# The role of digital skills in the use of shared modes and mobility hubs

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University of Twente

*TRAIL Symposium 13-5-2025*

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# The digital and micromobility era? For whom?

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# Contents

# Smart Mobility Hubs

***as a game changer towards inclusive, sustainable urban mobility and accessibility in European cities***

(May 2021-May 2024)

SmartHubs

**Rotterdam-The Hague (NLD)**: Gemeente Rotterdam, Gemeente Den Haag, MRDH, HTM, RET, NS Stations, CROW

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**Brussels (BEL):** Anderlecht, Brussels mobility

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**Our definition of a shared mobility hub**

a **physical location,** where **different shared transport options** are offered

at a **dedicated, non-temporary and recognizable** location, and

**public transport** is available within walking distance”

Hubs differ in functionality, size, location, etc.

Hubs can be categorized using different levels of physical, digital and democratic integration

MVG station St. Emmeram, München

https://www.unser-bogenhausen.de/2017/03/mvg-rad-neue-station-in-st-emmeram/

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## The Smarthubs integration ladder: a conceptual model for the categorisation of shared mobility hubs

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**ABSTRACT**

A variety of shared mobility hubs, offering shared mobility and other services, have emerged in many cities across the globe. This paper provides a literature review on of the definition and categorisation of shared mobility hubs, guidance for the design of these hubs, and develops a multidimensional typology for shared mobility hubs. The typology, named the SmartHubs Integration Ladder, is based on three integration dimensions: physical, digital, and democratic. The literature review shows that digital and democratic (participation) integration dimensions, and universal design principles are typically missing in shared mobility hub concepts, definitions and planning practice. This implies that existing shared mobility hubs will not reach their full potential in terms of user and societal value. The "smarter" shared mobility hubs are physically, digitally, and democratically, the more user and societal value can potentially be created.

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## Inclusive mobility hubs: An in-depth exploration of the requirements of disadvantaged groups

Lluis Martinez *, Cathy Macharis, Imre Keserü

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ARTICLE INFO

*Keywords:*
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Transport disadvantages
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Mobility hubs are becoming increasingly relevant in urban transport systems because they have the potential to enhance sustainability and decrease transport disadvantages. However, the literature has not yet identified the use that disadvantaged groups make of mobility hubs, nor has it thoroughly revealed their requirements for using them without difficulties. As a means to fill this knowledge gap, this qualitative study applied the Capabilities Approach to thoroughly investigate the requirements of disadvantaged groups concerning the use of mobility hubs. The data was obtained through 45 semi-structured interviews and four focus groups with local experts and potential or current users of mobility hubs in four European regions: Brussels, Munich, Rotterdam-The Hague and Vienna. As a result, eight main categories of requirements and their prevalence among disadvantaged groups were identified. The findings contain several recommendations to support decision-makers and practitioners in developing inclusive mobility hubs.

Networks and Spatial Economics
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RESEARCH

## Willingness to pay for shared mobility hubs: a stated choice joint-survey in four European cities

Anna Grigolon[1] · Kelt Garritsen[1] · Karst Geurs[1]

Accepted: 13 January 2025


**Abstract**

This paper aims to assess the relative importance of different shared mobility hub design elements. A standardised survey was developed and applied among users and residents in different areas, including a stated preference experiment, to examine trade-offs between integration dimensions and the willingness-to-pay for different attributes of hubs. The results underscore a disparity between the attributes most valued by respondents and their willingness-to-pay for them, which holds significance in the planning and functioning of mobility hubs. Although elements such as information and digital integration were indicated as being prerequisites for a successful shared mobility hub, respondents are not willing to pay for it, indicating that these would have to be arranged by the government and/or transport operators. Respondents are more willing to pay for shared mobility and public transport within walking distance from one another or for placemaking strategies (such as services or landscaping), which are more evident elements related to the physical integration (and design) of hubs.

**Keywords** Shared mobility hubs · Hub design · Physical and digital integration · Stated choice experiment · Willingness to pay (WTP)

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## The role of digital mobility skills in the uptake of shared modes at mobility hubs

Kelt É. Garritsen, Anna B. Grigolon, Karst T. Geurs

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### Abstract

The popularity of shared mobility services (such as bike or e-scooter sharing) and mobility hubs is increasing in cities worldwide, with the potential to improve accessibility for all. With the expanding role of shared mobility, travellers must rely on smartphones that are typically needed to use them, and not having the ability to use a smartphone could lead to digital inequality. However, the impact of digital mobility skills on the uptake of shared mobility has hardly been studied. This paper examines the determinants of digital mobility skills and their impacts on the uptake of different forms of shared mobility at mobility hubs. The results of a large-scale survey (N = 2515) across four different cities in Europe were analysed using statistical analyses, showing that lower digital mobility skills are related to other vulnerable-to-exclusion characteristics such as higher age, lower educational level, and unemployment. Furthermore, the uptake of shared modes at mobility hubs is much lower for people with low digital mobility skills, as they face additional barriers to using these services. These results reveal how the growth of app-driven shared mobility services can increase accessibility inequalities.

# The SmartHubs integration ladder

***The higher up the ladder, the "smarter" the mobility hub, and the higher the expected impact on user behaviour and societal impacts***

- **Physical integration**
  - Shared and PT services
  - Conflict free
  - Visibility and branding
- **Digital integration**
  - Plan, book, pay (level 2-4)
  - Training, assistance (level 2)
  - Analog alternatives (level 2)
- **Democratic integration**
  - Participation
  - Vulnerable-to-exclusion groups
  - Social learning

| | | Physical integration | Digital integration | Democratic integration |
|---|---|---|---|---|
| Smart Mobility Hub | 4 | Conflict free and place making | Integration of societal goals and policies, and consideration of universal design principles | Social learning |
| | 3 | Visibility and branding | Integration of service offers and consideration of universal design principles | Integration of different knowledge |
| | 2 | Wayfinding and consideration of universal design principles | Integration of booking and payment and consideration of universal design principles | Deliberative engagement of stakeholders, including (vulnerable) user groups |
| Mobility hub | 1 | Acceptable walking distance to shared and public transport, minimum inclusive design standards | Digital integration of information | Appropriate representation of stakeholder interests, no or limited attention for vulnerable user groups |
| Single mobility services | 0 | No physical integration | No digital integration | No stakeholder involvement and consideration of (vulnerable) user needs |

(Geurs et al., 2023)

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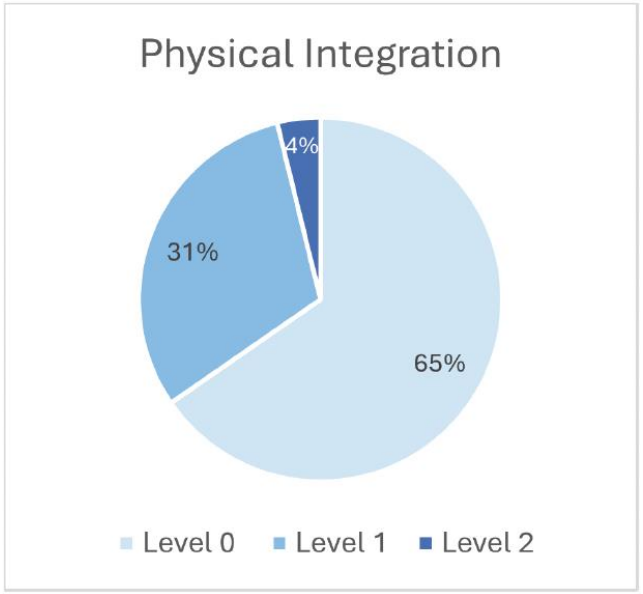
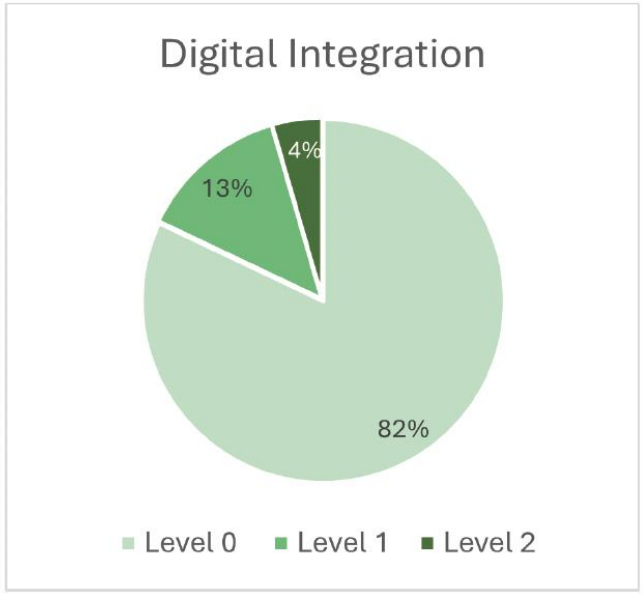
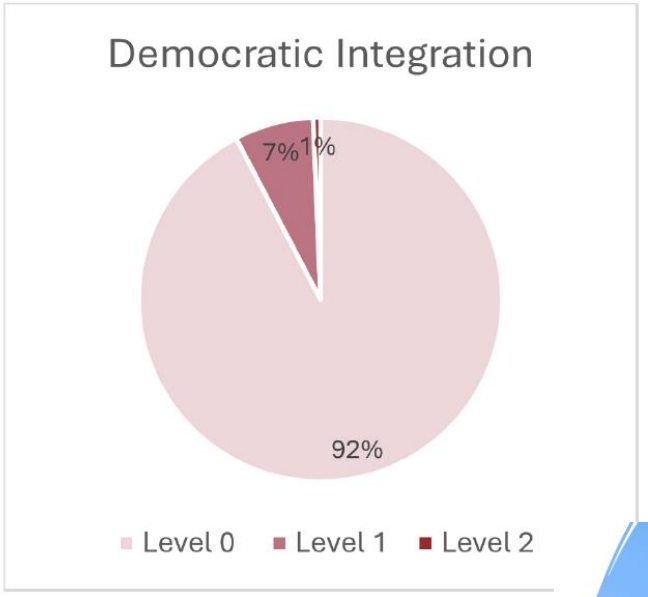
## Integration of hubs **Analysis of the integration level of the mobility hubs in the Open Data Platform**




**data.smartmobilityhubs.eu**

# Disadvantaged user groups


Low-income


Older people


Female


Migrants


Mobility impaired


Low digital mobility skills

Martinez, L., Macharis, C., Keserü, I. (2024) Inclusive mobility hubs: An in-depth exploration of the requirements of disadvantaged groups. *Transportation Research Part D: Transport and Environment* 136, 104447.
Martinez, L., Pappers, J., & Keserü, I. (2022). *Needs of users and digitally excluded citizens. SmartHubs Deliverable 3.2*. https://www.smartmobilityhubs.eu/publications

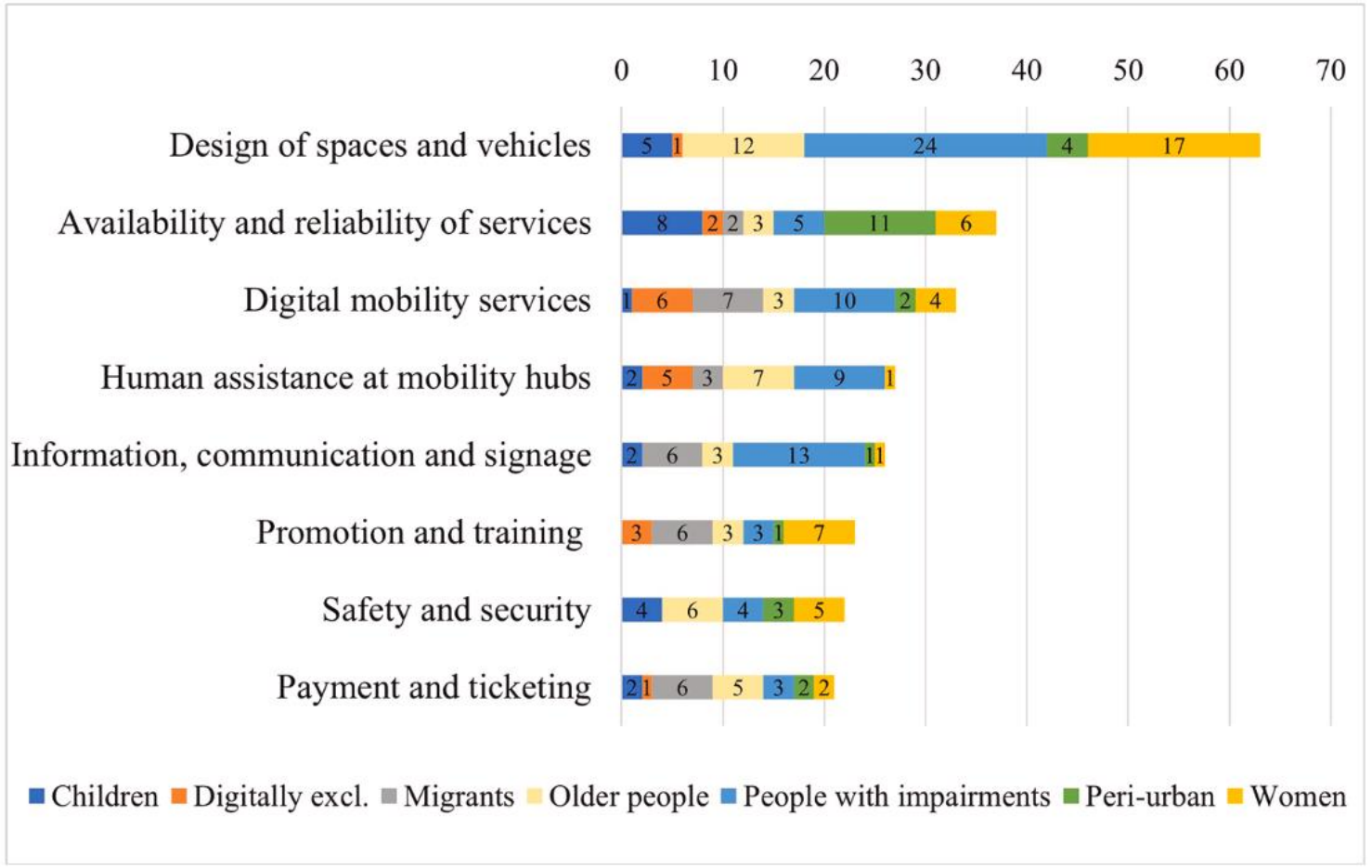



**Fig. 1.** Number of different requirements indicated by each disadvantaged group clustered into eight categories.



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# Digital Mobility Skills

- Digital skills are defined as the capacity to use digital resources, since access to technology is not the same as being able to benefit from it (Durand et al., 2022).
- 45% of Europeans do not have basic digital skills (Non et al., 2021). Advanced levels of digital skills are needed to use (most) shared mobility services
- The digital **mobility** skills (DMS) scale used in this study combines material access and digital skills (Van Dijk, 2005) and is based on the scale constructed by Horjus et al. (2022)

**Digital Mobility Skills (DMS) Scale:**

**L0 – No -** Respondents do not own/use smartphone

**L1 – Low -** smartphone for calls/messaging, not for travel planning apps

**L2 – Medium -** smartphone, use of travel planning apps, does not make online payments

**L3 – High -** smartphone, use of apps to plan, book and pay (seat reservations/tickets for *public transport*, uses apps to transfer money)

# SmartHubs survey

- **Objectives**
  - **Current usage** of hubs and shared mobility
  - Who are the **potential users** of hubs?
  - What are the **barriers of use** for different user groups?
  - How much people are **willing to pay** for a smart hub?
- **Data gathering:**
  - Online panels, assisted survey and online distribution
  - December 2022 – March 2023
  - Vienna, Brussels, Munich and Metropolitan Region Rotterdam – The Hague (MRDH)
  - N = 2515

**Individual**

Residence area
Socio-economics
Digital skills

**Mobility**

Mobility abilities
Mobility patterns
Mode choice behaviour

**Hubs**

Use and awareness
Needs and preferences
Participation and co-creation
***Hub design***

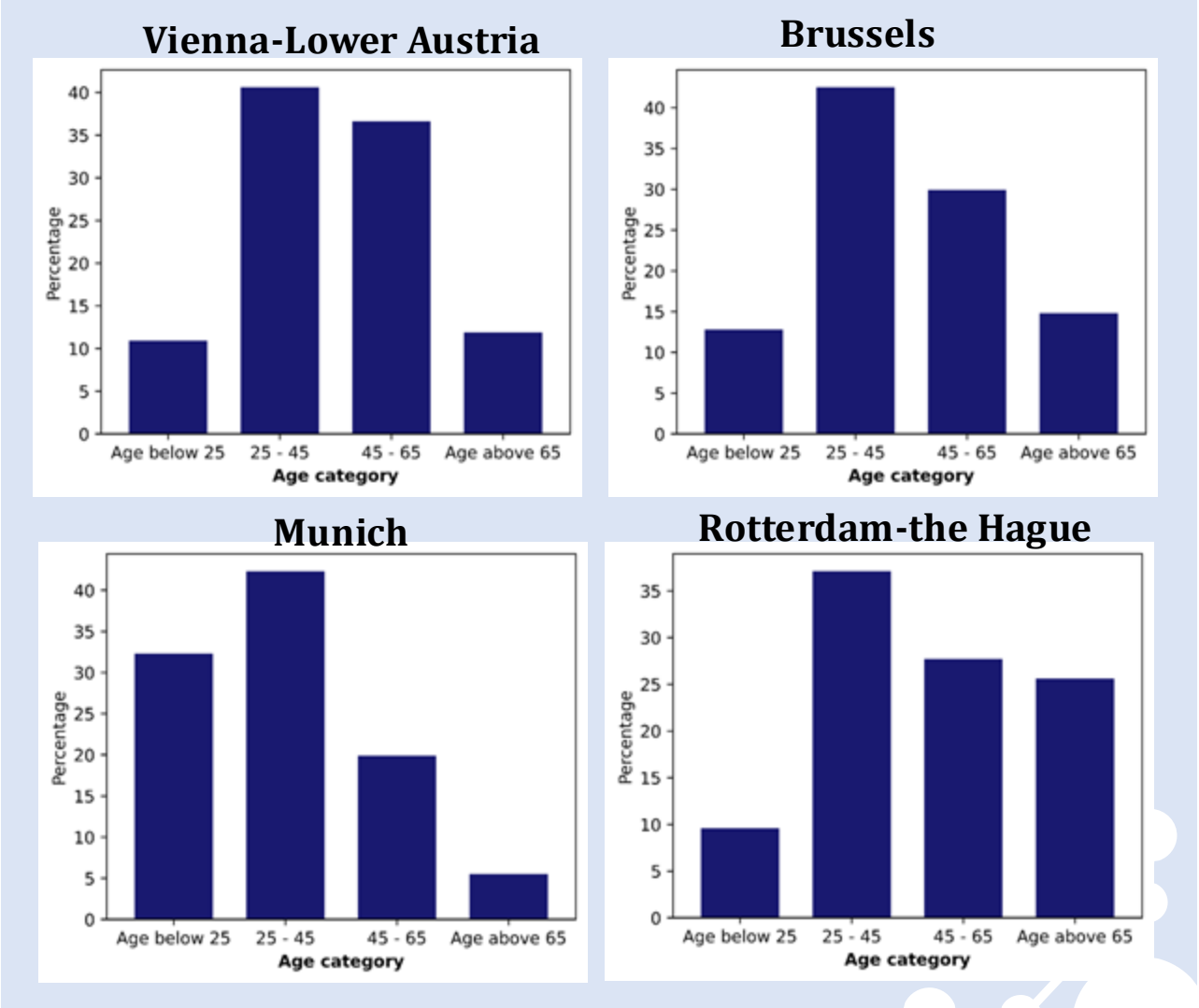
# Sample targets

Minimum sample requirements- target (2000) / realized (2515)

| | Brussels | Munich | Rotterdam-the Hague | Vienna-Lower Austria |
|---|---|---|---|---|
| Sample size | 500 / 589 | 500 / 542 | 500 / 805 | 500 / 579 |
| Females | 50%, min= 100 / 277 | 50%, min= 100 / 261 | 50%, min= 100 / 440 | 50%, min= 100 / 300 |
| Older (>65 years) | ~7%, min= 35 / 87 | ~12%, min 60 / 30 | ~ 10%, min= 50 / 206 | ~4%, min= 100 / 69 |
| Low income | 50%, min= 200 / 138 | 100 / 168 | 50%, min= 200 / 120 | 20%, min= 100 / 109 |
| Low education | 100* / 113 | 100* / 153 | 50%, min= 200 / 215 | ~11%, min= 50* / 212 |
| Low digital skills | 25 / 59 | 25 / 19 | 25 / 42 | 25 / 23 |
| Rural | - | - | - | 20% |

# Sample

N=2515



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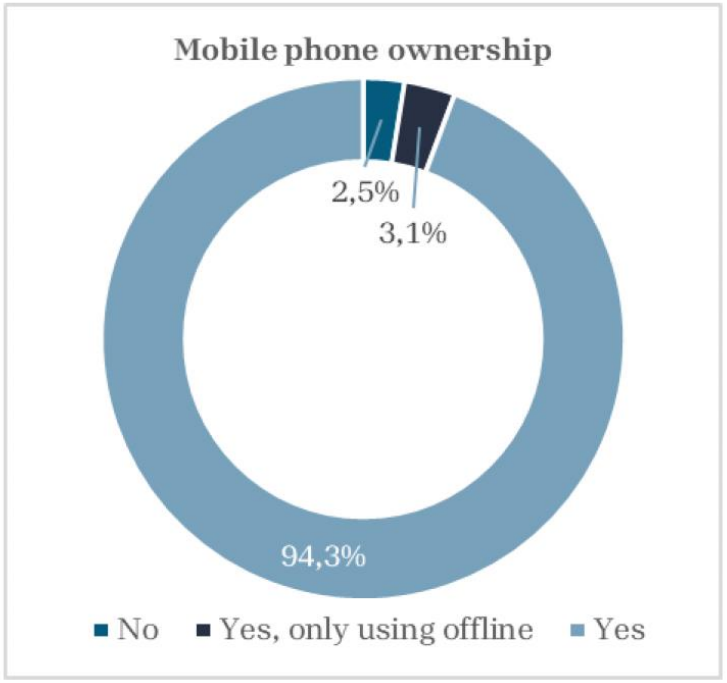
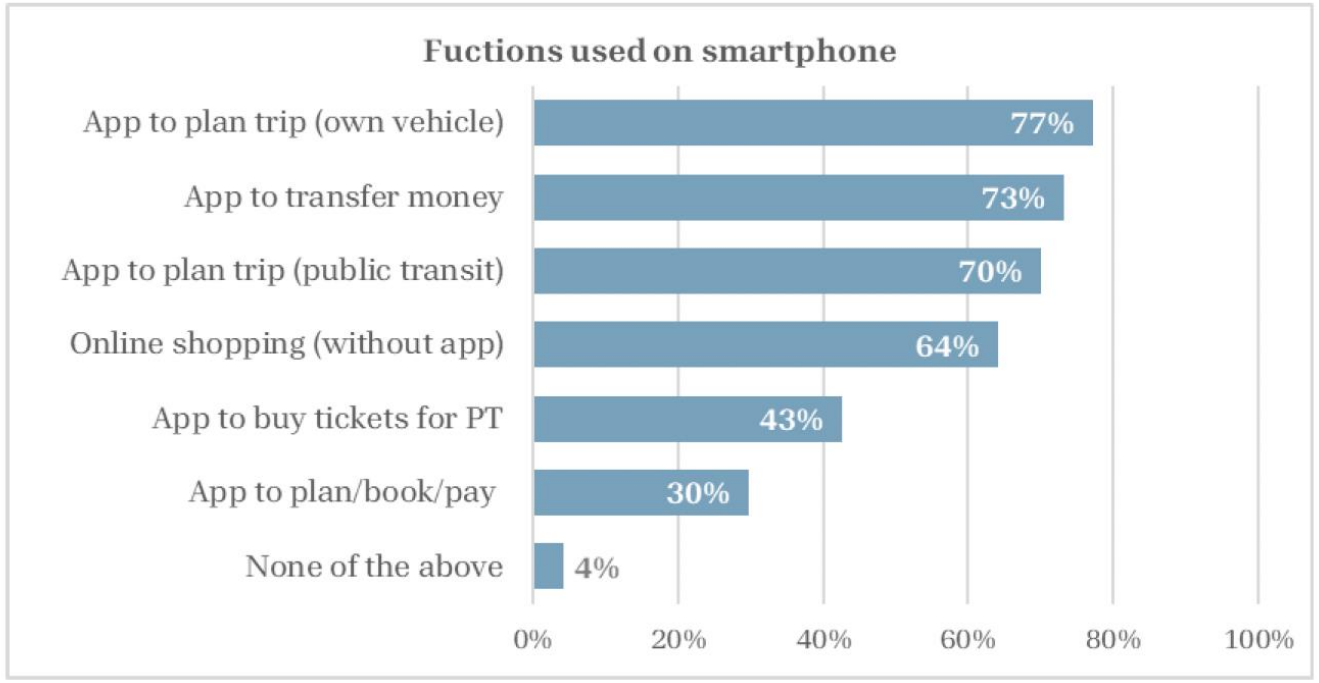
# Mobile phone owership and use

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# Digital Mobility Skills Scale

**L0 –** no skills
**L1 –** low digital mobility skills
**L2 –** medium digital mobility skills
**L3 –** high digital mobility skills

About one-third of the sample has high digital skills, needed to use (most) shared mobility services

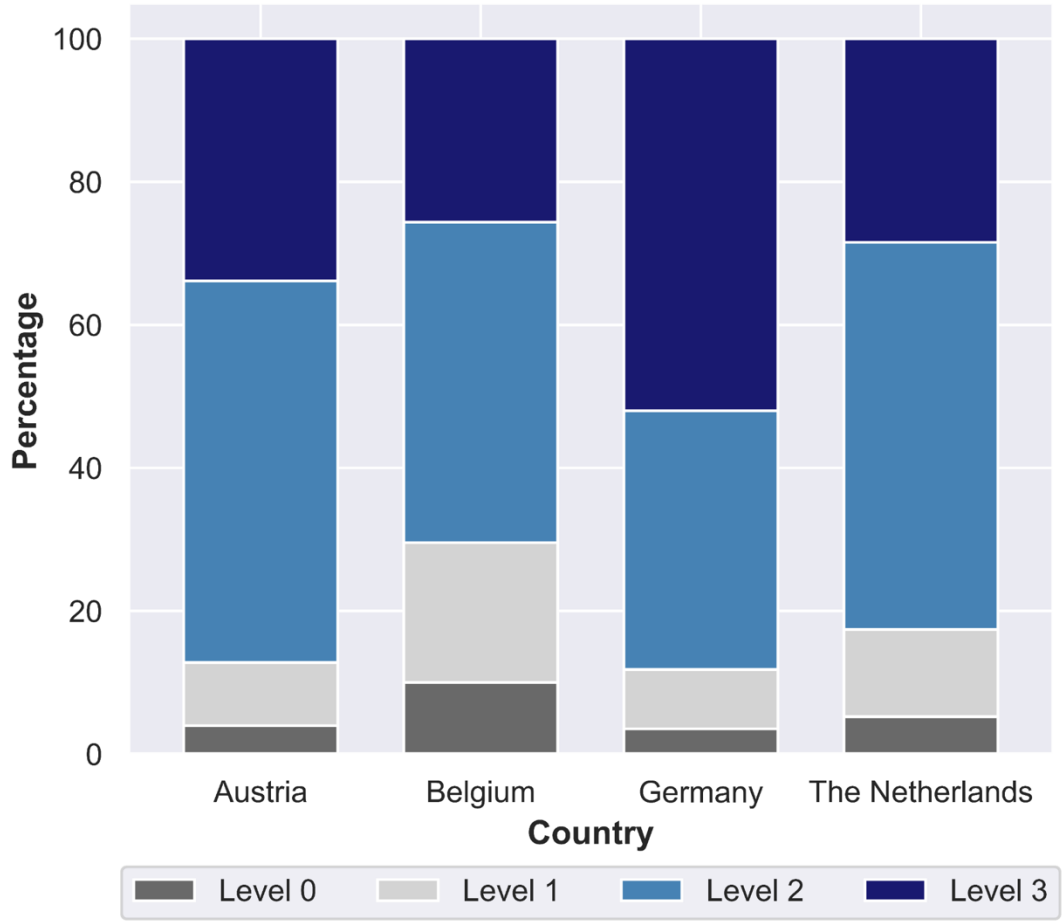
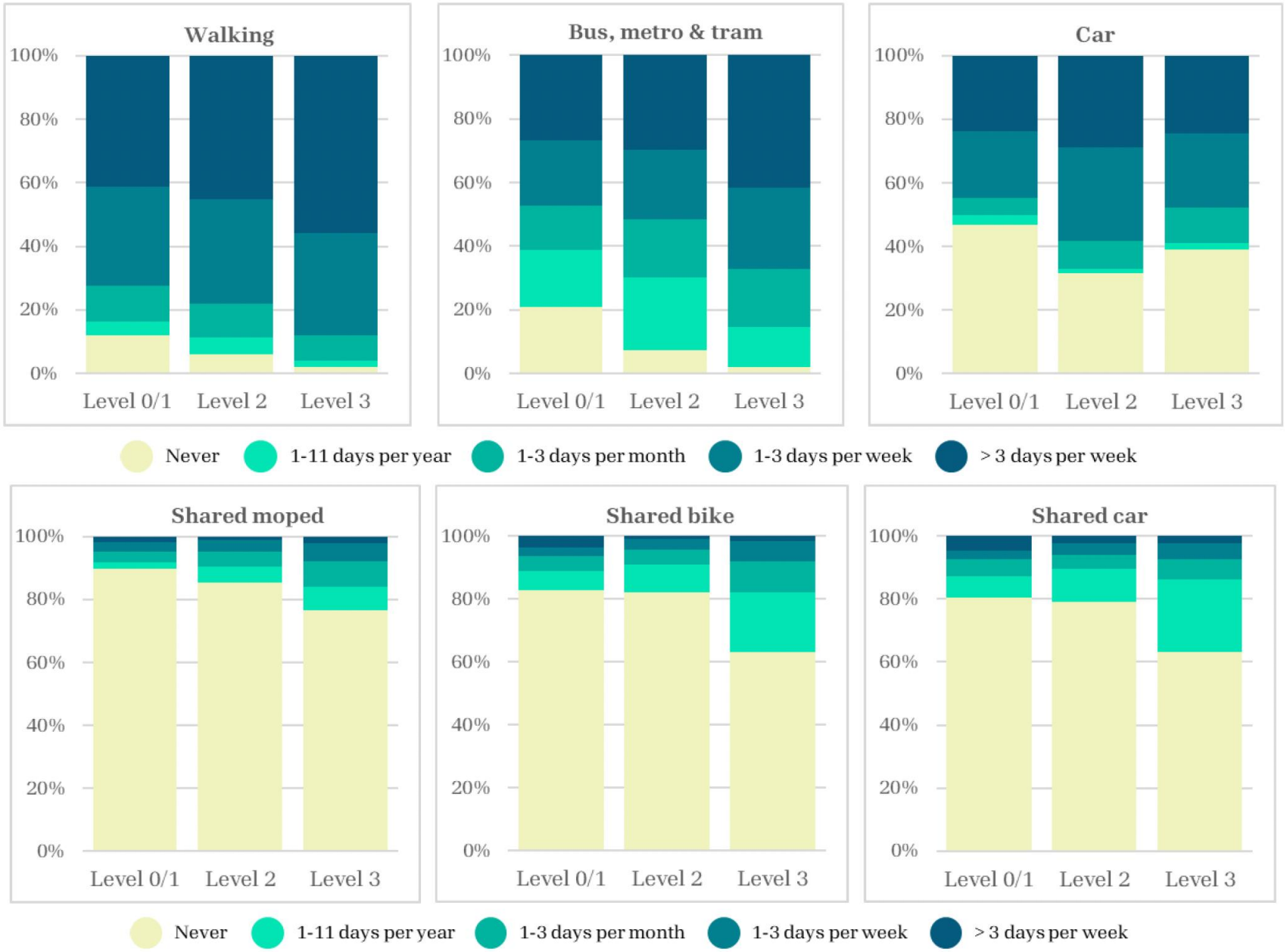



**Figure 3.**
Digital skills level per living lab

Garritsen, K.E., Grigolon, A.B., Geurs, K.T. (2025) The role of digital mobility skills in the uptake of shared modes at mobility hubs. *Journal of Urban Mobility*

# Current mode Choice by DMS level




Garritsen, K.E., Grigolon, A.B., Geurs, K.T. (2025) The role of digital mobility skills in the uptake of shared modes at mobility hubs. *Journal of Urban Mobility*

# Intention to use shared modes at a hub

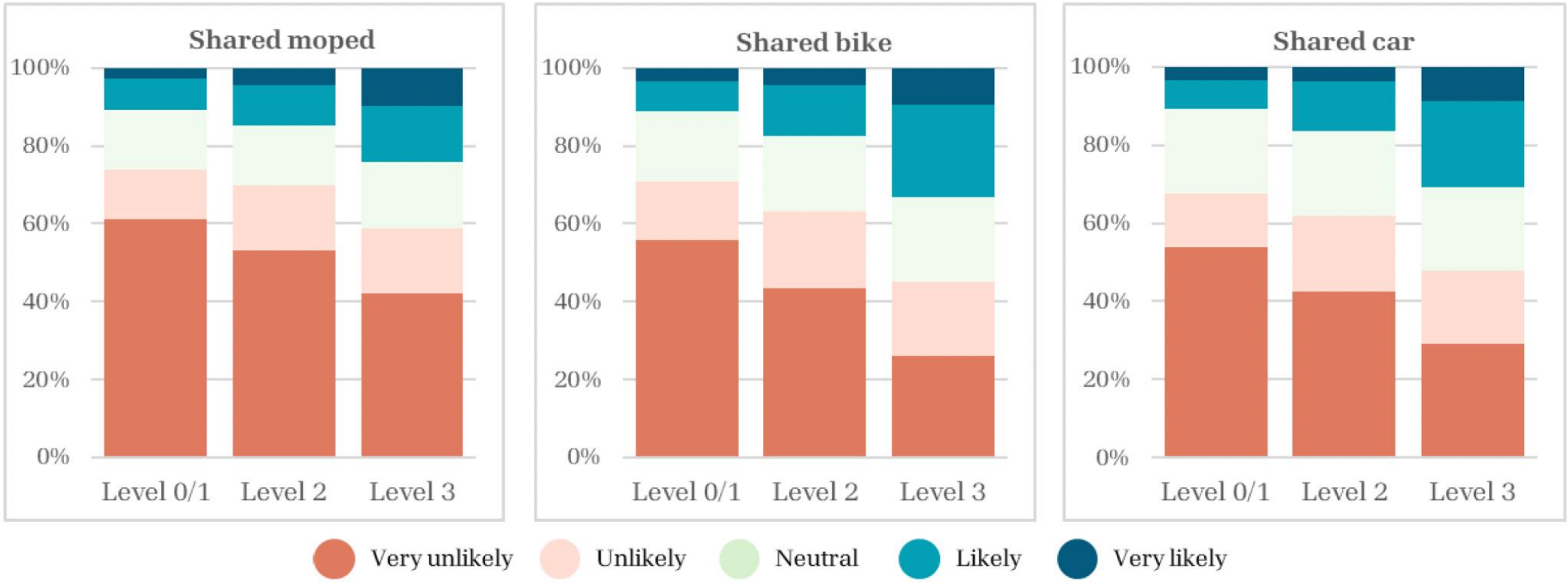



Figure 5. Likelihood of using differing shared modes at a mobility hub in the future, per DMS category.

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# People with low digital mobility skills

Low digital mobility skills

- Definition: Citizens with a low (level 0 or level 1) level of digital mobility skills
- Sample: N = 452
- Digitally excluded citizens are significantly older, have a lower income, have more walking difficulties, more likely to not own a driver's license, compared to digitally skilled.
- The travel behaviour of digitally excluded citizens differs significantly; they travel less by car, train and bike

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# Predicting Digital Mobility Skills
## CHAID and MNL models

- MNL is commonly used.
- CHAID, a chi-squared interaction detection (CHAID) is a Decision Tree Analysis, not often used to segment of users of shared mobility services
- Identifies homogeneous groups within the dependent variable using a set of predictor variables, by splitting classes based on significant chi-square values

**Table 4**
Predictor variables used in the various analyses.

| Predictor variable | Type | Coding | Mean |
|---|---|---|---|
| *Gender* | Binary | 0 = Man / 1 = Female | 0.49 |
| *Age* | Nominal | 0 = Below 25 / 1 = 25–34 / 2 = 35–44 / 3 = 45–54 / 4 = 55–64 / 5 = 65–74 / 6 = Above 74 | 43.15[1] |
| *Educational level* | Nominal | 0 = Compulsory education or less / 1 = High school graduate / 2 = Senior high school / 3 = University undergraduate degree / 4 = MSc/ MA/PhD or equal [Dropped: 5 = Other] | 2.27 |
| *Income level* | Nominal | 0 = < €1600 / 1 = €1601-€3200 / 2 = €3201–4800 / 3 = €4801–6400 / 4 = >€6400 / [Dropped: 5 = Do not know or do not want to say] | 1.32 |
| *Occupation* | Nominal | 0 = Self-employed / 1 = Employed / 2 = Working in household / 3 = Student / 4 = Unemployed / 5 = Unable to work / 6 = In retirement / [Dropped: 7 = Other] | 2.25 |
| *Number of years living in the country of residence* | Nominal | 0 = Born / Not born, but living for: 1 = Over 10 years / 2 = 6–10 years / 3 = 1–5 years / 4 = <1 year / [Dropped: 5 = Prefer not to say] | 0.41 |
| *Owning a driver's license* | Binary | 0 = No / 1 = Yes (car and/or motorbike) | 0.83 |
| *Digital Mobility Skills* [2] | Nominal | 0 = Level 0 and 1/ 1 = Level 2/ 2 = Level 3 | 0.81 |
| *Use shared modes* [2] | Binary | 0 = Never / 1 = Yes | 0.44 |
| *Frequency of walking* [2] | Ordinal | 0 = Never / 1 = Sometimes / 2 = Often | 0.99 |
| *Frequency of cycling* [2] | Ordinal | 0 = Never / 1 = Sometimes / 2 = Often | 1.48 |
| *Frequency of PT use* [2] | Ordinal | 0 = Never / 1 = Sometimes / 2 = Often | 1.75 |

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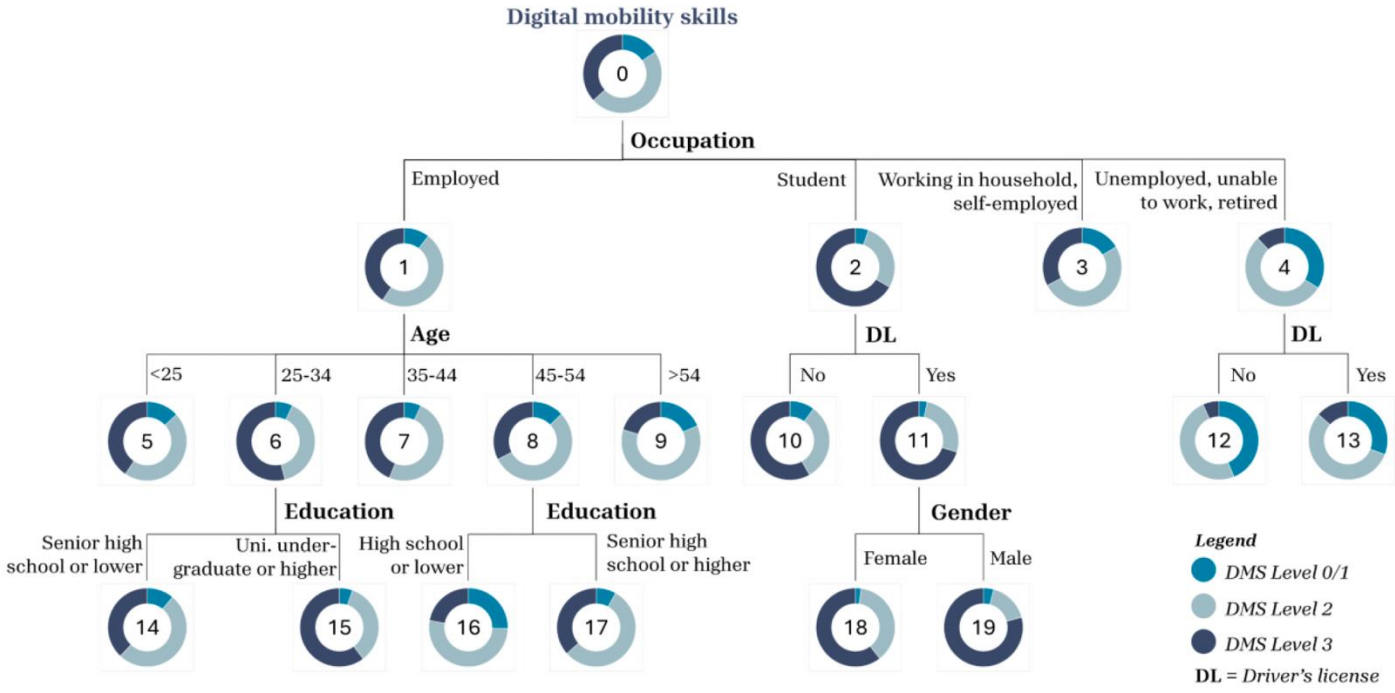
# Predicting Digital Mobility Skills CHAID and MNL models

- Personal characteristics play a role (as shown by previous studies)
- Digital Skills can be partly predicted by: occupation (employed or not), age, owning a driver's license and education level
- Other factors are at play
- MNL (with the same predictor variables) has low model fit (Pseudo-R2 of 0.12)
- The accuracy of the MNL model has a relatively high margin of error for predictin DMS levels correctly, especially for digitally excluded citizens.



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# Conclusions

1. Digitalization is crucial for the use of shared mobility services, as planning, booking and payment often require mobile phone applications and a credit card (except OV-fiets)

2. Digitally mobility skills are a significant explanatory factor for the use of shared mobility services (at hubs). The higher the DMS level, the higher the potential use of shared modes.

3. Digital mobility skills cannot be fully predicted using the (seven) personal characteristics that are used in this research. Other factors play a role, e.g. literacy, numeracy

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# Making mobility hubs smarter

## 10 recommendations for practitioners & policy makers

Deliverable 6.4: SmartHubs Final Report

### Making mobility hubs smarter

**1. Mobility hubs need to become smarter to be a game changer for urban transport**
The integration ladder can be used as a framework to create smarter mobility hubs.

**2. The implementation of mobility hubs should be integrated in the local SUMP**
Integrating mobility hubs into the local Sustainable Urban Mobility Plan facilitates the development of inclusive, democratic and effective solutions.


Co-designed mobility hub in Brussels (VUB Mobilse & Frame, 2023)


Mobility hub parklet in Munich (Duran-Rodas, 2023)

### Physical Integration

**3. Selection of the appropriate location for mobility hubs is crucial for promoting physical integration**
The location and services offered by mobility hubs must be based on their specific purpose and goals.

**4. Carefully consider placemaking as part of hub design**
Identify positive and negative effects for different mobility hub users and local residents.

**5. Inclusive mobility hubs consider the specific needs of vulnerable to exclusion groups**
People with physical impairments and low digital skills rarely use shared mobility services because the services are not adapted to their needs.

### Democratic Integration

**6. A good participation process has a clear goal, is transparent and allows active debate**
Organisers of participation processes communicate the context, structure and scope of the process and actively include different groups of people.

**7. Use participatory assessment methods to increase the quality of decision-making processes**
A participatory assessment process involves different stakeholders and collects their preferences in a structured and transparent manner.

**8. Co-design enables the design of inclusive, context-sensitive mobility hubs**
Co-design processes and tools facilitate making decisions that meet the needs of all stakeholders, including vulnerable people.


SmartHubs co-creation event in Anderlecht, Brussels (Martinez, 2022)

Digital information kiosk in Rotterdam (Garritsen, 2022)

### Digital Integration

**9. Provide training and assistance for citizens with limited digital mobility skills**
Initiate training sessions and assistance for citizens with limited digital skills to increase their access to app-based mobility services and reduce the digital gap.

**10. User-friendly interfaces contribute to inclusivity and usage of mobility hubs**
Digital interfaces need to be simple and intuitive to be useable by everyone.

**Do you want to learn more? Find out in our final report!** Scan the QR-code

# Provide training and assistance for citizens with limited digital mobility skills

*Initiate training sessions and assistance for citizens with limited digital skills to increase their access to app-based mobility services and reduce the digital gap.*

- Currently, only few hubs offer training and assistance

- **What to include in training sessions?**
  - Installing apps
  - Assisting with booking and payment
  - Searching for departure times

- Public authorities should take the lead

***Fig. 10.*** *Examples of mobility visits organized in Belgium, by MaestroMobile. (MaestroMobile by Espaces-Mobilités, 2024)*

# User-friendly interfaces contribute to inclusivity and usage of mobility hubs

*Digital interfaces need to be simple and intuitive to be used by everyone*

- **70%** of the population has never used a mobility hub
  - Information is key!

- **Digital information pillar**
  - High visibility
  - Integration of information
  - User-friendly!
    - Simple text
    - Universal design
    - Multiple languages

  - Most important feature: *real-time departure info*



***Fig. 11a.*** *Digital pillar experiment in Brussels (Martinez, 2022)*
***Fig. 11b.*** *The digital pillar during experiments in Rotterdam (Garritsen, 2022)*

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[a]Department of Civil Engineering and Management, Faculty of Engineering Technology, University of Twente, Enschede, The Netherlands; [b]Chair of Urban Structure and Transport Planning, Technical University of Munich, Munchen, Germany; [c]Institute of Spatial Planning, Research Unit Transportation System Planning, Technical University of Vienna, Vienna, Austria; [d]Business Technology and Operations Department, Mobility, Logistics, and Automotive Technology Research Centre, Vrije Universiteit Brussel, Brussel, Belgium; [e]Institute of Political Science, University of Munster, Munster, Germany; [f]Department of Landscape, Spatial and Infrastructure Sciences, Institute for Transport Studies, University of Natural Resources and Life Sciences, Vienna, Austria

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## Inclusive mobility hubs: An in-depth exploration of the requirements of disadvantaged groups

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ABSTRACT

Mobility hubs are becoming increasingly relevant in urban transport systems because they have the potential to enhance sustainability and decrease transport disadvantages. However, the literature has not yet identified the use that disadvantaged groups make of mobility hubs, nor has it thoroughly revealed their requirements for using them without difficulties. As a means to fill this knowledge gap, this qualitative study applied the Capabilities Approach to thoroughly investigate the requirements of disadvantaged groups concerning the use of mobility hubs. The data was obtained through 45 semi-structured interviews and four focus groups with local experts and potential or current users of mobility hubs in four European regions: Brussels, Munich, Rotterdam-The Hague and Vienna. As a result, eight main categories of requirements and their prevalence among disadvantaged groups were identified. The findings contain several recommendations to support decision-makers and practitioners in developing inclusive mobility hubs.

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RESEARCH

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## Willingness to pay for shared mobility hubs: a stated choice joint-survey in four European cities

Anna Grigolon[1] · Kelt Garritsen[1] · Karst Geurs[1]

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**Abstract**

This paper aims to assess the relative importance of different shared mobility hub design elements. A standardised survey was developed and applied among users and residents in different areas, including a stated preference experiment, to examine trade-offs between integration dimensions and the willingness-to-pay for different attributes of hubs. The results underscore a disparity between the attributes most valued by respondents and their willingness-to-pay for them, which holds significance in the planning and functioning of mobility hubs. Although elements such as information and digital integration were indicated as being prerequisites for a successful shared mobility hub, respondents are not willing to pay for it, indicating that these would have to be arranged by the government and/or transport operators. Respondents are more willing to pay for shared mobility and public transport within walking distance from one another or for placemaking strategies (such as services or landscaping), which are more evident elements related to the physical integration (and design) of hubs.

**Keywords** Shared mobility hubs · Hub design · Physical and digital integration · Stated choice experiment · Willingness to pay (WTP)

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## The role of digital mobility skills in the uptake of shared modes at mobility hubs

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### Abstract

The popularity of shared mobility services (such as bike or e-scooter sharing) and mobility hubs is increasing in cities worldwide, with the potential to improve accessibility for all. With the expanding role of shared mobility, travellers must rely on smartphones that are typically needed to use them, and not having the ability to use a smartphone could lead to digital inequality. However, the impact of digital mobility skills on the uptake of shared mobility has hardly been studied. This paper examines the determinants of digital mobility skills and their impacts on the uptake of different forms of shared mobility at mobility hubs. The results of a large-scale survey (N = 2515) across four different cities in Europe were analysed using statistical analyses, showing that lower digital mobility skills are related to other vulnerable-to-exclusion characteristics such as higher age, lower educational level, and unemployment. Furthermore, the uptake of shared modes at mobility hubs is much lower for people with low digital mobility skills, as they face additional barriers to using these services. These results reveal how the growth of app-driven shared mobility services can increase accessibility inequalities.

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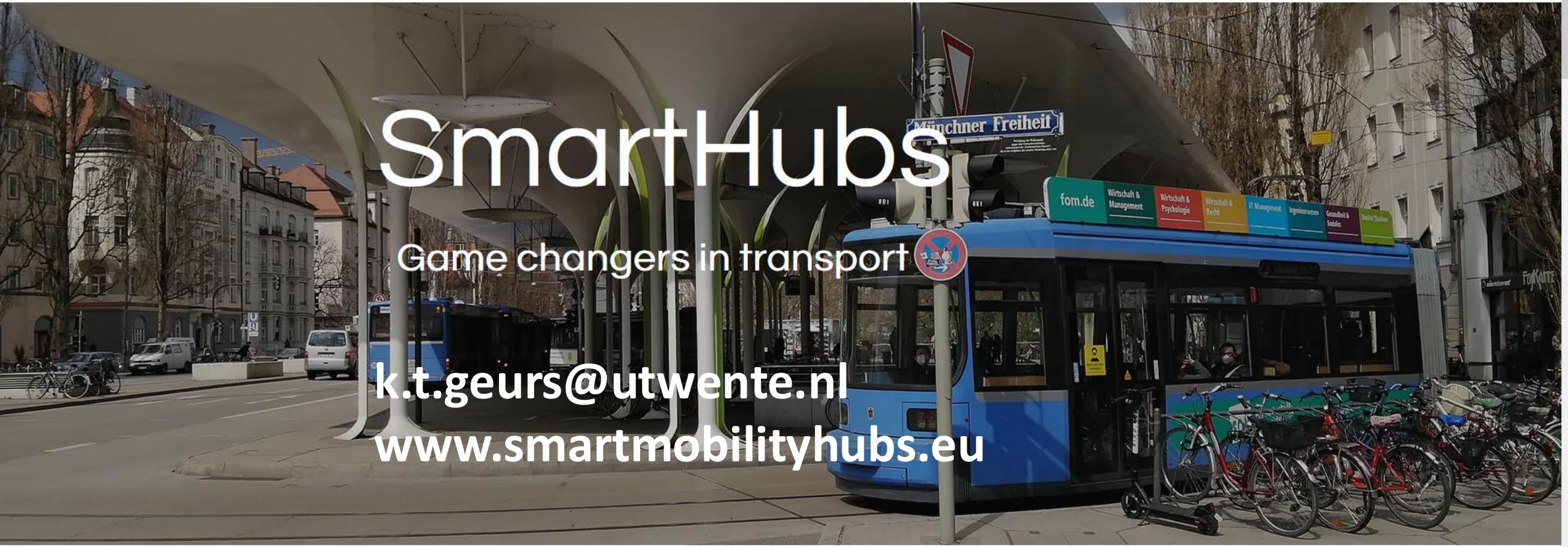


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