



Smart Mobility Hubs as Game Changers in Transport

WP4. SmartHubs Living Labs

T4.4. Rotterdam-The Hague Living Lab implementation of the Mobility Hubs

Deliverable D 4.4

Living Lab implementation report

Rotterdam – The Hague

Version: 1.4

Date: 05/06/2023

Responsible partner: University of Twente

Authors:

Kelt Garritsen, University of Twente

Karst Geurs, University of Twente

Anna Grigolon, University of Twente

**UNIVERSITY
OF TWENTE.**



This project is supported by the European Commission and funded under the Horizon 2020 ERA-NET Cofund scheme under grant agreement N° 875022



DOCUMENT CHANGE RECORD

Version	Date	Status	Author	Description
1.1	26/04/2023	Draft	Kelt Garritsen, Anna Grigolon and Karst Geurs (UT)	First version for review.
1.1	18/05/2023	Review	Lluis Martinez (VUB) and Jelten Baguet (Mpact)	Review.
1.3	31/05/2023	Concept version	Kelt Garritsen, Anna Grigolon and Karst Geurs (UT)	Version for internal review.
1.4	05/06/2023	Final version	Kelt Garritsen, Anna Grigolon and Karst Geurs (UT)	Final version.

TABLE OF CONTENTS

DOCUMENT CHANGE RECORD	1
TABLE OF CONTENTS	3
LIST OF FIGURES.....	4
LIST OF TABLES.....	4
1. LIVING LAB SET-UP	6
1.1. Regional context	6
1.1.1. Mobility challenges and opportunities.....	7
1.1.2. Mobility policies, projects and plans.....	7
1.1.3. Mobility hubs: policies and contributions.....	8
1.2. Living lab goal(s).....	8
1.3. Case study context of the living lab	9
1.3.1. Living lab locations	9
1.3.2. Context of Rotterdam – Zuidplein.....	9
1.3.3. Context of The Hague – Hobbemaplein	11
1.4. Case study goals.....	12
1.4.1. SmartHubs integration ladder potential	12
1.4.2. Main expected contributions of the living lab	13
1.4.3. Collaboration in the living lab.....	14
2. LIVING LAB PLANNING	15
2.1. Stakeholders’ and citizens’ needs	15
2.1.1. Stakeholder groups and requirements	15
2.1.2. Living lab activities.....	15
2.2. Case study status-quo	18
2.3. Adjustments of case study goals.....	19
3. LIVING LAB EVALUATION	20
3.1. Survey Findings	20
3.1.1. Data collection design	20
3.1.2. Data preparation	20
3.1.3. Sample characteristics.....	21
3.1.4. Sample mobility characteristics and mobility hub familiarity.....	22
3.2. Results of Co-design process.....	25
3.2.1. Co-design game	25
3.2.2. Selected elements	25
3.3. Alignment of mobility needs & stakeholders interest	26
3.3.1. Mobility needs.....	26
3.3.2. Alignment of stakeholder & citizens interests	26
3.3.3. Impact on policies and governance.....	27
4. CONCLUSIONS.....	28
4.1. Main Findings	28
4.2. Recommendations	29
4.3. Process Discussion	29
4.4. Next Steps	29
5. REFERENCES.....	30

LIST OF FIGURES

Figure 1 – General and Public Transportation information on the MRDH region.....	6
Figure 2 – Modal Split in Rotterdam and The Hague (period: average 2018-2021).....	7
Figure 3 – Metropolitan region Rotterdam-The Hague, and the two living lab locations.	9
Figure 4 – Public Transit services at the living lab locations	10
Figure 5 – Percentage of inhabitants with non-western migration background (neighbourhood level) per living lab location.....	11
Figure 6 – Research questions of the living lab case study locations.....	12
Figure 7 – SmartHubs Integration Ladder (Geurs & Münzel, 2022).....	13
Figure 8 – Living lab activities and planning per living lab location	15
Figure 9 – The digital kiosk during the testing in Rotterdam and some screens of the kiosk	17
Figure 10 – Playing the boardgame in The Hague and visualisations of the AR game	18
Figure 11 – Left: New bus station at Zuidplein during construction, picture taken from the metro station platform. Right: Hobbemapplein, with on the left the tram stop.	19
Figure 12 – Age categories Dutch survey sample	21
Figure 13 – Digital Skills levels Dutch survey sample.....	21
Figure 14 – Education categories Dutch survey sample.....	21
Figure 15 – Income level categories Dutch sample	21
Figure 16 – Current (own and public) mode use of Dutch survey sample.....	22
Figure 17 – Current shared mode use of Dutch survey sample.....	22
Figure 18 – Reasons for not using a shared car.....	23
Figure 19 – Reasons for not using a shared moped	23
Figure 20 – Reasons for not using a shared bike.....	23
Figure 21 – Familiarity with mobility hubs of Dutch survey sample	23
Figure 22 – Cumulative likelihood to use shared modes at a mobility hub in the future.....	24
Figure 23 – Cumulative likelihood to use a shared bike at a mobility hub in the future per digital skills level.....	24
Figure 24 - Cumulative likelihood to use a shared moped at a mobility hub in the future per digital skills level	24
Figure 25 – Importance of hub characteristics at a mobility hub.....	24
Figure 26 – Steps to be taken for the SmartHubs appraisal tool process.....	26

LIST OF TABLES

Table 1 – Socio-demographic characteristics of Rotterdam and The Hague inhabitants.	6
Table 2 – Socio-demographic characteristics of both living lab districts.....	10
Table 3 – Contribution of living lab locations per KPI category	14
Table 4 – Living lab partners and their contribution	14
Table 5 – Game rounds of the co-design board game.....	25
Table 6 – Most popular elements of citizens & stakeholders using persona cards during co-design game.....	26

EXECUTIVE SUMMARY

The SmartHubs project introduces living labs to assess if co-designed mobility hubs can function as game changer towards inclusive and sustainable urban mobility and accessibility. The Dutch SmartHubs living lab includes the metropolitan region of Rotterdam-The Hague, with two case study hubs. The first case study is Zuidplein, a busy metro and bus station. The area surrounding the square has been renovated during the past two years, improving the appearance and social safety. The focus of this case study is the role of digital integration within the development and use of the mobility hub. Hobbemaplein in The Hague is the second case study. The square is in the process of being redeveloped, and the municipality is currently finalising the participatory process. Therefore, the living lab activities are focused on democratic integration and co-creation, to see how Hobbemaplein can be developed as a “smart” mobility hub, to answer the research questions on which hub elements are important for stakeholder groups and if the co-design game is a useful tool to determine the mobility hub design preferences.

Different living lab activities are or will be performed to get understanding on the stakeholder and user needs: interviews with vulnerable groups, a joint survey (N = 805 in the Dutch living lab), playing a co-design game, digital kiosk experiment and a co-evaluation process using the SmartHubs appraisal tool. Using these tools, answers to the research questions can be formulated. For the Rotterdam case study it was found that the digital kiosk was likely to be used again, and could increase the uptake of hub usage when the user interface is improved upon. It is recommended that within policy making process, people with limited digital skills are considered in the participatory process, as it showed that they have other needs and preferences. Furthermore, the co-design game has proven itself to be a useful tool to determine the preferences and needs of local stakeholders, showing that stakeholders value a combination of mobility and non-mobility related elements for the Hobbemaplein case study. However, the appraisal process in The Hague is still ongoing, so these results will be validated during future research activities.

Regarding this report, section 1 describes the set-up of the living lab, provides policy context and describes the case study goals. Section 2 describes the planning of the living lab by describing the stakeholders and activities, as well as the case study status-quo. The evaluation of the activities is described in section 3, comprising the findings and describing which steps will still be taken in the future to align the hub to the needs of stakeholders. Finally, section 4 concludes the report and summarizes the findings.

1. LIVING LAB SET-UP

1.1. Regional context

The Dutch living lab comprises two hub locations in the metropolitan region Rotterdam-The Hague (further: MRDH), located in the western part of the Netherlands and consisting of 21 different municipalities, having a population of 2.4 million (MRDH, 2023). The MRDH region is located in the western part of the Netherlands, and it hosts 1.2 million job locations. For the future, the number of inhabitants is expected to increase rapidly, with 400.000 extra inhabitants in 2030, indicating a need of 170.000 extra housing units (MRDH, 2022). More information on the MRDH region can be found in Figure 1 (Goudappel, 2022; MRDH, 2020).

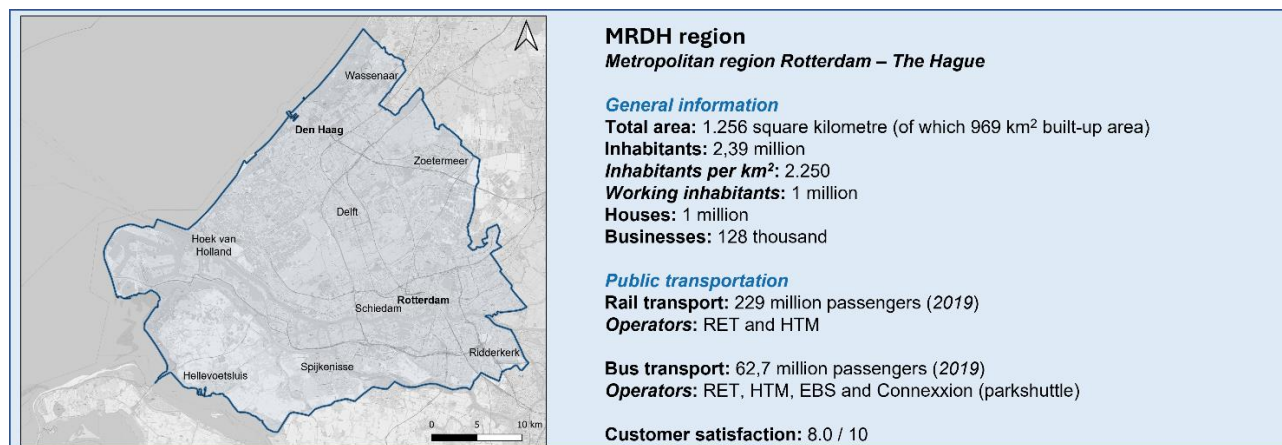


Figure 1 – General and Public Transportation information on the MRDH region (Source: OpenStreetMap, 2023 (map))

The largest municipalities within the MRDH region are Rotterdam (655.000 inhabitants) and The Hague (553.000), and both cities contain one of the SmartHubs living lab locations (CBS, 2022c). The largest seaport of Europe is located in Rotterdam, while The Hague houses the Dutch parliament, indicating the important position of both cities within the Netherlands. Rotterdam and The Hague are interesting case studies because they have a large share of inhabitants with a migration background (54% and 57%, respectively, compared to 25% for The Netherlands in general). A complete overview of socio-demographics characteristics of the inhabitants of Rotterdam and The Hague can be found in Table 1 (CBS, 2022a, 2022b, 2022c).

Table 1 – Socio-demographic characteristics of Rotterdam and The Hague inhabitants.

	Rotterdam	The Hague	The Netherlands
Total population (2022)	655.468	553.417	17.590.672
Gender (2022)			
Male	324.309	275.490	8.745.468
Female	331.159	277.927	8.845.204
Age (2022)			
0-15 years old	101.724	90.496	2.712.461
15-25 years old	89.322	70.124	2.158.241
25-45 years old	203.800	166.794	4.399.003
45-65 years old	158.600	143.232	4.795.514
>65 years old	102.022	82.771	3.525.453
Migration background (2022)			
Western migration background	92.316	112.674	1.909.408
Non-western migration background	259.747	202.745	2.529.492
Education level (2021)	506.770*	426.160*	13.301.410*
Low	155.620	126.120	3.565.510
Medium	189.430	144.640	5.520.240
High	161.720	155.400	4.215.660
Standardized household income (2021)**	€ 29.800,-	€ 31.800,-	€32.100

Note: [*] Education level numbers are based on the population aged between 15-75 in 2021. [**] The average disposable yearly income, corrected for size and household composition.

1.1.1. Mobility challenges and opportunities

The MRDH region is officially acting as public transportation (PT) authority, with a region-wide policy on transportation. In 2022 it was concluded that the PT network of the region is getting too crowded, with an increase in PT use of 3% from 2010 to 2017 (MRDH, 2022). Furthermore, the MRDH has the ambition to reduce CO₂ emissions from mobility by 30% in 2025 (CE Delft & Goudappel Coffeng, 2021). However, this is a challenging task while there is also a need for more housing and transportation in the area.

These challenges also play on the local level within the living lab. The city of **Rotterdam** needs 50.000 extra houses by 2040, suggesting the demand for a big investment in the PT network as well. At the same time, the city does not comply with European air quality regulations, requiring a reduction of CO₂ emissions with 49% in 2030 is necessary. Furthermore, PT is not spread out equally throughout the city, with PT connections lacking in the southern districts (Municipality of Rotterdam, 2020). On the positive side, bike and PT use is increasing while car use is decreasing, creating an opportunity to increase space for active and public transportation within the city. Additionally, there is an increased use of shared mobility. The municipality wants to act on this, by improving the use of docking stations, geofencing and working on a strategy of mobility hubs (Municipality of Rotterdam, 2020, 2021).

The Hague is a very densely populated city and with almost 50% of jobs filled by people living outside the municipality of The Hague, which results in high transportation demand and increasing delays on roads and the PT network (Municipality of The Hague, 2011). For instance, travel time for car users increases with 24% during rush hours (Municipality of The Hague, 2019). In addition to transportation challenges, The Hague has the ambition to be a climate neutral city in 2040 and is expected to have 100.000 extra inhabitants by this time (Municipality of The Hague, 2011, 2019). Similar to Rotterdam, the modal split in The Hague is changing slowly. However, car use is decreasing slightly, and active and PT use are increasing. Still, the car is used for 32% of all trips in The Hague (Municipality of The Hague, 2022b). When discussing future mobility challenges, the municipality acknowledges urgency, generation possibilities for a mobility transition (Municipality of The Hague, 2019). The modal split in The Hague and Rotterdam can be seen in Figure 2 (Municipality of Rotterdam, 2022).

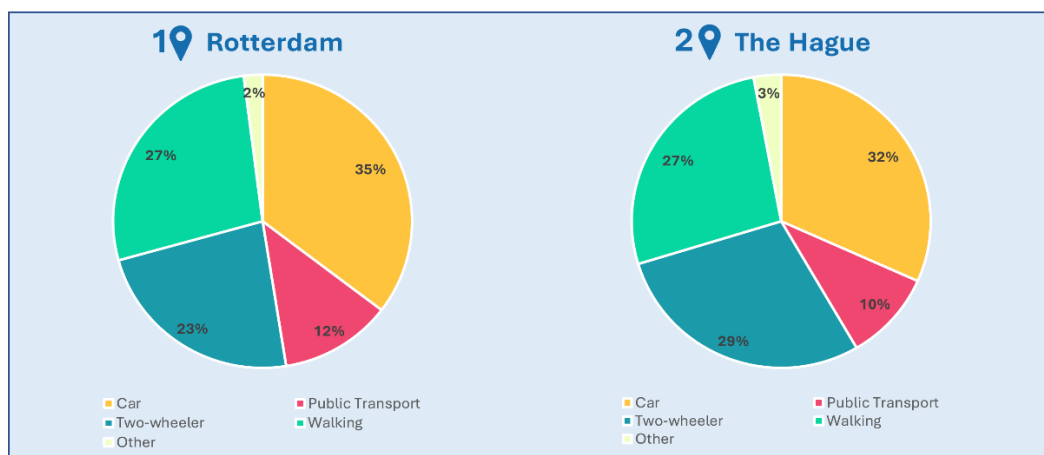


Figure 2 – Modal Split in Rotterdam and The Hague (period: average 2018-2021) (Source: Municipality of Rotterdam, 2022 (data))

1.1.2. Mobility policies, projects and plans

SmartHubs [Deliverable 2.3 – Governance frameworks for mobility hubs in the SmartHubs living lab areas](#) focuses on the Dutch The Hague living lab location and discusses its governance and policy based on policy documents and expert interviews. Parts of the deliverable are used in this section. For full information, see the deliverable D2.3, referred to as Graf & Hansel (2023).

At the regional level, the metropolitan region MRDH has a sustainability policy and a strategic agenda for the development of the economy and accessibility. Put shortly,, the MRDH region wants to increase accessibility by active or public transportation, improve PT quality, boost mobility innovations and reduce CO₂ emission by 30% in 2025 (CE Delft & Goudappel Coffeng, 2021; MRDH, 2022).

The main mobility policy and plans of **Rotterdam** arise from the “*Rotterdamse MobiliteitsAanpak*”, a long-term policy plan with concrete actions aimed at changing modal shift and regulating the number of trips. The leading principles within Rotterdam are summarized as: (i) enough space for active and PT, (ii) safe and healthy connections, (iii) inclusivity and (iv) efficient and clear logistics. Experimental projects have been planned (2019 -2020) to test the effects of the mobility plan (Municipality of Rotterdam, 2020). An example of such an experiment is the *Mobility Challenge Hoogkwartier*, investigating if a visible link between public space and shared mobility influences mobility choices, by challenging participants to use shared modes instead of their car and using vacant parking spaces for green space (Municipality of Rotterdam & Stadslab Hoogkwartier, 2020).

The overall mobility plan of **The Hague** is the *Mobility Transition Strategy 2022 – 2040*, with a focus on four topics: (i) the compact city, (ii) human scale, (iii) city-friendly transport modes and (iv) regional context and hub development (Graf & Hansel, 2023). Besides this, the “*Haagse Nota Mobiliteit*” from 2011 (planning period until 2020) is still in place but is expected to be replaced by the new “*Omgevingsvisie*” in 2023 (Municipality of The Hague, 2021b). The mobility plan also considers *learning labs*; pilot projects on several dilemmas, i.e., experimental governance instruments that help to pinpoint the exact effects of policy measures. As mentioned by experts, multiple policies are interlinked; housing, but also parking policies have an impact on mobility policy. The municipality of The Hague works with participation projects to find support for the upcoming measures to improve mobility (Graf & Hansel, 2023).

1.1.3. Mobility hubs: policies and contributions

Both living lab cities acknowledge the potential of shared mobility and mobility hubs to overcome part of the arising mobility challenges.

The development of mobility hubs will speed up the mobility transition towards more active and public transportation, according to the municipality of **Rotterdam**. The municipality focuses on several types of hubs, ranging from large PT-hub to neighbourhood hubs or logistic hubs, which focus on freight transportation within the city. In the city of Rotterdam, 46% of shared bike users and 24% of shared e-moped users combines the trip with either the train or the metro (Municipality of Rotterdam, 2021), already demonstrating the potential of shared vehicles as first- or last-mile modes for PT (Municipality of Rotterdam, 2020, 2021).

The Hague mentions mobility hubs within its *Mobility Transition Strategy*, recognizing its importance to increase use of public transportation. Existing hub locations, such as train stations, should be strengthened and prepared for new shared mobility options. The municipality also focuses on smaller hub locations within its neighbourhoods but wants participation with shared mobility providers and citizens before implementing those locations. , Mobility hubs in The Hague should contribute to ease transfers between modes, use urban space efficient, increase mode choice options, transition from ownership to usership. It is recognized that hubs increase the liveability of the city, for instance by also providing non-mobility related services (Graf & Hansel, 2023; Municipality of The Hague, 2021b, 2022c). Additionally, the municipality of The Hague expects car ownership to drop with increased shared mobility use (Municipality of The Hague, 2019).

1.2. Living lab goal(s)

Within the SmartHubs project, the main goal is to assess if a co-designed, user-centric development can enable mobility hubs to act as a game changer towards inclusive sustainable urban mobility and accessibility. Here, mobility hubs are defined as physical locations where different shared transport options are offered at permanent, dedicated and well-visible locations and public or collective transport is available at walking distance (Geurs & Münzel, 2022, p. 10). Following the SmartHubs project proposal, the main goal of the Dutch living lab is to examine *the mobility, accessibility and user satisfaction impacts of different levels of digital-physical integration between shared mobility modes and public transport*.

This main goal is in line with the challenges mentioned in both Rotterdam and The Hague. Both cities state the need for a mobility transition or “scale jump”, i.e., improve the PT networks, and increase active and public transportation in the cities. An improved integration between shared mobility and PT might support this transition, as also acknowledged by both municipalities (Municipality of Rotterdam, 2020; Municipality of The Hague, 2019).

1.3. Case study context

1.3.1. Living lab locations

The Dutch living lab consist of two locations, one in Rotterdam and one in The Hague. In Rotterdam, bus and metro station **Zuidplein** was selected as living lab location. The hub and neighbouring shopping centre have recently been renewed, with a new bus station, renovated metro station, improved bike parking and better walking connections to nearby services (Hart van Zuid Rotterdam, 2021). In The Hague, the currently under redevelopment **Hobbemaplein** was selected as the living lab location. Information on both locations and their position within the MRDH living lab can be found in Figure 3 (OpenStreetMap, 2023).

Living lab Zuidplein was situated at Rotterdam Zuid, right between the districts of *Charlois* (in the west) and *Feijenoord* (in the east). The Hobbemaplein hub is located on the border of two districts as well: *Transvaalkwartier* in the west and *Schildersbuurt* in the east. Both mobility hub locations are in neighbourhoods with a relatively young population, and a relatively high number of citizens with low education and non-western migration background. Additionally, the standardized household income in the districts is relatively low compared to the average of both cities, as can be seen in Table 2 (CBS, 2022a, 2022b, 2022c).

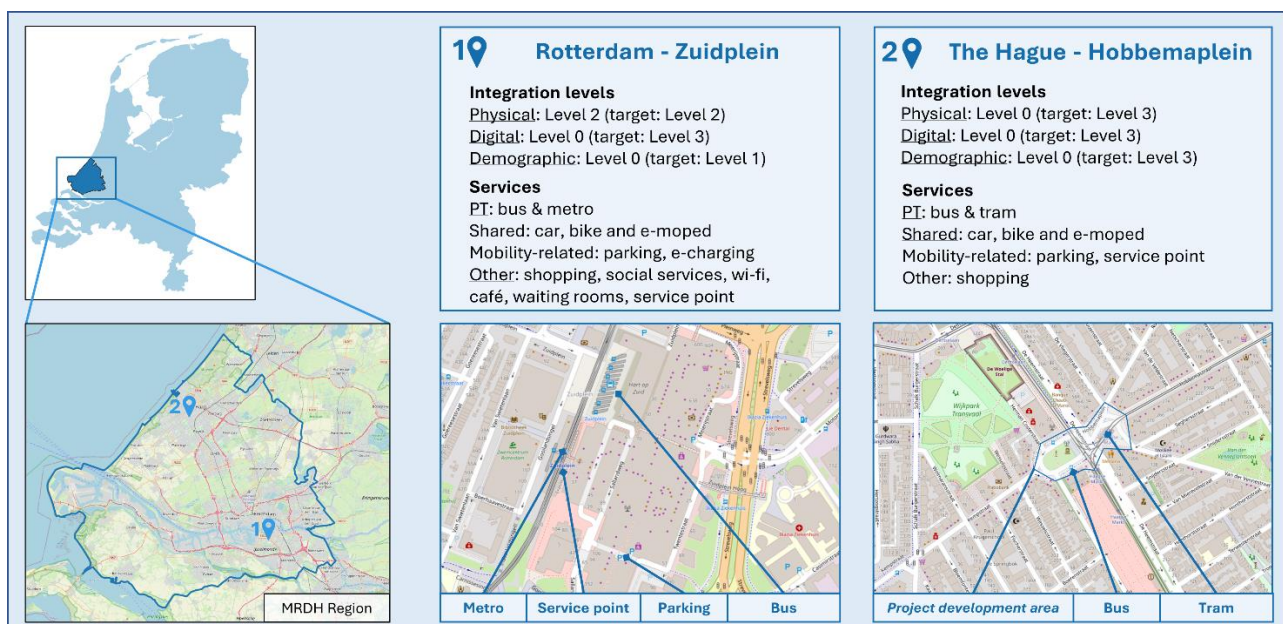


Figure 3 – Metropolitan region Rotterdam-The Hague, and the two living lab locations. (Sources: OpenStreetMap, 2023 (maps) and SmartHubs Open Data Platform (hub information))

1.3.2. Context of Rotterdam – Zuidplein

As mentioned before, Zuidplein is a key transportation hub located in the south of Rotterdam, offering various bus and metro connections (see Figure 4). The complete neighbourhood (also called Zuidplein) serves as a local centre with a large shopping mall, theatre, swimming pool and other services. Historically, the districts in Rotterdam South have been housing a large share of dockers working in the port of Rotterdam, with a large group of guest workers moving to the area in the 60’s and 70’s of the previous century. The municipality generally constructed cheap and small housing for these groups, currently causing a large share of disadvantaged and vulnerable inhabitants living in the areas (Programmabureau NPRZ, 2019).

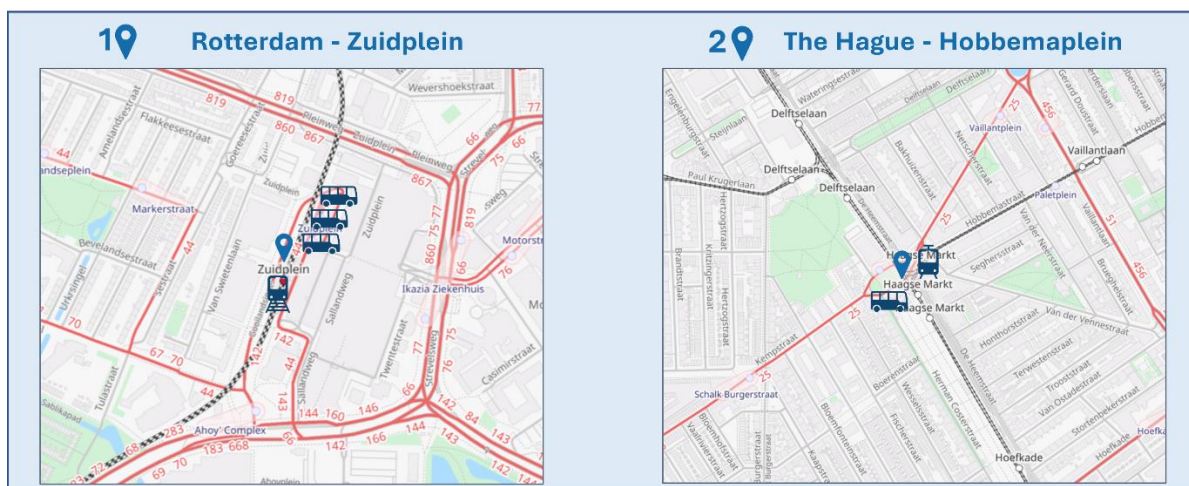


Figure 4 – Public Transit services at the living lab locations (Source: OpenStreetMap, 2023 (map))

In more recent years, there have been a number of efforts to improve the socio-economic situation in Rotterdam South, through various initiatives, including the ‘Hart van Zuid’ project (Kernteam Hart van Zuid, 2021b; Programmabureau NPRZ, 2019). The project, initiated by the municipality as a part of their 2030 vision, started in 2016 and focusses on the Zuidplein and Ahoy (congress centre) area with the aim to increase the number of job locations, accessibility, appearance and create more shopping and cultural destinations around Zuidplein. In the most recent years, the shopping mall has been extended, a new bus terminal was opened, and the station hall is renovated, offering opportunities for creating a new hub (Kernteam Hart van Zuid, 2021a, 2021b).

When focusing on the social-economic situation at Zuidplein, it becomes clear that the neighbourhood is still characterized by lower socio-economic status (see Table 2). Unemployment rates are higher than compared to the city as a whole, and income levels are generally lower (CBS, 2022b; Municipality of Rotterdam, 2023). Furthermore, the neighbourhoods deal with a relatively high share of inhabitants below the poverty threshold (16% and 18% for Charlois and Feijenoord, respectively), and the low educational levels also indicate challenges for the future (Municipality of Rotterdam, 2023).

Table 2 – Socio-demographic characteristics of both living lab districts

	Rotterdam – Zuidplein				The Hague – Hobbemaplein			
	Charlois		Feijenoord		Transvaalkwartier		Schildersbuurt	
Total population (2022)	69.645		77.935		16.250		30.870	
Gender (2022)								
Male	35.900	52%	38.585	50%	8.380	52%	15.385	50%
Female	33.740	48%	39.350	50%	7.870	48%	15.490	50%
Age (2022)								
0-15 years old	11.930	17%	13.240	17%	3.150	19%	5.730	19%
15-25 years old	9.310	13%	10.670	14%	2.335	14%	4.830	16%
25-45 years old	23.960	34%	24.680	32%	5.050	31%	8.580	28%
45-65 years old	16.080	23%	19.095	25%	4.030	25%	8.075	26%
65> years old	8.370	12%	10.250	13%	1.685	10%	3.655	12%
Migration background (2022)								
Western background	13.480	19%	9.825	13%	3.690	23%	3.040	10%
Non-western background	34.530	50%	44.160	57%	11.440	70%	25.055	81%
Education level (2021)*								
Low	20380	38%	22870	38%	6380	51%	13050	55%
Medium	23120	43%	22450	37%	4050	33%	7730	32%
High	10410	19%	15230	25%	2010	16%	3150	13%
Std. Household income (2021)**	€25.100,-		€26.900,-		€23.600,-		€22.800,-	

Note: [*] Education level numbers are based on the population aged between 15-75 in 2021. [**] The average disposable yearly income, corrected for size and household composition.

Additionally, as shown in Figure 5, the neighbourhoods surrounding Zuidplein house a relatively high share of people with a non-western migration background. Combined with the level of education, income and poverty, the area houses groups that can be classified as vulnerable to exclusion (Martinez, Pappers, & Keserü, 2022). From a transportation perspective, the inhabitants of Rotterdam South can be considered vulnerable as well. The area is considered as less connected by PT to the rest of the city and surrounding region, particularly regarding job locations. Zuidplein therefore experiences a high intensity of users, especially towards the central station (Municipality of Rotterdam, 2020).

Zuidplein is potentially a suitable location for a smart mobility hub, when considering spatial factors identified as important when selecting areas for mobility hub implementations (*SmartHubs Deliverable D3.1*). For instance, the location has a high population density, high PT frequencies, mixed land-use, public squares and leisure locations and is located in an area that services vulnerable to exclusion groups, i.e., having the opportunity to increase social equity (Duran-Rodas et al., 2022).

1.3.3. Context of The Hague – Hobbemaplein

Hobbemaplein is a busy square in The Hague, offering a lot of shops, restaurants and access to the (permanent) market location *Haagse Markt*. The square is located on the border of the *Transvaalkwartier* and *Schildersbuurt* neighbourhoods, two diverse and vibrant neighbourhoods, with relatively large shares of social housing units (DHIC, 2022a, 2022b). The tram and bus stops at Hobbemaplein are among the busiest in the city, and a lot of through car traffic is also passing the square, emphasizing its complexity and potential safety issues. While 46% of people walk to one of their destinations along the square, most space here is designated to the car (Municipality of The Hague, 2021a).

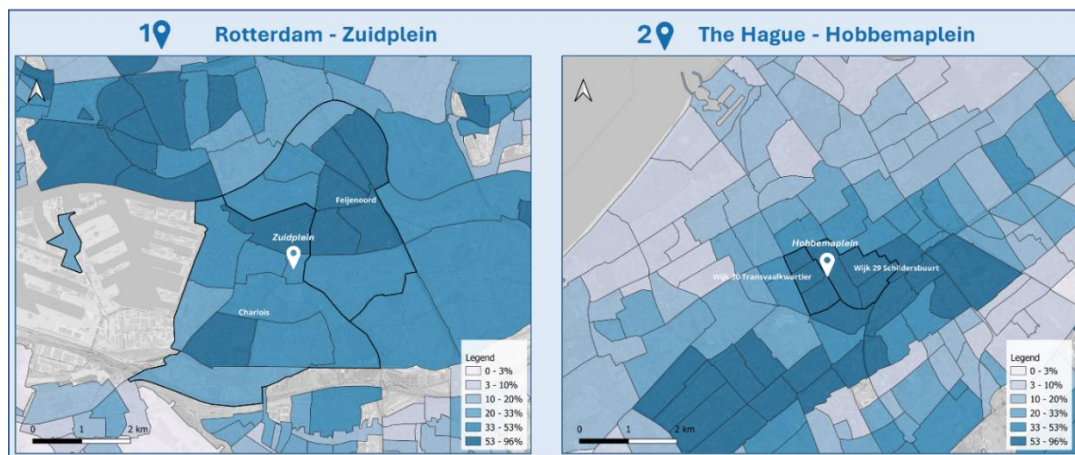


Figure 5 – Percentage of inhabitants with non-western migration background (neighbourhood level) per living lab location. (Source: CBS wijken & buurten 2022 (data), OpenStreetMap, 2023 (map))

The neighbourhoods have seen multiple revitalization projects in recent years. Currently, the ‘*Werk aan de wijk*’ project focuses on the area, aiming to improve safety, heat-stress on the square, quality of life and accessibility of public transportation. The latter one also being related to the arrival of new trams, which do not fit into the current infrastructure. This initiated an opportunity to renew the whole Hobbemaplein. An extensive participatory process is used within the project, including for instance gathering the opinion of residents or co-designing in a later stage. The project team of the municipality is currently working on two design alternatives for Hobbemaplein (Municipality of The Hague, 2021a, 2022d). The project itself, and its participatory process, do not yet included mobility hub elements, providing an opportunity to test co-creation of these elements.

Earlier participatory processes showed that there is a challenge in reaching the citizens of the respective neighbourhoods, partly due to the language barrier (Municipality of The Hague, 2022a). As previously shown in Table 2, the area houses a large share of citizens with a migration background (see Figure 5). The neighbourhoods are marked by lower socio-economic situation, with a lower income and lower education level compared to the average in The Hague. Crime rates and safety level have been improved in the past

decades. However, high school-leave rates or high educational disadvantage risks show an ongoing challenge for its vulnerable citizens, especially with a relatively high share of inhabitants below the age of 25 (CBS, 2022c; DHIC, 2022a, 2022b). Both neighbourhoods show relatively high shares of sustainable transportation movements, when looking into the mobility perspective, which is an important factor for a potential mobility hub to succeed (Municipality of The Hague, 2022c).

1.4. Case study goals

At **Zuidplein**, which is an already existing hub location with large numbers of passengers, digital-physical integration was the focus of the living lab activities. This means that especially digital integration will be improved in the upcoming period, with the municipality focusing on MaaS-services and -platforms (Municipality of Rotterdam, 2021). The redevelopment of Zuidplein itself is not part of the SmartHubs project and is done by the municipality itself. Therefore, the focus within SmartHubs is on digital integration with citizens and stakeholders in the area, since creating a smart mobility hub is not possible. The related research question is shown in Figure 4.

At **Hobbemaplein**, currently under development, the emphasis is on co-design and democratic integration. The municipality of The Hague is currently working on the definitive design for the new Hobbemaplein together with its citizens within an extensive participation project, which will be finished in 2023; the complete redesign is estimated to be finished in 2024 (Municipality of The Hague, 2022d). Additionally, The Hague also focuses on digital integration by making data available and developing MaaS platforms (Municipality of The Hague, 2022c).

The SmartHubs project is involved in the redevelopment of Hobbemaplein, where creating a smart mobility hub is an addition to the current project. Within the living lab, the focus lies on democratic integration, to see whether and how Hobbemaplein can be developed as a smart mobility hub. Co-creation and co-design are essential elements in this process, and are therefore integrated in the research questions for the Hobbemaplein case study (see Figure 4).

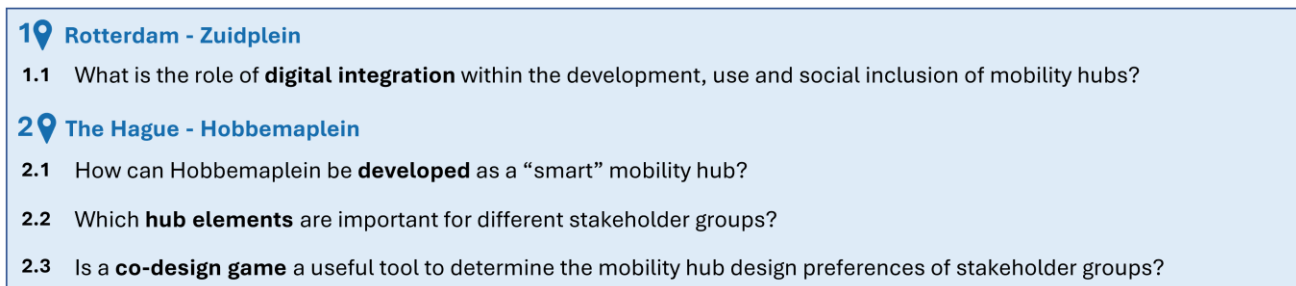


Figure 6 – Research questions of the living lab case study locations

1.4.1. SmartHubs integration ladder potential

The SmartHubs integration ladder is a tool that allows for comparing different hubs on three different integration dimensions (Geurs & Münzel, 2022). The current levels of the Dutch case studies are briefly mentioned in Figure 3. The input from the co-creation process and other tools, if applied, would result in the following potential integration levels for the case study hubs, where the levels correspond with the SmartHubs integration ladder as shown in Figure 7:

Rotterdam – Zuidplein

- *Physical Integration – Level 2*
Currently, shared modes may not be parked near the Zuidplein station area. Vehicles are allowed at a micro-hub nearby (within 400m walking distance), but this is not visible from the station area. It is expected that this policy will stay in the future, therefore Level 3 is currently not feasible. Wayfinding at the hub can thus be improved in order to find the shared vehicles more easily.
- *Digital Integration – Level 2*

At least level 1 can be reached, since the digital pillar allows for decision support and integration of information. When a MaaS-application is developed considering the universal design principles, achieving Level 2 is possible. It should be noted that the municipality of Rotterdam already works on the integration of societal goals and policies by enhancing the use of PT by lower income groups (using the *Rotterdam Pas*, offering cheaper PT for lower income households).

- *Democratic Integration – Level 2*

When considering the interviews with vulnerable groups and SmartHubs survey results in combination with the municipality’s participation process for the redesign of Zuidplein, one could argue that Level 2 can be reached. However, during the current redesign of Zuidplein, the SmartHubs project’s input is not considered.

The Hague – Hobbemaplein

- *Physical Integration – Level 3*

The final level of physical integration depends on the eventual design of the mobility hub. The research on vulnerable users and input from co-design tools allows developing a hub with adequate wayfinding and place making. However, crossing a street might be necessary to access PT from shared modes and vice versa, resulting in a difficulty to reach the highest level.

- *Digital Integration – Level 2*

As in Rotterdam, level 1 could be reached when using a digital kiosk tested at Zuidplein. Reaching Level 2 depends on the efforts of the municipality concerning MaaS-applications.

- *Democratic Integration – Level 3*

The municipality of The Hague has a comprehensive participation process for the redesign of Hobbemaplein. Together with the interviews with vulnerable groups and the (still ongoing) co-design and appraisal tools from the SmartHubs project, Level 3 can be reached since vulnerable users are actively involved in the process. Nonetheless, improvements are possible: participation processes are not independent from moderation and there is more passive than active participation.

		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	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

Figure 7 – SmartHubs Integration Ladder (Geurs & Münzel, 2022)

1.4.2. Main expected contributions of the living lab

Pappers et al. (2022) – within SmartHubs deliverable D2.2 – defined a list of key performance indicators (KPIs) to measure the performance of the mobility hubs across living labs (Pappers et al., 2022). In general, the Dutch living lab focuses on digital/physical integration. Hence, the main expected contribution is related to the mobility (e.g., improved integration of modes) and social (e.g., inclusivity and participation of vulnerable groups) KPI’s. In Table 3, the expected contribution of the hubs in the living lab per KPI category (considering the core KPIs) is briefly discussed (Pappers et al., 2022).

Table 3 – Contribution of living lab locations per KPI category

KPIs category	Rotterdam – Zuidplein	The Hague - Hobbemaplein
<i>Mobility</i>	PT frequency is already high. Shared modes will be increased, local micro-hub is introduced.	PT is already high at the location, no integration. Shared modes are available, no pre-set location, both will be improved in the redesign. Number of available modes / parking places / services could increase after redesign (based on co-design results).
<i>Services</i>	Number of services already relatively high. Digital information pillar tested at the hub.	Currently low number of services, expected to at more services after the redesign, no main contribution expected. If design suggestions from the co-design game are implemented, number of services will increase.
<i>Digital dimension</i>	Real-time PT travel information already present. The contribution of a digital kiosk will be tested at this location, if implemented this will increase presence of digital maps, manuals and ticketing services. MaaS pilots operating in Rotterdam, not in the LL.	Real-time PT travel information will be present, no main contribution expected.
<i>Accessibility</i>	Facilities and transportation are accessible, no main expected contribution.	The accessibility and inclusivity play an important role in the (co-designed) new hub.
<i>Safety and security</i>	New bike parking, no main expected contribution.	If design suggestions from the co-design game are implemented, social safety will increase.
<i>Democratic integration</i>	Democratic integration is not expected to be evaluated in this LL location; no contribution.	Participation of stakeholders plays a large role at both the redesign and the LL activities. The LL will contribute greatly to the process of involving vulnerable-to-exclusion stakeholders.

Note: Current developments in the LLs but independent from SmartHubs are stated in grey.

1.4.3. Collaboration in the living lab

Multiple local partners are involved and collaborate within the Dutch living lab to achieve the goals. The partners, their contribution and their interests are listed in Table 4.

Table 4 – Living lab partners and their contribution

Partner	Type of partner	Contribution & interest
<i>Municipality of The Hague</i>	Local government	Main partner.
<i>Municipality of Rotterdam</i>	Local government	Main partner.
<i>HTM</i>	PT provider (The Hague)	Integration with PT system.
<i>RET</i>	PT provider (Rotterdam)	Integration with PT system.
<i>MRDH</i>	Regional government	Supporting role.
<i>NS Stations</i>	PT provider (national rail)	Supporting role. Interested in how hubs can strengthen the train network and efficient use of space at stations.
<i>CROW</i>	NGO	Supporting role in the project, interested in helping local policy makers on how to use hubs in the right way.

Additionally, there is a collaboration with local partners. Examples of this are the community centres (e.g., *Huis van de Wijk De Brink* and *Huis van Carnisse*) near Rotterdam Zuidplein or libraries (e.g., *Loosduinen*, *Bouwlust* and *Transvaalkwartier*) in The Hague. At these locations, researchers of the SmartHubs project had the opportunity to listen directly to stakeholders involved in the living lab.

2. LIVING LAB PLANNING

The planning stage of the living lab focuses on the needs of citizens and stakeholders, i.e., what do they need in the living lab, and which elements should be included in the mobility hub? This section describes the activities to gather this information. The planning phase elaborates further on the goals and research questions set in the previous stage (section 1.4), with a focus on digital integration in Rotterdam and co-creation of the mobility hub in The Hague.

2.1. Stakeholders' and citizens' needs

2.1.1. Stakeholder groups and requirements

The stakeholder groups that are considered in the living lab are:

- Citizens: sometimes divided into local business owners and residents.
- Local government: municipality of Rotterdam and municipality of The Hague.
- Regional government: MRDH.
- PT providers: RET and HTM
- *Shared mobility providers. These stakeholders will be involved in the co-evaluation process later on.*

2.1.2. Living lab activities

This section describes the living lab activities, i.e. the methods to identify citizen and stakeholder needs within the SmartHubs project in the Dutch living lab. Below, the different activities, their planning and their setup are discussed. Figure 8 shows the five main living lab activities and when the activities have been performed at the specific living lab location. Activities shown in dark yellow are delayed and still need to be completed. Results of the different activities are combined in the next sections, with user needs and co-design being discussed in the living lab planning stage and co-design and co-evaluation in the living lab evaluation phase.



Figure 8 – Living lab activities and planning per living lab location

Interviews with representatives / users

This section is related to SmartHubs deliverable [D3.2 – Needs of users and digitally excluded citizens](#) by Martinez et al. (2022).

Experiences and opinions regarding mobility hubs as well as barriers and needs of vulnerable to exclusion citizens have been collected through semi-structured interviews. Both experts and users have been interviewed, with a total of seven expert interviews and 2 end-user interviews conducted in the Dutch living lab.

The experts, i.e. representatives of groups vulnerable to exclusion, are expected to have in-depth knowledge of their reference group due to their profession, social engagement, or position in the community. In the Dutch living labs, experts concerning the following vulnerable groups have been consulted: digitally excluded citizens (1), low-income citizens (2), migrants and ethnic minorities (2), older people (1), and people with physical impairments (1). These semi-structured interviews were conducted in January and February 2022. Additionally, two (potential) mobility hub end-users with physical impairments have been interviewed in May 2022 (Martinez, Pappers, & Keserü, 2022).

The analysis of the full set of interviews (across all LLs) showed that ‘assistance and training on how to use services’, ‘availability and reliability of transport services’, and ‘safety and security at the hub and inside vehicles’ can be seen as the type of needs most important for vulnerable groups (Martinez, Pappers, & Keserü, 2022).

Survey

The joint SmartHubs survey includes questions on socio-demographics, travel behaviour and two stated preference experiments regarding mode choice and mobility hub design (see Section 3.1), part of user needs assessment, co-design (choice experiment) and evaluation of current and future use. The survey was distributed in Rotterdam via multiple distribution channels. A number of shared mobility providers agreed to share a link to the survey with their users (in cooperation with the municipality), and also the RET shared the survey link on their social media platforms. Furthermore, two community centres have been visited to perform assisted surveys with the visitors of the centre, which were mostly elderly women, with most of them having low digital skills. Additionally, a link to the survey was shared on the online neighbourhood participation platform of the *Schilderswijk* district in The Hague. Furthermore, one library and one community centre have been visited to perform assisted surveys with the visitors in The Hague. The first results of the survey will be discussed in section 3.1.

Digital Pillar Experiment

This section is related to SmartHubs deliverable [D3.3 – Digital integration and signage at mobility hubs](#) by Baguet (2022). Results of the digital pillar experiment will be presented in a future paper and summary document.

The digital pillar, i.e., digital information kiosk, was available at Rotterdam Zuidplein for two weeks at the beginning of December 2022. The software, and thus the experiments, were adjusted to the local situation, showing local real-time travel information or the location of shared vehicles, for instance. The pillar was located at the RET service point. The testing days were promoted prior to the event with posters and flyers at the service point and local community centres, as well as through social media posts. Participants were also recruited on-the-spot at the service point. Combined over the six testing days, 55 people participated in the experiment in Rotterdam. A similar experiment was performed in Brussels with fifty participants (see Deliverable 4.3). The experiment will be used to understand how accessible the kiosk is and how future versions of this software can be improved.

During the experiment, participants assessed the digital kiosk by performing seven tasks while being observed by the researchers. After the experiment, participants filled in two surveys, one on the kiosk itself about satisfaction and usefulness, and one on-paper survey regarding the whole experience, feedback, digital skill level and demographic data. The digital kiosk in Rotterdam as well as some examples screens of the kiosk can be seen in Figure 9.

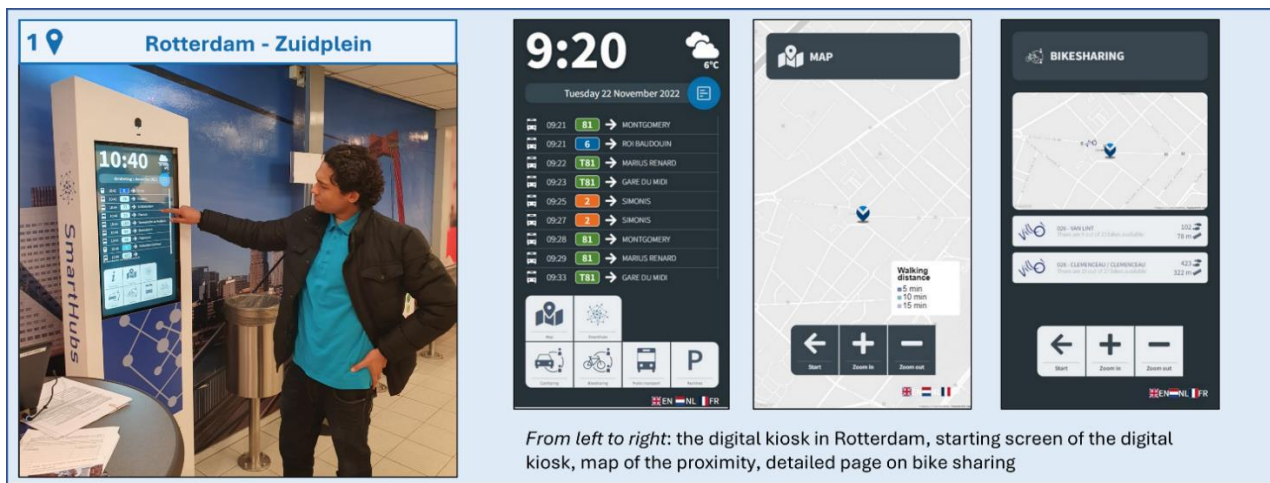


Figure 9 – The digital kiosk during the testing in Rotterdam and some screens of the kiosk (Sources: picture on left by Kelt Garritsen, UT, screenshots by Jelten Baguet, Mpac)

From the digital kiosk experiment, it can be concluded that 85% of participants had never used a similar device but most of them were interested to use one in the future, primarily to check public transit departure times, and participants with a lower educational level are more likely to use it. Furthermore, participants with lower digital skills level (no experience with trip planning and paying via a mobile app) had more difficulties using the digital kiosk, which shows that having limited digital skills is a real barrier for using new transportation services. Overall, the experiment showed the potential of a digital kiosk to facilitate the use of mobility hubs when designed according to the needs of all vulnerable groups.

Co-design game

This section is related to SmartHubs deliverable D3.4. Deliverable will be available [here](#) when published.

The first version of the co-design game is a boardgame in which participants discuss and negotiate on the design of a mobility hub, located at Hobbemaplein. Participants get dissimilar roles (for instance: PT users or car-lover) and tasks (for example: 'I would like a place for my children to play'), and discuss their motivation for certain choices made during the game afterwards. In the spring of 2022, the game has been played at multiple events with citizens and local policymakers in The Hague. In June 2023, an improved AR-multiplayer version of the game will be played with the project team that is responsible for redesigning the Hobbemaplein. Visualisations of playing both versions of the game can be found in Figure 10.

The goal of the co-design game is to identify which elements are important for each participant as well as their argumentation for this. Participants start with a persona card and personal goal, related to mobility and non-mobility services. The board game makes use of different elements with different sizes and points, and players pick elements important (related to their personal goal) to them and place them on the board. When the board is full, consensus must be met on the most important elements, showing a trade-off. In total 43 participants (a mix of local residents, policy makers and researchers) have attended a game session.

The results of playing the co-design game are discussed in section 3.2. Citizens preferred *trees, signage and wayfinding, a café, playground* and *shared two-wheelers* the most, showcasing the need for non-mobility placemaking attributes. Shared vehicles were amongst the most debated elements, demonstrating the difficulty of citizens to adopt to these new modes.



Figure 10 – Playing the boardgame in The Hague and visualisations of the AR game (Sources: picture on left by University of Twente, screenshots by Gerfried Mikusch, TU Wien)

Appraisal tool

This section is related to SmartHubs deliverable [D3.5 – SmartHubs Appraisal Tool for sustainability and stakeholder assessment](#) by Martinez et al. (2022).

The appraisal tool includes three participatory appraisal methods, of which one is used in the Dutch context. This tool can be used for the co-evaluation of co-designed mobility hub alternatives (Martinez, Pappers, Keserü, et al., 2022). The MAMCA tool will be used in cooperation with the municipality of The Hague together with stakeholders of the Hobbemaplein project. However, to overcome overlap with the newly designed square and the decision-making / participatory process, generalized design alternatives will be used in the assessment phase. The stakeholder groups that will be involved are the municipality of The Hague, HTM (PT-provider), a shared mobility provider, local business owners and residents.

2.2. Case study status-quo

The current situation of the case study areas is briefly mentioned in Figure 3 and Section 1.3. **Zuidplein** is currently in the final phase of the redesign of its public transportation facilities and the surrounding non-mobility services. At the beginning of the SmartHubs project, the municipality of Rotterdam started renovating of the area at Zuidplein and constructing of new houses in the area. The building of the new bus terminal (which is socially safer and has better walking connections) can be seen in Figure 9. The complete work on the station area, bus station and renovation of the shopping centre was finished in 2022 (Hart van Zuid Rotterdam, 2021).

The redesign of **Hobbemaplein** has not started yet, the municipality is planning to finish a final design in 2023 and start the construction works in 2024 (Municipality of The Hague, 2022d). The project formally started in 2021, so after the start of SmartHubs. The status-quo of the square can be seen in Figure 9 (right), where the square is a busy intersection between a wide range of modes.



Figure 11 – Left: New bus station at Zuidplein during construction, picture taken from the metro station platform. Right: Hobbemaplein, with on the left the tram stop.

2.3. Adjustments of case study goals

Since the start of the project, the focus at **Zuidplein** has been digital integration. The impact of moving up the digital integration ladder for different user groups is adjusted to digital integration in general, which is a slight change. Not all elements on the ladder of digital integration are included and the main focus of the case study in Rotterdam is based on experiments with the digital kiosk. A previously scheduled experiment, focussed on shared mobility applications, has not been performed due to the absence of shared vehicles at the micro-hub and the difficulty to find participants.

The case study of **Hobbemaplein** was focussed on the ongoing participatory process of the municipality, to see if co-creation and involvement of citizens would increase societal impact and support. However, during the first stages of the co-creation process and the separate participation process of the municipality, it became clear that the stakes were high. The redesign of Hobbemaplein is a difficult case with lot of different interests. Therefore, the municipality decided to downscale the involvement of SmartHubs' co-creation to cope with the risk of overpromising hub elements that cannot be delivered. Consequently, the case study goals were adjusted to focus more on the co-design game and hub elements, instead on the impact of the co-creation process in general. The co-evaluation will still be performed but separated from the Hobbemaplein designs to ensure clarity on what is included in the redesign and what is not.

In an earlier phase of the SmartHubs-project, , the potential hub and current tram stop **Leyenburg** (The Hague) was also included as case study within the Dutch Living Lab. This location has been removed from the living lab, since the project plans were not completely clear at the start, making it difficult to align the living lab activities to the ongoing Leyenburg project itself.

3. LIVING LAB EVALUATION

The Living lab evaluation is the stage where the impact of the mobility hubs in the living labs is evaluated in order to analyse if the mobility hubs reach the goals and satisfy the needs and interest of citizens and stakeholders, as discussed in the previous chapter. This section focuses on the process of the evaluation, not the outcomes, since the living lab evaluation activities are still in progress.

3.1. Survey Findings

The goal of the joint SmartHubs survey is to get more (quantitative) understanding of the current and potential use of mobility hubs, and the importance of different integration levels of the hub itself. For the Dutch living lab, the importance of physical and digital integration elements could play a role within the hub design at Hobbemaplein.

3.1.1. Data collection design

The survey consists of multiple parts, starting with questions on individual characteristics of the respondents, e.g., residence area, socio-demographics and digital skills, followed by a section on mobility characteristics and mobility hubs. Here, a distinction is made between hub familiarity and (future) needs and preferences. The next part of the survey consists of two choice experiments, one on mode choice behaviour and the other on hubs' attributes preferences. The survey ends with a section on participation and democratic integration, ensuring that the three dimensions of the SmartHubs integration ladder (physical, digital and democratic) are all included in the survey.

The study area on the survey consists of the four living labs of the SmartHubs project: Rotterdam-The Hague, Brussels, Eastern Austria and Munich. Within the Dutch living lab, the study area focuses on the MRDH region as depicted in Figure 1. The MRDH region is a well-connected region where the smaller cities have good connections with The Hague and Rotterdam. Having the MRDH region as a sample therefore allows for a larger sampling population while the conditions are the same.

From the end of December 2022 until the end of January 2023, a total of 805 responses have been collected (number of respondents after data cleaning). From the total amount of respondents, 84% (N=678) were recruited via a survey panel company (named *PanelClix*). The remaining 16% (N=127) were recruited via Dutch partners (e.g., shared mobility providers sharing the survey link after a ride was finished, sharing the survey link on social media of municipalities or sharing the survey at online neighbourhood platforms) and performing assisted surveys in 4 community centres/libraries in Rotterdam and The Hague.

The survey targeted a random sample of citizens within the MRDH region (minimum of 500 respondents, 805 realized eventually), additionally focusing on segments for a stratified sample. It was aimed to have at least 100 women (realized: 440), 50 respondents above the age of 65 (realized: 206), 200 low-income respondents (realized: 120), 200 low education respondents (realized: 215) and 25 low digitally skilled (realized: 42). The last group was partly recruited using assisted surveys. Based on the realized numbers, all targets were achieved except for one.

3.1.2. Data preparation

A total of 1526 responses was recorded for the Dutch living lab, with 4802 respondents across all living labs. The data cleaning process consisted in removing respondents that (i) did not provide their consent to save the data, (ii) only previewed the survey, (iii) were missing a respondent ID, (iv) were living outside the MRDH region (based on ZIP code), (v) did not fully complete the survey and (vi) had a response duration below four minutes, which was set as the minimum response time. This resulted in 805 (53% of total responses) valid responses for the Dutch living lab.

3.1.3. Sample characteristics

As mentioned in section 3.1.1, the survey focused on residents of the MRDH region but also tried to oversample some vulnerable to exclusion groups. Since the first part of the survey asked questions on socio-demographic characteristics, a comparison of the survey sample and the Rotterdam/The Hague population can be made for some characteristics. Females are slightly overrepresented in the survey (54.7%, compared to 51% and 50% for Rotterdam and The Hague, respectively) which could be caused by oversampling women. Older age groups are also slightly overrepresented with 25.6% above the age of 65 (16% and 15% for the full population of Rotterdam and The Hague, respectively), as shown in Figure 12. Figure 13 shows the distribution of the digital skills levels in the Dutch sample. Respondents having a digital skill level 0 or 1 (17.4%) do not use travel planning apps (e.g., Google Maps or 9292.nl) and can be considered to have low digital skills (see next section on the explanation of this typology). When considering the educational level of the sample, the low education (compulsory education and high school graduate) target is realized but there is also quite a large share of participants that finished a university masters or bachelors (41.7% for both), see Figure 14. Lastly, 51.9% of the sample has a household income between 1600 and 4800 euros per month, as depicted in Figure 15 (Low: below €1600, Medium: €1600-€4800, High: above €4800).

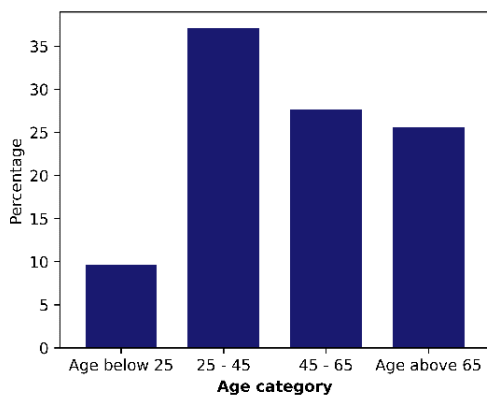


Figure 12 – Age categories Dutch survey sample

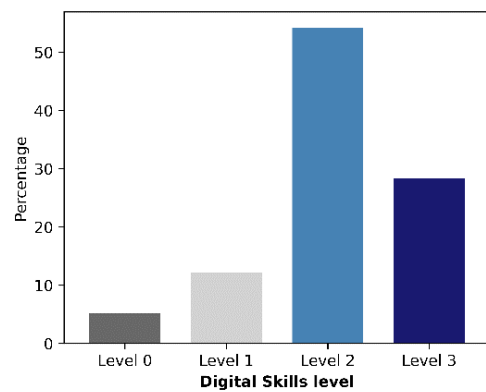


Figure 13 – Digital Skills levels Dutch survey sample

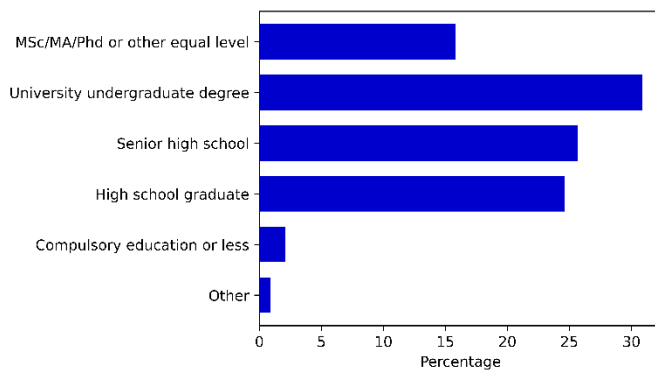


Figure 14 – Education categories Dutch survey sample

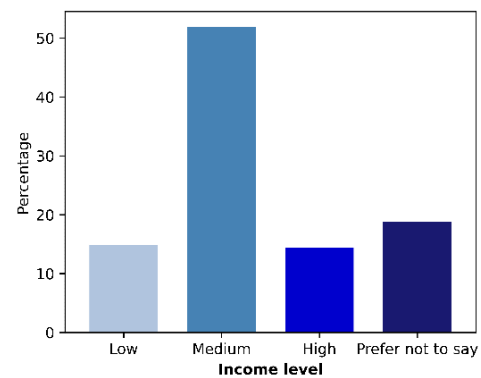


Figure 15 – Income level categories Dutch sample

Digital Skills level

The digital skills level of the participants is determined based on phone-use questions. 95% of respondents has access to / uses a mobile device with an internet connection. Most performed activities involving the use of a smart phone are online shopping, using applications to plan trips using the respondent’s own vehicle or transferring money.

The digital skills levels are based on the research of Horjus et al. (2022) and follow the following levels:

- Level 0 – No access to a phone with internet connection or only using the offline functions
- Level 1 – Access to smartphone but not performing any travel planning activities
- Level 2 – Access to smartphone and using an app to plan trip for own vehicle or public transportation
- Level 3 – Access to smartphone, an app to plan and pay/reserve trips and using an app to transfer money

3.1.4. Sample mobility characteristics and mobility hub familiarity

The Dutch respondents use their bike often in general, with 65.4% of respondents using their bike more than once per week (Figure 16). Other regularly used modes are the car, walking and urban PT, which is used more often than the train. When considering shared modes (Figure 17), the shared moped is used most often. However, the respondents primarily use their own or public modes, and the shared modes are used infrequently. Respectively, 85%, 82% and 69% of the respondents never use a shared car, bike or moped. The shared moped is the most used shared vehicle but primarily for a use of 1-3 days per month.

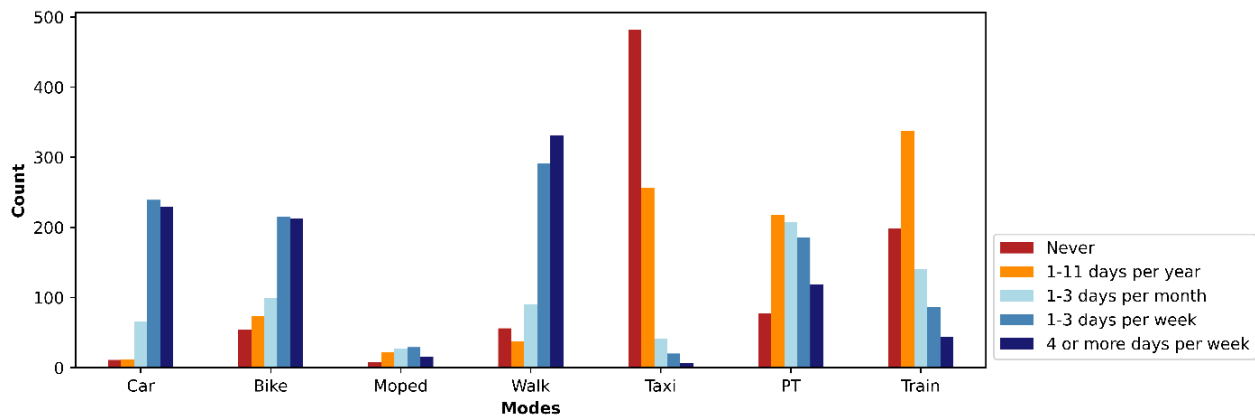


Figure 16 – Current (own and public) mode use of Dutch survey sample (PT = bus, tram and metro)

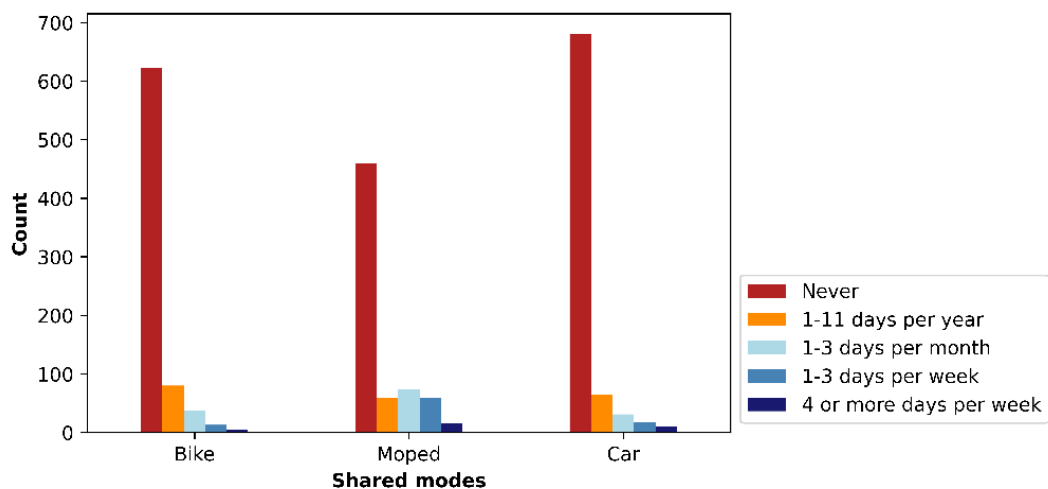


Figure 17 – Current shared mode use of Dutch survey sample

The reasons for not using shared vehicles were also considered in the survey. The Dutch respondents primarily stated that they preferred their own vehicle to the shared car, bike or moped. Other less mentioned reasons for not using the shared moped are its price or not knowing how to use it. The reasons for not using a shared vehicle are shown in Figure 18 (shared car), Figure 19 (shared moped) and Figure 20 (shared bike).

Besides the preferred use for their own vehicle, Dutch respondents state other reasons for not using the vehicles, primarily for the shared e-moped. Other barriers are: not knowing how to use it or considering the service to be too expensive. The barrier 'I need to walk too far' is most often mentioned for the shared car, potentially showcasing the lower coverage of those vehicles.

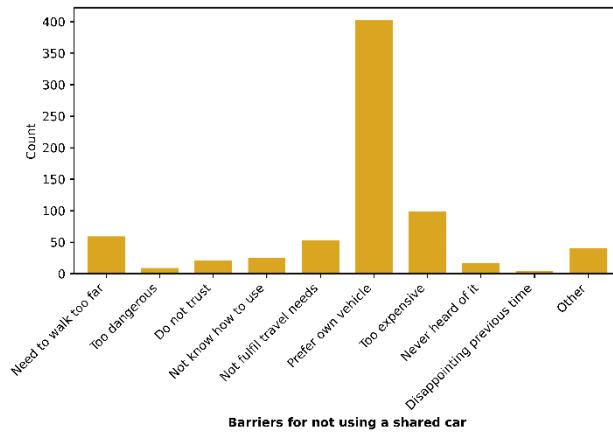


Figure 18 – Reasons for not using a shared car

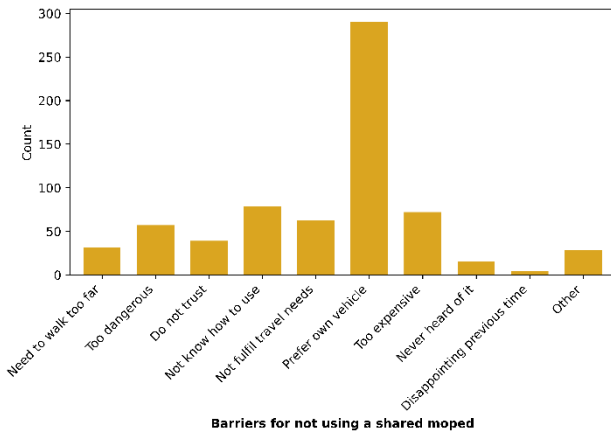


Figure 19 – Reasons for not using a shared moped

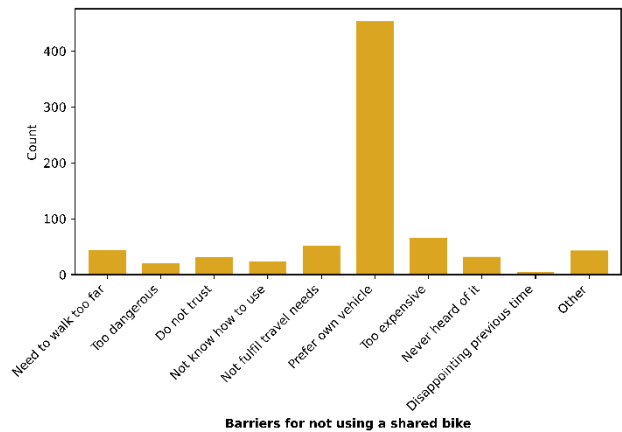


Figure 20 – Reasons for not using a shared bike

When considering the concept of a mobility hub, most respondents (around 65%) state that they have never seen a mobility hub or are not sure if they did (i.e., awareness of hubs in Figure 21). From the 35% of respondents that are aware of hubs, 36% (13% of the full sample) also travels via a mobility hub, showing that mobility hubs are not used by the majority of the Dutch sample.

Awareness of hubs	Usage of hubs		
	Yes	No	I am not sure
I am not sure	6	110	48
No	0	305	16
Yes	94	142	20

Figure 21 – Familiarity with mobility hubs of Dutch survey sample

However, there is potential for mobility hubs. Figure 12-24 consider the likelihood that a respondent uses a shared mode at a mobility hub during a future trip. As presented in Figure 22, the share of respondents that are positive (likely and very likely) about using a shared mode / travelling via a hub is larger than the current share of users, with on average over all modes 17.3% of respondents being positive compared to 13.5% of respondents currently travelling via a hub. The likelihood of future use also increases when the digital skill level increases, as showcased in Figure 23 and 24, indicating a potential inequality in access of shared modes at hubs that should be considered, showing the importance of making shared modes digitally accessible for all parts of the population.

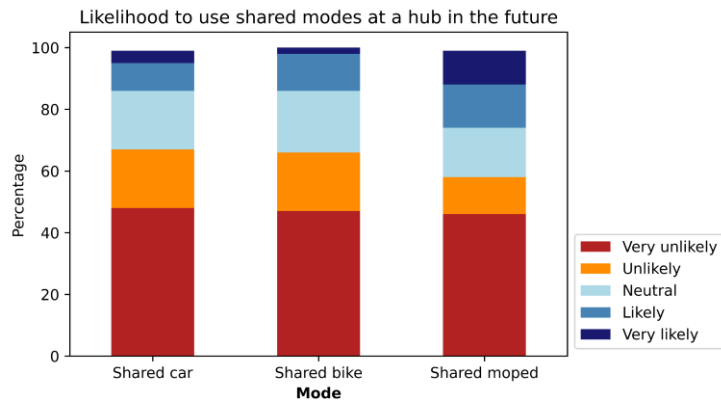


Figure 22 – Cumulative likelihood to use shared modes at a mobility hub in the future

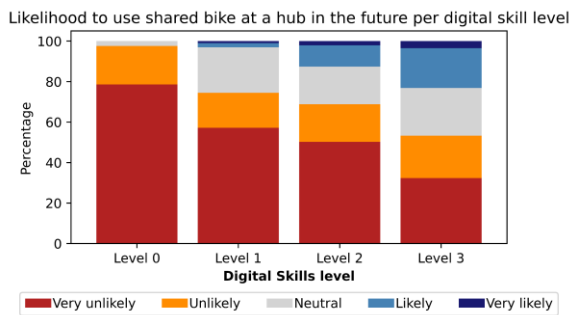


Figure 23 – Cumulative likelihood to use a shared bike at a mobility hub in the future per digital skills level

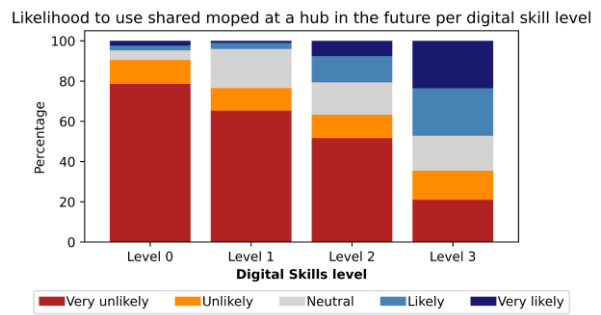


Figure 24 - Cumulative likelihood to use a shared moped at a mobility hub in the future per digital skills level

Regarding the potential of mobility hubs, respondents were asked which mobility hub characteristics are most important to them (5-point Likert-scale, presented in Figure 25). Having one mobile phone app to plan, book and pay for a mobility service was considered most important, followed by having proper information via digital displays and signage. An attractive design of the mobility hub was considered as least important. Lastly, it should be noted that a large share of participants is neutral about (one of) the options, which could mean respondents find it difficult to determine what is important when they are not familiar with a mobility hub.

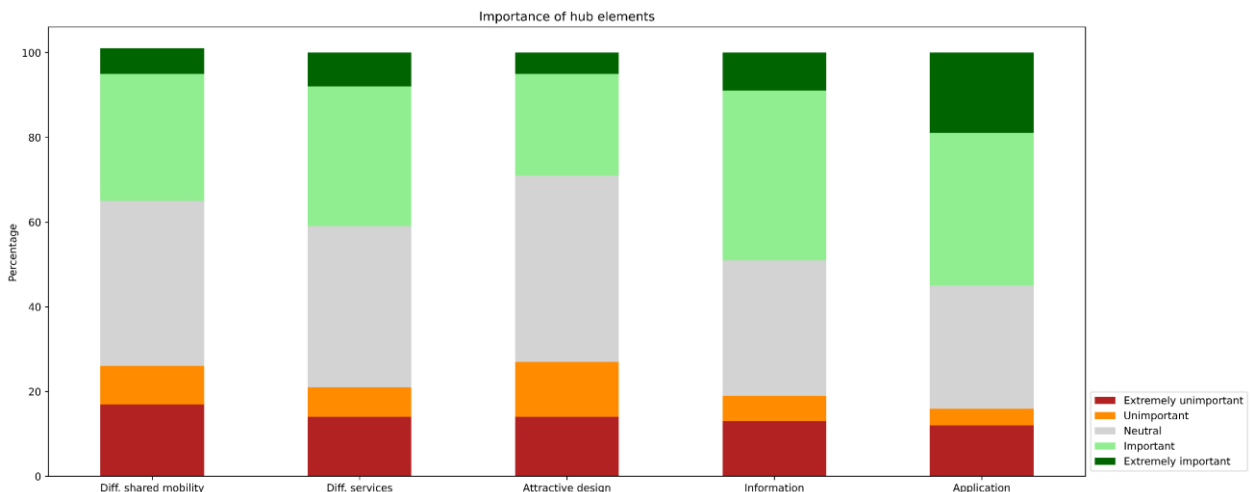


Figure 25 – Importance of hub characteristics at a mobility hub

Full results of the survey will be presented in SmartHubs publications: D5.1 – Mobility hubs impact on mobility patterns and behavioural change, D5.3 – Equity assessment and D5.5 – Integration of mobility hubs and public transport and possible others.

3.2. Results of Co-design process

The co-design process consists partly of the digital kiosk experiment as well as the co-design game, both mentioned in the living lab planning section of this report. However, the results of the co-design game itself will be discussed in depth in this section, to show the outcomes of the process.

3.2.1. Co-design game

The co-design game, as discussed in Section 2.1.2, mostly concerned physical and digital integration elements at mobility hubs. The game is played in the context on the Hobbemaplein case study since the full process of co-design and co-evaluation will be performed at this location. The Dutch version of this game was played as boardgame where participants (with a personal goal) choose elements, argue why they want to include certain elements in the hub design, and perform actions to fill the grid of the mobility hub and try to get the highest score as possible. Within the game, participants try to maximize their personal but also the overall score, asking for debate and compromises.

In April and May of 2022, the game has been played at seven separate occasions. An overview of these game rounds can be found in Table 5. In total, 43 participants have tested/played the co-design game. During round 1, 4 and 5, the game was played with actual residents of Hobbemaplein. Policy makers or researchers played during the other rounds, so persona cards were used.

Table 5 – Game rounds of the co-design board game

Round	Description	Date	Location	Number of participants	Type of participants
1	Hobbemaplein info event	20-04	Library Hobbemaplein	17	Residents and local businessowners
2	Online test	10-05	Online	6	Municipality & PT providers
3	Municipality meeting	18-05	Council hall The Hague	4	Municipality
4	Community centre	18-05	Community centre Mandelaplein	4	Residents
5	Community centre	18-05	Community centre Mandelaplein	3	Community centre employees
6	SmartHubs symposium	19-05	Bleyenbergh	4	Participants
7	SmartHubs symposium	19-05	Bleyenbergh	5	Project researchers

3.2.2. Selected elements

The (mobility and non-mobility) elements are ranked based on popularity during the course of the game, i.e., if the element was placed on the board as mobility hub element. For Table 6, only round 1, 4 and 5 are considered (N = 24) for citizens, where actual citizens have been playing these game rounds. The citizens valued, comparing all possible elements, *trees*, *wayfinding*, *a café*, *shared two-wheelers* and *a playground* the highest. When asking which elements they did not like, shared vehicles, or parking for cars and taxis were mentioned most often, showing the difficult position of shared vehicles in the current urban space. Participants that were positive about shared modes were mostly residents between 20-30 years old, while opposing participants were primarily local businessowners or participants with a higher average age.

Table 6 shows the most popular elements in both the mobility and non-mobility category for the hub at Hobbemaplein for citizens (N = 24) and stakeholders playing the game using a character role, i.e., persona card. Game round 2, 3 and 6 are considered for this analysis (N = 14). The stakeholders, playing a role, selected almost the same elements as the citizens themselves, with the *café*, *parking for two-wheelers*, *trees*, *shared two-wheelers* and *wayfinding* being valued as most important. The most popular elements will be considered in the different design options for the mobility hub within the co-evaluation process of Hobbemaplein later in 2023, when the multi-actor multi-criteria analysis will be performed using design alternatives.

Table 6 – Most popular elements of citizens & stakeholders using persona cards during co-design game.

Mobility & mobility related elements		Non-mobility elements	
Citizens	Character role	Citizens	Character role
1	Signage and wayfinding	Trees	Café
2	Parking for two-wheelers	Café	Trees
3	Shared two-wheelers	Park elements	Park elements
4	Loading zone	Playground	Benches
5	Car parking	Benches	Fitness equipment

3.3. Alignment of mobility needs & stakeholders' interest

3.3.1. Mobility needs

The evaluation of the living lab will (in a future stage) include the assessment of the accessibility and resilience of the mobility hub and its mobility system.

Accessibility of the mobility hubs

The analysis on the accessibility of mobility hubs includes both the accessibility of the mobility hub itself as well as which destinations are accessible from the hub. For this, the SmartHubs accessibility tool is currently in development. Input from the municipality of Rotterdam and The Hague will be used to pinpoint the tool to practitioners (input session taking place in May 2023). The tool will be used in the future to assess the accessibility of the living lab locations.

Accessibility analysis of the living lab will be discussed in the future work: *D5.2 – SmartHubs accessibility impacts.*

Resilient mobility system

The contribution of the living labs to a resilient mobility system will be assessed using the (currently under development) SmartHubs resilience tool. Data from the MRDH region (OD matrices of PT and active modes) is used as input, to assess (amongst others) the connectivity, resilience and vulnerability in potential scenarios.

The hubs' resilience will be analysed in future work: *D5.4 – SmartHubs resilience and vulnerability assessment.*

3.3.2. Alignment of stakeholder & citizens interests

The SmartHubs appraisal tool (referred to in section 2.1.2) will be used to evaluate if the living lab meets the needs of citizens and stakeholders. Figure 26 shows the steps of this process, highlighting the previously performed steps in dark. This appraisal process will focus on the hub development at **Hobbemaplein**, discussing the overarching objective of “*Designing Hobbemaplein as a hub that is accessible and pleasant for all & offers a range of (transportation) services.*”



Figure 26 – Steps to be taken for the SmartHubs appraisal tool process

The next steps in the appraisal process, i.e., the multi-actor multi-criteria analysis, is to determine the criteria of stakeholders and citizens in order to determine how the living lab can be improved in line with the needs of all stakeholders. This process included interviewing stakeholders or stakeholder representatives to determine a list of criteria and indicators, which can be used to evaluate alternative design options.

3.3.3. Impact on policies and governance

As revealed in section 1.1.3, the mobility hub policies of both Rotterdam and The Hague focus on hub network development, with a range of larger and smaller neighbourhood hubs, mostly focussing on physical integration and mentioning Mobility-as-a-service systems. The layout of these hubs and its elements are not fully taken into consideration, although non-mobility elements being mentioned (Municipality of Rotterdam, 2021; Municipality of The Hague, 2022c). The co-creation process in the living labs could therefore have an interesting impact on local policy and/or governance, showing the importance of certain mobility and non-mobility elements (see Table 6, for instance) for different (vulnerable) stakeholder groups. Additionally, the focus on digital and democratic integration could influence the policy of the municipalities, to focus more on low digitally skilled citizens, active participation when developing future mobility hub, and other elements.

Policy and governance impact will be discussed in: *D6.1 – SmartHubs policy and governance impacts.*

4. CONCLUSIONS

The main findings, recommendations and a discussion of the process can be found in this section.

4.1. Main Findings

The Dutch living lab tried to answer to two sets of research questions, one for Rotterdam and three for the case study in The Hague. In general, the living lab activities illustrated the wide range of possibilities to involve stakeholders and citizens in developing mobility hubs, as well as the variety of dimensions (e.g., physical, digital and democratic) of mobility hubs, that might not be highlighted in current policies.

Firstly, the answers to the research questions will be discussed briefly. However, not all questions can be answered already, since the co-design and co-evaluation activities are ongoing. For those questions, the future steps will be described.

1.1. What is the role of digital integration within the development, use and social inclusion of mobility hubs?

Digital integration in the **Zuidplein** case study was tested using a digital information kiosk, by evaluating the usefulness and usability of such a kiosk. The digital kiosk was likely to be used again by all segments of the population, also people with lower digital skills. However, the design of such kiosk needs to be in line with the needs of users with low digital skills, limited knowledge of the local language and lower educational level, to make sure it is easy to use the kiosk. When improving the interface and, for instance, simplifying the use of text and pictograms, and offering information and booking facilities for both public transit and shared modes, the kiosk could improve the inclusivity of mobility hubs. This would facilitate the use to people with limited digital skills, which might increase the uptake of mobility hub usage.

2.1. How can Hobbemaplein be developed as a “smart” mobility hub?

The development of **Hobbemaplein** as smart mobility hub is determined by the three integration categories of a smart hub: physical, digital and democratic integration. The potential physical and digital integration of the hub will be evaluated during the appraisal process. However, the “smartness” on the democratic level depends on the process as a whole. Active participation, considering vulnerable groups in particular, and co-design are essential elements to reach a “smart” level on the integration ladder. By implementing those participatory methods (e.g., design game, interviews with vulnerable groups and the MAMCA) for a future mobility hub at Hobbemaplein, the hub can be adjusted to the needs and preferences of stakeholders.

2.2. Which hub elements are important for different stakeholder groups?

The first stages of the co-design game at **Hobbemaplein** showed the most frequently chosen, and therefore most important hub elements for stakeholders in general. The elements selected by citizens were *trees*, *wayfinding*, *a café*, *shared two-wheelers* and *a playground*, which is a combination of mobility and non-mobility elements. The future co-evaluation stage should reveal which combination of elements is valued the most by the different stakeholders, whereas the survey analysis shows the willingness to pay for different mobility and non-mobility elements.

2.3. Is a co-design game a useful tool to determine the mobility hub design preference of stakeholder groups?

The co-design game has proven to be a useful tool to determine popular hub design elements and see which trade-off stakeholders make in selecting them. Nonetheless, the game itself should not distract from the design of the hub. A full game session requires a lot of effort and time from participants, making it difficult to apply the co-design game at walk-in consultation moments. Furthermore, during the first test of the AR version of the co-design game, it was concluded that the AR elements did not add a lot to the existing board game and was rather distracting for the participants. Concluding, when performed properly, the co-design game can be a useful tool to determine the mobility hub design, understand the opinion of others and visualize the future hub to potential users.

4.2. Recommendations

The living lab activities in the Dutch case study hub are still ongoing, making it difficult to create recommendations regarding the potential design of the mobility hub, especially for The Hague. However, a first recommendation regarding the digital integration can be made. The digital information kiosk experiment shows that there is a difference in ease of use of such a system between citizens with low and high levels of digital skills. People with limited digital skills or digitally excluded are a vulnerable group which is not often considered in policy-making. The digital skill level of citizens is not easy to determine based on generally available statistics (e.g. from CBS), and requires work to determine, which increases the difficulty to consider this group specifically in a policy making process. It is however recommended to take low digitally skilled citizens into account in the participation process, since this has a high impact on the social inclusion on the digital integration dimension of mobility hubs.

In general, the case study results can be transferred to other parts of the city and other major cities in the Dutch context. The lessons learnt on co-design as a tool to determine needs and preferences, the digital kiosk experiment and the upcoming co-evaluation stage could hold for other cities. The generalizability of the survey results will be examined by adding spatial and built environment variables to the models, checking if model results can be explained by them.

4.3. Process Discussion

It has proven to be difficult to align the SmartHubs activities to the ongoing projects in the living lab; the Leyenburg case study area was dropped from the project because of this. Large transportation and redesign projects take a long time, and are sometimes controversial, meaning that often stakeholders do not agree with all plans of the municipality at every stage. To add a (side-) participatory process to the existing procedure can therefore interfere with the ongoing plans. This caused delays at the Hobbemapelein case study, as well as the change of the appraisal process to use generalized designs. From this process, it can be concluded that aligning a research project with a decision-making process is a difficult job that requires a high level of planning.

4.4. Next Steps

The Dutch living lab included the user needs assessment and co-design stage. The next phase is to finish the co-design and co-evaluation stages in the Hobbemapelein living lab, concluding the full co-creation process. By doing so, it will be possible to study the different preferences between stakeholder groups for the design of a hub, and analyse which elements are considered more important, something that can be confirmed using the survey analysis. Furthermore, it might be interesting to analyse the different methods (e.g., interviews, experiments, serious games, assisted surveys and online surveys) that have been used to gather information on stakeholder needs and preferences: to examine the usefulness and usability of those methods in accurately determining the opinion of different social groups.

5. REFERENCES

- CBS. (2022a). *Bevolking 15 tot 75 jaar; opleidingsniveau, wijken en buurten, 2021*. CBS Statline. Retrieved 16-02-2023 from <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85372NED/table?ts=1673968536377>
- CBS. (2022b). *Kerncijfers wijken en buurten 2021*. CBS Statline. Retrieved 16-02-2023 from <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85039NED/table?ts=1673969152821>
- CBS. (2022c). *Kerncijfers wijken en buurten 2022*. CBS Statline. Retrieved 16-02-2023 from <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85318NED/table?ts=1671702238020>
- CE Delft, & Goudappel Coffeng. (2021). *Effecten van het programma duurzame mobiliteit - Doorrekening van het regionaal maatregelenpakket van de MRDH*. MRDH.
- DHIC. (2022a). *Wijkprofielen - 29 Schildersbuurt*. Municipality of The Hague.
- DHIC. (2022b). *Wijkprofielen - 30 Transvaalkwartier*. M. o. T. Hague.
- Duran-Rodas, D., Navarro-Ávalos, F., Hall, J., Nichols, A., Büttner, B., Baguet, J., & Susilo, Y. (2022). *SmartHubs Deliverable D3.1 Guidelines for the integration of mobility hubs into the urban space*. https://www.smartmobilityhubs.eu/files/ugd/c54b12_c50885556b2d49108e90d0c70c777c07.pdf
- Geurs, K. T., & Münzel, K. (2022). *SmartHubs Deliverable D2.1 A multidimensional mobility hub typology and inventory*. https://www.smartmobilityhubs.eu/files/ugd/c54b12_819c85702a6442c6bebb18538fb93516.pdf
- Goudappel. (2022). *OV-Klantenbarometer MRDH*. G. BV;.
- Graf, A., & Hansel, J. (2023). *SmartHubs Deliverable D2.3 GOVERNANCE FRAMEWORKS FOR MOBILITY HUBS IN THE SMARTHUBS LIVING LAB AREA*.
- Hart van Zuid Rotterdam. (2021). *Over op Zuid - Wij zijn op zuid, jij ook?* Hart van Zuid, Heijmans, Ballast Nedam. Retrieved 21-2-2023 from <https://www.hartvanzuidrotterdam.nl/over-op-zuid>
- Horjus, J. S., Gkiotsalitis, K., Nijënstein, S., & Geurs, K. T. (2022). Integration of shared transport at a public transport stop: mode choice intentions of different user segments at a mobility hub. *Journal of Urban Mobility*, 2. <https://doi.org/https://doi.org/10.1016/j.urbmob.2022.100026>
- Kernteam Hart van Zuid. (2021a). *Resultaten 5 jaar Hart van Zuid in uitvoering*.
- Kernteam Hart van Zuid. (2021b). *Voortgangsrapportage 2021 Hart van Zuid*.
- Martinez, L., Pappers, J., & Keserü, I. (2022). *SmartHubs Deliverable D3.2 Needs of users and digitally excluded citizens*. https://www.smartmobilityhubs.eu/files/ugd/c54b12_e1c66f737c2a46ef85f64edb5f60f8d1.pdf
- Martinez, L., Pappers, J., Keserü, I., & Boveldt, G. t. (2022). *SmartHubs Deliverable D3.5 SmartHubs Appraisal Tool for sustainability and stakeholder assessment*. https://www.smartmobilityhubs.eu/files/ugd/c54b12_8c0d1dd1b7ea4ef2b27db027a1f5ff74.pdf
- MRDH. (2020). *Prestaties OV in 2019*. Retrieved 17-04-2023 from <https://mrdh.nl/nieuws/prestaties-ov-2019>
- MRDH. (2022). *Strategische Agenda Metropoolregio Rotterdam Den Haag 2022 - Samen aan het werk!* MRDH.
- MRDH. (2023). *Gemeenten Metropoolregio Rotterdam Den Haag*. Retrieved 16-02-2023 from <https://www.mrdh.nl/wie-zijn/gemeenten>
- Municipality of Rotterdam. (2020). *Rotterdamse Mobiliteits Aanpak*. G. Rotterdam.
- Municipality of Rotterdam. (2021). *Nota Deeltweewielers - Rotterdam 2021*. G. Rotterdam.
- Municipality of Rotterdam. (2022). *Onderweg in de Metropoolregio 2018 - 2021*.
- Municipality of Rotterdam. (2023). *Dashbord Onderzoek010*. Municipality of Rotterdam. Retrieved 01-03-2023 from <https://onderzoek010.nl/home>
- Municipality of Rotterdam, & Stadslab Hoogkwartier. (2020). *Mobility Challenge Hoogkwartier - kennispaper*.
- Municipality of The Hague. (2011). *Haagse Note Mobiliteit*. G. D. H. Dienst Stedelijke Ontwikkeling.
- Municipality of The Hague. (2019). *Hoofdlijnenbrief mobiliteitstransitie*. Dienst Stedelijke Ontwikkeling Gemeente Den Haag,
- Municipality of The Hague. (2021a). *Stand van zaken proces aanpassingen tramlijn 6 en 12*. Dienst Stedelijke Ontwikkeling Gemeente Den Haag,
- Municipality of The Hague. (2021b). *Voorstel van het college inzake Strategie mobiliteitstransitie Den Haag 2022 - 2040*. Gemeente Den Haag,
- Municipality of The Hague. (2022a). *Participatiestrategie Mobiliteitsvisie Transvaal en Schilderswijk*. Municipality of The Hague
- Municipality of The Hague. (2022b). *Staat van de Stad - Den Haag 2022*.
- Municipality of The Hague. (2022c). *Strategie mobiliteitstransitie Den Haag 2022 - 2040*.
- Municipality of The Hague. (2022d). *Werk aan de Wijk - Hobbemaplein & Hobbemastraat*. Municipality of The Hague,. Retrieved 21-2-2023 from <https://werkaandewijk.denhaag.nl/projecten/hobbemaplein>
- OpenStreetMap. (2023). *OpenStreetMap viewer*. OpenStreetMap Foundation,. Retrieved 17-02-2023 from openstreetmap.org
- Pappers, J., Martinez, L., & Keserü, I. (2022). *SmartHubs Deliverable D2.2 Synthesis of KPIs to evaluate mobility hubs*. https://www.smartmobilityhubs.eu/files/ugd/c54b12_069c6d9efdd34a9dabbe9a31cc5fed5c.pdf
- Programmabureau NPRZ. (2019). *Uitvoeringsplan 2019-2022* (Nationaal Programma Rotterdam Zuid, Issue.