Smart Mobility Hubs as Game Changers in Transport

WP3. Development of co-creation, participatory planning and design tools

T3.4.   SmartHubs Co-design Tool

Deliverable D3.4
Report on recommended co–design technologies

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1 INTRODUCTION

In 2002, Sanders postulated a shift in perspective of creative processes (Sanders, 2002). She named it "a change from a user-centered design process to that of participatory experiences". This "Postdesign" phase results from "a shift in attitude from designing **for** users to one of designing **with** users." This significantly impacts the ways of thinking, feeling, and working in design settings. It is more than a simple method or a set of methodologies; it is "a mindset and an attitude about people." People other than designers can articulate and be creative when valuable tools help them express themselves and negotiate with others.

In this document, we present the Design Game as part of our TU Wien Mobility Games and as a result of a participatory design process that we have developed and provided to stakeholders other than designers to articulate their views, problems, feelings, ideas, needs, and solutions while designing mobility hubs in urban areas. This is the deliverable of the Design Game development in the project SmartHubs, which has been realized at four Living Labs of the project.

This deliverable is about the background knowledge of co-design and participation in creative processes based on the related research before presenting the evolution of the development of the "TU Wien Mobility Games." The change happened in three iterations:

1. Blank analog Design Game (ADG) (Iteration 1) – Version 1.0: TU Wien Mobility Games ADG
2. Mixed reality Design Game (MDG) (Iteration 2) – Version 2.0: TU Wien Mobility Games MDG
3. Real-life Design Game (RDG) (Iteration 3) – Version 3.0: TU Wien Mobility Games RDG

The different iterations will be described in increasing versions of this deliverable throughout the project.

1.1 Task description and relation to other tasks

Task 3.4 is part of SmartHubs Work Package 3 (WP3) and aims to develop the SmartHubs Co-design tool incorporating interactive methods for tangible interaction, augmented and mixed reality prototypes, and gamification for user experience (UX) design to support the co-design of mobility hubs. Focus groups and hands-on co-design workshops following the Design Thinking approach are organized in the four living labs of the SmartHubs project with (potential) users and vulnerable-to-exclusion citizens.

The output of this task will serve as input and guidance for WP4 (evaluation of living labs in tasks 4.2 through 4.6).

1.2 Structure of the deliverable

Firstly, we introduce the standard definition of co-creation processes and an overview of tools and methods used in cooperative settings. Secondly, we describe design games as powerful tools in general and how we used them in our project. We developed, experimented with, and evaluated several design games in our labs. Thirdly, we present the process and the games in detail. Finally, we will briefly show the design application and development result in the project's four living labs. The detailed analysis is not included in this deliverable but be added in the following versions.

2 CO-CREATION PROCESSES, TOOLS, AND METHODS

A co-creation process always starts with understanding the needs of the different stakeholders, including companies, consumers, policymakers, academics, and practicing designers, as well as the project's overall objectives. These activities can result in more concrete design solutions by focusing on innovation.

Designing the experience of people is more complex than often imagined. How can the users' experiences of things, events, and places be captured? What does "experience" actually mean to the relevant stakeholders?

Experiencing is an activity around the interrelation between a system providing functionality and an act, containing the interaction and perceived while acting by using the provided system (Sanders, 2002). As designers, we need to learn how to access people's experiences. Ideally, past, current, and potential incidents, to be inspired by them and be enabled to design for experience. First, we need to know how to access people's experiences. We can learn from them by listening to them, observing them, or reaching for an understanding of what they know, feel, or dream (Figure 1).
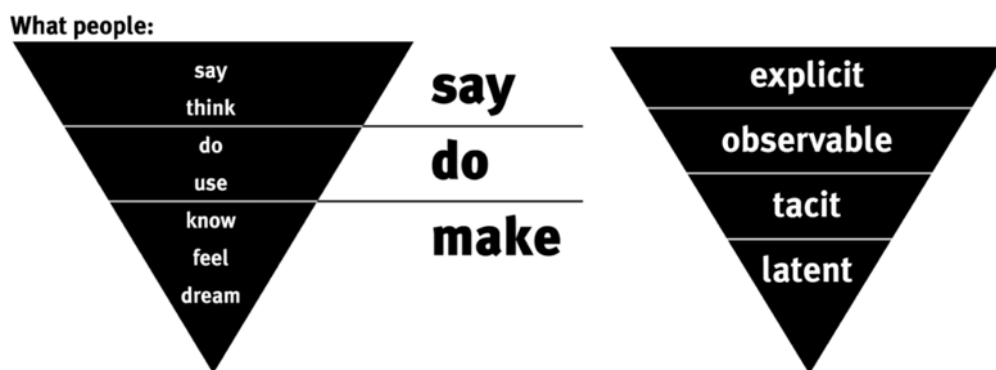
Figure 1: What people say, do, and make combined with the levels of need (Sanders, 2002).

One way of capturing people's knowledge, feelings, and dreams is to focus on what they make and create from the toolkits we provide to express their thoughts, feelings, and goals. The so-called "Make Tools" (Sanders, 2002) are visual or tangible. They build "a common ground for connecting the thoughts and ideas of people from different disciplines and perspectives." So, they become a new "design language" for users. Make Tools help "to discover as-yet unknown, undefined, and unanticipated user or consumer needs." They deliver user-generated artifacts or models – our design games are examples of such artifacts when populated with user data after a game has been played. Such artifacts tell stories, sometimes full of emotions, feelings, dreams, fears, and aspirations, sometimes showing how people understand or misunderstand things, events, and places.

Participation is the critical issue needed for co-creation. Depending on the context of application and use, different methods and approaches can be applied to involve people – not only the designers and planners but also other stakeholders – in an acceptable, understandable, and helpful way. As described from the design and development point of view, participation can have different forms (White, 1996). The basic structure is the *nominal* participation enabling legitimation and inclusion from other points of view. The legitimation happens by lending credibility and authority to a governmental body or organization sponsoring the participation activity. It also facilitates inclusion by allowing participants to participate in the participatory group. In sum, nominal participation demonstrates that participation has been part of the process. In *instrumental* participation, the participatory activity efficiently provides labor for essential services for the government or sponsoring agency. The involvement of the participants is viewed as a cost by participants, detracting time and resources from other activities. Still, participants are willing if they consider the move a necessity. This way, it is a way of providing services desired by all involved. The next level of participation is about being more *representative*. A Governmental body or sponsoring agency seeks participation to ensure the viability of a program over the long term. The participation process gives local people a voice in the project, which they use to influence decisions. So they can express their interests, but the program comes

from the top down. In the final form of participation, the *transformative* one, empowerment, is frequently perceived as a bottom-up strategy. Still, the impetus often comes from the top when the organization establishes appointment as a priority. The intent is to empower locals to plan and act for themselves, by providing services and by aiming at giving control to locals over their future. In SmartHubs, we create means and methods to enable the transformative participation of citizens in all living labs regarding the creation and maintenance of mobility hubs in their local environments.

Based on their professional and educational background, it cannot be assumed that all participants involved in co-creation activities possess comprehensive abilities to articulate their opinions about the subject attention, express their ideas, describe the context they want to address in their contribution, or formulate their suggestions for change in the co-creation process. Those lacking these abilities need appropriate methods and tools to stimulate their creativity. Design games are beneficial for this purpose. They also facilitate practices that enable them to participate efficiently in a design process, making them valuable tools to reach out and integrate vulnerable or excluded groups of our society.

There are at least three types of values in co-creation processes (Ali, 2015). These are monetary, use/experience, and societal value.

- Monetary Value – The economic value typically receives much attention in co-creation activities, which focus on business development and marketing (Sanders & Simons, 2009). The goal is to make money by creating innovative, sustainable, prospective products and services. The exchange between the customers and the company does not need to be direct, (digital) surveys are the most used tools.
- User or Experience Value – User insights and requirements can be captured as values and experiences to consider in the design of products and services.
- Societal Value – Social value is motivated by aspirations to improve sustainable living. The negotiations and collective visualization of ideas and needs can enhance the collaborative creativity among stakeholders involved in co-creation activities.

Already in SmartHubs Deliverable 2.1 (Section 2.4.4. Democratic (participatory) integration) (Geurs & Münzel, 2022), we presented, among others, the participation ladder with rights and duties of participation takers and givers and proposed a typology to categorize the democratic integration of participation processes with four Levels. In this document, we refer to the societal value of co-creation processes to envision the future cooperatively. As presented in the ladder of Arnstein (1967), the participation of others than designers can be established at different levels of involvement and engagement, varying from only informing and educating citizens to complete control and use of power (Figure 2).
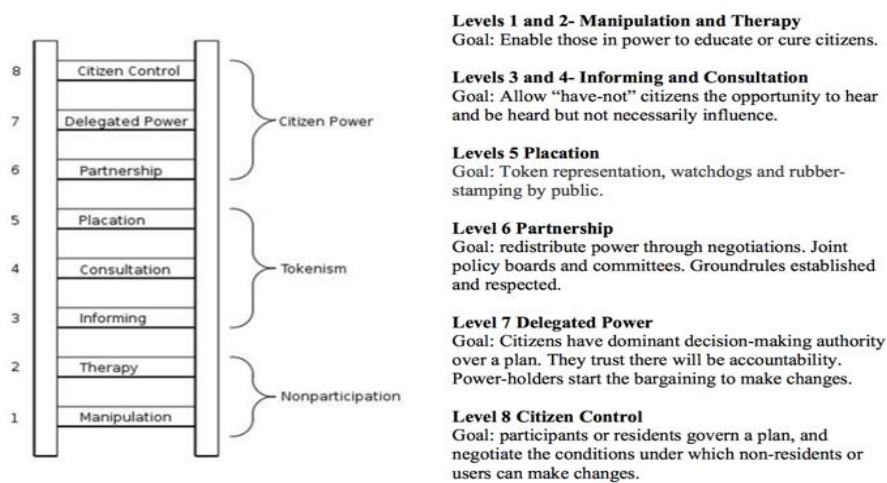
Figure 2: The ladder of participation (Arnstein, 1967).

Participatory Design contains cooperative, creative activities and design-related processes of designers and people not trained in design. In such methods, participating actors are not users, consumers, or customers anymore; they are considered experts in their understanding of living and working environments. Their participation makes them co-designers (Sanders & Stappers, 2008). To establish such a participatory design process, a shared understanding and a platform for communication between the designer and other participants must be installed first. Built upon this base, implicit and explicit user needs must be aligned with the stakeholders' analytical and creative thought processes to enable a conversation between the designers and other participants. The exchange between involved actors in such processes facilitates, at the same time, collective learning among them.

Participatory design processes need to be supported by different tools and methods. Co-creation tools can be applied for different types of engagement of users. Some examples are tools for sensing the urban environment, engaging users for participation through activation, making different perspectives visible, and communicating and activating in general. Co-creation methods are developed to support the ideation, implementation, and evaluation of new (technological) ideas by users or other related stakeholders. For instance, they can help co-creating interactions, get inspiration, generate ideas, gain knowledge on context, perspectives, etc.

By considering different Design Thinking tools and methodologies available so far and our experiences with the application of these in our previous projects, SmartHubs decided to focus on Design Games as enablers for exchange and co-creation among different stakeholders – which we want to further describe in the next section.

3   DESIGN GAMES AS AN INTERACTIVE CO-CREATION TOOL

Seeing participation as a critical issue needed for co-creation and knowing that tools can help to establish and maintain stakeholder participation in design and development processes, we ended up focusing on design games as powerful and joyful tools for interactive co-creation processes. Designing as a process is a social act involving communication, negotiation, and entering compromises (Brandt, 2006; Bucciarelli, 1994; Habrakan & Gross, 1987; Horgen et al., 1999). The game metaphor has been helpful for understanding and organizing participation (Wittgenstein, 1953; Ehn, 1988). *Exploratory design games* are particular design games:

"When discussing exploratory design games in design work, the players seldom compete to win a specific game. Participants in exploratory design games often have different interests and preferences. Still, instead of utilizing this by competing, the aim is to take advantage of the various skills and expertise represented and jointly explore various design possibilities within a game setting." (Brandt, 2006, p. 58)

Historically considered, some examples of exploratory design games are (a) games to conceptualize designing, (b) exchange perspective design games, (c) negotiation and workflow-oriented design games, and (d) scenario-oriented design games.

(a) Habraken and colleagues (1987) developed nine *concept design games* to understand, conceptualize, and improve the design of buildings and urban environments. People with different expertise and responsibilities act socially while creating. This act requires negotiation among participants by making proposals and, of course, by setting rules for the work planned. In SmartHubs, we conceptualized the design game within the design teams before we applied them as design games for exploration with other stakeholders.

(b) Sociology, anthropology, and psychology provided several methods to explore imagination and dense collaborations in the form of design games (Gooding & Brootchie, 1991). Starting with an everyday artifact, several techniques and lucid playful actions enabled the creation of new ideas through exchange among participants. In SmartHubs, we tried to add ludic elements to the design game toolkit, e.g., by considering pre-defined gameful actions triggering activities of players – sometimes even to engage each other, or by providing playful tangible elements to fire the creativity both of the game designers while creating the design game and of players while playing the game.

(c) Workflow orientation became important in the early days of participatory design. The focus was the work context to design for. The so-created games, which also used simulations of practices or everyday experiences, were played by future users and designers, mainly to explore technologies or other artifacts available. Several studies investigated the boundaries between employees. In SmartHubs, we did not consider this design element since the context is not directly work-related. Nevertheless, the games included flows of actions and scenarios created by citizens at the provided locations used in our design games.

(d) Scenario-oriented design games are based on scenarios that aim to restructure to provide new insights (Schön, 1983). Systems help to describe particular use situations by being incomplete so that they enable negotiation and change (Caroll, 2000). Brandt (2006) argues "that enacted scenario construction can be viewed as an exploratory design game because it involves a play with props, takes place within a pre-defined location, is limited in time, and follows specific rules." In SmartHubs, we based our design games on scenarios by providing the central location of action for the game and apparent elements to play with.

To sum up, exploratory design games are precious to organizing participation (Brandt, 2006). It would be wrong to think of one specific and generic match that would fit all kinds of projects. The design games should be designed for different purposes to achieve other goals. This diversity is exploratory and needed to understand the various scenarios that build these games' base.

Participation is central to exploratory design games. Certain ingredients are needed, like rules or tangible game elements such as "things-to-think-with" (Papert, 1980), which create a common ground and a new meaning while playing for everyone participating in the game. This common ground facilitates stakeholder

dialogue (Brandt and Messeter, 2004). These boundary objects (Star, 1989) are then shared among players. It is also about designing the future together by understanding each other's position and goals.

Design games are integrated well into "Post design" (Sanders, 2002). They implement a new mindset by making the user experience the focus of design inspiration and ideation. They show an attitude towards people. They recognize that people have something to offer that they can articulate by being creative at the same time. They represent the stories people tell who, in most cases, talk more about their life and work context, given enough space while playing the game. Design games are participatory. They are based on the active and direct participation of players. They facilitate co-designing by harnessing the collective and expanding ideas and opportunities that emerge when people play the game. They, when played, host changing perspectives of people.

In SmartHubs, we built several exploratory design games that provide a playful approach to generating design ideas by capturing people's experiences in given settings. For that, we created fun, including gaming material and a specific set of rules to be played with potential users or other relevant stakeholders in the labs we established in the project. Throughout the play, the players articulated their perspectives on specific tasks explicitly. This provided new insights and ideas for designing and planning the urban space and creating and shaping the mobility hubs. We used design games explicitly to develop a shared understanding of complex problems and challenges we could identify at different locations. Usually, design games are realized as haptic games, such as board games or card games. In our project, design games are used and implemented as co-design tools and enriched by elements of augmented reality (AR) within different iterations (Brand, 2006; Pedersen & Buur, 2000; Breton et al., 2003) (for more details, see the next section).

4 SMARTHUBS DESIGN GAME

In SmartHubs, we developed, experimented, and evaluated several design games in our labs. In this section, we present the process and the fun in detail.

4.1 Process of designing the design games

Iterative steps lead to a design, a development, and an evaluation path starting with a blank analog Design Game. The analog game is transformed into an augmented reality (AR) variant with additional activities and information layers for all stakeholders in further iterations. AR is a promising technology to be implemented in design games. It preserves the experience of the natural world while objects of the natural world are enhanced by virtual, computer-generated content. Using this virtual layer, information can be added to the perception of the real world. By doing so, users can likewise interact with real and virtual objects. This is usually realized by special AR glasses such as the Microsoft HoloLens or by AR applications for mobile phones, which use the mobile phone's camera to provide a live image of the natural world and add specific virtual information as an overlay to this image. Effective smartphone implementation is a relevant aspect of this approach for realizing design games within the SmartHubs project: smartphone applications can be tested very quickly with users due to the widespread availability of such devices. The third iteration finally takes the game from one specific playground (e.g., a gaming board) to the real world supported by AR. Here, the public space of an urban area is becoming the playground, and the game supports decision-making and generates inspiration for future urban planning and artifact design directly in the related area.

The evolution of the design game happened in three iterations:

1. Blank analog Design Game (Iteration 1) – Version 1.0: TU Wien Mobility Games ADG
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3. Real-life Design Game (Iteration 3) – Version 3.0: TU Wien Mobility Games RDG

The development of the three iterations is always overlapping and partly parallel. Thus, iterations are always designed and developed based on the findings of previous iterations. The following figure (Figure 3) shows the Design Game development process schedule throughout the SmartHubs project.
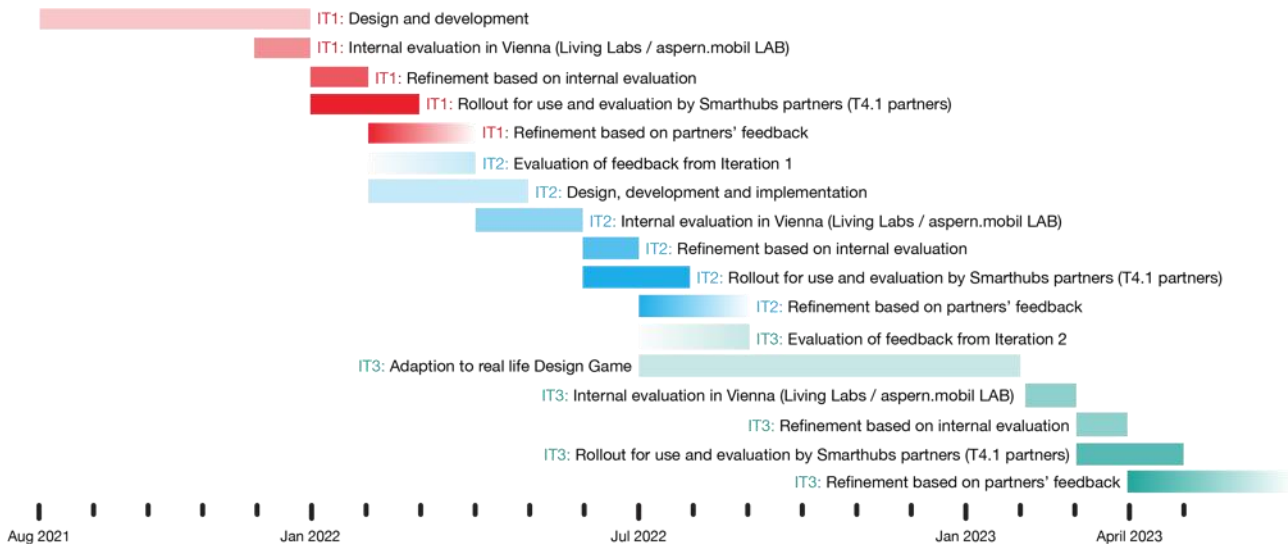

Figure 3: Schedule for the development of three design game iterations.

4.2 Lab profiles in SmartHubs

Before we started to prepare the blank analog Design Game (ADG) that we wanted to offer to SmartHubs Labs to facilitate and support the design process and realization of their tailored design game, we asked the labs to share their main issues and their context with us. So, we would understand their goals and be able to fill the ADG package with such gaming elements, materials, and guidelines that specifically support the process of these labs. Using a template, we asked them to answer the following questions to describe their lab and used the results to create specific lab profiles. The exact answers are documented in Annex: LAB PROFILES.

- **Context of the Lab** – What are the framing conditions of the Lab? Where is it located? What is the social context of the Lab? What are the solid restrictions and circumstances that need to be considered?
- **Stakeholders and partners** – Which organizations are involved in the Lab? Which stakeholders are relevant to the Lab? What is their relationship to the Lab, and how are they involved? Are there challenges in the interaction with the stakeholders and partners in communication and cooperation?
- **Relevant topics, key contributions, results, and goals of the Lab** – Which issues are mainly addressed by the Lab? What are the focus and the overall goal of the Lab in SmartHubs? Which outcomes have already been produced and are planned to be made by the Lab during SmartHubs?
- **Challenges** – What are the challenges the Lab is facing daily in general? What are the reasons for these challenges? Are there approaches and ideas on how to overcome these challenges?
- **Major activities within the Lab** – In which activities and events do the Lab engage – in general, with the stakeholders, with the citizens? Please give some examples. How often does the Lab engage with stakeholders? If there has been no interaction so far, please state this here.
- **Methodology** – Which (research) methods are used, and how are they applied to support the Lab activities? What is your experience with the already applied methods so far? What methodology works well, what is problematic in the Lab, and why?
- **Application of SmartHubs Design Game** – Which topics and goals could be addressed in the Lab using SmartHubs Design Game? Which locations can be used to gather and play the SmartHubs Design Game (Mobility Hubs, Living Lab Facilities)? Please use your research questions here as a starting point, but consider that SmartHubs Design Game can only cover particular questions you formulate.
- **Contact Person** – Who is the contact person (including contact data) of the Lab regarding the application of the SmartHubs Design Game?

The following tables summarize the most relevant issues we could extract from the lab profiles.

	Eastern Austrian Living Lab (EALL)	Brussels / Anderlecht Living Lab	Munich / Living Lab	Rotterdam / The Hague Living Lab
Context of the Lab	Two urban locations in Vienna, one in the village of Pillichsdorf. The social context of the urban hubs is mixed or yet unclear and the governance and customer structure is rather complex. In the rural location the social context is rather conservative, with a small customer group and a high level of car ownership.	The population of this neighborhood is composed of a high amount of disadvantaged and vulnerable individuals. This is due to the low-income levels, which around 25% lower than the regional average, and the condition of this neighborhood as an entry point for migrants and ethnic minorities. Furthermore, many newcomers leave the neighborhood as soon as they have sufficient income, and newcomers might not speak any official language (French or Dutch).	Integrate tactical urbanism, public transport and shared mobility. The current plan is to locate the living lab at one of three possible locations on the main campus of the Technical University of Munich. It may also be possible to rotate the living lab between the locations.	Redesign of a public square with public transport and multiple road intersections. The Square is the link between 2 shopping streets and a large market and therefore has economic importance to neighborhoods around it. A large part of car traffic on the square does not have an origin or destination in surrounding neighborhoods but is through traffic. The Neighborhood is very multicultural.
Stakeholders and partners	MO.point (Mobility development), Property developers, Wiener Linien (public transport provider), ÖBB (railway provider), Wien 3420AG (Urban development), City of Vienna (Municipality), Federal State of Lower Austria (regional administration), Fahrvergnügen (Car-Sharing provider), VOR (regional public transport provider), NÖ Regional (regional development)	VUB-MOBI (LL-Leader mpact (Mobility NGO) City of Anderlecht (Municipality) Brussels Mobility (regional ministry of mobility)	Technical University of Munich (main partner), UPS (logistics company; main partner), MVV (Munich public transport; contributor), City of Munich (municipality; contributor), International students (users)	City of The Hague (municipality), HTM (Public Transport operator and operator of shared free-floating bikes) MRDH (regional administration) Greenwheels (station-based carsharing), Sixt Share (freefloating carsharing), Felyx (freefloating scooter sharing)

	Eastern Austrian Living Lab (EALL)	Brussels / Anderlecht Living Lab	Munich / Living Lab	Rotterdam / The Hague Living Lab
Topics, key contributions, results and goals	Support in building up a network typology and transferable learning for future hubs in another context. Wayfinding in complex hubs. Coordination of hubs in complex stakeholder settings. Digital integration of hubs. Enhance cross-institutional learning processes in the region on mobility hubs. Support of local stakeholders in long term planning and network building. Reflecting SmartHubs Tools with planning practitioners. Enhance data availabilities in Case Study areas.	The key objective is to co-design a mobility hub from scratch and involve the potential users as much as possible. The study of transport disadvantages in the hub is a main concern of this living lab. Thus, a user-centric approach is applied to identify, analyse, and overcome the barriers experienced by users and vulnerable populations. We will also investigate to what extent digital exclusion poses a barrier to using the hubs and how digital elements of the hub (e.g., the information pillar) should be designed in an inclusive way using the universal design principles.	The key goal is to adapt a mobility hub into the existing infrastructure at the technical university, which is useful for the students and residents. The hub should include tactical urbanism concepts as well as a integration of public transport, and shared mobility.	The goal is to learn how the square can be designed as a (smart) mobility hub and how this can be achieved in a co-design manner. We want to learn if co-design games are a useful method to elicit different preferences of users, citizens, and other stakeholders for mobility and non-mobility functions at a hub.

	Eastern Austrian Living Lab (EALL)	Brussels / Anderlecht Living Lab	Munich / Living Lab	Rotterdam / The Hague Living Lab
Challenges	Clear communication structure towards stakeholders. Balance between regular updates (to keep everyone informed and involved) and specific meet-ups with certain needs. Identification of overlapping needs between stakeholders across case studies. In the rural hub it is unclear if interest in mobility hub services is existent at all. Strong time restrictions for operative level within stakeholder institutions. Overlapping in stakeholder communications regarding other projects and project proposals.	Recruitment of participants: VUB does not have any connections in the neighborhood. However, Mpact and the municipality will use their networks to reach vulnerable to exclusion of citizens. Sustained participation of participants: We intend to involve citizens at different stages in the project. However, we know that sustained participation is often a problem in co-creation projects, especially when there is no clear goal of the project outcome. Reaching vulnerable to excluded populations might be even more challenging during a pandemic.	Gaining permission from the university to locate the living lab on campus: The process of placing the living lab on the campus has already been started, but the administration at TUM can be extremely slow. This issue can be overcome by using other partners (the City of Munich, MVV) to find alternative locations that do not involve the TUM main campus.	The square is unattractive, has high traffic and can be and feel unsafe for pedestrians and cyclists. The challenge is to redesign the square in a way that it is attractive and offers an attractive multi-modal transport hub for citizen to gain access to mobility. Because migrant levels are very high (>90%) in the neighborhood it is an additional challenge to design the hub in a way that it is accessible to the inhabitants and fits their needs. Involving these population groups in a co-design process offers further difficulties as e.g. language and knowledge of the transit system or digital skills can be a barrier.
Major activities (until spring 2022)	Interaction with parts of the stakeholders in Aspern Seestadt is already institutionalized in the aspern.mobil LAB. On living lab level only bilateral exchange with selected stakeholders especially in the case study choice process. Two meet-ups internally for SmartHubs full partners.	The lab will be co-created with inhabitants. Different activities, such as co-design sessions, are foreseen in the coming months to collect the needs and interests of residents. Currently, we are focusing on contacting the representatives of vulnerable to exclusion groups for interviews.	The living lab in Munich should primarily engage everyday citizens, especially students. Most engagement will happen at the physical location when people show up to pick up or send parcels. The space around the living lab may also be used to provide information on the surrounding transportation options (bike share, transit)	With the municipality and the public transport provider we have regular contact and discuss and share their and our plans. No interaction so far with citizen. No interaction so far with providers of shared mobility (besides HTM bike) or MaaS app provider.

	Eastern Austrian Living Lab (EALL)	Brussels / Anderlecht Living Lab	Munich / Living Lab	Rotterdam / The Hague Living Lab
Methods	SmartHubs co-design technologies. Digital integration and signage of mobility hubs. Reaching out to users and digitally excluded citizens. Virtual and physical mobility needs and patterns. Accessibility assesment. Integration of mobility hubs and public transport. Integration of freight and mobility hubs. Policy governance impacts. Evaluation of Mobility Hubs within Living Labs. SmartHubs appraisal tools for sustainability and stakeholder assessment. Mobility hubs in the urban space.	Interviews with representatives of vulnerable-to-exclusion populations. Interviews with potential end users. Organise a co-creation process using participatory methods. Trial new participatory co-design tools (from T3.4). Appraise the co-designed options (using T3.5). Experiments with the digital information pillar. People with different digital/physical capabilities will interact with the prototype pillar to collect feedback and redesign selected features.	The evaluation of this lab will likely rely on user feedback and surveys. Additional observation methods may be brought in to examine how users interact with the space around them.	In this specific case of the Haagse Markt hub we would like to use the co-design method, surveys and focus groups/workshops. We do not have experience yet with the co-design method and hope to learn more from you. We have some idea on how to engage with the targeted vulnerable-to-exclusion groups but no interaction yet. Through these links we hope to be able to recruit people to take part in our research activities (all methods).
Application of SmartHubs Design Game	For EALL: understand possible cooperation fields in the Eastern Austrian Living Lab, collect innovation barriers for mobility hub development connected to national/federal policy frameworks For Seestadt Nord: Visibility, acceptance, walkability, marketing strategies combined with mobility management, User-Centered design ideas and framework	Where should the mobility hub be located in the Cureghem/Kuregem district? Which services should be offered by the mobility hub? What non-mobility functions do inhabitants expect from a mobility hub? How do users feel about mobility hubs regarding their design (for instance perceived safety, accessibility, and wayfinding)?	We would like to use a Design Game to prioritize the elements (mobility and non-mobility related) of the mobility hub by including the perspective of multiple stakeholders.	We would like to achieve the goal of engaging with vulnerable-to-exclusion groups and designing the mobility hub in a way that it fits their needs. We hope to be able to use locations of our partners (HTM/municipality) or of the citizen groups we also think of using for getting into contact with the targeted groups.

The resulting profiles enabled a tailored setup and design of analog design game packages containing material tailored to the commonalities of the SmartHubs living labs, such as cards with various user personas or 3D-printed game tokens representing various mobility modes. Taking the profiles into account for defining a set of provided material including extensive design guidelines is supposed to support the labs in designing their game on their own, at least to a certain extent.

4.3   Blank analog Design Game (Iteration 1): TU Wien Mobility Games ADG

In this first step, a "blank" design game is derived from existing games used in the aspern.mobil LAB, a living lab in Vienna (https://www.mobillab.wien). The blank analog Design Game, called "TU Wien Mobility Games ADG", short ADG, is designed to be used by labs and enable project partners to develop their design games that fit to their research agenda and the special context. In the ADG package, a collection of materials can be found, which can be used to inspire the designing process and for playing the resulting game. It includes a configurable set of gaming materials that can be adapted to fit a specific context and enable diverse game mechanics. This includes basic game mechanics such as rolling dice as well as conditions for 'winning' or 'losing'. The materials of the ADG are abstracted to a 'generic' level in order to make the ADG flexible regarding its actual application. The included materials and design guide support other labs in designing their own game.

4.3.1 Package content: Basic elements

The game package comprises a set of basic gaming elements. A gaming package keeps all the needed materials in order. Two blank game boards are provided that fit into the package. Multiple sets of different types of dice were provided to enable moving on a gameboard or for triggering specific actions. Sandglasses can be used to limit the time for decision-making, and playing money gives value to specific things. The basic elements of the package are illustrated in Figure 4.

Figure 4: The Blank Analog Design Game Package (ADG Package) with gaming material as it was disposed to the labs.

4.3.2 Package content: Set of dice

The package contains various sets of dice (Figure 5) including ordinary cubic dotted dice, numbered dice, dice in different colors as well as blank dice. For more special applications pentagonal dice with numbers from zero to nine, dice with interrogatives (in English), dice with directions, and math operation were added to the package. These sets of dice should enable the SmartHubs living labs to incorporate flexible handling of various activities within their games.

Figure 5: A selection of different sets of dice from the ADG.

4.3.3 Package content: Playing pieces and tokens

The ADG package includes different types of playing pieces and tokens, such as standard playing pieces and meeples but also different cylinders for representing players in a neutral way (Figure 6). To address the main objective and themes of the living labs some 3D-printed mobility-related pieces were added to the package, such as trams, busses, passengers, scooters, bikes, etc. but also more special and even climate change-related tokens such as temperature, fireballs, energy, tree tokens, etc. This allows the living labs to represent players, actions, and conditions in various ways.

Figure 6: Playing pieces and tokens from the ADG.

4.3.4 Package content: Set of cards

To support the design of card games, different sets of cards were added to the ADG package (Figure 7). Eight predefined and 32 blank character cards can be used to represent different types of stakeholders, users, or project-related personas. A set of 28 predefined and 12 blank condition cards can be used to include several occurrences, such as weather or travel-related conditions to the games. This can be used to influence gameplay and trigger surprising twists and turns while playing. In addition to these partly predefined card sets two empty sets were added with different but generic symbols at the back to allow individual use of cards as shown in Figure 8.
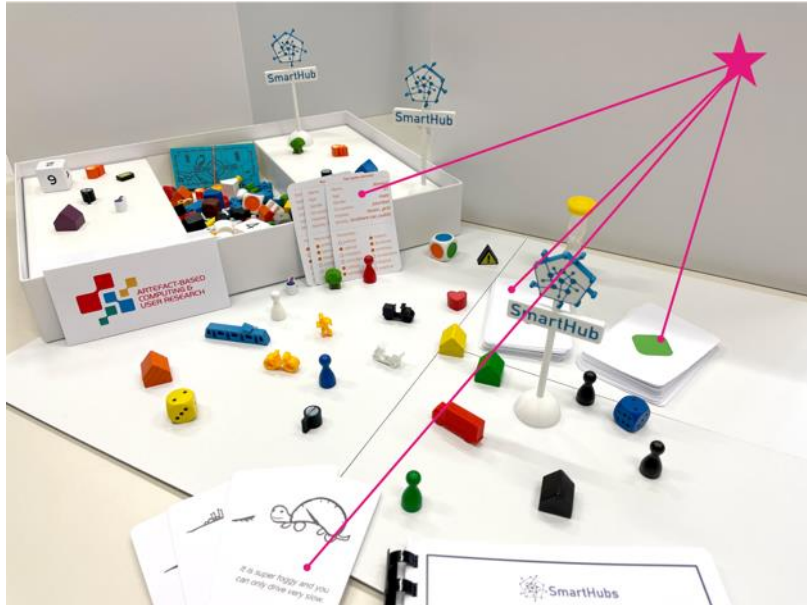

Figure 7: Set of cards from the ADG.

Figure 8: The four card sets included in the ADG package.

4.3.5 Customizing of elements

The provided package is blank and supposed to be adapted to the design of the resulting games of the labs by using labels. The game boards are also blank and supposed to be adapted by the use of game-specific labels. Instructions for individualization and placing DIN A4 adhesive labels on it were provided within the package (Figure 9). For designing and aligning the labels PosteRazor Software[1] was recommended. By using these tools one can easily design an individual gameboard that structures move, defines certain paths or provides different areas where actions can take place. In addition, blank dice were provided in the ADG package, which can also be tailored by the use of small labels. Generally, the labs were invited to adapt all the materials to their specific needs. Cards can be also customized by using adhesive labels and for example printing information in different languages on them. To support the labs in adapting material and generating their own material digital templates of cards as well as 3D models, including information where to find additional models, were provided.
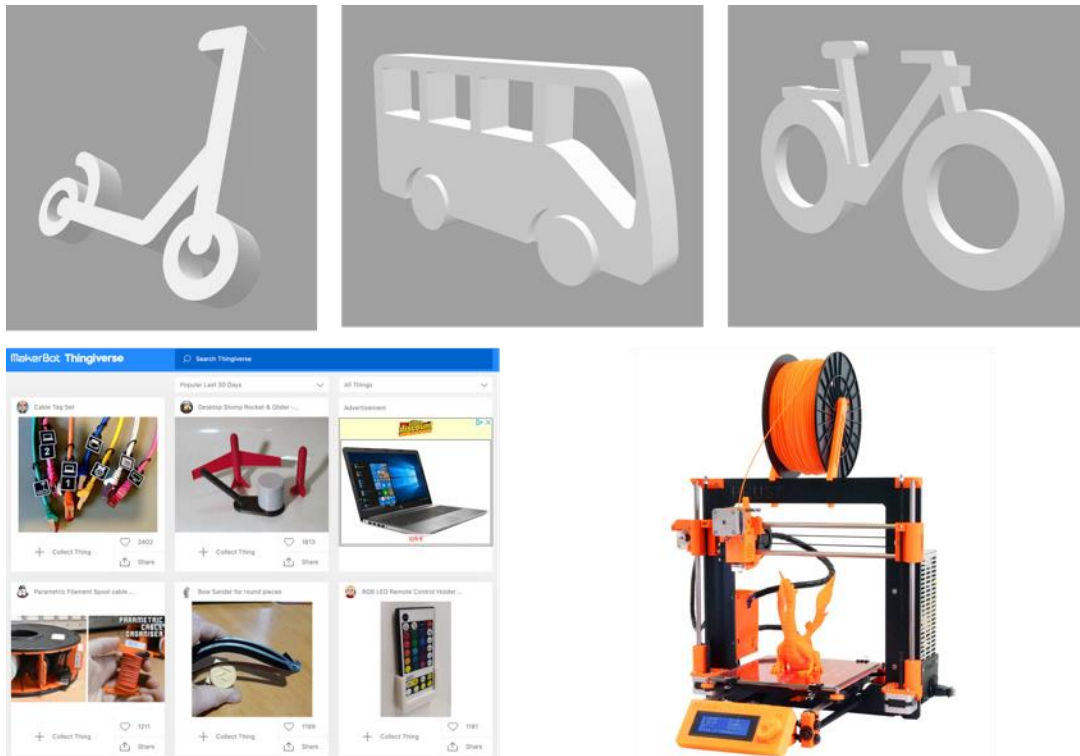

Figure 9: Customizing of elements in addition to the ready-to-use elements of the ADG package.

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[1]Two http://posterazor.sourceforge.net

4.3.6 Package content: Design Game Guide

This guide supports the labs in designing their individual Design Games tailored to the context of their project, lab or case study. Within more than 80 pages it describes the process of the creation of a design game, by introducing several key aspects (Figure 10) by defining the characteristics of the game, by showing what the key aspects are, why they are important in the process and how they should be seen as a step to carry out within the whole designing process. Additional questions provided to each step help to progress while designing the game. Summaries and quick check suggestions help designers to be aware of already carried out steps and the highlights as outcome. The guide also provides space for taking notes during the design process for documenting the ideas.
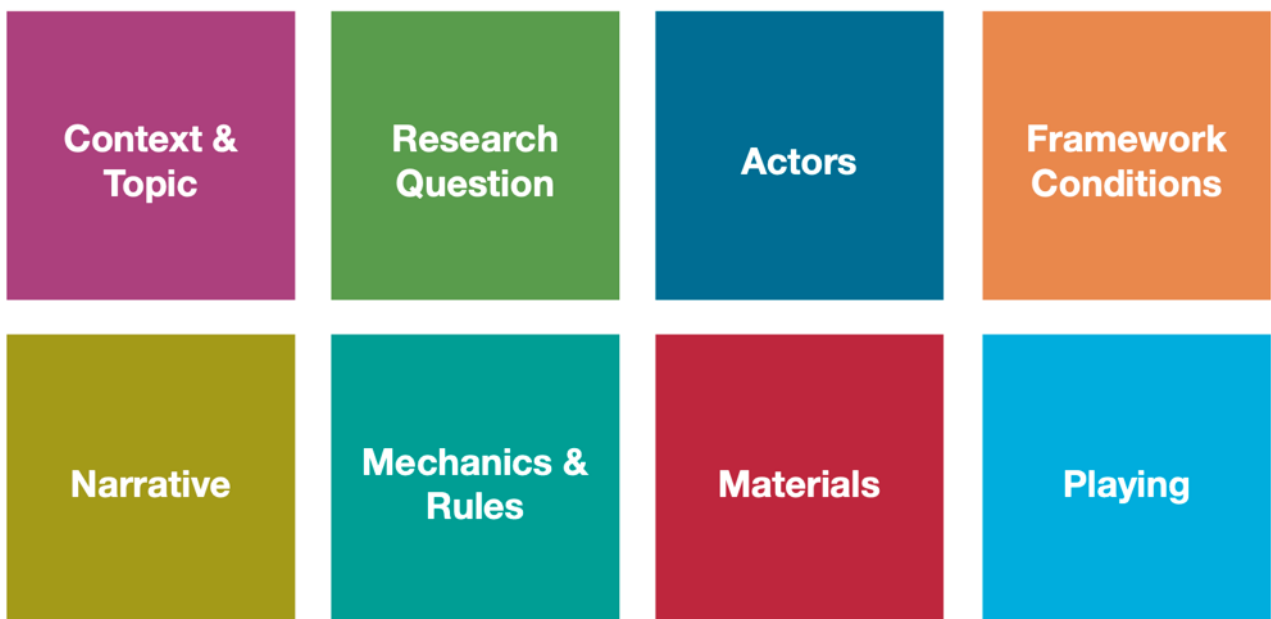

Figure 10: Key aspects defining the characteristics of a design game created by using the ADB package.

For each of the key aspects (Figure 10), further explanations and detailed questions are provided to support and guide the labs while designing the game.

- **Context & Topic**

    This category aims to define the context and topic of a particular Design Game. The context is usually bound to the context of the project, lab or case study the Design Game is used in, and can address a suitable topic for applying the Design Game.

    Topics and contexts for applying a Design Game comprise areas where real actors are involved. That is why an understanding of their perspectives is crucial. Design Games are played by a group of real players. It gathers different stakeholders in a comfortable setting to discuss their perspectives on a specific topic while playing the Design Game.

    The characteristics of the context and topic - a subarea of a project or case study - should support playful approaches. As the Design Game is designed to be actually played and generate insights through playing, the topic should allow a playful approach.

A design game should be applied in contexts containing open issues, where the inspiration for possible solutions can be gained through the playful exchange of different perspectives of participating stakeholders.

Since a Design Game mainly produces qualitative data, it should be used for topics where such data is valuable. Contexts and topics where it is important to elaborate an understanding of the users' behavior and their affordances appear to be more appropriate than contexts that can be accessed by quantitative measures.

The access, exchange, and understanding of the views and perspectives of different stakeholders are core elements of Design Games. Hence the context needs to comprise various stakeholders.

- **Research Question**

  Within this category, the research question of the Design Game is defined. This question is mostly derived from research questions of the project or case study the Design Game is part of. Although the research question of the Design Game is related to overall research questions, it needs to fit the actual context of the Design Game.

  First of all, it needs to be identified for which aspects of the project or case study the application of a Design Game is a promising approach and which existing research questions address the context and topic the Design Game is going to be applied.

  As the Design Game is highly dependent on the input of different perspectives, this aspect needs to be covered by the research question. The most relevant stakeholders should be addressed by the research question of the Design Game.

  In addition to relevant aspects of the project and the stakeholders, a particular topic should be addressed within the research question of the Design Game. This topic narrows down the actual goal of the Design Game and provides information about specific issues to be discussed in the game.

- **Actors**

  This category defines all actors, roles, and people somehow involved in the Design Game.

  The most important actors are the stakeholders addressed by the research question. Stakeholders might not be equivalent to a person who is actually playing the game. Furthermore, stakeholders could comprise companies, organizations, governments, etc. It is crucial to identify the stakeholders addressed by the game and to describe the perspectives they are supposed to contribute.

  Players are real people who are actually playing one or more game rounds. Players are representatives of stakeholders or user groups. Depending on the game's goal, players can contribute various perspectives (government, user, manager, etc.) or be part of one specific group (e.g., different users).

  Additional actors might be needed to successfully play a Design Game, such as facilitators, moderators, or people to document the play. Identify these roles explicitly and describe the responsibilities, duties, and activities of these roles.

- **Framework Conditions**

  This category describes a specific Design Game setting and identifies how the gaming situation is characterized.

  A relevant framework condition is the number of people involved. Depending on the goal, the research question, and the context of the Design Game, it has to be defined if there is a minimum number of players required and a maximum of active players.

  The Design Game needs to have an estimated gaming duration. Thereby researchers can assess the amount of data that is supposed to be collected within one game round. The players are able to schedule their participation when there is an estimated period of time in which they have to be present.

Another relevant aspect is the location where the game is played. Depending on the type of the game, the number of involved people, and the context of the game, an appropriate location needs to be specified that fulfills the requirements of the Design Game in terms of its size, available equipment (e.g., chairs, tables, etc.), gaming environment (indoors or outdoors), etc.

- **Narrative**

The narrative describes the story of the game and the paths that can be taken during playing. It frames the debate, discussion, and possible actions of the players in the game.

At the beginning of the game, there needs to be a starting point that is very clear for all players. The starting point is preset and marks the start of a journey through the game where the players influence the outcome.

To be able to influence the outcome, the players are confronted with specific circumstances or conditions where they have the chance to make a decision and form the journey of the game according to their perspective. These conditions and circumstances are part of the narrative and need to be elaborated.

The journey of the story is formed by the overall narrative, the occurring conditions, and the actions to be set by the players. These elements need to be designed in a way that they are open enough to allow the player to move and be creative, but they also need to provide a certain frame to ensure the goal of the game can be reached.

The scope of possible decisions that can be made by the players is a core element of the narrative. Players need to be able to express their perspectives regarding their roles but also to provide new, innovative, creative decisions and influence the journey through the game.

Since an essential element of Design Games is the exchange of perspectives, players need to interact with each other, discuss, and debate. The narrative should support - or even force - the interaction between players.

- **Mechanics & Rules**

The mechanics and rules of a Design Game represent the formalization of the narrative. The entire story, conditions, and possible actions are set to a formal framework that builds the rules of the game.

First, the process of the game needs to be defined from the starting point to the end. It needs to be specified who starts, how a player moves on, how the turn-taking works, etc.

Next, it needs to be defined how specific situations are triggered. The trigger can be provoked by players, by a reaction to a specific action or arbitrarily (e.g., throwing a dice), etc. The mechanics of the Design Game describe which aspects have to coincide that a certain condition or situation occurs.

Once a particular condition occurs, the mechanics define the possibilities of the players to make decisions and set specific actions. Here, the formalization of the rules needs to be done in a way that supports the player in making clear decisions but also enables the player to be creative. The player has to know the options but not be put in a too-tight corset. Once an action is set by a player, the rules need to give an orientation on how the game continues.

Since a game cannot run infinitely, conditions need to be defined that end the game. This can be done by generating a winner, over the course of time, by reaching a certain number of rounds, by the decision of the moderator, etc.

- **Materials**

This category encompasses the collection of the materials needed for playing the Design Game. Some materials are already provided in the game package, and a subset of these materials can be chosen for your Design Game. But there is also the possibility to adapt or complement these materials or design new ones that fulfill the needs of the Design Game.

To be able to choose appropriate materials, the type of the game needs to be defined. A Design Game can follow the principles of a specific game type (e.g., board game, card game, role play) or include elements of various kinds.

In the context of the type, the materials to represent the players (tokens, cards, etc.) and the materials to move (e.g., throwing a dice) need to be defined. Also, materials for representing actions can be chosen or designed, and supporting materials to represent options and conditions (unique cards, tokens, etc.).

To frame the gaming situation, the Design Game needs to support a common ground for players where the game actually takes place, and the players gather. This can be a set of cards and a table or a gameboard to gather around.

For designing individual materials, software for graphic design such as Adobe Illustrator is recommended to be used. The designs can be printed on labels and pasted on blank material such as cards, dice, or tokens. 3D-printing technology can be used to realize individual playing pieces. With the open-source Tool PosteRazor foldable gameboards can be created.

● **Playing**

This category focuses on playing the game. It describes what needs to be set up, what needs to be considered throughout and after playing the Design Game, and how the game is documented.

Before the players begin to play, the game needs to be prepared. Describe, which elements of the game need to be prepared to get to the starting point of the game and enable the players to play (e.g., handing out playing pieces, shuffling cards). Give a description of the start setting and provide a list of materials the players and facilitators need to start the game.

Since the goal of a Design Game is to get insights into the perspective of various stakeholders, the playing rounds need to be documented. Specify how the game is documented and which additional staff is needed to support proper documentation. Some materials of the game can be used for documentation (e.g., cards on which players take notes) and need to be preserved after playing. Identify this material and make sure to replace it after the game to be able to start the next round.

Identify how the game terminates and describe the situations that may occur to end the game. Design Games can be terminated following the mechanics and rules of the game or by other unexpected circumstances (e.g., players refusing to play or not interacting anymore).

To be able to improve the Design Game players should be asked for feedback. Define a concept for getting feedback and elaborate on which feedback is valuable and when the players are asked for it (e.g., at the end of the game).

4.3.7 Evaluation and design implications

To evaluate the created design games by the labs, we introduced an evaluation process which we accompanied with several meetings with the lab coordinators. The process was described as follows:

1. The process of designing the game
   o Each living lab designs its own design game.
   o Each living lab plans and conducts design sessions in the lab and documents them for further analysis. If possible, these sessions should be done in English or German.
   o The documentation can contain video recordings, photos, notes, filled-in Design Game Guide, etc.
   o The created documents are shared with the ACUR team for further analysis and usage in the following iterations of the design game.
2. Evaluation meeting
   o Once the game is finished and perhaps already played an evaluation meeting is held with each lab.
   o In this meeting, the game is played and the ACUR team acts as an observer.
   o After playing the created design game, the ACUR team runs an interview or a focus group session to get further insights into the design process.

The timeline in the project planned was (ACUR as the provider of the ADG, and LL as living labs in SmartHubs):

Preparing Design Game Packages	Design Game Workshop	Game Design and Development	Evaluation Meeting	Playing
ACUR	ACUR & LL	LL	ACUR & LL	LL

4.3.8 Results of the development of design games in SmartHubs Labs

All four labs in SmartHubs created their own design game which are summarized in the following sections. The labs documented their design process differently, which was expected from the beginning. That is why, the descriptions in the next subsections are not structured in the same way. They reflect the real documentation format of the labs. This shows the diversity of approaches when it comes to designing one's own design game in a team, even though the starting base was the same and the same guide and material were provided to all groups.

4.3.8.1 Vienna / Eastern Austrian Living Lab (EALL)

After the first questions had been clarified in a dedicated kick-off meeting together with ACUR and the other Living Lab coordinators, especially the workflow and expected number as well as the maturity of design games, EALL started to design the EALL game. After two hackathons among the actors in EALL and one evaluation meeting in EALL, there was an evaluation meeting with ACUR, which was followed by another hackathon by EALL. The final evaluation meeting with ACUR was arranged immediately after the last hackathon. All these activities have been carried out between March and July 2022.

Figure 11: Impressions from the first hackathon of EALL (25.03.2022).

In the first approach (25.03.2022), the group started with open brainstorming, not following the guidebook and its questions, jumping around between concrete game mechanics and topics to be addressed by the game. Also, some ideas were collected on how to link the game to the integration ladder (Figure 12).
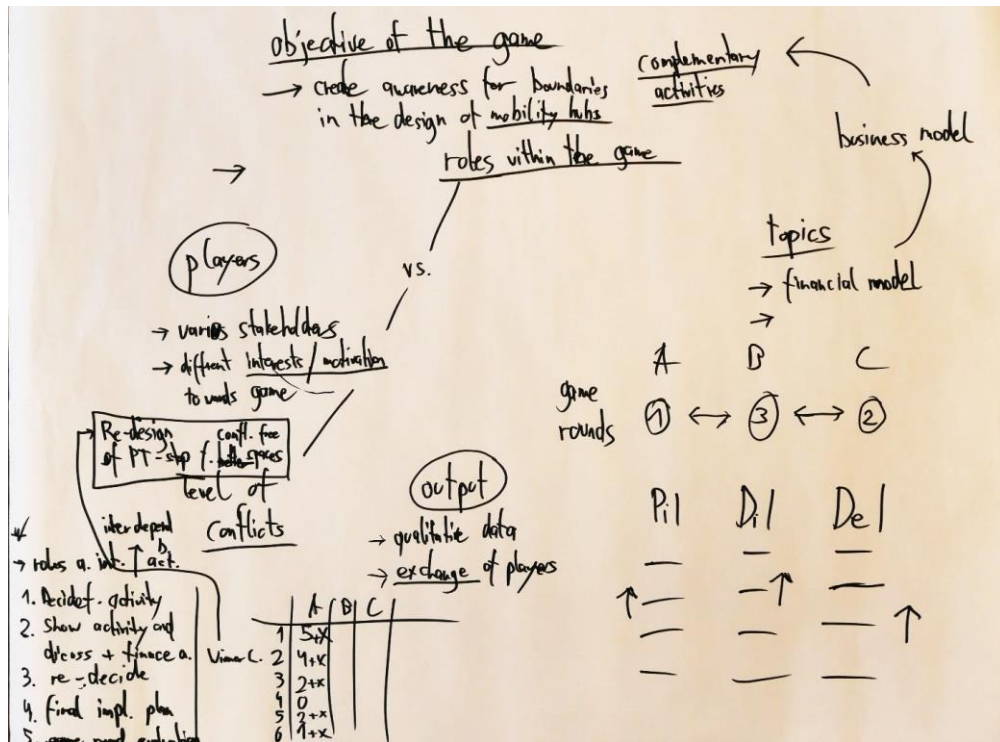
Figure 12: First open brainstorming by EALL (25.03.2022).

In parallel the group collected some ideas on games that can offer inspiration for game mechanics, basic modes, etc. (Figure 13).
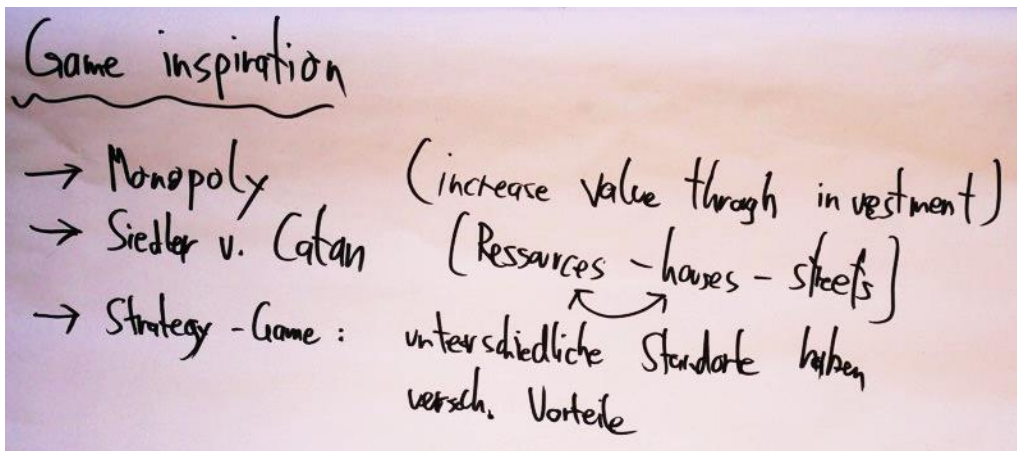

Figure 13: Game inspiration achieved by EALL during the first hackathon (25.03.2022).

In further discussion, the group took some inspiration from the design game booklet, focusing on the question which topics at all are suitable for playful approaches and qualitative data collection (Figure 14). One was, which was discussed seemed to be not covered yet (neither in research nor in practice): understanding mobility hubs much more as "places to meet" and necessary placemaking for this objective – also in the sense to make mobility hubs "fun" to increase usage in the long run.
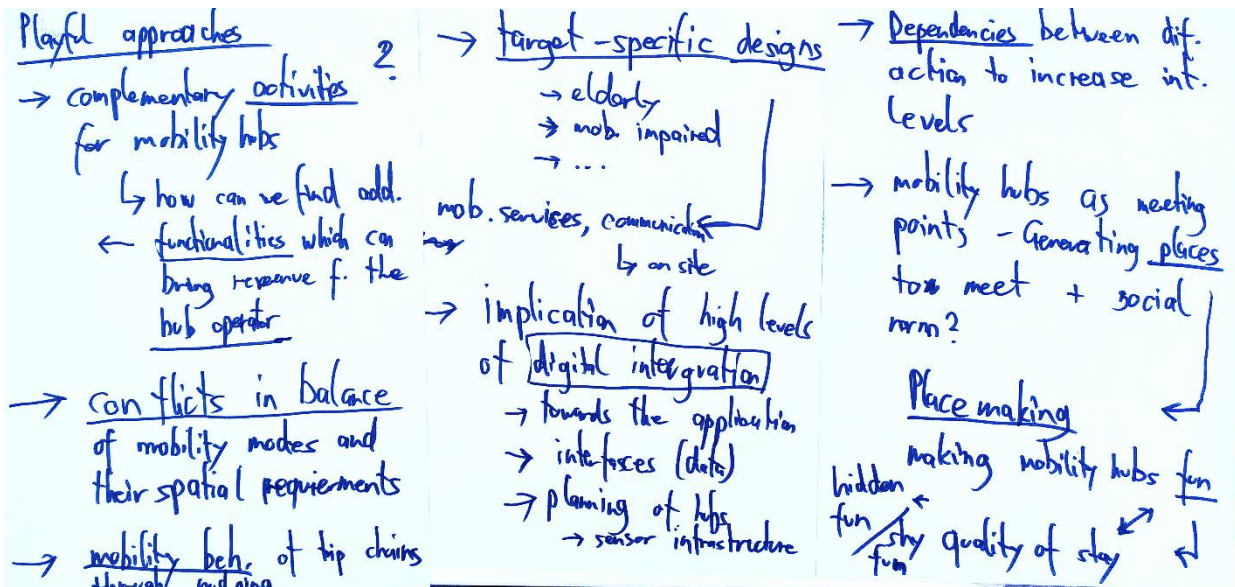
Figure 14: Topics for playful approaches by EALL (25.03.2022).

In the second hackathon (13.04.2022), the group focused on the objectives of the game and came up with a first list, covering "communicative" goals and "output" oriented objectives (Figure 15).
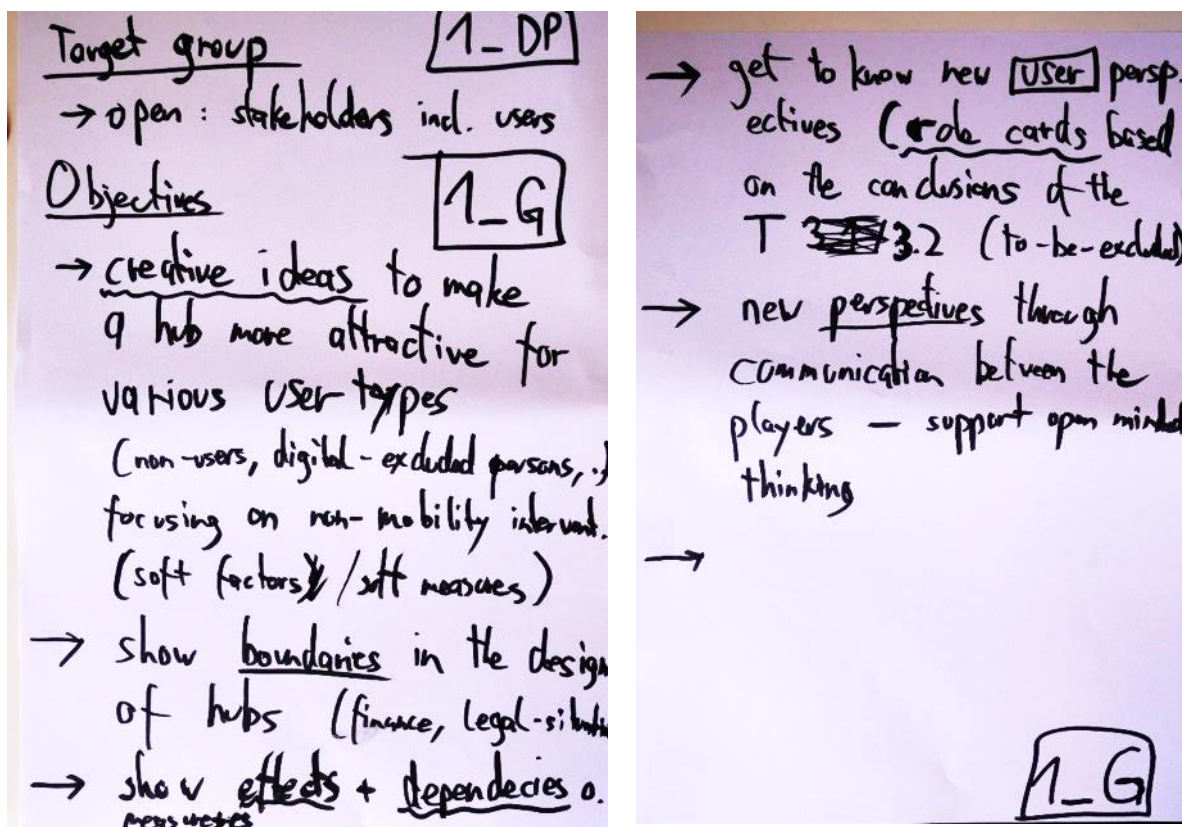

Figure 15: Objectives and target group for first game draft by EALL (13.04.2022).

In parallel, some first ideas came up for the first game draft (Figure 16), which were step by step added also using the later questions in the booklet (game mechanics, roles of players, types of rounds, …).
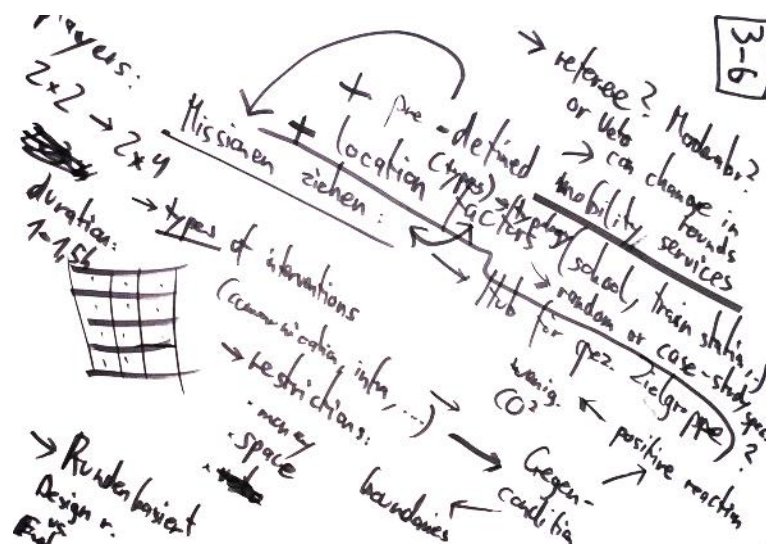
Figure 16: First basic game ideas by EALL (13.04.2022).

In a feedback meeting at EALL (25.04.2022), game objectives (what the game setting is, what users need), user profiles, and connected needs including purposes of the trips (non-negotiable aspects), as well as start setups (four setups for Alps, Tulln as countryside, inner city of Vienna, Aspern Nord) and missions (by setting clear constraints), were evaluated.

In an evaluation meeting with ACUR (12.05.2022), the so-far developed ideas were presented and discussed. The focus was on game "reductions", game mechanics, and game core topics. Finally, the EALL set up another hackathon (10.06.2022) to create the physical prototypes of the game (Figure 17) which was discussed with the ACUR team for evaluation later on (10.06.2022).

Figure 17: First paper prototype in progress by EALL (10.06.2022).

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During the course of this process, the EALL created several versions of their design games:

EALL Design Game V1

Live-Draft of the first version of the EALL Design Game can be found in Miro (Figure 18). The main objectives are to come up with creative ideas to make mobility hubs more attractive through non-mobility services (e.g., events, communication, services, …). This game can be played by 2-3 person teams, by 2-4 teams, and additionally one moderator or referee (not playing). There are three phases in the EALL Design Game: the setup phase, the game phase, and the final evaluation phase. The game is played in two rounds, one design round and one evaluation round, which could take min. 1-1,5 hours to play. Some elements of the design game are:

- Players draw missions to accomplish.
- Location factors are predefined, case-study specific, or random (need to suit missions).
- Action cards that change "circumstances" can have a positive or negative influence on the mission.
- Restrictions: Space (game field 4 x 4) and money (every player gets a starting budget to deal with).
- Mobility services are predefined and cannot be changed by players (only through action cards).
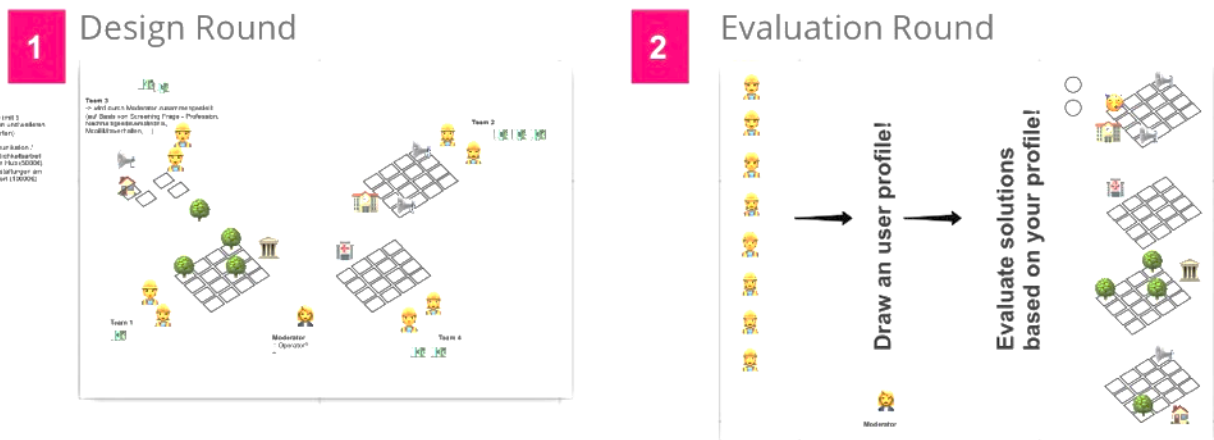

Figure 18: The first version of the EALL Design Game in Miro.

EALL Design Game V2

Live-Draft of the second version of the EALL Design Game can be found in Miro (Figure 19). The second version was developed during the evaluation meeting with ACUR (12.05.2022), making some central reductions in the game mechanics.
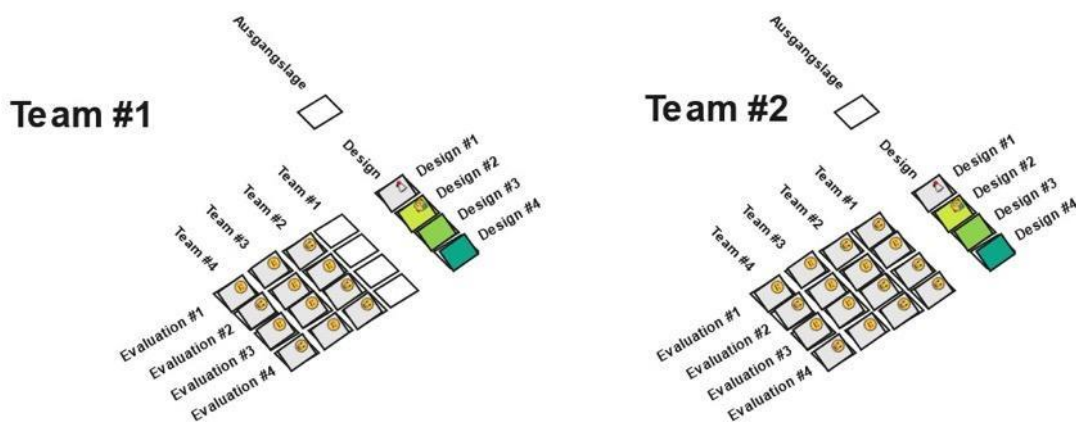

Figure 19: The second version of the EALL Design Game in Miro.

EALL Design Game V3

The third version of the design game was played by two teams which is illustrated in Figure 20 (overview of the whole design game) and in Figure 21 (results of Team 1 and Team 2).

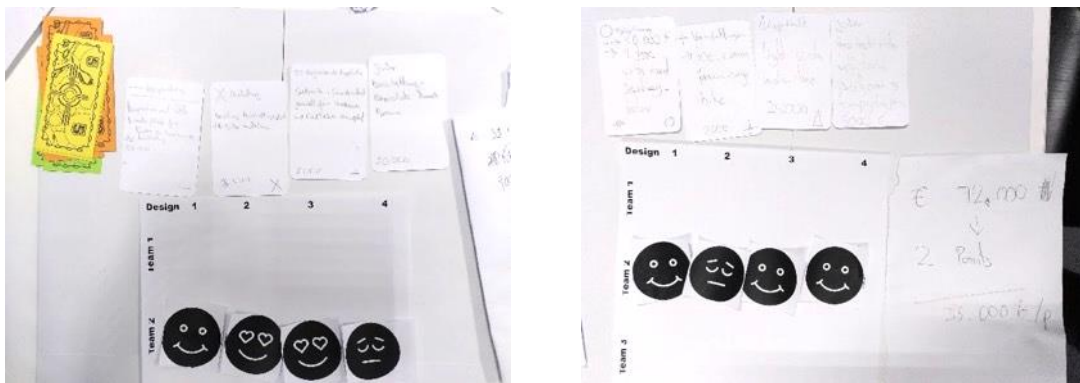*Figure 20: The third version of the EALL Design Game, played by two teams.*

Figure 21: Results of the Team 1 (left), results of the Team 2 (right).

4.3.8.2 Brussels / Anderlecht Living Lab

The Anderlecht Living Lab had two iterations to design their design game. They used the Design Game Guide to organize their design process in the team. At the beginning of the process, they identified several topics for discussion: Usefulness of a mobility hub for the local population, functions, and elements of a mobility hub, inclusivity of public space and transport infrastructure, and needs and barriers of neighbors to the use of transport and mobility hubs. At the same time, they considered several ways they could use the design game to address these topics. In the fall of 2022, they plan to co-design the first iteration of a prototype to decide what is a priority, and what should be included at first, as well as to understand other stakeholders' needs by enhancing empathy and to identify sensitive or hidden elements. Their final goal to achieve with their design game is: "Form and elements of a mobility hub to enhance accessibility and obtain an inclusive design that considers the needs and barriers of local populations, and especially those of vulnerable citizens." (21.08.2022)

The main research question of Anderlecht Living Lab is „How the design of a context-sensitive and inclusive mobility hub should be?" To approximate this question, several subjects need to be discussed and debated, like barriers and needs of citizens concerning mobility (hubs), elements required to overcome the barriers identified, and fulfill the needs of all citizens equally. What is more relevant and should be addressed in the first place? Following a user-centric approach, players will be citizens (users and non-users).

Conditions they set for the design game are the number of active participants of 2-6 players, the duration of gameplay of 20-60min and the gaming location as a board game on a table. For that, they need a board with a plan of the public space where the hub is being designed, and several elements to play with like objects, tokens, and cards. Each element is situated on the board at specific locations, filling existing gaps.

The narrative in their design game is about inclusivity (Figure 22). This narrative will be dealt with in two stages: 1) by making the preferred mobility hub from an independent point of view, where each player can decide what to include and explain why he or she makes such choices; 2) by randomly picking a "persona board" per player and making the most inclusive mobility hub for these personas. In the second stage, the previous design must be adapted in such a way that the result will produce a general group score. The new design will also give an individual score to each player depending on the remaining elements they choose.
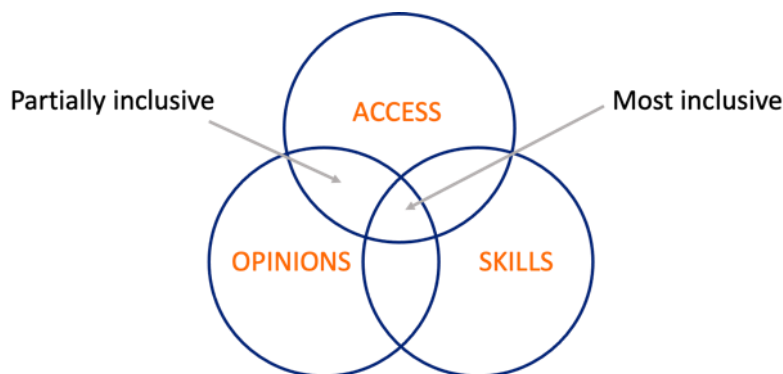

Figure 22: The narrative of the design game created by Anderlecht Living Lab.

The mechanics of the design game are defined as follows:

- **The start:** Each player receives 3-10 objects (related to access), 3-10 tokens (related to skills), and 3-10 cards (related to opinions), depending on the number of players. Players can not choose what they receive, and they do not show it to other players.
- **Stage 1 – Individual phase:** Each player can pick a new element (losing one) and can place a token, an object, or a card each round (between 4 and 10 rounds, depending on the number of players). Players explain why they make each choice. Players can trade and exchange elements before placing them (after picking). The goal is for each player to design their preferred hub, fulfilling the needs they consider relevant.

- **Inter-phase counting:** After 4-10 rounds, the game stops. The researcher takes a picture of the result to document the game, together with notes about the choices of players. Players count the total score of the elements they have placed. Each object, token, and card has a score that is visible and known by each player in possession of such element.
- **Stage 2 - Cooperative phase:** Each player picks a persona board. The existing hub must be adapted to the needs of these personas. Thus, specific elements must be present at the hub, providing similar scores to each persona. During 4-10 rounds more, players must choose together what elements to exchange from the existing ones, without picking new ones.
- **End of the game:** The resulting design is captured in a picture. The score of elements that are referred to in each persona's board is counted. The closest to the maximum possible score, the better. Each player will count the score of the elements that remain on the board and a winner will be designated.

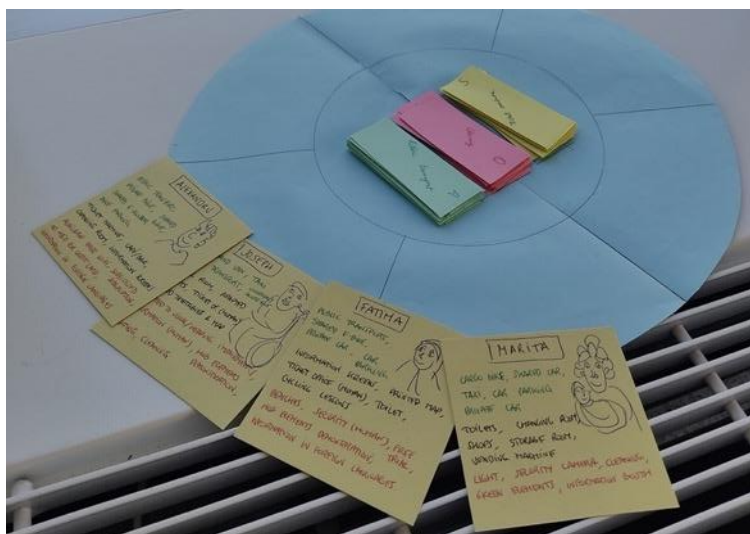*Figure 23: Playing the design game within the team of Anderlecht Living Lab (01.06.2022).*

Figure 24: The game after the first iteration, played and filled in with data during the game.
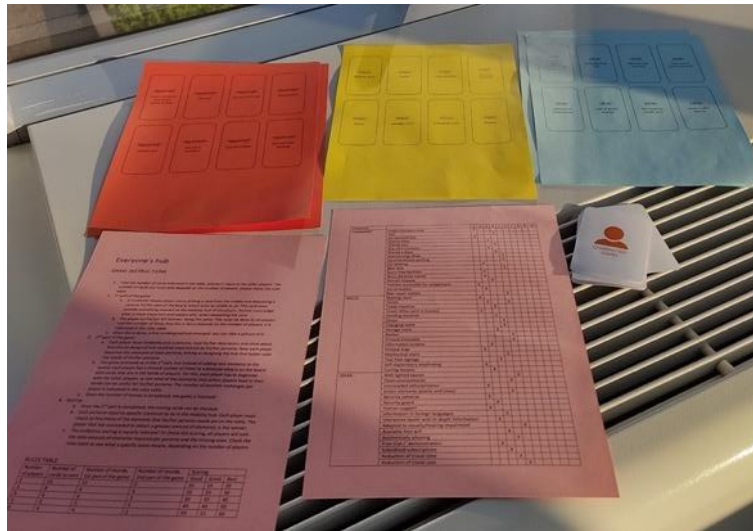
Figure 25: The game after the second iteration, played and filled in with data during the game.

The Anderlecht Living Lab found several issues after the first iteration. In the following these issues are listed:

- Change the names of cards from "access" to "transport", and "opinions" to "ideas".

- Change persona cards by describing the persona's needs and lifestyle. For this, the existing cards should be used.

- Make boards that explain how many elements are picked at the beginning depending on the number of players, and how many rounds can be played. For instance, 2 players pick 10 cards and have 10 rounds; 3 players pick 8 cards and have 8 rounds; 4 players pick 6 cards and have 6 rounds; 5 players pick 5 cards and have 5 rounds; 6 players pick 4 cards and have 4 rounds. Moreover, the second part of the game includes half of the number of rounds played during the first part.

- Scoring mechanics should be explained in a scoreboard. Individually it will depend on how many elements of the persona obtained per player (which advocates for the interests of this persona) are on the board and are counted once the persona card is turned around. Collectively it will be about how elements in total, from the ones needed for the ensemble of picked personas are on the board. For instance, the result would be 45 out of 60, so 7.5 scores (over 10). This should be possible if each persona has 5 elements of each (15) and a third of the elements are also in other cards. Calculate what the right number of elements per persona is, that are repeated and in how many rounds a game could achieve them all. Otherwise, it can be problematic when playing the second stage.

- Make double of element cards (printed in color paper) for secured bicycle parking, parcel lockers, bike pump/mechanic, shelter.

- Keep only adapted toilets, avoid cards that are conflictual such as toilet and adapted toilets (people needing a toilet can also use the adapted one).

- Make at least 12 personas (in existing cards).

Findings after the second iteration contain the following insights and decisions:

- Recalculate scoring: low (30% of total possible, good 60% and best 90%).
- Add icons to cards instead of transport, skills and ideas. Add icon for each specific element if possible.
- Reduce number of elements that are conceptually similar and double some. More simplified options would make the game more inclusive and understandable by different type of players, without reducing the relevance of the data collected. This is important.
- Add longer description to each persona, with a standard measurement of digital skills, physical ableness, income, language literacy, impairments.

- All players should know what possibilities are in the game: a table or list of the elements available should be shown and explained at the beginning so everyone knows what to expect.
- Add 1 or 2 blank cards that each player must fill in with elements that are not in the game and they consider important.
- Think about bonus points that allow players to benefit from an advantage that other players don't have. This issue is to discuss.
- Adding exciting cards that make the game more fun in the second round: steal a card from another player, get two cards in exchange of one.

4.3.8.3 Rotterdam / The Hague Living Lab

The SmartHubs Rotterdam-the Hague Living Lab project team designed a game to elicit the preferences of users, citizens, and other stakeholders for different mobility and mobility-related elements (e.g., shared bikes, cars, scooters; digital information kiosk) and other functions (e.g., design elements, trees, places to sit) in the re-development of the square Hobbemaplein.

The Hague Living Lab designed the game using the key aspects defined in the Design Game Package.

Context & Topic

The game should discuss the hub elements that are preferred, focusing on multiple stakeholder groups with various backgrounds. The selection of elements (debate) and the placing of elements on the board (playful approach) will be the main focus of the game for the real actors, to get a deeper understanding of the needs and wishes of diverse actors. The context for the game is the redevelopment area of Hobbemaplein, which is a recognizable location for the players.

Research questions

The Hobbemaplein living lab focuses on the co-creation and participation of various stakeholder groups. Therefore, the focus of the co-design game in this living lab is the design and selection of elements for this particular hub. The central problem of the game is therefore designing an inclusive hub, with value for different stakeholders' groups. The research questions are formulated as follows: "Which elements are of importance for different user groups? What are the preferences for mobility and non-mobility elements? What are the needs and preferences of different user groups?".

Actors

Since the game is located at Hobbemaplein, the actors at the location who are affected need to be represented in the game. All local stakeholders can play the game themselves but fictional character cards (i.e., personas) are developed to represent multiple groups located near Hobbemaplein. The persona description has the following information for the player:

- Persona description: resident, visitor, local shopkeeper.
- Age: young, middle-aged, elderly.
- Travel preferences: e.g.: car, scooter, PT, bike, or walking
- Personal goal: e.g.: 'I want a place to rent a shared bike' or 'I want more green space'.

In an earlier version of the game development, each individual persona would have a budget for elements they want to have and place on the board. However, this was dropped due to the difficulty for the gameplay. Additionally, the game has a moderator responsible for explaining the rules and documentation.

Framework conditions

Players of the game need to discuss and bargain on the elements they want to place. Therefore, the number of active players should not be too high (around 4-6 players). The game, depending on the number of rounds, takes a minimum of 15 minutes but could take 30-45 minutes.

There have been several iterations in the design process for playing multiple rounds during the game: (i) potentially changing the personal role, (ii) adding pre-conditions, or (iii) not knowing each other's goal in the first round. After testing, it showed that multiple rounds of gameplay are needed to fill the board (i.e., have enough elements on the playboard) to get a discussion on the location and type of elements that still need to be placed.

Narrative

The starting point of the game is the basic design for Hobbemaplein, which has some pre-conditions like the location of the streets and public transit stops. The players need to design the rest of the Hobbemaplein mobility hub, trying to fulfill their personal goals but also creating the best overall hub.

During the game, players are confronted with action cards. It was decided to add those cards to the game to add narrative and excitement to the game. The action cards contain assignments like: 'You can add an

element together with the person next to you' or 'The PT provider needs space for a bus stop, three spaces disappear'.

There have been multiple options for the decision-making process of the players, namely: (i) adding a personal budget, (ii) a budget for the whole group, (iii) voting to place an element, or (iv) points per element. This final option was chosen, since it is not related to actual costs but to the benefit it could bring to all stakeholders. In a later iteration of the game, location-based goals were added to the personal goals of players, to increase the discussion and bargaining of placing elements.

Mechanics & Rules

The mechanics of the game rely on the trade-off between the personal goal and the overall goal of designing the "best" mobility hub at Hobbemaplein, making the hub a smart hub, with at least two sharing services, one other service, and wayfinding. This leads to negotiation between the players. Turn-taking is regulated by the moderator. At the start, the player who scores the highest number of points on the dice can start, and the game continues clockwise.

The players need to argue why they take some actions (i.e., show their decision-making process), which is interesting for the other players but also the researchers as well. The game ends after a certain number of rounds, with two potential winners: (a) the persons who fulfilled their personal goal and (b) the group that scored highest on the leaderboard for the overall hub.

Materials

No player figures are needed but hub elements are. Furthermore, role cards, goal cards, and action cards are needed. Also, empty personal and goal cards are needed, so local stakeholders can play as themselves and pick their own goals. The hub element cards need to have a score, based on their value for the smart mobility hub (e.g., car parking scores lower than shared bike parking). The earlier version of the game included the cost and budget calculation per element, but this was removed. The game board itself has the background of the Hobbemaplein, with the latest version of the re-design (see Figure 26). A later iteration of the game (see Figure 30) removed the need for most physical elements using AR, however, this decreased the ease of playing and the degree of negotiation between players.

Figure 26: The result of a game played on 20.04.2022. The board shows a lot of information about the player's background, interests, and ideas, combined with the audio recording which is then analyzed by the lab.

In the final game, there are several hub elements in use:

- Mobility elements: Shared bike, shared scooter, shared car, 2-wheeler parking, car parking, taxi stand, loading zone
- Non-mobility services: Parcel station/package locker, café/restaurant terrace
- Information elements: Digital information display for mobility options, wayfinding signs (arrows) to hub services and destinations in vicinity, information 'kiosk'/locket
- Landscape elements: Tree, bench, water fountain or piece of art, playground attributes or fitness device

Playing

The preparation of the game is short: elements are put around the board and players pick their role and goal cards. Important is the role of the facilitator, who needs to write down the picked elements and their argumentation. Pictures after every round might help to show the differences between the rounds.

Figure 27: The settings in which the game was played several times by different stakeholders.

Final Game Description

After multiple iterations and tests, the final co-design game for Hobbemaplein was ready for playing. The final description and stages of the game will be explained in this section.

- The game board is on the table and the elements, personal goals, and character cards are next to it. The action cards are placed face-down in a pile.
- Introduction: The Research Objective of the game is described and preconditions are explained.
    - o We are researchers from the UT and are researching Mobility Hubs in the European SmartHubs Project. We support the Municipality of The Hague with our research into the layout of Hobbemaplein. We will share our research results with the municipality.
    - o The research aim of the game is to discover what different groups of people would like to have on the square. We want to learn which elements of a hub match the wishes of residents, entrepreneurs, and visitors to the square.
    - o The game lasts about 15-30 minutes. One of us is going to document what is happening on the game board and take pictures in between. If you do not want to be in the photo, please let us know.
- Rules and Goal
    - o It is a cooperative game. – You have to try as a group to score as many points as possible.
    - o Next to it everyone has a personal goal and must try to reach the personal goal at the end of the game.
    - o Players choose a character and a personal goal.

- o Then players take turns one after the other. They always perform 2 steps:
  - ▪ They may choose an element and place it on the board. They explain why they chose the element.
  - ▪ They draw an action card and perform the action. This concerns different types of actions, e.g., an extra element may be placed or an element may be removed that another player has placed. Some actions require negotiation.
  - o The game ends when the board is full. Then the points are counted. And the personal goals are checked.
- ● Phase 1: Character and Personal Goals
  - o Players are asked to choose a character card that best describes themselves or someone they know well (whose needs, preferences, and skills are known). Alternatively, they can also design a character card themselves.
  - o Players are asked to choose a personal goal for Hobbemaplein (without showing it to the others). They can also write their own goal.
- ● Phase 2: Play
  - o Each player rolls the dice, and the player with the highest number starts.
  - o The player performs the 2 actions: firstly, place an element, then take an action card. The game master helps, if necessary, with facilitating a negotiation or a vote.
- ● Phase 3: Counting points
  - o The points are counted.
  - o Each player can tell his personal goal and it will be checked whether he has achieved it.
- ● Phase 4: Feedback Round
  - o The players are asked how they liked the game.
    - ▪ Are they happy with the design?
    - ▪ What would they change?

Figure 28: The augmented reality extension of the game designed in The Hague Living Lab

4.3.8.4 Munich / Living Lab

The main goal of this study in Munich is to design and apply a game board to contribute to the collaborative and participative design of mobility hubs by identifying which hubs' elements (mobility and non-mobility related) are important for the players and at the same time that they empathize with potential vulnerable to exclusion (v2e) users.

The "SmartHubs game" focuses on players having to select the elements that they consider important and that a hub should have. The maximum number of elements in a hub is six, which represents the lack of space and resources a hub can have. In addition, they can highlight their priorities by selecting certain elements.

The game requires 2, 3, or 6 players, a board with a potential location of a mobility hub, cards of v2e personas, and cards of potential elements of the hub. Figure 33 shows the 48-element cards. These elements were selected based on essential elements of smart mobility hubs, including mobility opportunities (Aono, 2019; Geurs & Münzel, 2022; Schemel et al., 2020), placemaking elements (Aono, 2019; CoMoUK, 2019; Metrolinx, 2011; Urban Design Studio, 2016), inclusive design guidelines (The 7 Principles | Centre for Excellence in Universal Design, n.d.)), and wayfinding (Aono, 2019; CoMoUK, 2019; Johansson et al., 2021; Miramontes, 2018; Monzón et al., 2016). The players are given blank cards where they could add any element that was not present on the element cards provided if they wished. In this regard, arise the question of the budget and limitations. In this way, they were given the freedom to propose alternative design elements for the mobility hub. Cards of v2e personas include visually impaired users, people with physical and cognitive limitations, and people with mental conditions. The cards were taken from an open online tool that provides character cards for more inclusive designs (Idean, n.d.) (Figure 31, Figure 32). These characters match also v2e previously identified in the literature (Bogren et al., n.d.; Nybacka & Osvalder, 2019; Ongel et al., 2018). The game has two phases. First, players choose the elements for the hub based on their own preferences (Phase I). In the second phase (Phase II), players will represent different personas, and the elements should be selected according to the preferences of the v2e people.

The game has the following steps:

Phase I:

1. Players should circle the game board, the v2e people cards should be face down and the element cards (Figure 31) should be face up.
2. Each player should choose an element card. When the game is for 2 and 3 players, each player should choose 3 or 2 cards respectively.
3. Once the 6 elements are chosen. The whole players can discuss/negotiate to remove and add one or more elements.

Phase II:

4. Randomly, each player chooses a v2e card (Figure 29, Figure 30).
5. They can remove one or more elements based on the needs of the v2e card, that they are representing.

In addition, a third phase (Phase III) can be added to the game, when it has been played several times by different players. To add competition to the game, a jury can vote and select the "best design" or the "best selection of elements" of the hubs.

Alternatively, when the game has been played several times, a hierarchical process can help reduce the number of "designs" and the jury selection process is simpler. In the hierarchical process, two teams, which already have a design (i.e., the players who completed Phase I and Phase II), can negotiate and choose a third design based on each team's six elements.

Katherine Holman, 65 Is easily distracted	Consider It can be difficult to hold some people's attention. It can be challenging for some people to remember key information. Some people need more orientation in a process so they know which step they are on.	Lucia Petrilli, 55 Is always upbeat	Consider Some people might not want to say what is wrong. Some people will always give good feedback.	Kristyn Lipham, 40 Likes to plan everything in advance	Consider Some people like to plan everything and need to feel prepared. If you make changes to some people's products or services without consulting them, you're likely to lose their trust.	Svetlana Newkirk, 85 Is often a bit rude	Consider Some people become very defensive when they're uncomfortable. Different cultures consider different things to be 'rude'. People may appear abrupt if they're communicating on different channels, or if they're under pressure.
Lupe Bridgett, 16 Is overly trusting	Consider Some people believe something they've read or heard without question. Some people may not have access to or know where to look for trustworthy sources.	Svetlana Newkirk, 85 Is ofted a bit rude	Consider Some people don't engage with processes they perceive to be complicated and need an answer as quickly as possible. Some people quickly become frustrated with too much information or too many steps in a process.	Verla McPeters, 95 Is disorganized	Consider Some people forget key information and can easily get confused. Some people may not necessarily have key information to hand.	Mike Blandford, 75 Is very independent	Consider Some people don't want any help or don't like the idea of receiving help.
		Afton Slovak, 60 Is very impatient	Consider Some people want things done immediately and get frustrated if that's not possible. Some people may experience time differently, for example, because of illness.	Jenny Wang, 16 Is shy	Consider Some people are not always comfortable meeting face-to-face or talking over the phone. Some people find it difficult to give feedback or ask for what they need.		

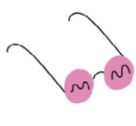*Figure 29: Cards of the personas to be included in Phase II.*

And is partially sighted	Beachten Sie	And is deaf	Consider
	People who are partially sighted might be using an accessibility aid like a screen reader. Any visual content needs to be described in written form for the screen reader.		People with hearing loss may not be able to hear verbal announcements or listen to any content. They might not be able to communicate over the phone.

And has dyslexia	Consider	And has dementia	Consider
	Some fonts are easier to read than others and large amounts of text can be hard to read and comprehend. Some people use accessibility settings to change how their device displays content to make reading easier.		Having dementia often means that people will experience memory loss and difficulties with thinking, problem-solving and language. Some people may have someone helping them.

And has arthtitis	Consider	And has learning disability	Consider
	Having arthritis can make physical movement painful and difficult. Complex or cramped digital user interfaces can be hard for people to use. Arthritis can affect young people as well as older people.		A learning disability affects the way a person understands information and how they communicate. Some people may have difficulty understanding new or complex information, learning new skills, or coping independently.

And is wheelchair user	Consider	And is not very confident when using a computer	Consider
	Some people visit physical service touchpoints using a wheelchair and/or need someone physically helping them to complete tasks.		Some people may have someone helping them use a computer. They may be much more comfortable accessing a service via a phone or a physical location.

And is a non-binary person	Consider	And German is not their native language	Consider
MALE ☐ FEMALE ☐ NON-BINARY ☑	Non-binary people may use different pronouns from 'he' and 'she' such as 'ze' or 'they'. Using inclusive language such as 'hello everyone' rather than 'hello ladies and gentlemen' makes more people feel welcome.		Some people may need more time to understand things. Lengthy, complicated text can be really challenging. Colloquialisms aren't always universally understood.

Figure 30: Cards of the characters' vulnerabilities to be considered in Phase II.

Ride-hailing 1	Ride-sharing station 2	Bus stop 3	Bike parking 4
E-scooter parking 5	Bike-sharing station 6	Car-sharing 7	Cargo bike-sharing station 8
Car charging station 9	E-bike charging station 10	Parking meter 11	Moped-sharing station 12
E-scooter-sharing station 13	Pack delivery station 14	WiFi 15	Seating 16
Covered waiting areas 17	Bicycle repair station 18	Information maps 19	Digital information 20
Restrooms 21	Graffiti wall 22	Outdoor gym 23	Mini Biergarten 24

Drinking fountain 25	Bike cleaning station 26	Cellphone charging station 27	Urban garden 28
Drinks shop 29	Kiosk 30	Local urban art 31	Trees 32
ATM 33	Crosswalk 34	Playground 35	Wayfinding 36
Cafe 37	Lighting 38	Ice cream shop 39	Handrail & support 40
Ramps 41	Inclusive information 42	Texturized & color-differentiated pavement 43	Simple information – symbols & short text 44
Accessible height & width 45	Gender-inclusive 46	Avoid pull/push doors 47	Low slope sidewalks 48

Figure 31: Hubs' Element cards.

A game session was prepared to design two mobility hubs at the main campus of the Technical University of Munich, Germany in two specific locations at the main campus (see Figure 32). These locations were chosen based on a survey (Klanke, 2022) and space availability. A satellite image (Figure 33) was used as a board in both locations (example in Figure 34) The aimed users of the hub are students and residents of the area, therefore, students of a residency close to the university campus were invited to participate. The approach chosen was a hierarchical process including Phase I, II, and III of the game. For the details on Phases I, II, and III please see "Annex: Report on The SmartHubs Game in MUNICH".
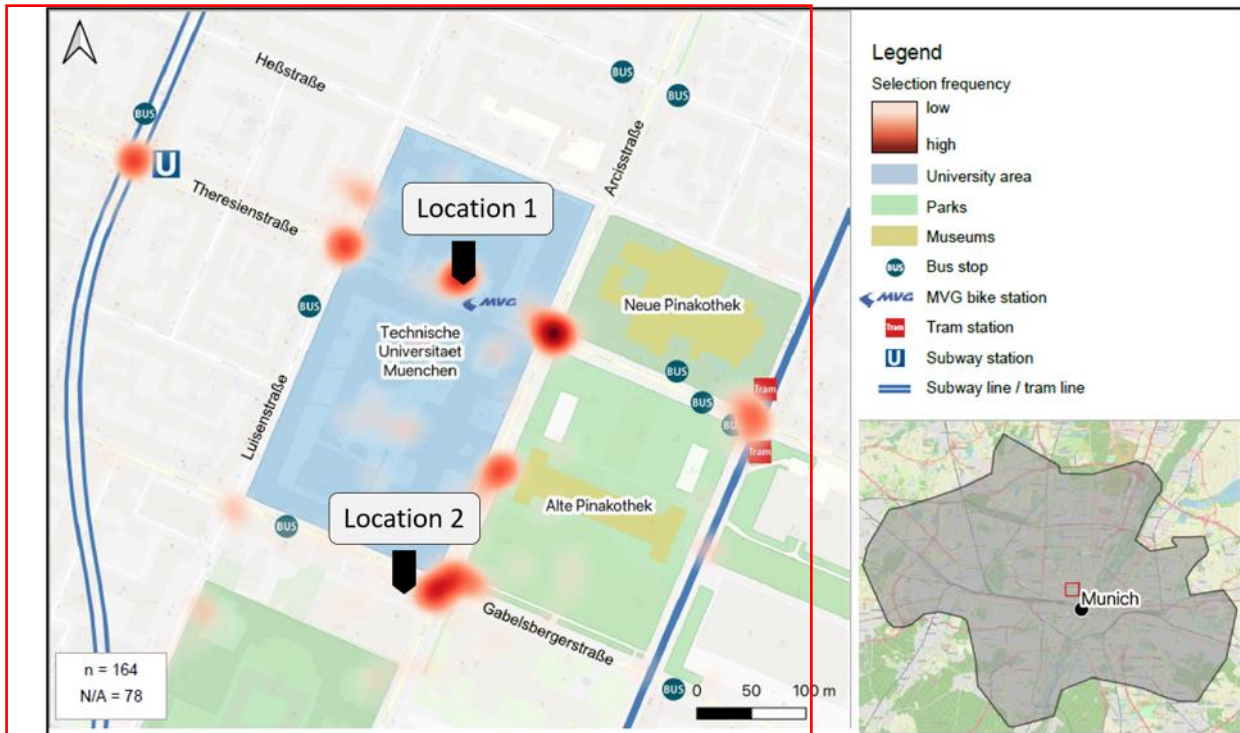
Figure 32: Places considered for the location of the mobility hubs. Source: Klanke, 2022.

Figure 33: Board used for the "Location 1".

On August 26th, 2022 from 19:00 to 20:30, 31 students who are also residents of the area volunteer to plan the game. In addition, 4 volunteers familiarized with the game supported the implementation and documentation process. First, the game was introduced by a 20-minute presentation including the mobility

hubs definition, design elements, and examples. Furthermore, the moderator explained the mechanics and purpose of the game. The first phase was explained and the players proceeded to play. The subsequent phases took place in the same way. The activity concluded with a debrief of the results of each team and the determination of a winning team from a jury formed by students who did not play the game. Figure 36 summarizes the methodology of the session. The students were asked to record audio during the three phases to document the process. The debriefing process was also documented through an audio recording. The following sections cover in detail the implementation of each phase.
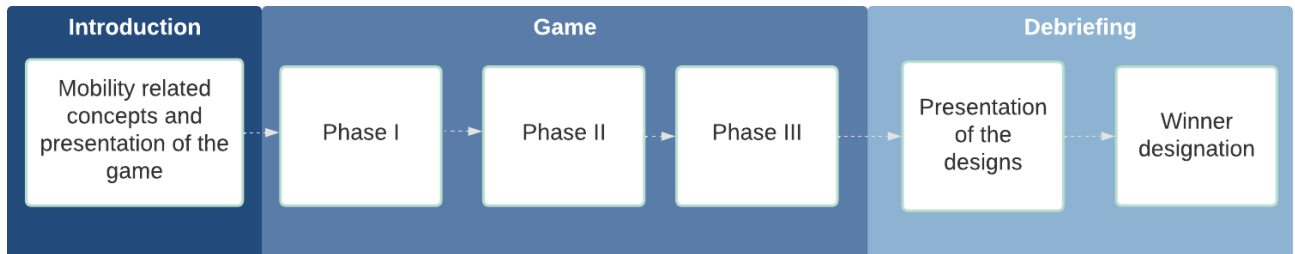

Figure 34: Summary of the game session procedure.

4.4   Mixed reality Design Game (Iteration 2): TU Wien Mobility Games MDG

The second iteration combines the analog Design Game that was used in the first iteration with mixed reality elements. The result is an augmented design game, called TU Wien Mobility Games MDG, short MDG. The ruleset, gameplay, and mechanics stay largely the same but specific parts of the game are realized in a virtual environment. Smartphones can possibly be used to implement this and to realize a game, which is still played as a board game but enhanced by virtual parts such as further information, game statistics, or specific actions. For example, the actions and results that are invoked by playing a specific card can be displayed virtually on the smartphone. Points and game results can be collected and saved on the smartphone. Tokens can be individually configured and visualized as bicycles, pedestrians, cars, etc. This supports the scientific evaluation process of the game as well as the gameplay itself: results can be directly shared with others and compared to. Additionally, the Design Game can be adapted by players or configurers to relate to the real context, in which it is played, e.g., in our case based on different scenarios and hub conditions. On a technical level, libraries such as AR.js in combination with Three.js are used.

Figure 35: Schematic representation of the TU Wien Mobility Games MDG.

4.5   Real-life Design Game (Iteration 3): TU Wien Mobility Games RDG

In order to evaluate the Design Game on a large as well as virtual scale, the concept will be expanded to the real world with the playing mat being substituted by an actual urban area, where the players literally move around while playing. Comparable to the very prominent example of Pokemon Go, playing the Design Game at this scale requires the players to move through the city, enabling the game designers to incorporate places of interest such as buildings, squares, or streets into the game. Participants are actively exploring parts of the city or the SmartHubs while discussing relevant topics, hence generating knowledge, in a playful and engaging way. Markers, although they aren't mandatory at this stage, can still be applied for potential visualizations of game elements (points of interest, game scores, etc.). A digital interface of the design game TU Wien Mobility Games RDG which can be accessed via mobile devices guides players during the game and displays relevant information. In accordance with the game's specific application, a digital map might be implemented to support different layers of information and enhance the urban area even further. Other materials which are used for playing such as dice or cards can be realized as virtual elements as well. Furthermore, tracking of said devices enables the players to find other participants and the researcher to apply game mechanics like treasure hunting or playing tag. Furthermore, metadata such as the routes of the players can be gathered for further analysis. The result of this iteration is a sandbox of game rules and mechanics which can be applied without the need of an actual playing mat but rather extending the gameplay to the physical SmartHub. By doing so, the potential fields for an application of the Design Game are further extended.

Figure 36: Illustration of the TU Wien Mobility Games RDG.

5   LESSONS LEARNED

Design Games were useful tools to establish and carry out planning of mobility and design of urban environments by considering the participation of different stakeholders. In SmartHubs Living Labs, we have established the participation process by several means, and as shown in this deliverable, also by means of Design Games.

On four different sites at our project Living Labs, we have started with the same Design Game Package including the guide on how to create a design game considering the circumstances, goals, questions, and different expectations of participating stakeholders. Parallel, we offered support while designing the specific games on these sites, which ended up with several intermediaries showing different stages of the design game development. At the same time, we evaluated the processes and obstacles we faced during these phases. A detailed analysis of the evaluation of the processes will be included in Deliverable 5.6 of WP 5.

One of the remarkable experiences is about the differences in the resulting games. Even though the basis was the same, including the materials, the supporting guide, and our personal consulting and support, the results differed significantly. Design Games in SmartHubs helped to empower our Living Labs to create their own game specifically without forcing them to use a certain format or type. The flexibility provided by the

Design Games is a benefit for researchers and planners, but at the same time a challenge to overcome because one faces uncertainty while progressing in the design of the games within the teams. Additional help is needed, e.g., multimedia tutorials, FAQs, personal consulting possibilities, etc.

Another insight we gained while experimenting with design games as tools for co-creation and participation, we found out that the Lab Frameworks that we used as a template at the beginning of this process to capture the most relevant information about the lab setting helped us to define the elements which were used in the design games created by the labs.

Definitively, there is a need to further disseminate and evaluate the use of design games for co-creation and participation purposes. A better understanding and more insights are included in Deliverable 5.6 of WP 5 of SmartHubs.

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