last-mile integration	7	7	P2 - Budget-sensitive student	0.203

IV.5 Pilsen ICB implementation workflow

Step	Implementation stage	Pilsen-specific implementation evidence
1	ICB expert inputs collected	ICB organisations submitted Round 0 and Round 1 workbooks covering the active Pilsen solution tabs SOL7, SOL8 and SOL9.
2	Round 0 baseline allocation	Experts distributed 100 points across the seven final Pilsen personas for each Pilsen solution.
3	Round 0 processing	Point totals, missing values, Best/Worst selections and rationales were checked; valid values were converted into normalised baseline weights.
4	Round 1 Best-Worst elicitation	Experts selected the most and least influential personas for each Pilsen solution and completed Best-to-Others and Others-to-

		Worst comparisons on a 1-9 scale.
5	BWM optimisation	For each ICB organisation and Pilsen solution, the BWM model generated an individual persona-weight vector and consistency indicator.
6	Aggregation across ICB organisations	Individual Round 1 BWM weights were aggregated using the normalised geometric mean.
7	QA and consistency check	The Pilsen results were checked for response coverage, mandatory anchors, BWM feasibility, positive weights and consistency indicator values.
8	Operational SOMI input	The final Pilsen weights are stored in the consolidated Round 1 final-weights workbook and merged with persona-level SOMI scores using solution, city and persona ID.

IV.6 Highest-weighted personas for Pilsen

Report solution	ICB tab	Persona ID	Most significant persona	Final R1 weight	Implementation interpretation
PIL SOL1 - Cycling and bike-share uptake	SOL7	P2	Budget-sensitive student	0.341	Cycling and bike-share implementation is strongly shaped by affordability, flexible short-distance travel and everyday uptake among students and cost-sensitive users.
PIL SOL2 - Connected corridors and smart traffic management readiness	SOL9	P3	Industrial-zone shift commuter	0.293	Smart corridor and traffic-management readiness is strongly shaped by commuting reliability, employment-area access and time-sensitive shift-based travel.
PIL SOL3 - Public transport and first-/last-mile integration	SOL8	P2	Budget-sensitive student	0.203	Public transport and first-/last-mile integration is strongly shaped by cost-sensitive everyday users because

					affordability, transfer quality and practical access determine whether the solution is adopted.

IV.7 Final Pilsen persona-influence weights used for SOMI

The following table reproduces the final Round 1 weights used as operational SOMI inputs for Pilsen. For each solution, the persona weights sum to 1.000 after rounding differences are taken into account.

Persona ID	Persona	PIL SOL1 / SOL7 Cycling and bike-share uptake	PIL SOL2 / SOL9 Connected corridors and smart traffic management readiness	PIL SOL3 / SOL8 Public transport and first-/last-mile integration
P1	City/urban resident, occasional car user	0.236	0.202	0.158
P2	Budget-sensitive student	0.341	0.125	0.203
P3	Industrial-zone shift commuter	0.122	0.293	0.137
P4	Suburban family	0.072	0.099	0.142
P5	Older / less mobile resident	0.051	0.102	0.124
P6	Leisure and culture visitor	0.106	0.079	0.095
P7	Regional commuter family	0.072	0.099	0.142

IV.8 BWM consistency and quality assurance for Pilsen

The BWM consistency indicators show that the Round 1 comparison judgements for the Pilsen solutions were feasible and internally coherent enough to be retained as operational inputs. Lower values of xi indicate stronger consistency between the Best-to-Others and Others-to-Worst comparison vectors.

ICB tab	Report solution	Solution title	Mean xi	Max xi	Valid R1 experts
SOL7	PIL SOL1	Cycling and bike-share uptake	0.080	0.141	7
SOL9	PIL SOL2	Connected corridors and smart traffic management readiness	0.084	0.151	7
SOL8	PIL SOL3	Public transport and first-/last-mile integration	0.085	0.159	7

IV.9 Evidence tracking table for Appendix IV

The following tracking table identifies the material that should be included in, or retained alongside, Appendix IV to prove the Pilsen ICB implementation process.

Evidence item	Description / file or sheet
ICB participant list and domain table	UITP, ALICE, POLIS, PAVE Europe, EPA, MPACT and TTS Italia with their GOLIA domains.
Round 0 submitted workbooks	ICB Round 0 workbooks submitted by the seven ICB organisations.
Round 1 submitted workbooks	ICB Round 1 workbooks submitted by the seven ICB organisations.
Consolidated Round 1 workbook	Final SOMI-ready weights and solution summary for SOL7, SOL8 and SOL9.
Pilsen solution-scope table	SOL7, SOL8 and SOL9, each with R0 n = 7 and R1 n = 7.
Pilsen BWM consistency table	Mean and maximum xi values for SOL7, SOL8 and SOL9.
Pilsen final weights table	Final persona-influence weights for P1-P7 across SOL7, SOL8 and SOL9.
Report-to-ICB solution-code mapping	PIL SOL1/SOL7, PIL SOL2/SOL9 and PIL SOL3/SOL8.
Analyst / facilitator notes	Notes on corrections, missing values, rescaling or quality-assurance decisions.

APPENDIX V

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

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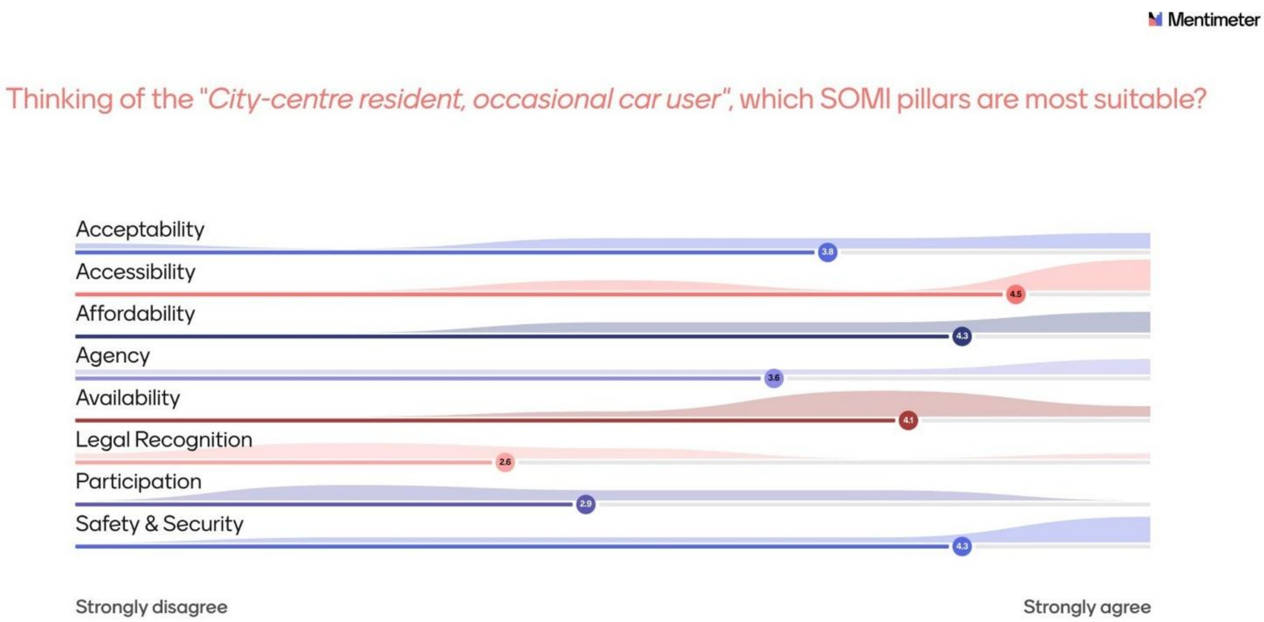
Author(s):

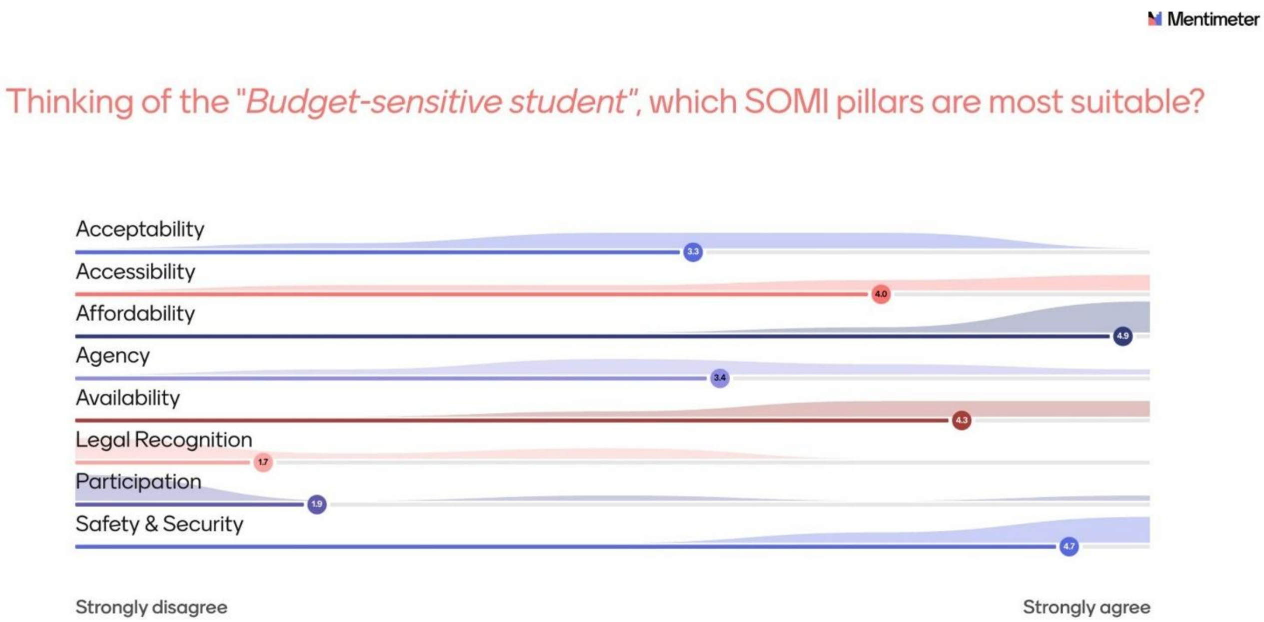
CERTH I Mallidis, V Giannoudis, S Dais

APPENDIX V: Antwerp Mentimeter Score exercise

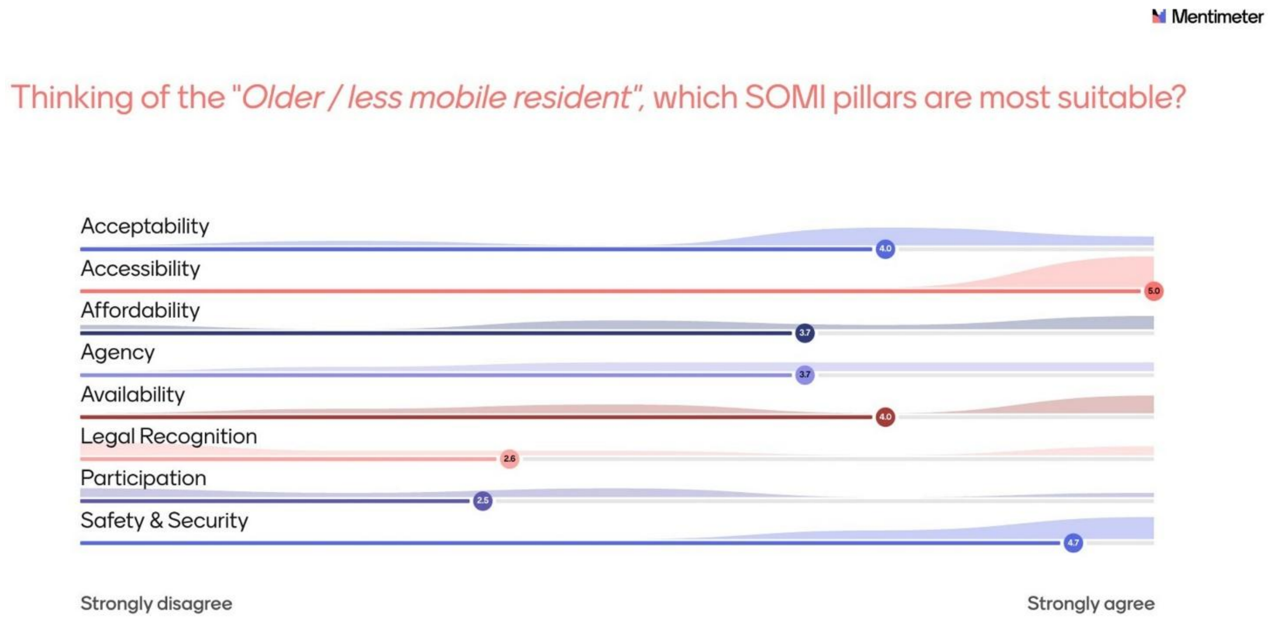
This appendix presents the Mentimeter scoring outputs used to support the Antwerp persona-pillar significance weights. The screenshots document the scoring of the SOMI pillars in relation to the Antwerp personas and provide the evidence base for the pillar-weight inputs used in the SOMI methodology. The appendix is included to make the elicitation process transparent and to show how the persona-based interpretation of the Antwerp mobility ecosystem was translated into operational weighting inputs.

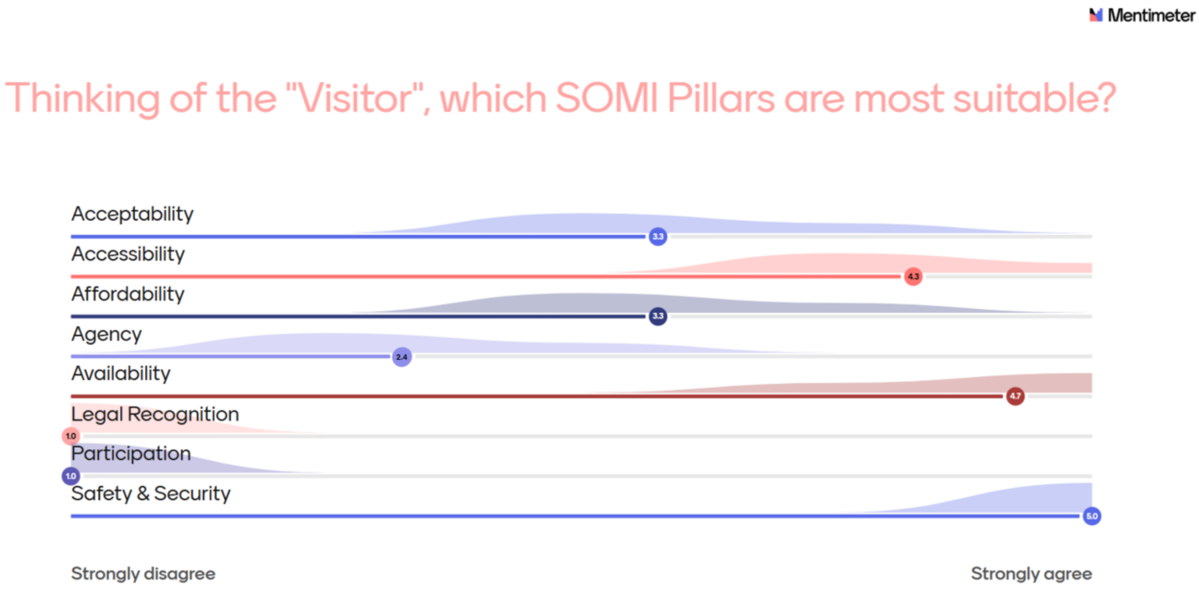



Mentimeter
Thinking of the "*Suburban commuter*", which SOMI pillars are most suitable?
Acceptability
3.4
Accessibility
4.2
Affordability
4.2
Agency
3.2
Availability
4.8
Legal Recognition
2.4
Participation
2.0
Safety & Security
4.8
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "*Budget-sensitive student*", which SOMI pillars are most suitable?
Acceptability
3.3
Accessibility
4.0
Affordability
4.9
Agency
3.4
Availability
4.3
Legal Recognition
1.7
Participation
1.9
Safety & Security
4.7
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Young urban family", which SOMI pillar are most suitable?
Acceptability
4.1
Accessibility
4.9
Affordability
3.7
Agency
3.9
Availability
4.7
Legal Recognition
2.0
Participation
2.1
Safety & Security
4.9
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Older / less mobile resident", which SOMI pillars are most suitable?
Acceptability
4.0
Accessibility
5.0
Affordability
3.7
Agency
3.7
Availability
4.0
Legal Recognition
2.6
Participation
2.5
Safety & Security
4.7
Strongly disagree
Strongly agree


Mentimeter
Thinking of the "Visitor", which SOMI Pillars are most suitable?
Acceptability
3.3
Accessibility
4.3
Affordability
3.3
Agency
2.4
Availability
4.7
Legal Recognition
1.0
Participation
1.0
Safety & Security
5.0
Strongly disagree
Strongly agree

APPENDIX VI

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

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Author(s):

CERTH I Mallidis, V Giannoudis, S Dais

APPENDIX VI: ICB implementation workflow results for Antwerp

VI.1 Purpose and evidentiary role of this appendix

This appendix documents the route through which the Impact Creation Board (ICB) persona-influence weighting methodology was implemented for the Antwerp case study. It provides a transparent audit trail from the ICB expert inputs to the final persona-influence weights used in the Antwerp SOMI implementation.

The appendix focuses on the implementation evidence for the one Antwerp solution examined in the current use case: **SOL4 – Multimodal journey planner / Smart Ways to Antwerp scale-up**. The weights reported here are implementation-influence weights. They express how strongly each persona is expected to influence the successful implementation of SOL4 through acceptance or opposition, behavioural response, operational leverage, legitimacy of concerns, political salience and potential uptake or resistance. They are not population shares, expected benefit shares, vulnerability weights or general stakeholder-importance scores.

VI.2 ICB organisations involved in the Antwerp implementation-weighting process

The Antwerp implementation used the same consolidated ICB expert group as the wider GOLIA weighting exercise. The organisations and their relevance to the weighting exercise are summarised below.

ICB organisation	Full name / participant name	Domain used in ICB	Relevance to Antwerp SOL4 weighting
UITP	Union Internationale des Transports Publics	Public transport; MaaR	Public-transport operations, user accessibility, modal integration and Mobility as a Right.
ALICE	Alliance for Logistics Innovation through Collaboration in Europe	Logistics	Freight, port-related mobility, operational feasibility and logistics-related implementation perspectives.
POLIS	POLIS AISBL	Cities	City and regional authority perspective, policy transferability and implementation feasibility.
PAVE Europe	Partners for Automated Vehicle Education Europe AISBL	CCAM	Connected and automated mobility acceptance, readiness and public understanding.

ICB organisation	Full name / participant name	Domain used in ICB	Relevance to Antwerp SOL4 weighting
EPA	European Parking Association AISBL	Parking and curbside management	Parking, park-and-ride, curbside access, access management and impacts on urban space.
MPACT	Mpact vzw	Mobility hubs; MaaR	Mobility hubs, shared mobility, multimodality and inclusion-oriented mobility services.
TTS Italia	TTS Italia	ITS promotion; smart city	Intelligent Transport Systems, digital journey planning, traffic management and smart-city applications.

VI.3 Antwerp solution scope and response coverage

The current Antwerp SOMI use case examines one active solution tab. SOL4 received seven valid Round 0 inputs and seven valid Round 1 inputs, confirming complete response coverage across the ICB organisations for the Antwerp SOL4 weighting exercise.

Solution	City	Antwerp solution title	R0 n	R1 n	R1 top persona	R1 top weight
SOL4	Antwerp	MaaS / Smart Ways to Antwerp scale-up	7	7	P3 - Sub-urban commuter	0.199

VI.4 Antwerp ICB implementation workflow

Step	Implementation stage	Antwerp-specific implementation evidence
1	ICB expert inputs collected	ICB organisations submitted Round 0 and Round 1 workbooks covering the active Antwerp solution tab SOL4.
2	Round 0 baseline allocation	Experts distributed 100 points across the Antwerp implementation-influence personas for SOL4.

Step	Implementation stage	Antwerp-specific implementation evidence
3	Round 0 processing	Point totals, missing values, Best/Worst selections and rationales were checked; valid values were converted into normalised baseline weights.
4	Round 1 Best-Worst elicitation	Experts selected the most and least influential personas for SOL4 and completed Best-to-Others and Others-to-Worst comparisons on a 1-9 scale.
5	BWM optimisation	For each ICB organisation and SOL4, the BWM model generated an individual persona-weight vector and consistency indicator.
6	Aggregation across ICB organisations	Individual Round 1 BWM weights were aggregated using the normalised geometric mean.
7	QA and consistency check	The SOL4 results were checked for response coverage, mandatory anchors, BWM feasibility, positive weights and consistency indicator values.
8	Operational SOMI input	The final SOL4 weights are stored in the consolidated Round 1 final-weights workbook and merged with persona-level SOMI scores using solution, city and persona ID.

VI.5 Highest-weighted persona for Antwerp SOL4

Antwerp solution	Persona ID	Most significant persona	Final R1 weight	Implementation interpretation
SOL4 - Multimodal journey planner / Smart Ways to Antwerp scale-up	P3	Sub-urban commuter	0.199	Smart Ways to Antwerp scale-up is strongly shaped by commuting into and across Antwerp from outside the central area. Sub-urban commuters can strongly influence modal shift, platform uptake, perceived usefulness of multimodal route planning and the success of Functional Urban Area-scale mobility information.

VI.6 Final Antwerp SOL4 persona-influence weights used for SOMI

The following table reproduces the final Round 1 weights used as operational SOMI inputs for Antwerp SOL4. For SOL4, the persona weights sum to 1.000 after rounding differences are taken into account.

Persona ID	Persona	SOL4 Multimodal journey planner / Smart Ways to Antwerp scale-up
P1	City-centre resident, occasional car user	0.132
P2	Port worker, car-dependent	0.067
P3	Sub-urban commuter	0.199
P4	Cost-conscious/Multimodal Student	0.152
P5	Young urban family	0.141
P6	Older resident and resident with reduced mobility	0.155
P7	Visitor	0.155

The SOL4 results show that the most influential implementation persona is the sub-urban commuter (0.199), followed by the older resident and resident with reduced mobility (0.155), the visitor (0.155), the cost-conscious / multimodal student (0.152) and the young urban family (0.141). This indicates that Smart Ways to Antwerp scale-up is shaped primarily by groups whose mobility choices, digital information needs and multimodal options can influence uptake at Functional Urban Area scale.

The lower weights assigned to the port worker, car-dependent persona (0.067) and the city-centre resident, occasional car user persona (0.132) do not imply that these groups are unimportant. Rather, the ICB judgement suggests that, for the general scale-up of Smart Ways to Antwerp, their influence on adoption and implementation is lower than that of commuter, accessibility-sensitive and visitor-related groups.

VI.7 BWM consistency and quality assurance for Antwerp SOL4

The BWM consistency indicators show that the Round 1 comparison judgements for SOL4 were feasible and internally coherent enough to be retained as operational inputs. Lower values of ξ indicate stronger consistency between the Best-to-Others and Others-to-Worst comparison vectors.

Solution	City	Solution title	Mean ξ	Max ξ	Valid R1 experts
SOL4	Antwerp	MaaS / Smart Ways to Antwerp scale-up	0.058	0.097	7

VI.8 Round 0 baseline vs Round 1 final weights for Antwerp SOL4

Round 0 remains useful as a transparency and sensitivity layer. The comparison below shows how the direct 100-point baseline allocation changed after the more structured Round 1 BWM elicitation and aggregation. Positive delta values indicate personas whose implementation influence increased in the final Round 1 weights; negative delta values indicate personas whose influence decreased relative to the baseline allocation.

Solution	Persona ID	Persona	R0 baseline	R1 final	Delta
SOL4	P1	City-centre resident, occasional car user	0.137	0.132	-0.005
SOL4	P2	Port worker, car-dependent	0.097	0.067	-0.030
SOL4	P3	Sub-urban commuter	0.183	0.199	+0.016
SOL4	P4	Cost-conscious/Multimodal Student	0.154	0.152	-0.002
SOL4	P5	Young urban family	0.137	0.141	+0.004
SOL4	P6	Older resident and resident with reduced mobility	0.163	0.155	-0.008
SOL4	P7	Visitor	0.129	0.155	+0.026

The Round 0 to Round 1 comparison shows that the structured BWM round strengthened the relative influence of the sub-urban commuter (+0.016), the visitor (+0.026) and the young urban family (+0.004), while reducing the relative influence of the port worker, car-dependent persona (-0.030), the older resident and resident with reduced mobility (-0.008), the city-centre resident (-0.005) and the cost-conscious / multimodal student (-0.002). This does not overturn the baseline allocation, but clarifies which personas are most influential once the Best-Worst comparison structure is applied.

VI.9 Evidence tracking table for Appendix VI

The following tracking table aims to make the route from ICB input to SOMI-ready weights auditable without overloading the main report body.

Evidence item	Description / file or sheet	What it proves
ICB participant list and domain table	List of UITP, ALICE, POLIS, PAVE Europe, EPA, MPACT and TTS Italia with their GOLIA domains.	Proves the expert basis and sectoral relevance of the ICB weighting group.
Round 0 submitted workbooks	ICB_T1.4_Round0_ALICE.xlsx; ICB_T1.4_Round0_EPA.xlsx; ICB_T1.4_Round0_MPACT.xlsx; ICB_T1.4_Round0_PAVE.xlsx; ICB_ICB_ID_POLIS_Initials_Round0.xlsx; ICB_T1.4_Round0_TTSItalia.xlsx; ICB_T1.4_Round0_UITP.xlsx.	Proves that seven ICB organisations provided the direct baseline allocation inputs.

Evidence item	Description / file or sheet	What it proves
Round 1 submitted workbooks	ICB_ALICE_Round1.xlsx; ICB_ICB_ID_EPA_Round1.xlsx; ICB_ICB_ID_POLIS_Round1.xlsx; ICB_ICB_PAVE Europe_NH_Round1.xlsx; ICB_T1.4_Round1_MPACT.xlsx; ICB_T1.4_Round1_TTSItalia.xlsx; ICB_T1.4_Round1_UITP.xlsx.	Proves that seven ICB organisations provided structured Best-Worst comparison inputs.
Consolidated Round 0 workbook	GOLIA_ICB_R0_Consolidated_Results_v2.xlsx, including Response_Coverage, QA_by_Org_Solution, Processed_R0_Responses, Aggregated_R0_Weights, Best_Worst_Counts and Solution_Summary.	Shows how raw Round 0 allocations were checked, processed and aggregated.
Consolidated Round 1 workbook	GOLIA_ICB_R1_Consolidated_Final_Weights_v2.xlsx, especially Final_Weights_for_SOMI, QA_R1_by_Org_Sol, Processed_R1_Ratings, BWM_Consistency and R0_R1_Comparison.	Shows how raw Round 1 comparisons became final SOMI-ready persona weights.

Evidence item	Description / file or sheet
Antwerp SOL4 solution-scope table	SOL4, with R0 n = 7 and R1 n = 7. This proves complete Antwerp response coverage for the examined solution.
Antwerp SOL4 BWM consistency table	Mean and maximum xi values for SOL4. This proves feasibility and internal consistency of the Round 1 BWM calculation.
Antwerp SOL4 final weights table	Final persona-influence weights for P1-P7 for SOL4. These are the operational weights used in the SOMI calculation.
Antwerp SOL4 R0 vs R1 comparison table	R0 baseline, R1 final and delta for each SOL4 persona using the final Antwerp persona framework. This supports sensitivity interpretation.
Analyst / facilitator notes	Notes on corrections, missing values, rescaling or quality-assurance decisions. Retain as project evidence and include if requested by evaluator.

APPENDIX VII

SOMI AND ATLAS OF ACCESSIBILITY

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CERTH I Mallidis, V Giannoudis, S Dais

APPENDIX VII - Persona-destination category relevance and weighting matrix

This appendix presents the persona-destination category relevance and weighting matrix used for the Atlas of Accessibility. The matrix links broad persona profiles to destination categories such as public transport stops, healthcare, education, retail, culture, leisure, green space, mobility services and employment-related destinations. For each combination, the appendix records the relevance level, proposed weight, rationale and supporting sources. This provides the methodological basis for producing persona-oriented accessibility scores and explains why different destination types contribute differently to the accessibility assessment of each persona. The table below provides the literature-informed relevance matrix used to justify the persona-destination category weights. The proposed weights are methodological proxies.

Persona	*Destination category*	*Relevance level*	*Proposed weight*	*Rationale*	*Supporting sources*
Resident	Mobility / bus stops	High	0.20	Public transport access is a general enabler of broader urban accessibility and supports access to multiple opportunity types across the city.	OECD (2020); ITF (2024)
Resident	Healthcare	Medium	0.15	Healthcare is an essential urban service, but for a broad resident profile it is less routine than daily errands and should not dominate the score.	Moreno et al. (2021); OECD (2020)
Resident	Education & childcare	Medium	0.10	Educational and childcare facilities matter for many households and neighbourhood livability, but not for every resident equally.	UNICEF (2018); UNICEF (2022)
Resident	Parks & playgrounds	Medium	0.15	Green and recreational spaces support neighbourhood livability and everyday quality of life, although they are secondary to daily needs in the resident profile.	Moreno et al. (2021); WHO (2007)
Resident	Supermarkets & daily needs	High	0.30	Access to routine daily services is central to proximity planning and everyday residential accessibility.	Moreno et al. (2021); ITF (2024)
Resident	Attractions / culture & tourism	Medium	0.10	Cultural destinations contribute to urban life and social participation, but are less fundamental than daily services and mobility access.	Moreno et al. (2021); OECD (2020)
Student	Mobility / bus stops	High	0.25	Student accessibility is strongly shaped by active and public transport connections to education, services and urban opportunities.	Zannat et al. (2020); de Alba-Martinez et al. (2021); Moreno et al. (2023)
Student	Healthcare	Medium	0.10	Healthcare is relevant to student well-being but is not usually the defining daily accessibility need for students.	Moreno et al. (2023); ITF (2024)
Student	Education & childcare	High	0.25	Educational access is central to the student persona, assuming that the category captures relevant educational facilities.	de Alba-Martinez et al. (2021); Moreno et al. (2023)

Student	Parks & playgrounds	Medium	0.10	Recreational and outdoor spaces support student urban life, but are secondary to education, mobility and daily services.	Zannat et al. (2020); Moreno et al. (2021)
Student	Supermarkets & daily needs	High	0.20	Daily needs access supports everyday student life, convenience and independent urban living.	Zannat et al. (2020); Moreno et al. (2023)
Student	Attractions / culture & tourism	Medium	0.10	Cultural and leisure destinations contribute to student urban experience, but are less central than education and transport.	Bouhouras et al. (2022); Moreno et al. (2023)
Family	Mobility / bus stops	Medium	0.15	Public transport supports family mobility and trip chaining, but the strongest family needs relate to child-oriented services and household errands.	UNICEF (2018); ITF (2024)
Family	Healthcare	High	0.15	Child- and family-friendly environments require access to health and social support services.	UNICEF (2018); UNICEF (2022)
Family	Education & childcare	High	0.30	Schools and childcare are foundational to family proximity needs and child-friendly urban environments.	UNICEF (2018); UNICEF (2022)
Family	Parks & playgrounds	High	0.20	Access to play and green space is central to children's health, development and family-friendly neighbourhoods.	UNICEF (2018); Zhou et al. (2022); Martin et al. (2023)
Family	Supermarkets & daily needs	High	0.15	Household maintenance and care work make daily-needs access a core family requirement.	Moreno et al. (2021); UNICEF (2018)
Family	Attractions / culture & tourism	Low	0.05	Cultural and tourism destinations may support family leisure but are not part of the minimum everyday-access bundle for families.	UNICEF (2018); UNICEF (2022)
Elderly user	Mobility / bus stops	High	0.20	Age-friendly frameworks and empirical evidence identify transport access as fundamental for older adults' participation and mobility.	WHO (2007); WHO (2015); Twardzik et al. (2023)
Elderly user	Healthcare	High	0.30	Community support and health services are among the most direct and strongly evidenced accessibility needs for older adults.	WHO (2007); WHO (2015); Lowen et al. (2015)
Elderly user	Education & childcare	Low	0.05	Education and childcare are not primary age-friendly domains compared with health, transport, daily needs and outdoor spaces.	WHO (2007); WHO (2015)
Elderly user	Parks & playgrounds	Medium	0.15	Outdoor and green spaces support walking, social interaction and quality of life in later life.	WHO (2007); Hasselder et al. (2022)
Elderly user	Supermarkets & daily needs	High	0.20	Ageing in place depends strongly on nearby access to routine services and everyday destinations.	Lowen et al. (2015); Hasselder et al. (2022)

Elderly user	Attractions / culture & tourism	Low	0.10	Social and cultural participation can be relevant, but formal cultural/tourism destinations are secondary to healthcare, shops and transport.	WHO (2007); Lowen et al. (2015)
Visitor	Mobility / bus stops	High	0.30	Visitor movement in cities depends strongly on public transport and walkable access between destinations.	Coppola et al. (2020); Zientara et al. (2024)
Visitor	Healthcare	Low	0.05	Healthcare is relevant mainly as a contingency or safety factor rather than a routine visitor destination.	UN Tourism; Coppola et al. (2020)
Visitor	Education & childcare	Not relevant / contextual	0.00	Education and childcare are generally not part of the core visitor opportunity set in urban tourism accessibility.	Coppola et al. (2020); Zientara et al. (2024)
Visitor	Parks & playgrounds	Medium	0.10	Parks and public spaces can function as leisure and sightseeing resources, but are secondary to attractions and mobility.	UN Tourism; Zientara et al. (2024)
Visitor	Supermarkets & daily needs	Medium	0.10	Visitors may need routine services, but these are supporting rather than defining destinations.	UN Tourism; Zientara et al. (2024)
Visitor	Attractions / culture & tourism	High	0.45	Attractions, culture and tourism destinations are the defining destination category for visitor accessibility in city destinations.	Coppola et al. (2020); Zientara et al. (2024); UN Tourism

APPENDIX VIII

SOMI AND ATLAS OF ACCESSIBILITY

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APPENDIX VIII – Cities KPI input workbook for champion solutions

This appendix presents the city-specific KPI input sheets used during the iterative exchanges with the pilot cities and technical partners. The sheets translate the eight SOMI pillars into practical data requests for each pilot use case, documenting the proposed KPIs, expected units, direction of improvement, preferred or alternative data sources, proxy options, calculation notes and data availability status. The appendix shows how the SOMI methodology was operationalised through official city sources, city documentation, open datasets and traceable technical evidence. It also defines the data structure that can support future dynamic KPI retrieval and updating through GO-DATA and GO-WISDOM. The tables below present the KPI input workbook iterated between CERTH, TT and FIT and the cities to collect and validate the KPI information needed for the SOMI calculations.

Florence

FLO – SOL1

Florence 30 km/h Expansion - City-friendly SOMI KPI input sheet

Fill only the yellow cells. Enter ONE number for each pillar in the Preferred, Alternative, or Proxy value column. The final SOMI input value is generated automatically.

SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note
Acceptability	Whether citizen consultation priorities indicate support for Zone-30-relevant road-safety objectives.																	
Accessibility	How much of the built-up urban area is actually covered by active Zone 30 areas.																	

Affordability	Whether lower and smoother urban speeds may reduce fuel consumption and therefore everyday travel costs.																	
Agency	Whether residents already use the integrated public-transport network as a realistic alternative to private car travel.																	
Availability	Whether active Zone 30 areas are physically present and spatially available within the built-up urban area.																	
Legal Recognition	Whether Zone 30 implementation is formally backed by approved regulatory changes.																	
Participation	Whether the Florence metropolitan mobility-planning process generated relevant participation inputs from citizens and stakeholders.																	

Safety & Security	What the baseline level of injury crashes is before the Zone 30 measure, so that future safety improvements can be assessed.																	

FLO – SOL2

Florence Micro Hubs - City-friendly SOMI KPI input sheet																		
Fill only the yellow cells. Enter ONE number for each pillar in the Preferred, Alternative, or Proxy value column. The final SOMI input value is generated automatically.																		
SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note
Acceptability	Whether available stakeholder-engagement evidence indicates positive appraisal or acceptance of the shared micro-hub concept.																	
Accessibility	Whether logistics operators can access better information on loading/unloading opportunities within the ZTL through real-time sensor coverage.																	
Affordability	Whether the pilot includes mechanisms that reduce or manage the operational and financial burden of proximity-logistics services.																	
Agency	Whether logistics providers have practical delivery-management choices during the pilot, rather than being constrained to a single operating model.																	

Availability	Whether physical micro-hub locations are available for testing and operational validation within the pilot.																	
Legal Recognition	Whether the micro-hub and ZTL logistics approach is supported by regulatory-readiness mechanisms that enable pilot implementation.																	
Participation	Whether dedicated participatory processes have involved relevant urban-logistics stakeholders in shaping or validating the pilot.																	
Safety & Security	What the baseline level of injury crashes is in the relevant urban area, so that future safety effects of the logistics intervention can be assessed.																	

FLO – SOL3

Florence (Re-) Distribution of road space - City-friendly SOMI KPI input sheet																		
Fill only the yellow cells. Enter ONE number for each pillar in the Preferred, Alternative, or Proxy value column. The final SOMI input value is generated automatically.																		
SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note
Acceptability	Whether citizen priorities indicate support for reallocating street space away from car dominance and toward sustainable mobility, safer streets, and higher-quality public space.																	
Accessibility	Whether Florence has sufficient cycling infrastructure to make sustainable mobility physically accessible across the city.																	
Affordability	Whether citizens perceive affordability benefits from measures that reduce dependence on private vehicles and improve access to																	

	shared, cycling, and walking options.																	
Agency	Whether residents already use cycling as a practical mobility choice, indicating the presence of real alternatives to private car travel.																	
Availability	Whether pedestrian-priority space is physically available in the city, especially in the historic centre where road-space reallocation is most visible.																	
Legal Recognition	Whether pedestrian-priority and road-space reallocation measures are formally recognised through defined regulatory categories.																	

Participation	Whether citizens and stakeholders contributed inputs to the metropolitan mobility-planning process relevant to sustainable mobility and public-space priorities.																	
Safety & Security	What the baseline level of injury crashes is, so that future safety improvements from road-space reallocation can be assessed.																	

Pilsen

PIL – SOL1

Solution SOL6 - Pilsen: Digital Twin integration & scale-up

Pilsen uses the Digital Twin for traffic forecasting, scenario testing, and cross-sector mobility planning. This sheet asks for KPI inputs that help estimate how strong the 8 SOMI pillars are for the Digital Twin as an operational planning and forecasting solution.

SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note	TT note	TT (link)
Acceptability	Whether local stakeholders positively appraised the pilot after testing, indicating acceptance of the digital-twin approach and its practical relevance.																			
Accessibility	Whether the pilot uses sufficiently rich spatial public-transport datasets to represent access conditions and support mobility analysis.																			
Affordability	Whether the pilot received financial support that reduced the local implementation burden and enabled Pilsen-based participation.																			

Agency	Whether participants had a real opportunity to express suggestions, concerns, and remarks, rather than only reacting passively to predefined pilot content.					
Availability	Whether the pilot had operational mobility data and model inputs available for implementation, testing, and practical use.					
Legal Recognition	Whether the city formally supported the DUET pilot, giving the intervention institutional legitimacy within local mobility planning.					
Participation	Whether the pilot involved stakeholders through concrete co-creation, consultation, or testing sessions during the evaluation process.					
Safety & Security	Whether the pilot addresses safety and resilience by modelling crisis scenarios and possible countermeasures, rather than only describing					

ordinary mobility conditions.				

PIL – SOL2

Solution SOL7 - Pilsen: Cycling uptake and bike-share support																				
Pilsen (CZ): Combine cycling infrastructure, route quality, monitoring, greenways, and shared-bike / e-bike support so cycling becomes a more practical everyday mode across the city and nearby areas.																				
SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note	TT note	TT (link)
Acceptability	Whether residents express demand for safer, more comfortable cycling conditions, indicating public support for cycling-oriented mobility improvements.																			
Accessibility	Whether dedicated cycling infrastructure is physically available to support safe and direct access by bicycle across the city.																			

Affordability	Whether the bike-sharing option remains financially accessible for everyday short urban trips.																	
Agency	Whether cycling is already used by residents as a realistic everyday travel option, rather than only as a recreational activity.																	
Availability	Whether bike-share infrastructure is sufficiently available across the city relative to population size.																	
Legal Recognition	Whether cycling is formally recognised as part of the city's approved mobility-planning framework.																	

Participation	Whether the city collected citizen input through a mobility survey that can inform cycling-related planning decisions.																		
Safety & Security	What the baseline level of reported traffic accidents is in the urban area, so that future cycling-safety improvements can be assessed.																		

PIL – SOL3

Solution SOL8 - Pilsen: Public transport and first/last-mile access

Pilsen (CZ): Strengthen public transport by improving first/last-mile access - especially from peripheral areas - through better links with walking, cycling, bike-share, and station/stop accessibility.

SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note	TT note	TT (link)
Acceptability	Whether citizens support the continued development of the tram network, indicating public acceptance of tram-based public-transport investment.																			
Accessibility	Whether the city has a sufficiently dense network of public-transport stops to support access to mobility services across the urban area.																			

Affordability	Whether regular public-transport use remains financially manageable for residents relative to local income levels.																	
Agency	Whether residents have complementary first-/last-mile mobility options that expand their practical travel choices beyond fixed-route public transport.																	
Availability	Whether public-transport services are physically and operationally available through a sufficient number of active lines.																	
Legal Recognition	Whether public transport and first-/last-mile accessibility are formally recognised in the approved																	

	mobility-planning framework.																
Participation	Whether the city collected a sufficiently broad base of citizen input through the PUMP 2026–2035 mobility survey to inform public-transport planning.																
Safety & Security	Whether tram stops and stations provide safe, accessible boarding and access conditions for users, including people with reduced mobility.																

Antwerp

ANT - SOL1

Antwerp MaaS / Smart Ways - simple SOMI KPI input sheet

Fill only the yellow cells. Enter ONE number for each pillar in the Preferred, Alternative, or Proxy value column. If a pillar is not relevant or no data exist, leave values blank and explain briefly in Notes.

SOMI Pillar	What CERTH wants to understand	Preferred KPI (city may already monitor)	Unit + direction	Example city reply + likely source	CITY VALUE - Preferred	Alternative KPI (acceptable / CERTH can derive)	Unit + direction	Example city reply + likely source	CITY VALUE - Alternative	Simple proxy if needed	Unit + direction	Example city reply + likely source	CITY VALUE - Proxy	Final KPI used (auto)	Final value for SOMI (auto)	Final unit + direction (auto)	City notes / source / year / area definition	CERTH note
Acceptability	Whether the route-planner app has been adopted by a meaningful number of users, indicating practical acceptance and public uptake of the service.																	

Accessibility	Whether the route planner includes dedicated accessibility information that helps users identify accessible mobility options and routes.																	
Affordability	Whether the route-planner service is publicly supported in a way that keeps access to mobility information available without placing direct costs on users.																	
Agency	Whether users are offered multiple clearly represented mobility choices, allowing them to compare and select realistic																	

	alternatives for their trips.																	
Availability	Whether the app integrates a broad range of mobility providers, making multimodal travel options visible and practically available through one platform.																	
Legal Recognition	Whether the route planner is formally recognised as part of the Antwerp SPINE Living Lab, giving it institutional relevance within the pilot framework.																	
Participation	Whether target users were involved in validating the route planner's																	

	accessibility and inclusiveness, especially in relation to WCAG-oriented design.																
Safety & Security	Whether the route planner actively supports safer mobility choices by including road-safety information or guidance in turn-by-turn navigation.																

APPENDIX IX

SOMI AND ATLAS OF ACCESSIBILITY

Project deliverable D1.4

Version number: **V2.0 - Final**

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Author(s):

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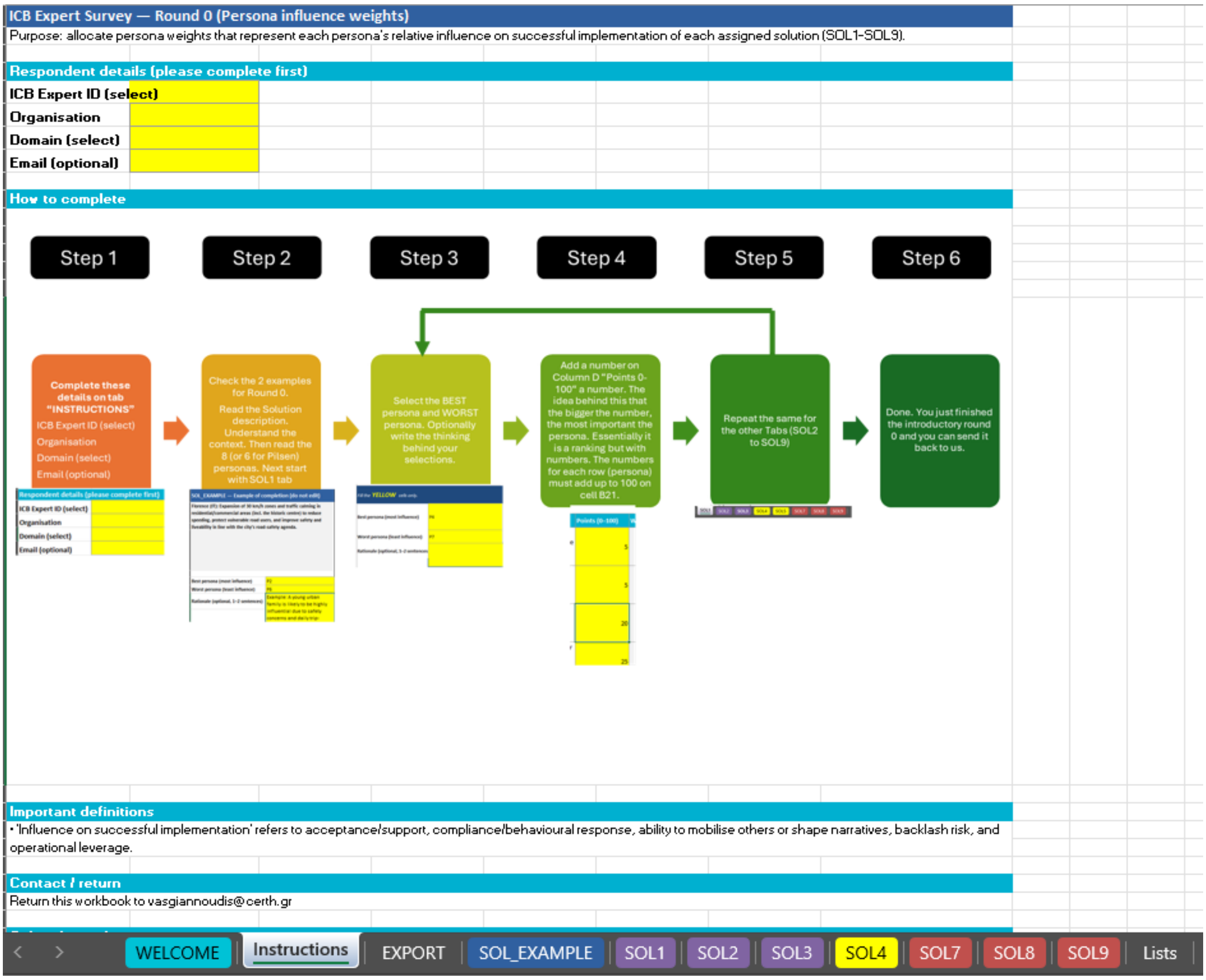
Appendix IX – ICB Expert consultation r0 and r1 spreadsheet templates

This appendix presents the spreadsheet templates used for the Impact Creation Board expert consultation. The Round 0 template supported the initial 100-point allocation exercise and the identification of the most and least influential personas for each solution. The Round 1 template supported the structured Best-Worst Method comparison process, including Best-to-Others and Others-to-Worst ratings on a 1–9 scale. The appendix is included as methodological evidence, showing the format through which expert judgement was collected, structured and transformed into the persona-influence weights used in the SOMI calculation.

1.1 ICB Expert consultation round 0 template



ICB Expert Survey — Round 0 (Persona influence weights)
Purpose: allocate persona weights that represent each persona's relative influence on successful implementation of each assigned solution (SOL1–SOL9).
Respondent details (please complete first)
ICB Expert ID (select)
Organisation
Domain (select)
Email (optional)
How to complete
Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Complete these details on tab "INSTRUCTIONS"
ICB Expert ID (select)
Organisation
Domain (select)
Email (optional)
Check the 2 examples for Round 0.
Read the Solution description. Understand the context. Then read the 8 (or 6 for Pilsen) personas. Next start with SOL1 tab
Select the BEST persona and WORST persona. Optionally write the thinking behind your selections.
Add a number on Column D "Points 0-100" a number. The idea behind this that the bigger the number, the most important the persona. Essentially it is a ranking but with numbers. The numbers for each row (persona) must add up to 100 on cell B21.
Repeat the same for the other Tabs (SOL2 to SOL9)
Done. You just finished the introductory round 0 and you can send it back to us.
Respondent details (please complete first)
ICB Expert ID (select)
Organisation
Domain (select)
Email (optional)
Points (0-100)
5
5
20
25
Important definitions
• 'Influence on successful implementation' refers to acceptance/support, compliance/behavioural response, ability to mobilise others or shape narratives, backlash risk, and operational leverage.
Contact / return
Return this workbook to vasgiannoudis@certh.gr
WELCOME
Instructions
EXPORT
SOL_EXAMPLE
SOL1
SOL2
SOL3
SOL4
SOL7
SOL8
SOL9
Lists

These are illustrative examples. Please apply your own judgement based on implementation influence, not wh

SOL_EXAMPLE — Example of completion (do not edit)

Florence (IT): Expansion of 30 km/h zones and traffic calming in residential/commercial areas (incl. the historic centre) to reduce speeding, protect vulnerable road users, and improve safety and liveability in line with the city's road-safety agenda.

Best persona (most influen	P2
Worst persona (least influe	P6
Rationale (optional, 1-2 se	Example: A young urban family is likely to be highly influential due to safety concerns and daily trip-chaining; visitors are least influential in implementation success for this solution.

Persona ID	Persona
P1	City-centre resident, occasional car user
P2	Young urban family
P3	Older / less mobile resident
P4	Urban small business operator
P5	Budget-sensitive student
P6	Culture visitor

SOL_EXAMPLE2 — MaaS / Smart Ways to Antwerp scale-up

Antwerp (BE): Antwerp already operates Smart Ways to Antwerp as a mature multimodal mobility ecosystem, not only a basic app. It includes a route planner with real-time information and multimodal combinations, policy-aligned nudges, walking/cycling route options, truck routing, a mobility map and hubs/wayfinding features, and reusable roadworks data for routing providers. Antwerp now wants to upgrade the service quality of this ecosystem: improving route guidance and multimodal combinations, strengthening real-time information and nudges, and expanding the use of accessibility and traffic-safety related nudges to support better travel choices.

We are assessing which personas have the greatest influence on the successful implementation of these service enhancements (acceptance, adoption, and effective use at scale).

Best persona (most influen	P3
Worst persona (least influe	P7
Rationale (optional, 1-2 se	Example: Best --> P3 This group depends on multimodal chains (regional rail/park-and-ride + local services). They are extremely sensitive to delays, disruptions, and transfer penalties. If Smart Ways improves route reliability, transfer guidance, disruption info, and multimodal coherence, P3 will either adopt and advocate the tool (success) or reject it quickly (failure). Their routine commuting makes them a strong "stress test" for service upgrades and adoption at scale. Worst --> P7 This group depends on multimodal chains (regional rail/park-and-ride + local services). They are extremely sensitive to delays, disruptions, and transfer penalties. If Smart Ways improves route reliability, transfer guidance, disruption info, and multimodal coherence, P3 will either adopt and advocate the tool (success) or reject it quickly (failure). Their routine commuting makes them a strong "stress test" for service upgrades and adoption at scale.

Persona ID	Persona	Short description	Points (0-100)	Weight
P1	City-centre resident, occasional car user	Lives/works in dense inner districts; uses walking/cycling/public transport for most trips, with occasional car use. Responds to visible local improvements and clear information.	20	0.200
P2	Port/industrial worker, car-dependent	Commutes to industrial/port areas, often with shift hours. Prioritises reliability and travel-time certainty; limited off-peak public transport can increase car dependence.	18	0.180
P3	Sub-urban commuter	Travels from surrounding municipalities; relies on reliable multimodal chains (regional rail/park-and-ride + local services). Sensitive to delays, disruptions, and transfer penalties.	15	0.150
P4	Cost-conscious multimodal student	Student/young adult combining affordability with flexibility. Uses walking/cycling/public transport and may adopt digital tools; sensitive to small barriers and perceived safety.	12	0.120
P5	Young urban family	Family with children managing complex schedules. Needs predictable, low-stress options and safe infrastructure; may revert to car if the system feels unreliable.	12	0.120
P6	Older resident	Older adult prioritising comfort, clarity and supportive infrastructure (safe crossings		

1.2 ICB Expert consultation round 1 template

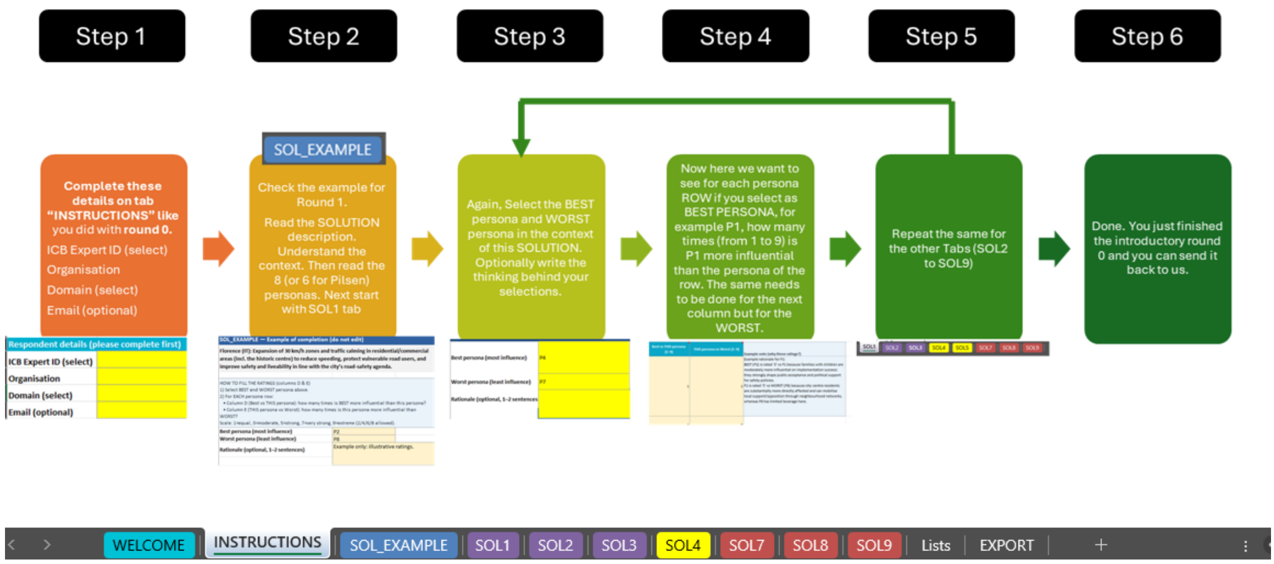
ICB Expert Survey — Round 1 (Persona influence comparisons)

Purpose: provide structured comparisons that quantify each persona's relative influence on successful implementation for each assigned solution (SOL1–SOL9).

Respondent details (please complete first)

ICB Expert ID (select)	
Organisation	
Domain (select)	
Email (optional)	

How to complete



SOL_EXAMPLE — Example of completion (do not edit)

Florence (IT): Expansion of 30 km/h zones and traffic calming in residential/commercial areas (incl. the historic centre) to reduce speeding, protect vulnerable road users, and improve safety and liveability in line with the city's road-safety agenda.

HOW TO FILL THE RATINGS (columns D & E)
1) Select BEST and WORST persona above.
2) For EACH persona row:
- Column D (Best vs THIS persona): how many times is BEST more influential than this persona?
- Column E (THIS persona vs Worst): how many times is this persona more influential than WORST?

Scale: 1-equal, 3-moderate, 5-strong, 7-very strong, 9-extreme (2/4/6/8 allowed).

Best persona (most influence)	P2	*Select the persona that, in your judgement, has the greatest influence on successful implementation of this solution (e.g., acceptance/support, compliance/behavioural response, ability to mobilise others or shape narratives, backlash risk, operational leverage).*
Worst persona (least influence)	P6	*Select the persona that, in your judgement, has the least influence on successful implementation of this solution (same factors as above).*
Rationale (optional, 1–2 sentences)	You can keep the same rationale like in Round 0.	

Persona ID	Persona	Short description	Best vs THIS persona (1–9)	THIS persona vs Worst (1–9)	Example note (why these ratings?)
P1	City-centre resident, occasional car user	Lives in the historic/central area; mostly walks, cycles or uses public transport, but relies on a car for specific trips (family needs, heavy goods, trips outside the centre). Values liveability and predictable access rules.	2	6	**Best (P2) is rated 2 vs P1** because young families are slightly more influential for implementation success (high safety salience and political visibility), while city-centre residents are still highly influential as directly affected daily users. **P1 is rated 6 vs Worst (P6)** because residents can mobilise support/opposition and shape local acceptance, whereas visitors have limited leverage on implementation decisions.
P2	Young urban family	Household with children; frequent trip-chaining (school, work, errands). Prioritises safety, reliability, and low-stress travel options; may use a car as a fallback when coordination is difficult.	1	9	**P2 is the BEST, so Best vs P2 is 1 by definition.** **P2 is rated 9 vs Worst (P6)** because families with children are highly influential for road-safety measures (legitimacy, acceptance, compliance narratives), while visitors have minimal influence on adoption and sustained implementation.
P3	Older / less mobile resident	Older adult or person with reduced mobility/confidence. Needs step-free routes, safe crossings, benches and clear information. Sensitive to complex systems and digital-only access.	2	6	**Best (P2) is rated 2 vs P3** because families typically drive broader acceptance and political feasibility, while older/less mobile residents are also influential but slightly less central in agenda-setting. **P3 is rated 6 vs Worst (P6)** because vulnerable residents influence acceptance through safety/accessibility narratives and are directly affected by
P4	Urban small business operator	Local small business owner/operator in a dense centre who depends on regular deliveries and customer access. Needs predictable loading/unloading options and clear access rules.	3	5	
P5	Budget-sensitive student	Student/young adult with limited budget. Relies on walking/cycling/public transport; sensitive to fares and late-night safety; generally open to integrated tickets and digital support.	4	4	
P6	Culture visitor	Short-stay visitor/tourist. Needs clear wayfinding, simple rules and intuitive, safe walking environments; may use public transport/taxi due to unfamiliarity.	8	1	
P7	Sub-urban commuter	Lives outside the centre and commutes regularly. Values time certainty and reliability; may combine car + public transport (e.g., park-and-ride) and is	3	5	