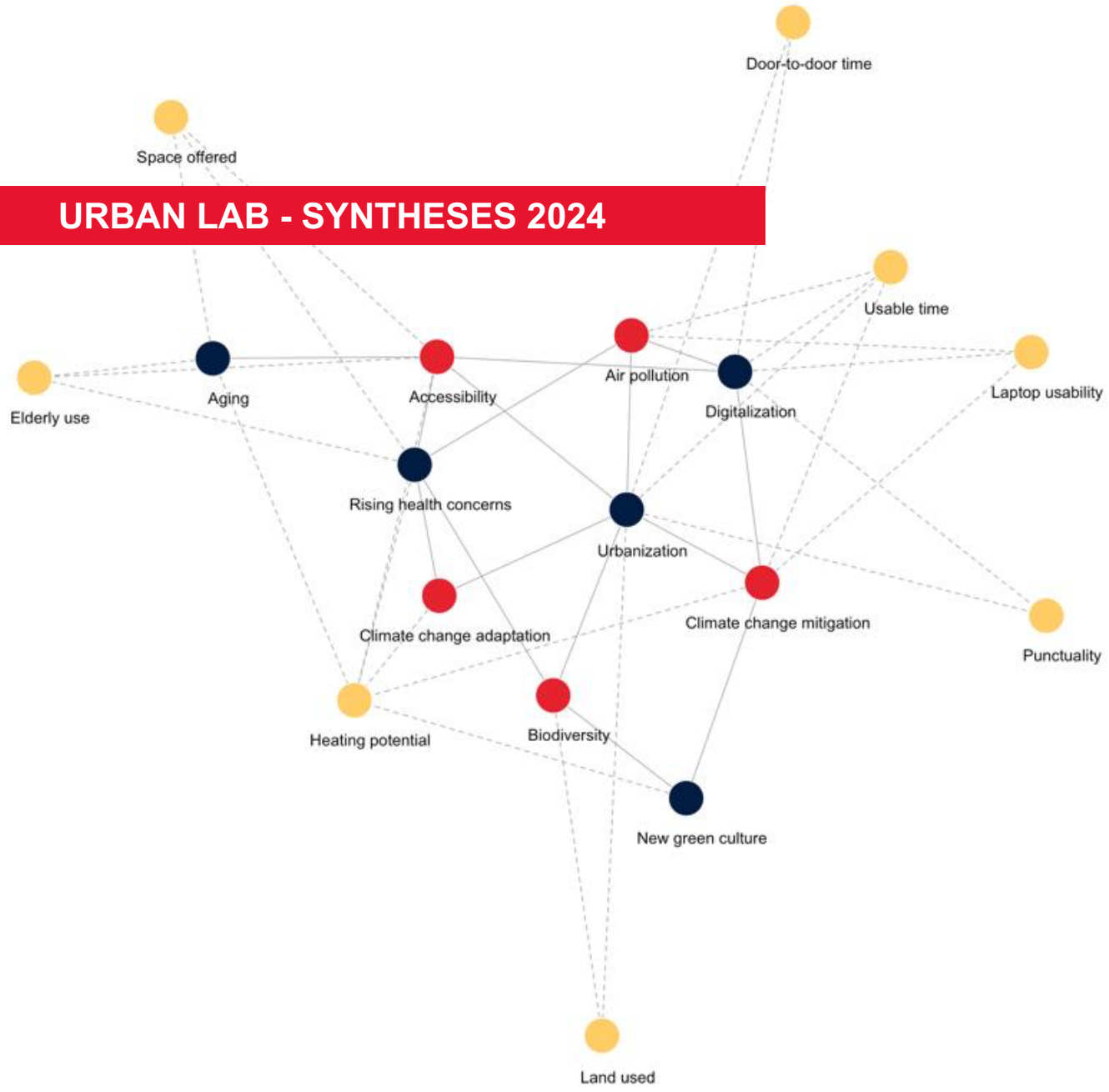
URBAN LAB - SYNTHESES 2024




# COMPARING MOBILITY MODES : A NEW SET OF INDICATORS

## Capstone Project - Futura Mobility

**MASTER Governing the Ecological Transitions in European Cities**
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futura-mobility

SciencesPo URBAN SCHOOL

# PREFACE

## Futura-Mobility

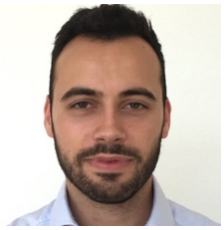
Futura-Mobility is a think-tank dedicated to innovation and foresight in the transport sector, both passenger and freight. Current members are SNCF, Keolis, Bouygues, ADP Group, OPmobility, Stations-e, ESTACA, and Valeo as an associate founder. The think-tank brings together a community of professionals from the world of transport, inviting people from a wide range of backgrounds (designers, researchers, urban planners, start-ups, etc.).

Futura-Mobility's mission is 'to imagine and share the necessary transformations in mobility between now and 2050 to respect planetary limits and increase societal benefits'. The Futura-Mobility Board of Directors has decided to launch a study comparing the costs and externalities of different means of transport for passengers in Europe.

The aim is to create a tool for comparing different means of transport in a nonpartisan way, for use by both passengers and policy-makers. Futura-Mobility is ideally placed for such work, since it is non-partisan with regards to modes of transport. This work should provide objective indicators for comparing the use of different means of transport in relation to different societal and environmental issues, to be determined by the study in line with Futura-Mobility's mission.

The end objective is also for the think-tank to capitalize on the study, at conferences, workshops and other events, to be organized for an audience of mobility professionals – from both the public and private sectors.

## Adrien Sartre, tutor of the project



If we are to think about the transport of the future, we must look beyond the debate confined to costs, journey times, and greenhouse gas emissions. Transport should be viewed as an experience in its own right—an experience of life, work, and sharing. Unfortunately, this experience still often excludes entire sections of the population, lacking in safety, comfort, or technical capabilities.

This study aims to explore this emerging field of thought. By reflecting on the major challenges and megatrends of our time, as well as the evolving needs of our changing societies, it seeks to develop new mobility indicators. These indicators will empower passengers and decision-makers to make informed choices about future mobility.

By reimagining mobility as an inclusive and enriching experience, this study aspires to transform transportation modes into genuine opportunities for life enhancement, while addressing contemporary demands for sustainability, practicality, and accessibility.

## THE PARTNERS

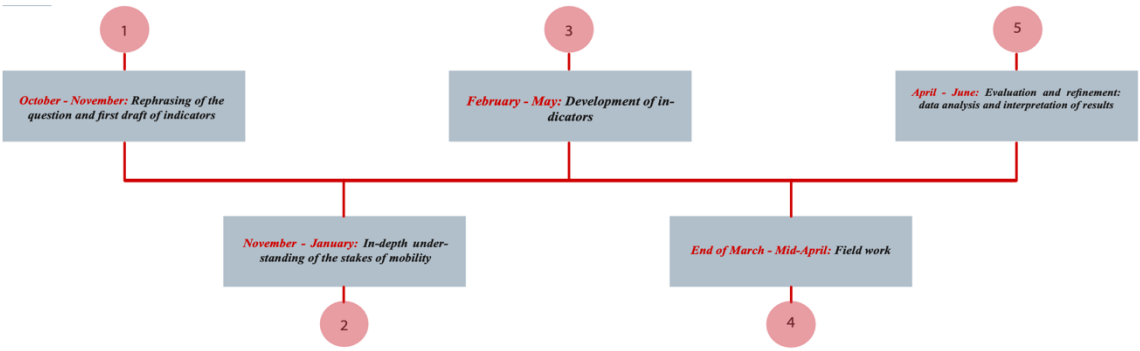
Futura-Mobility is a Paris-based innovation and prospective think tank for mobility stakeholders. Created by and for the transport players, its members – SNCF, Bouygues, Groupe ADP, Keolis, ESTACA, Opmobility, and Stations-e – represent a broad range of business activities in this field. Valeo is an associate founder of the think tank.

Futura-Mobility provides a platform for people from the world of mobility to share their views on disruption, ongoing or future, and come together to explore avenues for innovation. They cover topics ranging from the energy transition to the impacts of the digital revolution, the emergence of new markets to eco-design.

## METHODOLOGY

This Capstone project spanned nine months, starting in October 2023. It was supervised by both Futura-Mobility -with its general delegate and professionals from SNCF, Groupe ADP, ESTACA and Bouygues- and our tutor, Adrien Sartre, at every stage of the project detailed below.

The first step of the project was to conduct an extensive literature review of the stakes of mobility today, identifying megatrends and challenges. The aim was to understand the mobility challenges faced in urban, rural, or touristic areas and better grasp how and why people move from one point to another. The second step was to define a list of indicators relevant to both passengers and decision makers when choosing a mobility mode. The choice of indicators was informed by the megatrends identified during the first step, ensuring their relevance. Additionally, personas were also created to guide our research, allowing us to determine specific issues faced in certain locations based on the characteristics of people studied. The third part of the project involved field trips, to analyze the indicators in four European locations. Initially, a benchmark was conducted to select the European cities to be analyzed. Then, we contacted officials and public or private actors and experts in the field. During our field trips, we conducted both interviews and observation work. We divided into two groups: Group 1 covered Amsterdam (Netherlands) and Castellón de la Plana (Spain), while Group 2 focused on Budapest (Hungary) and Bratislava (Slovakia). Each group carried out street interviews with passengers using a structured questionnaire (on google form). Additionally, we interviewed professionals (policy makers and consultants) and academics to gain further insights into the state of mobility in each city. Calculations were made for each indicator in those destinations to assess their efficiency in a real-life context.



# ISSUES

## Why it matters

The functioning of our society depends on people's ability to move. Consequently, the crises we face today are also mobility problems.. Addressing these crises hinges on how well we adapt our transportation systems. Yet our ability to analyze today's mobility in comprehensive ways is limited. The advantages, downsides and effects of transport modes often hide behind the complexity of data. Most importantly, comparison is challenging due to the lack of meaningful indicators that enable cross-modal comparison.

This study aims to develop new and relevant indicators to address this lack of ways of measurement, providing a new basis for passengers' choices, but also of debate for decision-makers. First, it will analyze the forces that shape and challenge today's mobility in order to identify relevant questions and applications in specific locations. Based on this mapping, it will create new methods for converting existing data into meaningful indicators. To ensure their validity across different regions of the European subcontinent, field studies will be conducted to compare the outcomes with local realities. Finally, the generalizability of these indicators will be explored.

As outlined in Futura-Mobility's preface, the initial objective of the project was first to compare the cost and externalities of different means of transport. However, as the project unfolded, its focus shifted towards prioritizing the perspective of passengers, and thus the priorities of policymakers. This change was particularly evident in our selection of indicators. Indeed, while a focus on costs and externalities would have led us to indicators such as greenhouse gas emissions, or the overall cost of a given mode of transportation, Futura-mobility underlined the importance of using indicators that are, first and foremost, relevant to passengers. The goal was to provide information that would aid individuals in choosing between different modes of transportation for a specific journey. Therefore, instead of measuring the effect of a given mode on biodiversity per territory or region for instance, the indicators should rather produce values that break down the effect to the level of each passenger for each journey. Moreover, the initial end goal of developing a simulation tool that could be used to provide mobility as a Service app with enhanced indicators also quickly proved to be unattainable and rather unrealistic given the time and data constraints of the project.

Recognizing that transportation significantly contributes to GHG emissions and resource depletion, this Capstone project aims to align with the imperative of ecological transition, by encouraging modal shifts. Indeed, by analyzing various indicators that could guide users in choosing one mode of transportation over another, we aim to direct them towards mobility modes with lower ecological impacts. These indicators are designed to play a pivotal role in informing policy decisions towards the promotion of sustainable transportation methods, therefore facilitating a transition to a more sustainable and resilient transport system.

## Research Question

Based on the broad mission described above, the research question is twofold: it first addresses the type of indicator needed and the properties it should have; and secondly it examines the current stakes in mobility in Europe.

- Indicators

The indicators are designed from the perspective of the passenger comparing different modes of mobility. They should provide valuable guidance for choosing between different transportation options for a given journey. Ultimately, they could be integrated into an application, which offers passengers additional information on journeys of their choice.

In terms of aspects that relate directly to passenger convenience, clarity and simplicity of indicators were our guiding principles. Above all, indicators should be easy to understand and to read, to ensure they reach a broad audience and meet their expected outcomes. Regarding externalities, the indicators should not compute the effect of a given mode on biodiversity per territory or region, but rather should produce values that break down the effect to the level of each passenger of each journey.

- Mobility in Europe today and in the future

To be relevant to both passengers and decision-makers, the indicators developed should resonate with contemporary mobility issues. In essence, these indicators should represent an intelligent choice addressing and engaging with our time. Making such an intelligent choice of new indicators ensures that the contribution has a higher impact on the discourse. Three aspects are fundamental in this choice:

- To be relevant to the general discourse, the indicators must be informed by and address the **megatrends** affecting mobility today and tomorrow.
- To be relevant to decision-makers, the indicators need to capture the current mobility **challenges** faced by mobility in Europe.
- Finally, to be relevant to passengers, the indicators need to relate to their **important needs**.

The answer to these questions forms the map in which the indicators are developed and situated. To achieve this, personas are established based on the results: ideal-typical, fleshed-out fictional figures with specific needs and obstacles in their mobility that guide the choice of indicators. These personas are crucial in informing the selection of field trips, as well as the assessment and evaluation of the indicators. In line with the scope of the study, the persona should represent the geographical, political and social variability of the European subcontinent as well as the spectrum of journeys typical for the European travelers.

This brings us to the **core question** of the study:

*Which new mobility indicators do decision-makers, entrepreneurs, and consumers miss to jointly shape the best passenger transport mix in the future?*

This document is a synthesis of our end report, presenting our study and its main results. More information can be found in the fuller version of the report.

## Stakes of mobility today:

A thorough understanding of the current stakes of mobility was crucial for this project. This understanding was achieved through a detailed analysis of the various trends and challenges impacting our societies and their mobility. We thus analyzed the forces that shape and challenge today's mobility. This enabled us to identify the following megatrends, i.e. large-scale and long-term transformations, in Europe: the aging of the population, the advent of new social practices reinforced by growing ecological awareness, the increase in concerns about health, recently highlighted by the Covid-19 crisis, as well as urbanization and digitalization. At the same time, European societies are facing major challenges, such as mitigating and adapting to climate change and the collapse of biodiversity. Other challenges, such as improving the accessibility of public transport, or responding to high levels of air pollution in cities, will also have profound implications on the way we travel.

The following network mind map underlines the interconnectedness of those mobility and challenges, while emphasizing that our indicators resonate with the contemporary issues of mobility.

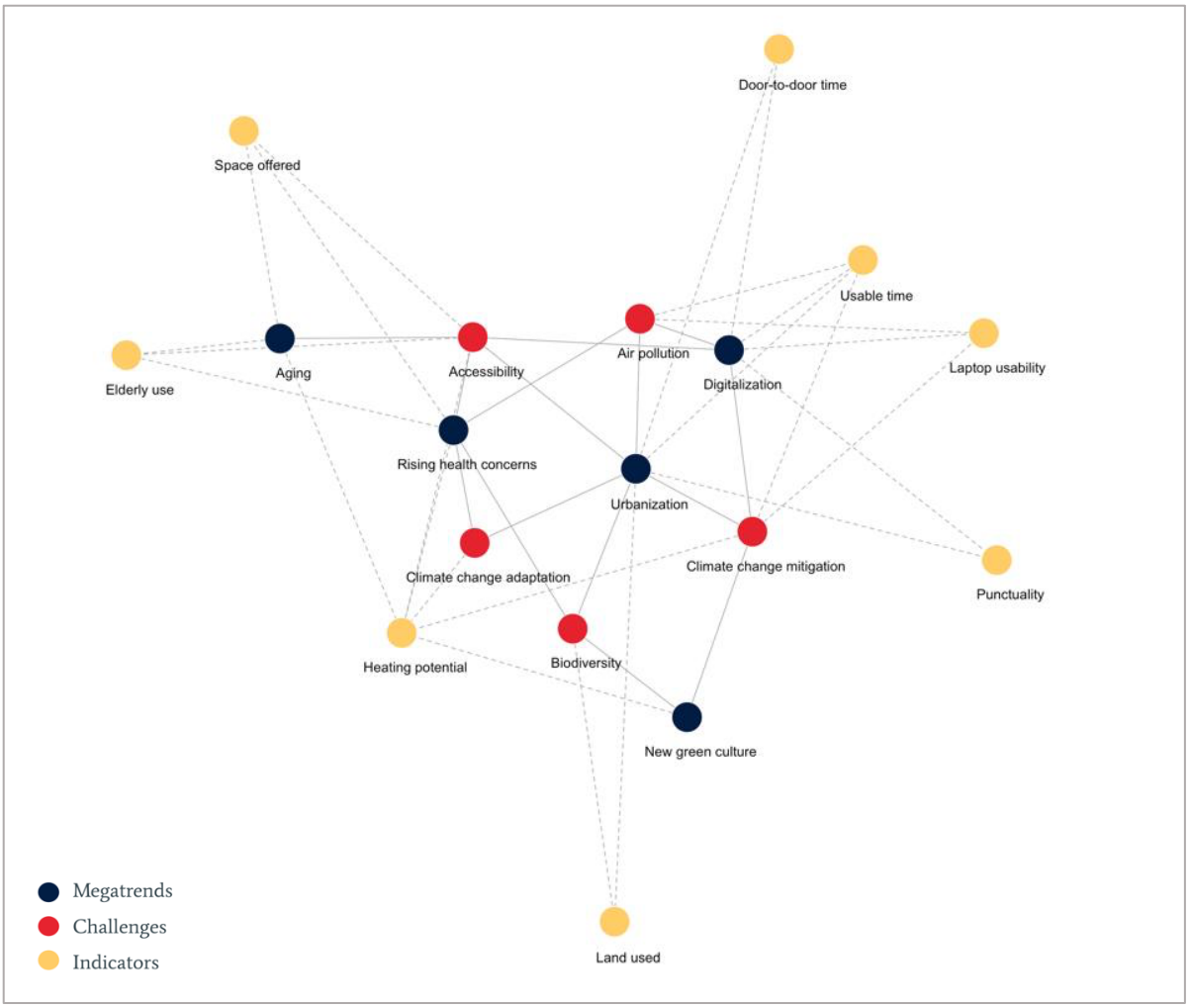



*Figure 1- A network of megatrends, challenges and indicators of mobility*

## FIELDS STUDIED

Field studies were conducted in four European locations to assess the relevance and validity of our indicators across different regions of the European subcontinent. The fields studied were selected based on benchmark results, aiming to reflect:

- the European diversity of cultures and regimes;
- the challenges and megatrends that mobility faces in Europe.

Additionally, three typical personas (Rebecca, Dino, and Selma) were created to help us understand user requirements, designing tailored solutions, and prioritizing features crucial in the selected areas. They are typical from southern, northern and eastern European contexts.

**Amsterdam**

*Persona*: Dino: 26-year-old digitalization startup employee, living on the outer circle of Amsterdam, commuting daily to the city center for work. He often visits his grandmother Selma, who lives on the Galician coastline in Spain. Despite his average income, Dino is committed to reducing his carbon footprint and avoids using cars and planes.

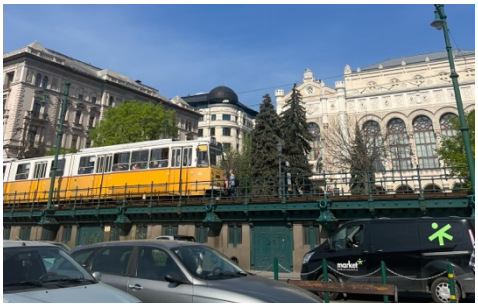
Amsterdam was notably selected for its high social welfare spending, translating into good public transport, its strong awareness of inequality issues, as well as for its urban, inner city environment. Sustainable and smart mobility is also famously well implemented in Amsterdam. Observations and interviews showed that the city's status as "smart" doesn't automatically make every indicator compelling. Instead, population and density growth dominate local agendas, with a keen focus on flux, flows, traffic, space/land use, and social events, all monitored extensively through cameras and sensors, reflecting a strong emphasis on security. Interior comfort, although undervalued by residents accustomed to overcrowding, presents a policy challenge of providing comfort without excessive space per person. Reliability, especially concerning trains, emerges as a significant issue in the Netherlands, possibly due to the densely urbanized nature of the country with its multitude of connections and interference.

**Eastern Europe**

We opted to focus on Eastern European countries due to the prevalence of car usage in the region, coupled with institutional and financial barriers that impede the advancement of public transportation systems.

*Persona*: Rebecca: 40-year-old mother of two, living in the suburbs (of either Budapest or Bratislava) with her family, her daily routines involves commuting into the city center for work, as well as managing her children's activities. Despite her low income, she relies on her combustion engine car.

- Budapest



The strong cultural reliance on cars, linked to the legacy of the post-Soviet era, as well as the Covid crisis and inflation, was confirmed by interviewees. The convenience of door-to-door travel often leads individuals to choose cars over public transport, resulting in a recent surge in car traffic at the expense of more sustainable transportation options. This trend is reflected in the allocation of land resources, with significant implications for urban planning and development. Fast-growing suburbanization processes, more pronounced than in other parts of Europe, exacerbate the divide in service availability between major cities and their surrounding suburbs or rural areas. The lack of financial resources is an important obstacle to the effectiveness of public transport, exacerbated by political conflict. The national government has indeed withheld European funds, primarily due to Budapest's political opposition to the national government.

- Bratislava

Interestingly, a significant emphasis was put on enhancing the comfort of public transport as a means of incentivizing its usage. This focus, driven by the mayor's priorities, has led to notable improvements in comfort levels. However, despite these efforts, door-to-door travel time remains a key factor influencing individuals to opt for private cars, contributing to the prevalent "motorization" trend observed. Attempts by policymakers to curb car usage face political risks, as they challenge deeply ingrained cultural norms and individual preferences. While initiatives to promote modal shifts and compact urban development are underway, reliability issues persist within the public transport network, particularly concerning trains. The prevalence of numerous connections within the public transport system further exacerbates reliability concerns, impacting the door-to-door and useful travel times for passengers.

**Castellon de la Plana**

*Persona*: Selma: 82 years old, living in a small village near Castellon de la Plana, retired and with family far away, she finds walking increasingly difficult and feels less confident driving her car.

We selected Spain primarily due to the country's significant aging trend, which positions it as the fastest-aging nation in Europe. This justification supports our decision to create a persona representing an 80-year-old woman. Interestingly, bus mobility has been subject to improvements and increased funding. Observation and interviews showed that fiscal constraints greatly hamper the implementation of the mobility plan. As a consequence, increasing coverage and frequency have had to be prioritized over other much-needed improvements. Hypomobility remains important among elderly population, it is often unrecognized by the individuals themselves. Despite efforts to enhance accessibility through initiatives like building accessible bus stops, the impact is limited when there's only one line in operation.

## MAIN RESULTS

# Usable Time

Digitalization
Climate change mitigation
Air pollution

### Definition

The amount of time that can be used for productive activities during a journey.

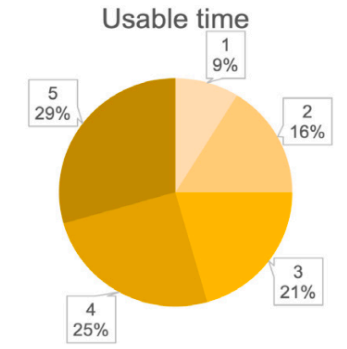
### Formula

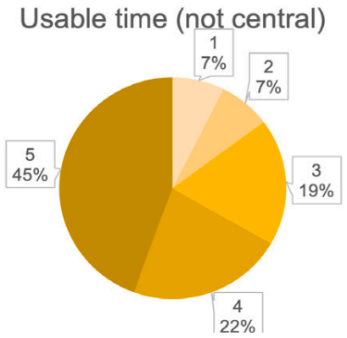
$$t_u = \sum_i^{n_s} d_i \, \delta_i$$

| | |
|---|---|
| $t_u$ | usable time |
| $n_s$ | number of steps |
| $d_i$ | duration of step i |
| $\delta_i : 1$ | if usable or 0 if not usable |

Time is usable either if you can use your laptop on a table (7am to 10pm) or if you can lay down (10pm to 7am).

People were asked on the street to rate the indicator from very relevant (5) to not relevant at all (1).



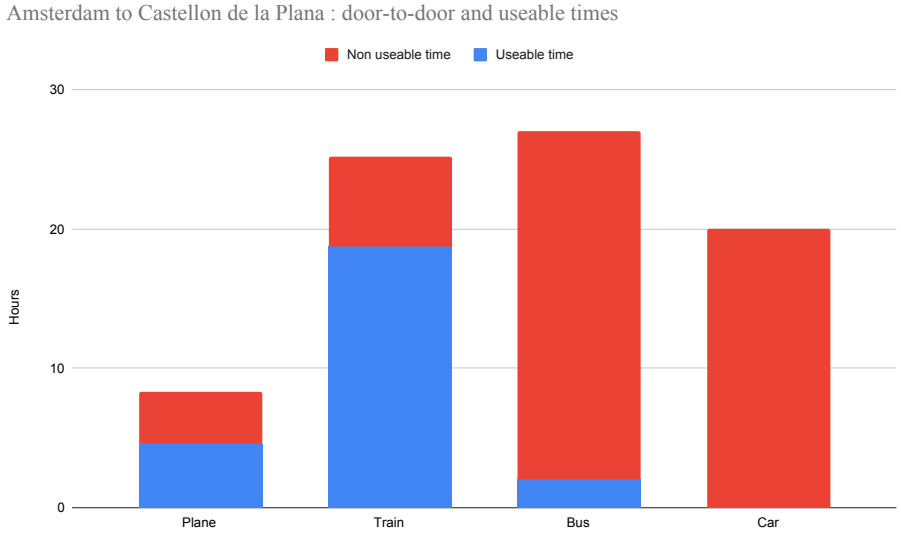




### Findings from the field

In central urban areas, where the trajectories tend to be shorter, people valued usable time substantially less than in not central areas. In turn, the longer trajectories in not central areas render usable time relevant.

### Example

During your trip from Amsterdam to Castellón de la Plana, the usable time depends on the mode you choose. Computed with online data, usable time is ->



# Punctuality

Urbanization
Digitalisation

## Definition

The share of journeys arriving late. A journey is late when the delay is higher than 1.5 x √ of the journey length.

## Data source

Operators, archives, IT-companies like Google or Géovelo.

## Formula

$$Pm = (Jml \ / \ Jm) \ *100$$

| | |
|---|---|
| $P_m$ | *Punctuality of a mode m* |
| $J_{ml}$ | total of journeys being late |
| $J_m$ | total of journeys |

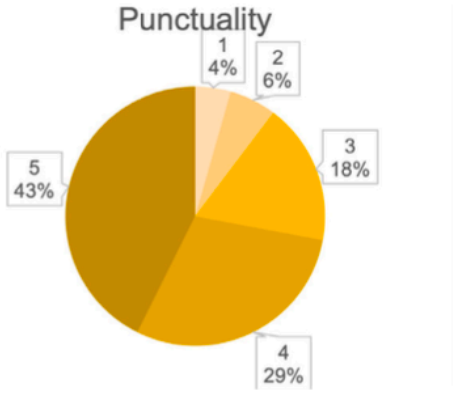
## Example

You want to make sure to be on time on the way back to Amsterdam because you have to work again. Punctuality from Paris to Amsterdam, computed with data from an online train archive, is:
Train: 25% late.

## Findings from the field

The field trips demonstrated that punctuality is a central concern for policy-makers. In Bratislava, Budapest, and Castellón de la Plana, Spain, interviews revealed that the punctuality of public transport is regarded either as a main problem or a main solution. Only in Amsterdam it was not a priority, likely because of the high share of biking in the city.

People were asked on the streets to rate indicators from very relevant (5) to not relevant at all (1).



# Space Offered

Aging
Rising health concerns
Accessibility

## Definition

Surface availaible per passenger as a proxy for the freedom of distress and constraint given to passengers by the built interior.

## Data source

Engineer drawings from car manufacturers as well as operators

## Formula

$$S_m = (S_{t\,m} - s_{f\,m}) / P_{m\,max}$$

| | |
|---|---|
| $S_m$ | *space offered of a mode m* |
| $s_{t\,m}$ | *total surface of m* |
| $s_{f\,m}$ | *surface of furniture* |
| $P_{m\,max}$ | *maximum passenger capacity of m* |

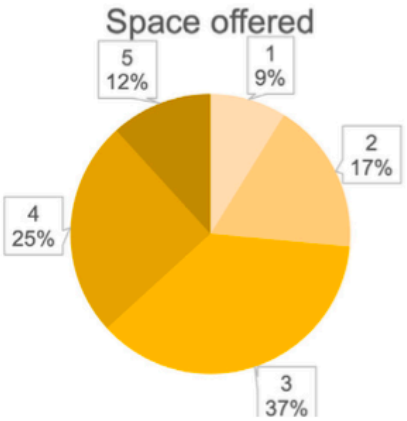
## Example

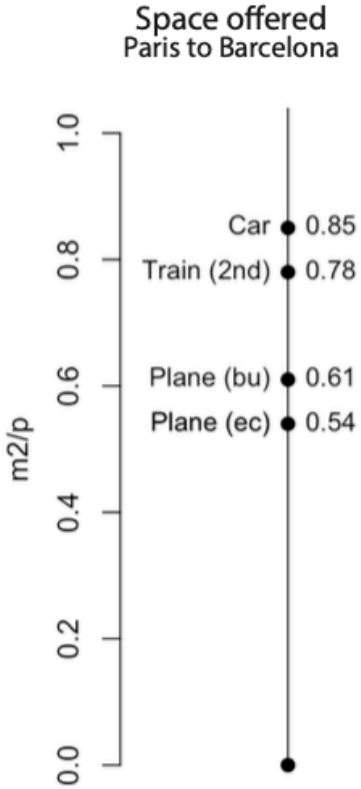
While you are working between Paris and Barcelona, you want to make sure to have a comfortable environment. Space offered, calculated with technical data from operators, is ->

## Findings from the field

In Bratislava, comfort has been a key concern in mobility policy. Following dissatisfaction of the population, the mayor made comfort a priority and urban planners focused on improving it to attract people to use public transport.

People were asked on the streets to rate indicators from very relevant (5) to not relevant at all (1).



# Elderly Use

Aging
Rising health concerns
Accessibility

## Definition

The deviation of the elderly (65+) modal split compared to the non-elderly modal split in percentage points.

## Data source

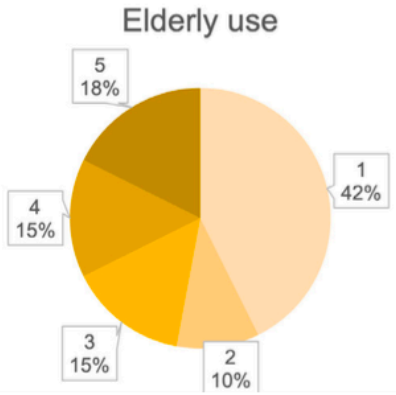
Operators, surveys, IT-companies like Google.

## Formula

$$\Delta U_{e\,m} = ((U_{e\,m} / U_e) - (U_m / U)) * 100$$

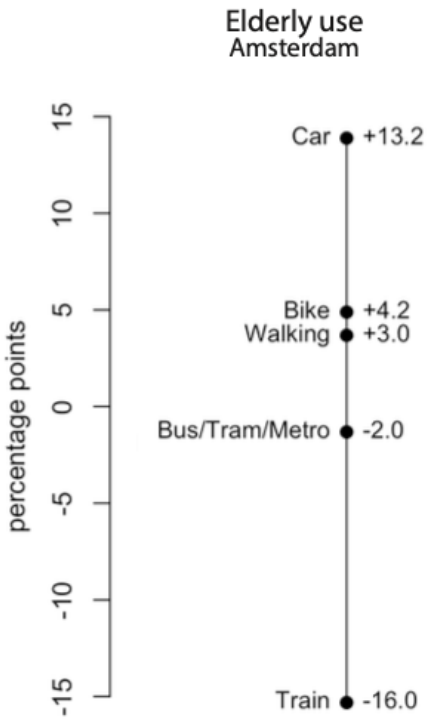
| | |
|---|---|
| $\Delta U_{e\,m}$ | *elderly use differential* |
| *Ue m* | *pkm of a mode m among elderly* |
| *Ue* | *total elderly pkm* |
| *Um* | *pkm of m among people under the age of 65* |
| *U* | *total pkm among people under the age of 65* |

People were asked on the streets to rate indicators from very relevant (5) to not relevant at all (1).




## Example

Your grandmother might come to visit you in Amsterdam. You want to know how accessible the different modes of transportation are in the city. Elderly use in Amsterdam, calculated with survey data, is ->




## Findings from the field

In Amsterdam, the accessibility of mobility is a policy priority. For example, people aged 65 or more with little money don't pay for public transport in the city. Still, as elderly use shows, the use of train, bus, tram and metro drops among the elderly, pointing to barriers. Surprisingly, the bike is attractive to the elderly, showing the high quality of Amsterdam's bike infrastructure.

# Heating Potential

Aging
Rising health concerns
New green culture
Accessibility
Climate change mitigation
Climate change adaptation

## Definition

The percentage of journeys with the humidex exceeding the threshold of 30 (26°C for 50% humidity for instance).

## Data source

Air conditioning of planes, buses, cars and trains. Operators.

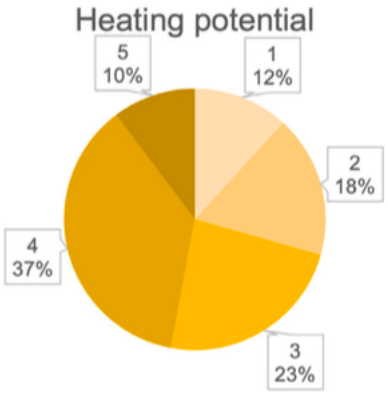
## Formula

$$HP_m \quad \frac{N_{H\geq 30,m}}{N_m} \; *100$$

$N_{H\geq 30,m}$ *number of journeys with humidex and higher*

$N_m$ *number of journeys*

People were asked on the streets to rate indicators from very relevant (5) to not relevant at all (1).




## Findings from the field

In Castellón de la Plana, heat is a pronounced climate risk. While people tended to value the indicator heating potential as relevant in the street interviews, it was found to not resonate with policy priorities. A deputy pointed to the ACs installed in most transport modes, and an academic recounted how back in the days, they would open the doors and windows of the buses while driving to cool the inside.

## Example

You want to know how hot the buses get at your destination in Spain. A fictional value of heating potential for the main bus line in Castellón de la Plana could be:
6% of journeys uncomfortably hot.

# Land Used

Urbanization
Biodiversity

## Definition

Artificialised area needed for a given journey per passenger.

## Data source

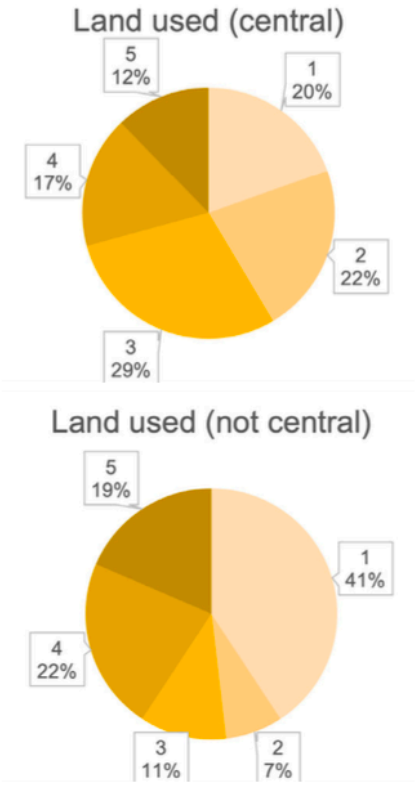
Google Maps, operators, zoning plans.

## Formula

$$A_{m,j} = \frac{A_m L_j}{U_m}$$

| | |
|---|---|
| *Am* | *Total area used by the infrastructures in the countries traveled in (e.g. highways, airports, train stations etc.) (km2)* |
| *Lj* | *Length of the journey (km)* |
| *Um* | *Total use of infrastructure in the countries traveled in (pkm: number of passengers x number of km they travel each)* |

People were asked on the streets to rate indicators from very relevant (5) to not relevant at all (1).

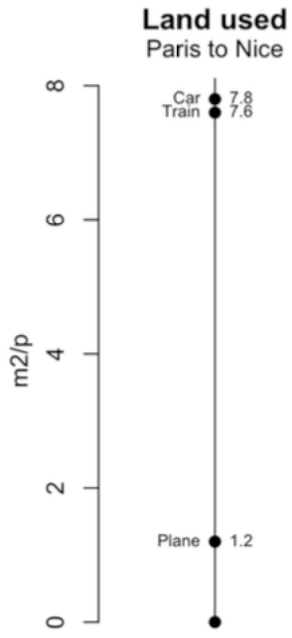



## Findings from the field

Non-central dwellers valued Land used much more often as not relevant at all than central dwellers. This likely reflects the higher availability of land in rural areas. Conversely, the city is a place where space is scarce. The results show that urban people are more aware of this distributional conflict.

## Example

You would like to know how much artificialized land is required for you to go from Paris to Nice. Land used, computed with data from an engineering agency, is ->



## LEARNINGS

The topic of this Capstone Project with Futura-Mobility has been captivating to study. Delving into such an important and current topic, and exploring the professional field of transportation, has been particularly valuable and intellectually stimulating.

As for the learnings to be drawn for the mobility sector, efforts should first be made to enhance the findability of municipal databases and ensure open access to them. Transparency regarding the indicators used in these databases is crucial. Budapest, for example, has published insightful reports based on such indicators, serving as a valuable model. Additionally, special attention should be given to the mobility needs of mid-size and small cities. Improving data collection processes, particularly regarding modal shares (which we identified as lacking in smaller cities), and ensuring that their specific challenges and opportunities are addressed effectively is essential.

As students about to enter the job market, this experience was truly professionalizing. It enabled us to grasp the stakes and operations of the mobility sector. Our initial research phase was crucial for understanding the underlying issues of our topic and its significance. Then, the in-depth study of a field of research allowed us to connect the theoretical knowledge from our courses and prior research with practical field experience, of great value for our professional future. Additionally, the research conducted during field trips was also a great opportunity to engage with various public and private actors from the mobility sector, whose insights were invaluable.

## FIND OUT MORE


- Futura-Mobility – Mobility and transports, innovation and research (futuramobility.org)
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**The Capstone project : an original educational tool**

Thanks to this original tool, students are placed in a work situation on a real problem posed by a public, private, or associative organization. For all the Masters of the Urban School, the structure and management are identical: the project is jointly monitored by the Urban School, and the partners, at all phases of the project, and regular methodological supervision is provided by a professional or academic tutor specialized in the issue. The Capstone projects allow the partners to take advantage of the research and training acquired within the Urban School, to benefit from the production of studies and quality work, and to have a capacity for innovation.

Capstone projects are a great tool to study, diagnose, forecast, lead a comparative analysis, even to prepare for evaluation, and more generally to deal with any problem that can enlighten the organization concerned in a logic of “R&D”. Each project mobilizes a group of first-year students from one of the Urban School’s Master’s. Students work between 1.5 days and 2 days per week on dedicated time slots for a period of 6 to 0 months (depending on the Master’s concerned). In Executive education, collective projects concern the Executive Master “Territorial governance and urban development” and mobilize professionals for a period of 4 months.

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