Interreg CENTRAL EUROPE
European Union European Regional Development Fund
SHAREPLACE

D.T1.4.4 REPORT ON CO-DESIGN FO INNOVATIVE MOBILITY

FINAL REPORT DECEMBER 2018

ulm university universität ulm

Table of content

1. Introduction to the need of co-design for innovative mobility

Transport generates a quarter of European greenhouse gas emissions and can be considered as the main cause for urban air pollution (EUROSTAT, 2017). Thus, transport has a major share in the total emissions with a significant impact on climate change (Olivier et al., 2016). By 2050, Europe aims to reduce greenhouse gas emissions caused by transport by at least 60% compared to 1990 (European Commission, 2011). Current developments contradict the intention of reaching their climate goals. This assumption is supported by the following facts:

- From 1990 to 2015, road transport in Europe rose by 23.3% (EUROSTAT, 2017).
- During the year 2017, the global vehicle ownership increased and Europe experienced the highest growth rate of 2% in oil demand since 2001, partly caused by a rise in usage of Sport Utility Vehicles (SUVs) (OECD/IEA, 2018).

To achieve the climate goals and slow down global warming, Europe has to accelerate the implementation of alternative and sustainable mobility solutions. Those solutions should address challenges related to urbanisation and population growth. By 2050, more than nine billion people will live on the earth with about 70% to 80% of them living in cities (Bundesregierung, 2016). This so-called urbanisation causes several problems related to mobility, such as the lack of space for additional traffic in urban areas, the

need for more efficient use of rare public space and the necessity to improve the safety in transportation (Willing et al., 2017, Chang & Kalawsky, 2018, Schrenk et al., 2016, Russ & Tausz, 2015). In addition, will the emerging economies increase their motorization, impacting resource consumption and global demand for vehicles and mobility infrastructures (Endter, 2015). Therefore, new mobility concepts are needed to lower the rate of motorized individual transport in order to reduce traffic congestion, provide cleaner air, set areas free for greening and increase accessibility for pedestrians and cyclists. Thus, increasing the attractiveness and economic output of cities (Chang & Kalawsky, 2018, Kopatz, 2016, Canzler & Knie, 2017).

There is a need for a holistic mobility solution which offers an added value in all three dimensions of sustainability – environment, economy and society. Alternative mobility solutions that try to address those needs are (automated) electromobility, mobility as a service, sharing economy and the expansion of public transport with multimodal offers (like tram, subway and bus) or intermodal opportunities, whereby two or more transport modes can be used within a one-way trip (Willing et al., 2017). Moreover, mobility efficiency can be improved by increasing number of ICT solutions (information and communications technology) as well as real-time information services available via mobile devices (Meurer et al., 2014). This report attends to case examples that consider different approaches to implement such sustainable mobility solutions with the help of 'co-design'.

Co-design can be understood as an innovative collaboration of experts and non-experts (Nesti, 2017). Co-design as a method can be applied in various contexts, amongst them the so called 'living lab' format. A living lab is a longer-term experiment, set within a real-world context in order to explore potential new usages or evaluate the impact on users´ behaviour generated by an innovation (Nesti, 2017).

The acceptance of the end user or the willingness to use an alternative mobility service is a crucial part for a successful implementation of sustainable mobility solutions (Zimmerling et al., 2017, Wright et al., 2018, McPhee et al. 2013). User involvement in co-designing products and services within a living lab can support behavioural changes towards more sustainable habits (Nesti, 2017). For this reason, regional solutions should be designed in cooperation with all affected stakeholders such as user-groups, local companies, representatives of the municipality etc.. The International Transport Forum recommends an incremental and iterative strategy to increase adoption and acceptance of automated mobility solutions, by providing users hands-on experiences of the systems at every stage and gather input from consumers themselves (Merat et al., 2017). Changing mobility behaviour within an entire population requires time and appropriate approaches since influence on user behaviour depends on a multitude of conscious and unconscious factors (McPhee et al. 2013, Merat et al., 2017). Those factors can be habits, trust, costs, fun factor, performance and expectancy (Merat et al., 2017). The willingness for eco-innovation adoption depends amongst other factors on personal values, beliefs and norms (Jansson et al., 2010). "Personal norms have a strong positive influence on willingness towards certain behaviours whereas habit strength has a negative influence." (Jansson et al., 2010, p.358). Susanto et al. (2017) discovered that a positive attitude towards new solutions needs to be created in order to overcome psychological biases and conventional travel habits. The positive attitude depends on ease of use and perceived usefulness (Susanto et al., 2017). Those and other influences for a positive attitude can be tested in living labs. By analysing four different living labs, this report examines how co-design and co-creation can help to build up a positive attitude towards innovative mobility solutions. Further, this report identifies co-design approaches to enable innovative mobility solutions with a specific focus on user needs.

After a short introduction to the SHAREPLACE approach in chapter 2, chapter 3 introduces details about co-creation and co-design practises within living labs for mobility solutions. The report is based on four case studies which offer best practice examples for SHAREPLACE and ideas for implementation at pilot level. The first case example describes the development of mobile devices for elderly that support sustainable and multimodal mobility. The second case example implemented a long-term living lab that focuses on the use of tools for user interaction. With the help of Urban Mobility Labs, case example three follows another approach by focusing on individual mobility behaviour within one city. The forth case

example includes the citizen's vision of tomorrow's mobility to deduce alternative solutions. A co-design approach is used to enable consumers to learn and participate in the development of future sustainable mobility concepts. This makes it possible to design products and services with the user, focusing to meet their real needs and thus potentially launch new solutions faster and more successfully on the market. Chapter 4 analyses all case studies and collects findings and challenges which are combined in best practises examples for the SHAREPLACE approach in chapter 5.

2. Introduction to Shareplace approach with Living Labs and Co-Design

The overall goal of SHAREPLACE is to develop an innovative approach to improve the connectivity of local, regional and transnational mobility systems. SHAREPLACE is open to all types of passenger transport services and target groups. Initial development and testing is carried out in six pilot regions: Bergamo, Crema (both Italy), Fuschlsee-Mondseeland/FUMO (Austria), Osijek (Croatia), Ulm (Germany) and Zalaegerszeg (Hungary). By implementing living labs (in the following LL) and actively engaging stakeholders, transferable solutions for a more integrated, accessible and harmonised mobility system in six central European regions will be designed.

The main approach for achieving this goal is the implementation of the six living labs, which build on specific strategies for local engagement. Through identifying the relevant stakeholders for each pilot region, an active group of participants will be gathered to collectively plan the aims of the different living labs with co-design workshops. The following report will provide further information on the analysis of examples which user co-creation methods for developing sustainable mobility solutions. In this context, we refer to co-creation: as "any act of collective creativity, i.e. creativity that is shared by two or more people." (Sanders & Stappers, 2008, p.2). Co-design reflects a shared design process, where designers and people, not trained in design, are working together to develop products, tools, processes and services. It combines the collective creativity of diverse actors across the whole span of a development process, and is thus to be seen as a specific instance of co-creation (Sanders & Stappers, 2008). In the context of this project we refer to co-design as a collective creative process which is facilitated as workshops, with diverse stakeholders who sketch, ideate, experiment, learn and develop concepts together (Mattelmäki & Sleeswijk Visser, 2011). Based on this analysis of co-creation approaches, we will identify the most suitable approach for SHAREPLACE.

3. Co-creation practices for sustainable mobility

This chapter and the following cases give an idea on how a co-creation process could look like, the potential of co-design and which methods can be used to integrate user into innovation processes. This theory can be used to co-create new concept for sustainable mobility.

3.1. The idea of co-creation and co-design

In **co-design**, typical roles get mixed up and tomorrows co-designing teams will be even more diverse. In past decades, the design professionals have been moving closer to the end 'user' or potential 'co-designer' when ideating, planning and designing products, to move even beyond 'user-centred' design. This changes the roles from the designer and what was known as the user, towards greater user-empowerment, but also nourishing the product, service or concept-development through the creative input of the future user and other stakeholders. The user plays an important role in the development of

knowledge, ideas and new concepts, because a user is seen as the expert of his/her life. However, their qualification as co-designer depends on their level of creativity, expertise and passion as well as the researchers support in providing users with appropriate tools for expressing themselves through visualization. Researchers have to change their role from being a translator (between user and designer) to acting as a facilitator referring to leading, guiding and encouraging people to support creativity. (Sanders & Stappers, 2008)

The term **co-creation** refers to user and stakeholder involvement during the product design and development process. Co-creation is a very broad term and emphasises the collective creativity of stakeholders, designers, researchers and end-users (Sanders & Stappers, 2008). Therefore, one can refer to co-design as a specific case of co-creation (ibid.). In a wider context, co-design is a creative act of designers and non-designers sharing the work during a design process (ibid.).

3.2. Co-creating Product-Service-System solutions

This chapter considers the potentials of co-creation and co-design to support the development of user-friendly service concepts for sustainable mobility. Rozenes & Cohen (2017) point out that users play an important role in value-co-creation mechanisms. Consequently, the role of co-creation within the Product-Service-System (PSS) development gains greater attention. Therefore, companies work on methods and tools to change customer´s role from a passive user to an active co-creator to better engage and integrate user into the early design and development process (Rozenes & Cohen, 2017).

PSS is defined as a combination of products, dematerialised services and supporting networks that aim to fulfil customer needs as well as minimising the environmental impact of consumption (Williams, 2006 & Mont, 2002). PSS is a possible answer to dematerialise the economy building on the concept where consumers pay for intangible services, not for material goods. The development to PSS solutions is seen as a result of economic transition away from mass-production and standardised products to flexible production and customised products and services. Markets aim for a stronger service-orientation, thereby opening the potential to minimise environmental impacts of production and consumption by decreasing material flows. (Mont, 2002)

Decreasing the rate of material consumption is challenging to put in practice. For this reason, the actual use phase of a product's life cycle and a product´s function need to be at the centre of attention. This is exactly the aim of most PSS solutions (Mont, 2002). Regarding sustainable mobility, PSS offers alternative scenarios of product use, while maintaining consumer´s level of welfare and convenience through sharing, renting or leasing schemes. To buy mobility instead of a vehicle is one example in a service-driven economy which is also called functional economy. "The economic objective of the functional economy is to create the highest possible use value for the longest possible time while consuming as few material resources and energy as possible" (Mont, 2002, p.238). According to Mont (2002) a successful development of a sustainable PSS requires the willingness of manufacturers and service providers to extend their involvement and responsibility in the consumption phase of the product life cycle, e.g. take back, upgrade, remanufacturing and reuse.

Likewise, an early integration of end-users in the innovation process for successful PSS solutions is important (Zimmerling et al., 2017). The study of Zimmerling et al. (2017) on end users as co-developers looked at three European firms and highlights the benefits of extensive end user integration along the innovation process of products and services for e-mobility and smart housing. Usually, green innovation requires changes in consumption behaviour and market acceptance for a successful market launch (Zimmerling et al., 2017). However, the findings of Zimmerling et al. (2017) show that an early and constant end-user integration can be useful as a risk management tool, because they can uncover behavioural changes in the consumption phase, strengthen acceptance as well as minimize the chances of market failure. As a result, Zimmerling et al. (2017) claim that these companies, which integrate end-user

at the beginning of their innovation process, are less risk-averse towards the development and market launch of novel green innovations. Also, they are more willing to invest in green products/services. They even go one step further by claiming that a strong user integration allows firms to distance themselves from incremental and traditional innovations (Zimmerling et al., 2017). By collaborating with multiple stakeholders, a company can gain important insight into the everyday lifestyle of users and therefore gain a competitive advantage. This implies a change of user roles, towards co-developer of novel green products and services. Their case studies illustrated that user collaboration even showed positive effects in a later phase of user integration. The companies were able to increase their chances of market success, because they further improved their products/ services with the help of user´s feedback and ideas. Zimmerling et al. (2017) further note that the investigated companies experienced a learning process during extensive end user integration. Their expectations were exceeded, and they changed their previous methodological approaches of low or no user integration. (Zimmerling et al., 2017)

Hakkarainen & Hyysalo (2013) support the perspective of a positive effect of co-design and interaction between different stakeholders in a LL. They propose that user-involvement supports the development of more context-specific insights for successfully embedding new technology solutions in society, while illustrating the potential societal impacts of such innovations. The case study by Hakkarainen & Hyysalo of a four-year living lab shows how an IT-start-up gains a deep understanding of the products´ use contexts, risks and real-life benefits. With the help of the user-insights into the daily life of their target group, new product features could be developed, which helped to successfully launch their product into the market. At the end, user integration supports the consumers´ acceptance while innovation failures get reduced. (Hakkarainen & Hyysalo, 2013) According to Nesti (2017) & Lindner et al. (2016), institutions and users can learn from each other and can create awareness for future mobility challenges. In addition, involving a heterogeneous group of users may increase the learning process and enable rethinking amongst the users with regards to their mobility behaviour. Nesti (2017, p.5) states that „the core of ULLs lies the concept of open innovation“ (ULL referring to Urban Living Lab). Especially within ULLs participants are encouraged to generate and discuss ideas through the use of different techniques (like brainstorming, group work, scenario building and prototyping). The approach of open innovations with its continuous process of knowledge exchange, is more targeted to the society as a whole (Nesti, 2017). The user as an active co-designer increases acceptance and therefore success of innovative mobility solutions on the market (Zimmerling et al., 2017).

3.3. Case example 1: InnoLab

A very recently concluded project as part of the InnoLab (https://www.innolab-livinglabs.de), explored from 2015 to 2018 the development of sustainable mobility solutions for elderly, in particularly related to accessibility and assistance systems.

InnoLab is a project that uses LL to develop a platform that draws attention to sustainable and multimodal mobility and service offerings as well as existing on-site support services in the region of Siegen (Germany) by addressing intergenerational interaction. Due to demographic change, the seniors' user group is becoming increasingly important (Meurer et al., 2017, Meurer et al., 2014).

The objective of the project was to develop an assistance system supporting sustainable and multimodal mobility (public and private transport) for elderly. According to their final report, the overall goal was to demonstrate the Living Lab potential through co-creation, prototyping and application scenarios for environmentally and resource-optimized mobility concepts for older people in urban and rural areas. Therefore, the research team searched for new features of the existing prototype of a mobility platform to influence the user´s behaviour in a way to use more sustainable mobility modes. Additionally, they examined its appropriation, like reasons for their choice of transport mode according to personal preferences or according to access to public transport. (Meurer et al., 2017)

Within the framework of PRAXLABS, a research and competence network of the region Siegen-Wittgenstein and Dortmund (Germany), environmentally relevant requirements for mobility for seniors were researched and prototypically implemented within an existing mobility platform called “Sehrmobil”. The mobility platform offers public and private transport with train, bus, tram, bicycle, taxi, rides in private cars and footpaths. It can be used via smartphone and laptop. (Meurer et al., 2017)

The Living Lab approach allowed the user group, consisting of 15 elderly people, to be involved in the entire innovation and development process, together with researchers and developers from industry. The participants used the final prototype, EcoMobil as smartphone app, for one month in their daily life and evaluated its functionality and usability.

The research design is divided into three interrelated phases:

1. Context study: Qualitative interviews, to better understand how users interpret their own mobility situation in terms of sustainability. In advance, users' individual movement profiles were tracked over a period of four weeks and then visualized to talk about decisions and mobility behaviour.
2. Design phase of the prototype: In the participatory design workshop with users, they got interviewed to their mobility behaviour as well as their mobility needs and sensibilized to the topic of sustainability. During the workshop, they discussed different mobility scenarios as well as the relevance of different eco-feedback approaches and they expressed ideas for a better design of the eco-feedback-system. Afterwards, they developed a prototype of an eco-feedback in group work.

   In a second workshop, experts of sustainability and mobility reflected results from the contextual study, they discussed the elimination of rebound effects and chose reliable measurements such as the CO_2 footprint or the material footprint.
3. Evaluation study: The third phase was a usability test of the EcoMobil app with eight users who were interviewed for 90-120 minutes at their homes. The app´s function has two main components: a logbook editor where the user can feed in information such as details of used transport modes, distances and travel times. The second component is an information visualization of mobility data, called Eco-Feedback which provides users information on carbon dioxide emissions and material footprint in reference to their choice of transport mode.

   In the interviews, the users had to reflect upon the user-friendliness of the EcoMobil-prototype and the usability of the Eco-Feedback. The Eco-Feedback aimed to provide a better understanding for the user regarding environmental impacts of their individual travel behaviour and, in the end, support sustainable mobility. Through the Eco-Feedback the research team could investigate whether the different visualization formats (e.g. charts) were well understood by the users and attracted their attention. After further improvements of the app´s user interface, all participants installed the EcoMobil app on their smartphone and set targets (like monthly budget). These targets aim to avoid rebound effects by illustrating their savings on environmental impacts (the app shows an overview of saved CO_2). The following evaluation phase included a sustainability assessment SDG-check (Sustainable Development Goals) from the UN (UN, 2015) where the targets were monitored (e.g. in terms of consumption) to detect rebound effects.

To raise awareness and encourage more environmentally friendly behaviour, the Eco-Feedback-System visualizes the resource requirement (material footprint) and the greenhouse gas emission CO2 (carbon footprint) for every trip. However, the full utilization of the transport mode cannot be measured, which is why only average values of the transport mode´s environmental impact are used for the calculation per trip and per person. Overall, the interviews showed a clear preference for informative visualization concepts. On the one hand, the emotional approach with playful competition was perceived as far less motivating or even patronizing by the elderly participants. The reason for that was a lack of agreement to publish data about their personal mobility. On the other hand, however, they were interested in the

calculations of the average mobility behaviour of all users in relation to their own behaviour. (Meurer et al., 2017)

3.4. Case example 2: Open Innovations

Mengual et al. (2018) describe the usage of tools for co-creation and collaborating interaction with visitors of a LL for open innovations. The paper examines the visitor roles in relation to the use of tools for interaction in a Living Lab.

The case study is managed by JOSEPHS®, which is an open innovation laboratory for product and service development in the city center of Nürnberg (Germany) in cooperation with the application-oriented research institution Fraunhofer (http://www.josephs-service-manufaktur.de/). Companies can present, discuss and evaluate their products or service prototypes in five co-creation spaces of JOSEPHS. At the beginning of the case study in 2014, the staff at JOSEPHS needed to take on the role as an innovation intermediary, because companies could not mobilize enough resources to be present continuously. This is why the integration was more passive, observation and open discussions dominated. After that, more quantitative survey-based methods (e.g. questionnaires) and tools for co-creation were used (e.g. corner for post-it-notes). They tried in different experiments to create a certain atmosphere in the co-creation spaces to simulate a real-life-situation.

Results are based on a long-term study of more than three years and about 76 different projects. Since the launch in 2014 until August 2017, citizens and visitors of Nürnberg could enter the LL at any time during the opening hours, were able to test prototypes and give feedback. A team of guides welcomed, encouraged and lead the visitors. During a period of three years, different companies, from start-ups to large established companies, were able to co-create products and services with a large variety of participants.

The various data sources were analysed in a qualitative data analysis during two expert workshops in April 2017. Tools for reactive integration were used the most (voting mechanism, closed/opened questionnaire, interviews, toolkits) which means that a visitor gives feedback when he did interact with a prototype or concept beforehand. The following figure illustrates all tools used, clustered in three categories of interaction: passive integration, reactive integration and co-creation. (Mengual et al.,2018, p.304)

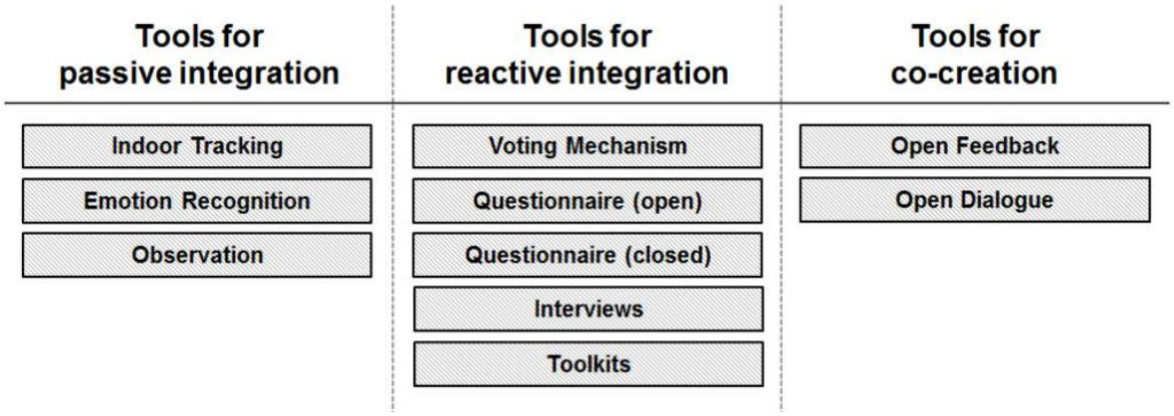

Figure 1: Tools for categories of interaction (Mengual et al., 2018, p.304)

In order to collect structured data and support the innovative way of thinking, a LL should use tools that create enough freedom for creativity. In addition, it is suggested to provide a mix of different tools while interacting with visitors in order to address different types of participants. (Mengual et al., 2018)

3.5. Case example 3: Action research for Urban Mobility Labs

The case from Kirchberger et al. (2017) is about the method transfer of Urban Mobility Labs (UML) in case of so-called 'mobility expeditions'. The objective of the mobility expeditions is to collect mobility experiences in the place of action as well as reflecting on existing knowledge while personally experiencing on-site mobility (Kirchberger et al., 2017). The experiment aimed to create an unusual situation within a familiar environment which is an important factor in the emergence of new perspectives, like poor lighting, difficult transfer conditions or lean signage. Participants were encouraged to leave their comfort zone to take another perspective and temporarily change their daily routines and everyday mobility behaviour.

The general objective of the UML was to gain more insights in personal mobility behaviour within a city and mobility beyond the city borders. Participants within the mobility expedition were able to gather mobility experiences and reflect on existing knowledge in the personal experience of on-site mobility in their respective city context. The more specific goals provided through the mobility expedition, helped to raise awareness on participants mobility behaviour, perceived mobility limitations in the local transport system, as well as observing the handling of digital and analogue navigation tools (route planning, timetable information and navigation) in Graz.

The team counted 40 participants consisting of the participating local companies, network partners, students and implementing research institutions from politics and administration, but no nationwide stakeholders. During the three public events in 2015, participants played an active role in the event.

At the beginning, all participants, which were locals of Graz, got a short introduction and were split into two groups for each mobility mode. The four mobility modes were walking, public transport, bicycle and private car. The task was to reach a common destination from the same starting point by different transport modes. The groups had a free hand in the selection of the route and the tools used. The area of the expedition showed a variety of different traffic routes (e.g. rail, highway, roads, bike paths, etc.). Each group were accompanied by one staff member that shared all necessary information about the tasks. Starting from a common starting point, all groups had to travel to one more point before the final destination and solve assigned mobility-related tasks on the way, like shop in a grocery store, take pictures from a viewpoint or pick up a person from a specific address.

At the end they came together for the presentation of all impressions and findings. All participants wrote down their impressions independently. The tangible experience of mobility inspired them to formulate ideas and possible solutions for regional mobility. The documentation was realized in a written (answering key questions), photographically and spatial (GPS, map) version. All in all, the focus of the experiment was on finding solutions for local mobility problems. (Kirchberger et al., 2017)

3.6. Case example 4: Future City Lab

The Future City_Lab for sustainable mobility culture (in German "Reallabor für nachhaltige Mobilitätskultur", short RNM) of the University of Stuttgart started in winter 2016 with a vision workshop for sustainable mobility culture (RNM). The workshop´s focus lied on the conjoint development of visions and needs for sustainable concepts for passenger transport in the city and region of Stuttgart. The co-creation of visions to urban mobility resulted in modelling different scenarios. Furthermore, RNM wants to enrich and fuel the public debate on the future of a sustainable mobility culture through the co-creation of participatory scenario between scientists and interested citizens.

The workshop took place with employees from science, administration and civil society. This event was also part of a seminar for students of architecture from the University of Stuttgart. Further, inter-institutional cooperation, like research centres and institutions that deal with technical innovations, urban changes, road and transportation collaborated within the workshop. Target group were citizens of the city

and region Stuttgart. The inclusion of citizens (bottom-up) was the central method of the transdisciplinary vision workshop. This gave scientists an insight into the reality of life on the spot and user could comprehend scientific methods better.

The transdisciplinary vision workshop took place on two consecutive days in October 2016. The first day, 46 participants and 18 team members of the LL joined the event. On the second day, around 35 citizens and 28 students were present. Students helped to prepare and visualize the scenarios in the second workshop.

First point on the agenda was a clarification of central conceptual distinctions, like vision versus scenario, as well as the difference between mobility and transportation. After three expert presentations to create a common knowledge base (average mobility behaviour in Germany in comparison to Stuttgart, numbers about the past and current traffic development and its consequences, practical examples of other cities), the participants were separated in three groups in different rooms with one moderator each. Each group was asked the same questions (i.e. future headline method), carried out discussions and had to present one vision of mobility in Stuttgart 2030. The elaborated visions were modelled by the scientists and architecture students.

For the second day, the visions were further developed in terms of transport science. The vision´s impact was visually translated in urban design. The various visions got summarized in four scenarios. Four groups of citizens had to give feedback to each scenario within a World Café[1] based on different qualitative and quantitative criteria. One moderator supported each group by summarizing comments on post-its on a flip chart.

The exchange of thoughts and content-related discussions during group work enabled the participants to understand and to face the challenges of everyday mobility. This led to a revision of one's own conception and brought visions closer together. Every participant could gain a better understanding of different challenges of the daily mobility from other citizens and partially increased the understanding of work processes on administrative and policy level. (Lindner et al., 2016)

An important method used was visualization to clarify projects and reduce abstract imaginations, especially for non-professionals, like the citizens. Pictures of concrete implementation solutions can make scenarios comprehensible but also emotionally tangible, so participants are able to gain a more uniform understanding of the different scenarios. This also can help for discussions and opinion-forming process. (Lindner et al., 2016)

After the workshop, participants had to reflect upon both workshop days and give feedback with regards to the methods applied. (Lindner et al., 2016)

4. Reflection and Analysis

On basis of the four recently presented case examples, in the beginning of a co-design workshop, participants need input from experts. In addition, benefits of the event and its hypothetical outcome for the future should be explained to increase extrinsic and intrinsic motivation factors.

For participants, the option to ask questions during the co-design process and between workshops is important. Meurer et al. (2017) from case example 1 showed that not all values or visualizations are tangible and intuitive for users. There is still great uncertainty about the resource consumption of different transport modes and environmental impact of mobility behaviour. The user workshop showed

[1] Method, where a group of 4-6 people rotates on many different tables within one room and discusses in a constructive way about one topic and its solution. Everybody can write their ideas on paper which lie on each table.

existing difficulties in understanding or interpreting the abstract consumption data. Therefore, a better translation of the data units is needed, which makes it easier for the user to understand and to evaluate abstract data. (Meurer et al., 2017)

Every LL represents other values, because every city is different in quality of life, infrastructure, and possibilities of different transport modes. The outcome of a LL could lay on solutions for local mobility problems (see Kirchberger et al., 2017).

Every execution of a LL could be different and partly misleading because of group dynamics and method adoption. The role of a moderator is to lead the group dynamic in the right direction.

Through LL, researchers are in the position to learn more about the citizen´s behaviour in order to develop concrete solutions to the major societal challenges of the future. In the first case of elderly people, saving resources was seen as important, but not motivating enough to change the individual mobility behaviour (Meurer et al., 2017). For the individual participant, the exchange of thoughts and content-related discussion enables to face and understand the challenges of others everyday mobility. This can lead to a revision of one's own conception and bring individuals visions closer together, like in case example 4. Every participant could gain a better understanding of different challenges of the daily mobility from other citizens and partially increase the understanding of work processes on administrative and policy level (Lindner et al., 2016).

Besides the active involvement, users can passively be involved into the design process, when it comes to development of open source software or mobile application (Nesti 2017 & Amsterdam Smart City, 2016). Data of devices that are connected to the internet (Internet-of-Things) can be used to gain a better understanding on the historical and current mobility behaviour of citizens. Based on that, smarter and more flexible mobility concepts for the future can be designed. (Amsterdam Smart City, 2016)

Group dynamics play a key role in action research methods that build on the interaction between participants. Furthermore, it is necessary to give participants time to reflect the questions or tasks they are asked to complete, and the methods used. To archive a spontaneous and flexible atmosphere, tasks and questions should be formulated open. Leaving the comfort zone and taking new perspectives requires the willingness of the participants to deal with the unforeseen. In addition, an increased degree of flexibility and spontaneity from the accompanying research team is required (Kirchberger et al., 2017).

Documentation:

- For action research, it is essential to carry out comprehensive documentation that also makes use of the digital possibilities (e.g. sound recordings, GPS tracking, film). On the one hand, to catch the specific atmosphere or important discussions on the route can be an important contribution to innovation processes in living labs. On the other hand, this kind of documentation requires an increased amount of staff. Alternatively, however, the participants can also carry out the documentation and become investigators themselves (Kirchberger et al., 2017).

Challenges:

- During interviews, many users stated that the private car is the most used mode of transport and preferred over public transport. This fits to the fact in case example 1 that many seniors live alone in suburban or rural areas where access to public infrastructure is often difficult (Meurer et al., 2017, Föbker et al., 2006). The car enables spontaneity, independence and the sense of control that cannot be achieved by other transport modes (Meurer et al., 2014). Walking in their free time or for health reasons is also popular for many users, but less ecologically motivated. Emission saving goals are hard to reach in rural areas. In addition, users point out that they are unsatisfied with the current public transport infrastructure (Meurer et al., 2017).

- Usability tests could be more difficult with less tech-savvy people when it comes to use and evaluation of prototype apps. In case example 1 (Meurer et al.,2017) usability problems occurred, because the elderly had problems to navigate themselves in the app on their smartphone.
- A LL needs investments in time and human resources for preparation, implementation and follow-up. At the beginning of the LL at JOSEPHS in case example 2 the staff had to take on the role as an innovation intermediary, because participating companies could not mobilize enough resources to be present in the co-creation spaces continuously. This is why the integration was less reactive and more passive, observation and open discussions dominated. After that, more quantitative survey-based methods (e.g. questionnaires) and tools for co-creation were used (e.g. corner for post-it-notes) (Mengual et al. 2018).

  Lindner et al. (2016) states that the process of moving from a discussion on possible solutions to a tangible vision is a time-consuming one. For participants, a specific exercise should facilitate the precise formulation of ideas to create a shared vision. Furthermore, every group responds differently to certain methods, therefore different methods should be used or the moderation should respond flexibly to the specific group requirements. A LL needs to take group dynamics into account, which is why standardized processes and methods could fail.
- The tool implementation is challenging with heterogeneous visitor groups (in terms of interests and background) which is why no interaction can be initiated the same way. (Mengual et al. 2018)

  The user´s qualification as co-designer depends on his/her level of creativity, expertise and passion (Sanders & Stappers, 2008). In the case of Lindner et al. (2016), for some participants it was not easy to think only in desirable futures and leave probabilities and given framework conditions behind. The biggest challenge was to find a common vision in a heterogeneous group with different backgrounds and mobility needs. Also, it was challenging for participants to capture many different effects and their relationships to the complex system of urban mobility. (Lindner et al., 2016)

In the cases discussed above, the number of participants varies. A LL with fewer participants should not be seen as less representative or less successful in finding sustainable solutions. Menny et al. (2018) point out that co-creation should rather be a combination of various user involvement levels. It is suggested “to consider the right form and the right time. […] While a broader issue calls for a smaller group to be involved, a more focused issue allows for a larger number of engaged participants” (Menny et al., 2018, p.76).

The following table summarizes all important information about the previously described case studies.

Case study	Innolab	Open Innovation	Action Research	Future City Lab
Aim	Develop an assistance system to support sustainable and multimodal mobility for elderly in urban and rural areas	Examine the visitor roles in relation to the use of tools for interaction in a living lab	Gain insights in personal mobility behaviour within Graz	Development of visions and needs for sustainable mobility solutions for the region Stuttgart
Location	Siegen (Germany)	Nürnberg (Germany)	Graz (Austria)	Stuttgart (Germany)
Duration	2 months (2017)	More than 3 years (2014 – 2017)	2 days (2015)	2 days (2016)
Partners	PRAXLABS of the University of Siegen	JOSEPHS and different companies in 76 projects	Companies, network partners, local research institutions	University of Stuttgart, different research centre
Participants	15 seniors	Unknown, heterogeneous	40 students	35-46, heterogeneous
Leading actors	InnoLab research team	Innovation guides of JOSEPHS and different companies	Research team of UML (Urban Mobility Lab)	Moderators of RNM (Sustainable Mobility Culture) of the University of Stuttgart
Methods/tools used	Qualitative interviews; co-creation: user and expert workshop, application-scenarios; co-design; feedback; field test, …	Passive integration, co-design, reactive integration, real-life-simulation, expert workshops	Field test: mobility expedition; feedback and presentation	World café; 3D scenario visualizations; vision workshop: group work, future headline method, discussion, presentation
Level of user-participation in co-creation	medium	medium	high	high

Table 1: Overview of all case examples

5. Best practices for Shareplace Co-design approach

The collaborative approach of co-design is seen as an appropriate approach to successfully develop a sustainable and multimodal mobility service within the SHAREPLACE project. It aims at involving different stakeholders with different roles, such as public administration, researchers, companies, citizens/user to design, develop and implement a new mobility service able to fit with specific users' needs and urban possibilities.

Location:

- To hold the first meeting at an easy to access location can increase awareness and acceptance.
- The location of a LL depends on the methods, materials and devices which are necessary.
- Different locations are conceivable for a LL. These range from a single room to an outdoor area.

Organizational frame:

- Co-creation can be realized in different ways. For example, in a long-term project which could take several months to years, or in a short-term project which could be a one or two-day workshop. Motivation for a stable participation (over a longer period of time) and collaboration among volunteers is essential to achieve useful results in the LL process (Nesti, 2017). Therefore, the methods and tools should be easy to understand, the collaboration should be associated with fun and enough brakes with refreshments (drinks, snacks) should be provided.
- A LL should create opportunities to evaluate digital ideas, scenarios or (sub-) solutions in an effective manner and to prototype together with relevant stakeholders in real-life conditions.

Experts and non-experts represent different perspectives. By working together, they can share expertise and expectations (Maffei & Villari, 2017). A LL should include all necessary stakeholders from the study area. Maffei & Villari (2017) point out that the design of mobility solutions needs interaction of both macro- and micro-systems. Micro-systemic levels contain competitive scenarios of new products and services. Macro levels are linked to political affairs (like sustainable development models or urban policies) and design strategies (such as consumption models and users' behaviour) (Maffei & Villari, 2017).

Participants:

- In order to create a higher level of acceptance in society and to meet the mobility needs of the general population, the group of participants should be heterogeneous.
- Different stakeholders with different roles should be included. The creative phase should be a collaboration of a mixed team of institutional and entrepreneurial stakeholders (like public administration, universities, mobility companies and/or other industries), a multidisciplinary team composed of experts (like designers, engineers and researchers) and other volunteers (like users, citizens, community groups, representatives of the municipality) (Maffei & Villari, 2017).

Co-design tools & methods:

- The use of tools determines the level of interaction which means that the determinants of interaction need to match different integration types. In other words: "one-size-fits-all" (Mengual et al., 2018, p.307) is not appropriate for all LLs, because every participant is different. For this reason, a repertoire of matching tools should be prepared. Mengual et al. (2018) discovered three categories of tools for participant integration: passive integration, reactive integration and co-creation.

- Co-creation spaces and co-design workshops should be designed in a way that visitors can choose the most suitable integration tools by themselves. This strengthens the focus on the type of interaction, not on the type of user. Even if a LL already has a variety of tools for reactive integration, there could be the need to develop new tools. For time-sensitive visitors, for instance, you need a tool that generates enough high-quality feedback in a short time with less information (Mengual et al. 2018).
- In order to collect structured data and support the innovative way of thinking, a LL should use tools that create enough freedom for creativity or a mix of tools while interacting with visitors in order to address different types of participants (Mengual et al. 2018).
- The chosen workshop methods should bring the complexity of the topic of mobility closer to its participants. To avoid situational emotional influences that can hinder acceptance afterwards, an emotional distance of modelling enables an objective substantive exchange. This was noted as particularly positive in the case of Lindner et al. (2016).

Interaction rules:

- In co-creation processes participants, should be given the possibility to select their own roles, otherwise creative visitors may not become active and innovative. The reason for that is the so-called 'role taking process'. This means that a role is predefined, while users react to given expectations or responsibilities and follow the instructions, whereas role making allows users to define their own roles in living labs and become proactive. A more proactive user is more likely to ideate and design novel products (Leminen et al., 2015). Thus, a LL should open the opportunity to become proactive. The more proactive participants the better. Leminen et al. (2015) state also that a careful user selection is very important for the living lab´s innovation outcome.
- Time and commitment (besides matching tools for different integration types) are the limiting factors for interaction with visitors in a LL. It is important to consider the structure of interaction (Mengual et al. 2018).
- Group dynamics play a key role in action research methods that build on the interaction between participants. To archive a spontaneous and flexible atmosphere, tasks and questions should not always be set with too many details. To leave the comfort zone and to take new perspectives requires the willingness of participants to deal with the unforeseen. In addition, an increased degree of flexibility and spontaneity from the accompanying research team is required (Kirchberger et al., 2017).
- It is necessary to give participants time to reflect the tasks and methods used (Kirchberger et al., 2017). The retrospective reflection after the workshop of Linder et al. (2016) showed how every group has applied the methods differently. This shows the important part of the moderation in paying attention to the group and to respond accordingly. Moderation is necessary to overcome contradictions and misunderstandings. Otherwise the motivation of the participants suffers (Lindner et al., 2016).

6. Concluding Remarks

This report focused on the potential of co-design for innovative mobility solutions which are useful for the SHAREPLACE approach to improve the connectivity of local, regional and transnational mobility systems.

Active user involvement can be seen as a promising tool for designing and implementing sustainable mobility solutions. SHAREPLACE will be open to all types of passenger transport services and target groups. Therefore, every living lab should actively engage different stakeholders, experts, non-experts and different institutions for each pilot region, to transfer region-based expectations and needs into the co-design of mobility solutions.

Further, this report dealt with the effects and benefits of co-creating Product-Service Systems (PSS) on sustainable mobility solutions. The product use phase requires greater attention in a service-oriented economy, where user involvement as co-designers within the innovation and development phase is highly beneficial. This approach implies changes in traditional market structures and company structures, like organisational frameworks, marketing strategies, companies´ involvement and responsibility within the consumption phase, the relationship between stakeholders as well as the relationship between companies and consumer.

A closer look at four different case studies illustrated how a living lab and the co-creation process for sustainable mobility solutions could look like. Based on these case studies, relevant activities and strategies for a SHAREPLACE approach were identified.

References

Amsterdam Smart City (2016) "SMART MOBILITY - Action plan 2016 – 2018" [online] https://amsterdamsmartcity.com/projects/actieprogramma-smart-mobility-2016-2018 [20.09.2018]

Bundesregierung (2016) „Deutsche Nachhaltigkeitsstrategie – Neuauflage 2016" [online] https://www.bundesregierung.de/resource/blob/975292/730844/3d30c6c2875a9a08d364620ab7916af6/deutsche-nachhaltigkeitsstrategie-neuauflage-2016-download-data.pdf [28.10.2018]

Canzler, W. & Knie, A. (2017) „Festgefahren: Anleitung zum Wandel der Automobilgesellschaft - Was die sozialwissenschaftlicheMobilitätsforschung auf Fragen nach den Herausforderungen und Chancen der Mobilität der Zukunft antwortet" Z Politikwiss (2017) 27:475–481, Springer Fachmedien. https://doi.org/10.1007/s41358-017-0116-x

Chang, A. & Kalawsky, R.S. (2018) "European Transport Sector Interventions for Smart City" ResearchGate: 2017 7th International Conference on Power Electronics Systems and Applications. https://ieeexplore.ieee.org/document/8277778

Endter, C. (2015) "Engpass Green Mobility – Grenzen des Mobilitätswandels versus Erfolgsfaktor Akzeptanz". Igel Verlag RWS, Hamburg.

EUROSTAT (2017) "Energy, transport and environment indicators". Statistical books. Luxembourg. https://ec.europa.eu/eurostat/documents/3217494/8435375/KS-DK-17-001-EN-N.pdf/18d1ecfd-acd8-4390-ade6-e1f858d746da
[17.09.2018]

Föbker, S. and Grotz, R. (2006) "Everyday mobility of elderly people in different urban settings: the example of the city of Bonn, Germany". Urban Studies, 43(1), pp.99-118. https://doi.org/10.1080/00420980500409292

Hakkarainen, L. and Hyysalo, S. (2013) "How do we keep the living laboratory alive? Learning and conflicts in living lab collaboration". Technology Innovation Management Review, 3(12).

Jansson, J., Marell, A. and Nordlund, A. (2010) "Green consumer behavior: determinants of curtailment and eco-innovation adoption". Journal of consumer marketing, 27(4), pp.358-370. https://doi.org/10.1108/07363761011052396

Kirchberger, C., Berger, M., Zech, S. & Hirschler, P. (2017) „Transfer von Methoden der Aktionsforschung für urbane Mobilitätslabore am Beispiel von Mobilitätsexpeditionen" REAL CORP 2017 Proceedings/Tagungsband. Pp. 587-597. https://publik.tuwien.ac.at/files/publik_261444.pdf (09.08.2018)

Kopatz, M. (2016) "Wie viel Mobilität ist genug? Suffizienz im Mobilitätsalltag und als verkehrspolitische Strategie". SYM 1/2016: p.8-10. https://core.ac.uk/download/pdf/35143335.pdf (12.09.2018)

Leminen, S., Nyström, A.-C., Westerlund, M. (2015) "A typology of creative consumers in living". Journal of Engineering and Technology Management. 37 (2015) 6–20. http://dx.doi.org/10.1016/j.jengtecman.2015.08.008

Lindner, D., Alcántara, S., Arnold, A., Busch, S., Dietz, R., Friedrich, M., Ritz, C. & Sonnberger, M. (2016) „MOBILITÄTSVISIONEN FÜR STUTTGART - Ein transdisziplinärer Workshop in Kooperation mit der VHS Stuttgart". Paper. http://www.r-n-m.net/wp-content/uploads/2018/03/Zukunftslabore_web.pdf (29.08.2018)

Mengual, M.P., Jonas, J.M., Schmitt-Rüth, S., Danzinger, F. (2018) "Tools for collaborating and interacting in Living Labs – an exploratory case study on JOSEPHS®". In ServDes2018. Service Design

Proof of Concept, Proceedings of the ServDes. 2018 Conference, 18-20 June, Milano, Italy (No. 150, pp. 298-310). Linköping University Electronic Press.

McPhee, C., Westerlund, M. & Leminen, S. (2013) "Editorial: Living Labs and Crowdsourcing". Technology Innovation Management Review, December 2013: 3-5. https://doi.org/10.22215/timreview/1052.

Maffei, S. & Villari, B. (2017) "Service Idea: Creating Mobility Scenarios Through Service Design". https://doi.org/10.1007/978-3-319-61964-4_2

Mattelmäki, T. & Sleeswijk Visser, F. (2011) "Lost in Co-X – Interpretations of Co-desig and Co-creation", Proceedings of IASDR 2011, the 4th World Conference on Design Research, 31 Oct. - 4 Nov. Delft, Neatherlands, Edited by. Roozenburg N.F.M. , Chen L.L. & Stappers P.J.. https://window874.files.wordpress.com/2012/09/mattelmaki_lost-in-cox_fin-1.pdf (16.08.2018)

Menny, M., Voytenko Palgan, Y. & McCormick, K. (2018) "Urban Living Labs and the Role of Users in Co-Creation". GAIA 27/S1(2018): 68 –77. Oekom verlag. https://doi.org/10.14512/gaia.27.S1.14

Merat, N., Madigan, R. & Nordhoff, S. (2017) "Human Factors, User Requirements, and User Acceptance of Ride-Sharing in Automated Vehicles". International Transport Forum, Discussion Paper No. 2017-10. https://www.itf-oecd.org/sites/default/files/docs/human-factors-ride-sharing-automated-vehicles_0.pdf (04.11.2018)

Meurer, J., Geibler, J., Stadler, K., Koch, H. and Rudigier, G. (2017) „Gestaltung einer intermodalen und ressourcenschonenden Mobilitäts-App im Alter mit dem Living-Lab-Ansatz". Arbeitspapier im Arbeitspaket, 5.**Meurer, J., Stein, M., Randall, D., Rohde, M. und Wulf, V. (2014)** "Social dependency and mobile autonomy – Supporting older adults' mobility with ridesharing ICT", in: Proceedings of the 2014 ACM annual conference on Human Factors in Computing Systems CHI, 1923-1932. https://doi.org/10.1145/2556288.2557300

Mont, O.K. (2002) "Clarifying the concept of product–service system". Journal of Cleaner Production 10 (2002) 237–245. Elsevier Science Ltd. https://doi.org/10.1016/S0959-6526(01)00039-7

Nesti, G. (2017) "Co-production for innovation: the urban living lab experience, Policy and Society". Journal homepage: http://www.tandfonline.com/loi/rpas20

OECD/IEA (2018) "Global Energy & CO2 Status Report 2017". https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/geco2017.pdf (19.10.2018)

Olivier, J.G.H, Janssens-Maenhout, G., Muntean, M. (2016) "Trends in global CO2 emissions: 2016 Report". By PBL Netherlands Environmental Assessment Agency. http://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf (16.10.2018)

Mengual, M.P., Jonas, J.M., Schmitt-Rüth, S., Danzinger, F. (2018) "Tools for collaborating and interacting in Living Labs – an exploratory case study on JOSEPHS®". In ServDes2018. Service Design Proof of Concept, Proceedings of the ServDes. 2018 Conference, 18-20 June, Milano, Italy (No. 150, pp. 298-310). Linköping University Electronic Press.

Rozenes, S. & Cohen, Y. (2017) "Handbook of Research on Strategic Alliances and Value Co-Creation in the Service Industry". IGI Global. https://doi.org/10.4018/978-1-5225-2084-9

Sanders, E.B.-N., & Stappers, P.J. (2008) "Co-Creation and the New Landscapes of Design" CoDesign 4.1 (2008): 5–18. https://doi.org/10.1080/15710880701875068

Schrenk, M., Popovich, V.V., Zeile, P., Elisei, P. & Beyer, C. (2016) "REAL CORP 2016. Smart Me Up! How to become and how to stay a Smart City, and does this improve quality of life?". 21st International

Conference on Urban Planning, Regional Development and Information Society. https://www.corp.at/fileadmin/user_upload/201601_businessmarketingfolder.pdf (19.10.2018)

Susanto, T.D., Diani, M.M. & Hafidz, I. (2017) "User Acceptance of e-Government Citizen Report System (a Case Study of City113 App)". Elsevier B.V., Procedia Computer Science 124 (2017) 560–568. https://doi.org/10.1016/j.procs.2017.12.190

Russ, M. & Tausz, K. (2015) "Mobilität als Service – Nutzerorientierung als Paradigma zwischen Markt und öffentlicher Grundvorsorge". Springer Verlag Wien, Elektrotechnik & Informationstechnik (2015) 132/7: 404–408. https://doi.org/10.1007/s00502-015-0341-2

UN (2015) "Resolution: Transforming our world the 2030 Agenda for Sustainable Development". https://sustainabledevelopment.un.org/post2015/transformingourworld/publication (13.10.2018)

Williams, A. (2006) "Product service systems in the automobile industry: contribution to system innovation?". Journal of Cleaner Production 15 (2007) 1093-1103. Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2006.05.034

Willing, C., Brandt, T. & Neumann, D. (2017) "Intermodal Mobility". Springer Fachmedien Wiesbaden, Bus Inf Syst Eng 59(3):173–179 (2017). https://doi.org/10.1007/s12599-017-0471-7

Wright, S., Cellina, F., Bulgheroni, M., Cartolano, F., Lucietti, L., Van Egmonde, P. & Van Wijngaarden, L. (2018) "Public acceptance of SocialCar, a new mobility platform integrating public transport and car-pooling services: insights from a survey in five European cities". ResearchGate, Transport Research Arena 2018. https://www.researchgate.net/publication/324825424 (19.10.2018)

Zimmerling, E., Putrik, H. & Welpe, I.M. (2017) "End-users as co-developers for novel green products and services e an exploratory case study analysis of the innovation process in incumbent firms". Journal of Cleaner Production 162 (2017) pp.51-58. https://doi.org/10.1016/j.jclepro.2016.05.160