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Sustainable Mobilities in the Neighborhood: Methodological Innovation for Social Change

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Abstract: The German federal state of Baden-Wuerttemberg with its regional capital Stuttgart is a major field for the mobility transition in Europe. As one of seven living labs in the state, *MobiQ—Sustainable Mobility through Sharing in the Neighborhood* follows a civil society, non-commercial approach. Utilizing the research design of living labs, research and practice work hand in hand to promote citizen participation in co-designing and co-producing neighborhood-based, and developing shared mobility solutions. The spatial focus is on three locations: A 10,500-inhabitant post-war settlement on the outskirts of Stuttgart (Stuttgart-Rot), a city-neighborhood with about 6000 inhabitants (Geislingen an der Steige) and a rural municipality of approximately 3000 inhabitants (Waldburg). In this article, we propose how theoretical considerations of the sustainability transitions of mobility systems can be deployed on the ground. Through this study, we offer first-hand insights into living lab experiences and inspire scholars worldwide to harness the networks of civic actors in order to contribute to a cultural change in mobility practice.

Keywords: living labs; mobility transition; mobility culture; urban space; participation; transdisciplinary research; sustainability; real-world laboratory; mobilities research

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1. Introduction

It is becoming increasingly clear that the political efforts to achieve the sustainability goals of the United Nations [1] and to fulfil the commitments made by the national and state governments to the Paris Agreement [2] are proving insufficient as the targets for carbon emissions reduction are regularly missed. As a consequence, in their biennial report, the German Council of Experts on Climate Change recently called for progress in the climate protection efforts of their government for a paradigm shift in German climate policy [3]. The council recommends that politics relocate their primary efforts from the task of controlling emissions to the more challenging task of "shaping change in such a way that it is economically and distributively sustainable for the economy and society" ([3], p. 17.). This new approach also implies the acknowledgement that solutions to address sustainability challenges cannot solely be found in supporting technological innovation.

1.1. The Triad of Propulsion, Transport, and Mobility Transition

In the context of transportation and mobility—the sector with the highest emission reduction gaps in Germany—this means that change must happen beyond a shift in propulsion technologies. A mere focus on the electrification of transport (see "Propulsion transition", Figure 1) will prove to be an insufficient carbon reduction strategy.

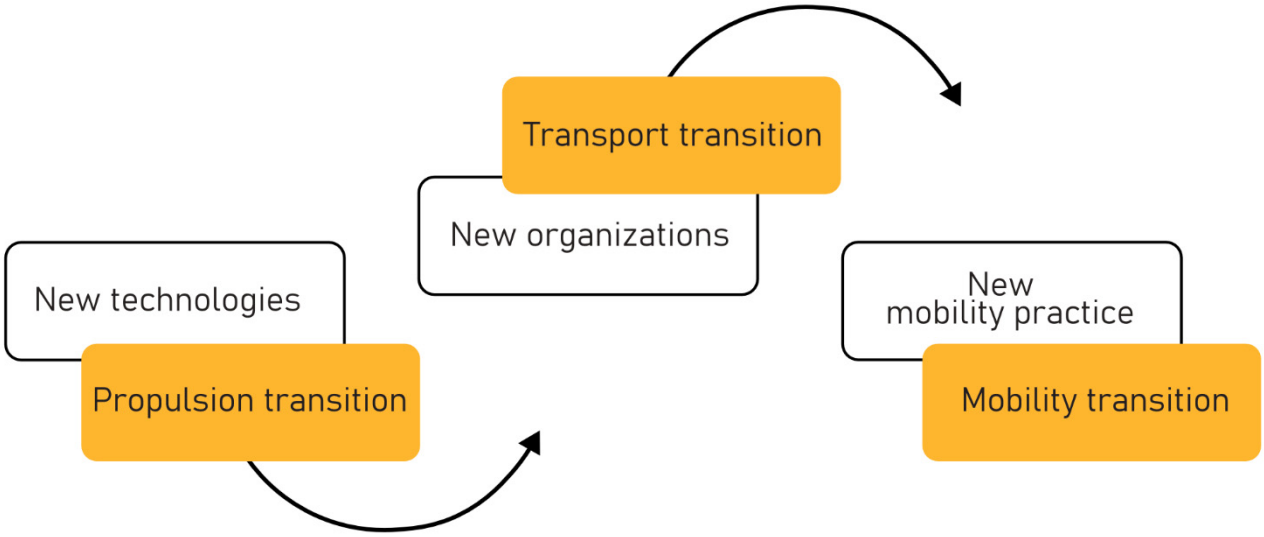

Figure 1. Triad of propulsion, transport, and mobility transition (own illustration).

One of the key regions of car manufacturing in Germany (Daimler, Porsche, Audi and suppliers of the industry), the federal state of Baden-Württemberg has formulated CO_2 reduction goals that are more ambitious than those of the German government. Within the next seven years, up to 2030, the federal state aims to cut CO_2 emissions by 55% in relation to 1990 [4]. To make this a realistic project, the government of Baden-Württemberg has formulated five goals for the mobility transition [5]:

1. Public transport shall be doubled within this time span;
2. Every second car shall drive without causing any negative climate effects;
3. Every second ton of cargo shall be transported without GHG emissions;
4. Urban and rural car traffic shall be lowered by one fifth; and
5. People shall move every second trip actively on foot or bike.

The types of measures and interventions defined to reach these goals testify to a profound awareness of the fact that comprehensive organizational and infrastructural innovations are key to realizing the desired transition. These include mobility as a service, easy ticketing, seamless mobility, or various sharing models—each of which can be considered measures that aim for a reorganization of transport (see "Transport transition", Figure 1). However, even in combination with an increase in the use of automation and artificial intelligence, this will not guarantee reaching the ambitious goals. The reason is that the achievement of sustainable mobility systems must be characterized as a 'wicked problem' ([6] p. 4). This fact makes the transition extremely difficult to implement because of the quantity of involved agents, their frequently contradictory preferences, and the embeddedness of current practices in the logics and routines of everyday life [7–9].

Scholars have argued for a multitude of approaches to address wicked problems. Most of them would agree with Brown et al. [8], who call for transdisciplinary research methods that account for the needs of the society and produce creative ideas based on the knowledge of the individual, the community, and different academic disciplines. In other words, individuals, civil society actors, and institutional stakeholders together are required to collaboratively and dynamically develop new perspectives to change everyday practices in mobility, transport, and in particular, the consumption of distance [10]. The consequence of such dynamics could be a sustainable mobility culture anchoring in the everyday lives and practices of people, institutions, and organizations, making the consumption of energy and resources a key topic on the agenda and an integral part of everyday practice and decision-making (see "Mobility transition", Figure 1). Only then is it justified to speak of a serious mobility transition, because people's everyday lives, routines, and social practices will be essential for a transformation process that is long-lasting and sustainable,

in conjunction with technological and organizational innovations and policy design as well as regulation.

Against this backdrop, a transition to sustainable mobility can gain momentum even before a sudden and full electrification of transport. Neither should one expect the complete reorientation of people and their values toward non-motorized means of transport. Rather, low-threshold offers and small changes can already produce measurable impact. For instance, the sharing of existing private vehicles and their more efficient use could achieve strong social, environmental, and economic sustainability effects [11]. By organizing and sharing journeys, CO_2 emissions can be reduced, costs can be saved, and people can be empowered to mobilities at low investments. Citizens who were previously excluded from activities such as cultural events, social, or political engagement, or who could not take advantage of shopping opportunities because they do not own a car can be socially integrated on the basis of shared mobility. In this way, socially innovative mobility concepts significantly expand people's opportunity spaces without the need for complex and expensive technologies. As a consequence, people's activity spaces grow and the degrees of freedom can be broadened [12] without extra cost to the environment.

More generally, people can often solve longstanding and vexing mobility problems at comparably low costs, without the need for path breaking technologies that they cannot afford. In fact, social innovations frequently come across as unspectacular, almost mundane. Quite often, simple solutions achieve the greatest effects [13]. Tina Saaby, the former city architect of Copenhagen, liked to call them "low-hanging fruits" [14]. The secret of the success of such small-scale solutions is that they directly address people's needs and match the reality of their everyday lives.

1.2. Mobilizing Society

Based on the conviction that solutions to current challenges are to be found within society, Hajer (2011) developed the concept of the energetic society, which values new forms of stakeholder involvement and governance [15]. Here, civil society becomes a key factor in actively propelling sustainability; open innovation systems become the basis for socially, organizationally, and technologically innovative solutions.

Against the background of the energetic society concept, co-creative and transformative potentials in society can be mobilized and become drivers of socio-technical and socio-ecological innovations. At the level of everyday life, new mobility potentials can be tapped and citizens can actively develop the future of mobility and become co-producers or "prosumers" of mobility solutions as needed. In this way, innovative solutions are often generated spontaneously by committed citizens or organizations because they see an opportunity or because they simply feel the necessity to act [16].

Wherever such local solutions emerge, imagining and designing post-fossil mobilities lose their abstract character. Mobility transition thus turns into a hands-on practical process, placed right in the middle of society, instead of somewhere else in some remote and closed-shop industrial districts [17]. In systemic terms, this means that social synergy effects are generated that enable people to practice sustainable mobility without experiencing this as a loss, a deficit, external demand, or even moral imperative.

In this context, it is imperative to acknowledge that mobility is far more than the "brute fact" of wanting to move from place A to place B ([18] p. 3). Rather, mobility is a highly emotional issue that modern people closely associate with their self-image as a mobile individual and with modern notions of freedom and autonomy [19]. Therefore, we reaffirm that sustainable mobility should not be treated primarily as a technical issue. Rather, it is about enabling sustainable mobility by reaching people close to their needs, and sometimes even at their pain points. In other words, the instruments, measures, services, and technologies essential in sustainable mobility systems must be accessible and intuitively plausible to people. Citizens must experience their affordance as meaningful, and they must be designed in a way that people can integrate them into their everyday lives. If we succeed in developing solutions for people's real-life problems that take their rationalities,

their needs, constraints, and opportunities seriously, we can achieve sustainability in transportation and in the organization of mobility.

1.3. The Three Pillars of Sustainable Mobility

In addition to ecological and economic burdens, the mobility sector in Germany faces major social challenges as there is unequal access to different forms of mobility, depending on the respective population class and its economic and social situation [20]. Accessibility and mobility options differ strongly between urban, suburban, peri-urban, and rural regions [21]. Sustainable mobility concepts address these ecological, social, and spatio-structural challenges [22]. These are aimed at meeting people's mobility needs equally and creating resilient, efficient structures in the long-term that do not place excessive burdens on people and the environment, either now or in the future. In addition, these concepts are supposed to not only be sustainable in social and ecological terms, but also financially [23,24].

Accordingly, we interpret the term sustainability as a multidimensional concept. It is not narrowed down to a primarily ecological perspective. Based on Brundtland [25] as well as the World Business Council for Sustainable Development [26], within MobiQ, we define sustainable mobility as mobility that meets society's needs for free movement, open access to resources, communication, trade, and social as well as economic relationships without compromising other essential human or ecological needs today or in the future. Additionally, in our view, the question of how movement in space can be organized in a resource-efficient manner necessarily also includes

- Climate change impacts;
- Medium- and long-term climate-friendly behavioral changes in the area of mobility (mobility practice);
- Redesigns in neighborhoods, as mobility and public space can be rethought and thus also be redesigned;
- The development of viable, new mobility services;
- The transferability of results to other regions and places.

1.4. Changing Mobility Culture

For lasting sustainability effects, the social innovation of a civil mobility culture is necessary to accompany the technological transformation of the current transport system [10,11,27]. Mobility is considered a basic need and a means of social integration and participation. Therefore, mobility must not simply be restricted or prohibited; rather, mobility systems and structures must be promoted that enable people to be mobile. Today, this can be established and realized in very different ways. Owning a vehicle does not have to be the sole key to mobility, as was often the case in the past [28,29]. Rather, it is about access [30] to mobility technologies and options. "Freedom is measured more by access to others in networks than ownership of property in markets. The deeper and more inclusive one's relationships, the more freedom one enjoys. (...) Freedom for an Internet generation is the ability to collaborate with others, without restriction, in a peer-to-peer world." ([31] p. 276).

These theoretical considerations leave us with the question of how they can be deployed on the ground. With the article at hand, we aim to offer first-hand insight into the living lab experience and inspire our colleagues around the world to harness networks of civic actors in order to contribute to a cultural change in mobility practice.

Along with a case of an ongoing living lab project, the article presents methods and experiences of opportunities taken to initialize mobility transitions. The methodological framework of the case, the living lab MobiQ (www.reallabor-mobiq.de (accessed on 13 February 2023)) in the southwest of Germany serves as an example for a bottom–up co-creative process of activating the civic energy for the future of sustainable mobilities. After a general introduction into living lab research, we elaborate on the methodological approach in MobiQ in Section 2. Section 3 presents the results of our analyses and of the practical

experience in their co-production with citizens. We discuss these results in Section 4 and present our conclusions in Section 5.

2. Methods

Due to its transdisciplinary and participatory approach, the method of living labs is particularly suitable for applications in the fields of the socio-economic transformation of mobility and sustainability. They offer "(...) a set of instruments (...) to work on societal problems together with science and with partners such as municipalities, associations and economic actors on site. Through scientific support, social transformation processes such as the redevelopment of urban districts, the introduction of sustainable mobility or energy systems can thus be better understood and shaped." ([32] p. 5). In the context of living labs, scientists carry out interventions together with the local population in the sense of real-life experiments, which are then analyzed and provide important insights into the social processes and dynamics of transformation processes [33,34]. The methodological approach of a community-led implementation aims at a sustainable transition of stakeholders' mobility practices in the context of living labs and beyond. Seemingly small changes through the active participation of civil society actors can achieve sustainable and profound effects [35,36].

2.1. Research Design in MobiQ

MobiQ is run by a team of transdisciplinary scientists working in close cooperation with local citizens and other stakeholders to identify the transformative potential in the project areas, activate it in the sense of the "energetic society" [15], and dynamically develop it with the citizens. The project applies an inter- and transdisciplinary, transformative, and research-based living laboratory approach. It aims at providing a regulatory experimental space to test the design and implementation of sustainable and neighborly organized mobility offers in a local context to make their added value tangible and easy to access. MobiQ thus initiates a transformation process that sensitizes and activates the citizens and local actors from different social classes for demand-oriented, neighborhood-based forms of mobility and an alternative use of public (road) space [37,38].

As shown in Figure 2, the MobiQ concept puts the research team at the center of the project. The researchers play multiple roles in the labs as initiator, facilitator and neutral activator as well as a research observer in order to analyze, evaluate, and feed in information and findings to the local working processes [39]. In addition, experiences from practice and research findings are continuously and scientifically reflected. As part of the internal self-reflection process of the project team, the funding institution of the living lab (Ministry of Science, Research and Arts Baden Württemberg, MWK) finances an external coaching process. Within this process, the collaboration within the team and with external partners is supported, the methodological reflection of the ongoing work is facilitated and a common understanding of the results of the whole living lab is developed.

The participation of local citizens, agencies, groups of activists, and companies (box to the left in Figure 2) ensures the relevance of the interventions and raises their interest in the sustainable and livable development of their own living environments and neighborhoods. In addition, the social acceptance of the developed and implemented measures can be significantly increased [40]. The key terms are therefore: *co-design* and *co-production*. These cooperative elements serve three functions (to the right of Figure 2). First, they enhance the probability that measures will be continued after the end of the project. Second, they are key to the production of transformatory knowledge and its retention on site. Finally, co-design and co-production facilitate the transfer of good practices to other contexts.

In order to kick-off processes of changing everyday mobility behavior and travel patterns, the lab initiates collaborative work in several domains. One subtopic addresses new concepts of using road space and finding community-based solutions for the neighborhood (city of Stuttgart). Another one seeks to reinvent shared mobility solutions for the grocery shopping of mobility impaired people and applies a participatory approach for reusing

space by conceptualizing a multifunctional mobility station in the heart of the city (city of Geislingen). The third subtopic explores innovative solutions for short-term, off-the grid commutes to work and cargomobilities (community of Waldburg). It is important to note that these subtopics have not been pre-defined. Instead, they emerged according to the articulated challenges and needs of the three study sites as part of the lab's philosophy is that activities, measures, and products are not planned and constructed for the citizens, but rather together with them [37,38,41–43].

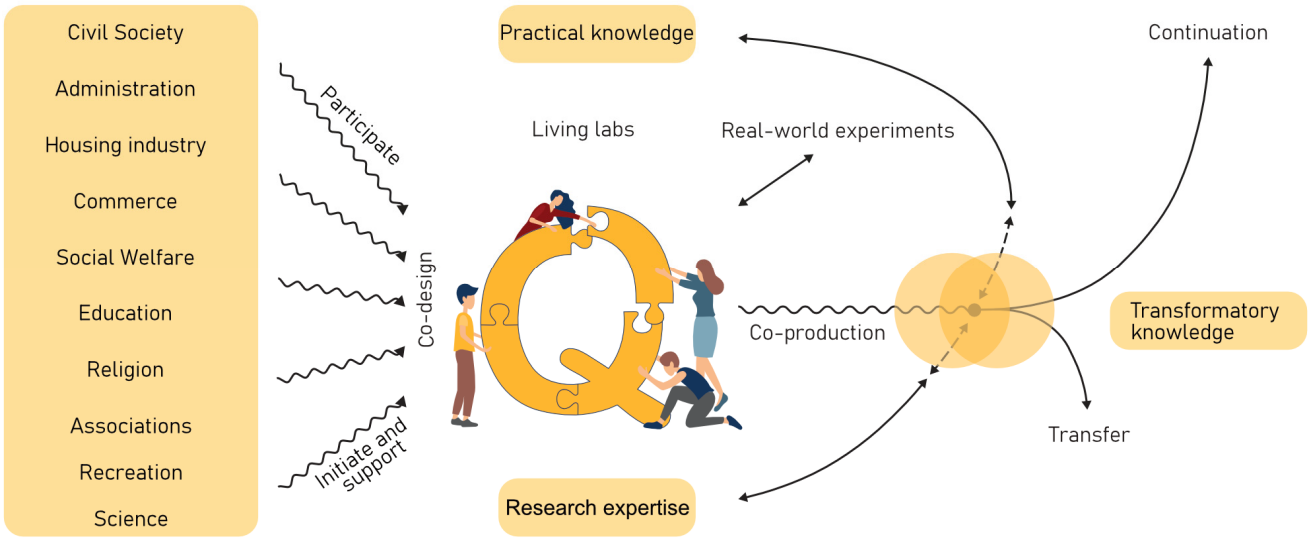

Figure 2. The concept of the living lab work in MobiQ (own illustration).

2.2. Spatial and Socio-Demographic Context Analysis

For the successful development of solutions tailored to the individual framework conditions and needs of the neighborhoods, an in-depth contextual examination of the sites is required. As part of the analytic strategy in MobiQ through mapping and photographic documentation, the team collected comprehensive data, analyzed the information gathered and provided a differentiated contextual analysis [39]. In order to gain an understanding of the field, spatial, functional, and design aspects had to be considered as well as the social, economic, and ecological ones [44,45].

Obviously, the traffic situation plays a key role in the analysis, in all three places. Different road categories, super-ordinate bicycle and pedestrian paths, and public transport services were examined and systemized. For the classification and specification of the neighborhoods, their topography as well as the different availabilities of open and green spaces were elaborated. A differentiation of the various uses of buildings was provided. Secondary analyses of existing datasets on family and age structure, migration background, net migration, housing types, and household sizes were used to determine the socio-demographic and socio-economic framework conditions of the neighborhoods. The aim of the situational context analysis was to make the qualities and deficits of the respective location visible and to identify potentials as well as risks in order to derive the need for action for the respective real laboratory [44].

In the context of the supplementary actor analysis, the living lab project sees itself as a stakeholder in the social fabric of the neighborhood and the immediate surroundings (Figure 3). Stakeholders from different sectors were grouped according to their potential degree of participation in the lab's projects in a three-circle model [46]. The analysis serves to identify existing linkages between active individuals, groups, companies, and authorities. In turn, it facilitates the linkage of the project to the social fabric of the neighborhood through the in-depth social network analysis.

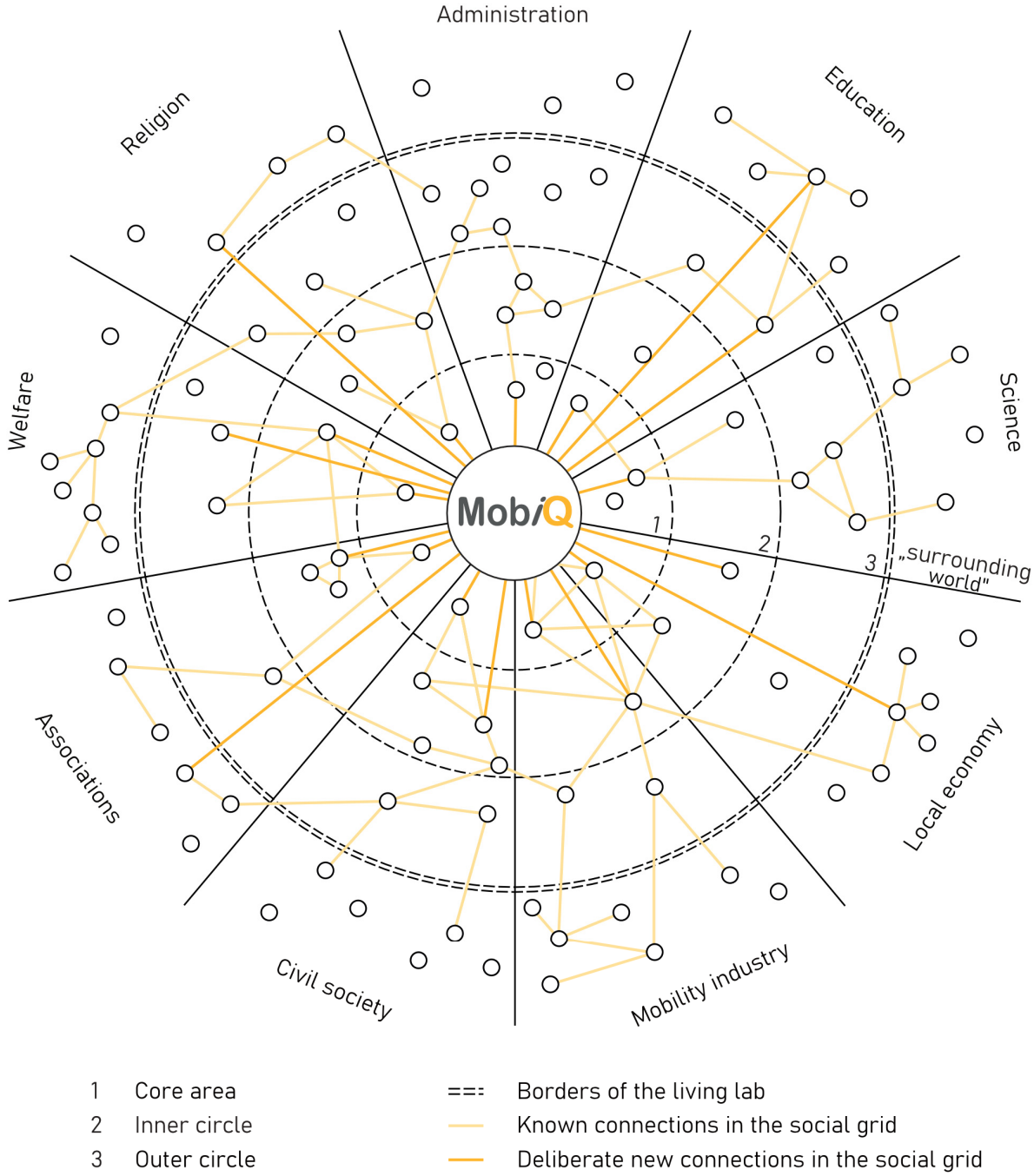

Figure 3. Actor analysis in MobiQ (own illustration based on [46]).

2.3. Learning from Best-Practice

Living labs aim to co-design and co-produce socially and sometimes technologically innovative solutions for citizens with the support of scientists and other stakeholders in the field. In order to prepare the practical work with citizens, we conducted 12 detailed analyses of other approaches, projects, and specific services for sustainable mobility. These cases were selected from a sample of more than 40 cases by the socio-economic structure of the cities, their spatial location, and their practicability and usability for the three neighborhoods of the lab. Most of the analyzed cases are situated in Germany, but examples from other countries such as Austria, Belgium, and France were included. The cases that were part of the investigation range from car sharing initiatives to cargo bike services, the integration of mobility services into co-housing concepts and the development of

ridesharing apps. The projects are described in detail by Kasten et al. [47] and are presented in short dossiers on the website of the living lab.

These examples are meant to serve as an inspiration for the development of tailored solutions in the three neighborhoods. The basis for this analysis is the canvas model after Osterwalder and Pigneur [48], which focuses on building business models. We expanded this model by considerations about how environmental policies can initiate and support new transformation processes toward more sustainable socio-technical systems [49]. The complete theoretical framework is elaborated in Peter Kasten et al. [47].

Based on the analyses of best practice cases, seven preliminary conclusions—formulated as hypotheses—were drawn, which guided the subsequent co-production work in the local sub-labs of the project:

1. *Mobility offer:* Community-based mobility offers vary by target group and context. In other words, solutions for local mobility problems are mostly specific, place-sensitive, and almost never immediately transferable. This makes the upscaling and dissemination of solutions challenging, even for successfully established projects.
2. *Use patterns and users:* Many community-based mobility services have been used primarily by homogeneous groups of rather high-income and well-educated people. Nevertheless, low-threshold sharing offers without too many rules as well as ridesharing offers and driving services with a high level of social interaction amongst users are increasingly also reaching other social groups.
3. *Leitbilder:* A strong common mission statement as a guiding vision that is supported by different stakeholders and people active in the projects provides incentives to engage in the operation of the collaborative mobility service and strengthens the acceptance to adopt common rules for the design of the mobility service.
4. *Key persons:* In almost all cases analyzed, individuals carrying and promoting the co-productive processes to a wider public play an important role in its success. They often stem directly from the group of people who initiated the collaborative work on mobility solutions and offers to the neighborhoods. Some of the technical expertise for the development and operation of the service frequently comes from external sources and the supporting networks around the projects.
5. *Types of implementation processes:* Typical implementation processes can be identified: (1) mobility offers in community housing projects, where the mobility offer is part of the community development of the living and residential environment; (2) initiatives of persons (groups) who want to create more suitable mobility offers for themselves and others; and (3) participative projects initiated by politics.
6. *Financing and ensuring operation:* The central pillar for the operation of community mobility offers is civic commitment and activities. Financing structures can vary widely between different types of collaborative mobility offers. In particular, providing initial investment can be a key challenge for the emergence of collaborative mobility offers. Overall, financial support from public sources (e.g., via direct grants, research projects, donations, etc.) plays a central role in the emergence and operation of mobility offers and for the success and the stability of the overall project.
7. *(Im)material key resources:* There are differing opinions on a reasonable degree of automation and digitization of the operation of offers. While automation and digitization can simplify the organization of operations, they can also raise the threshold for entry, acceptance, and use.

These hypotheses will be tested further as part of the evaluation of the MobiQ sub-labs and will be reformulated and communicated at the end of the lab (spring 2024). The conclusions from the case studies must be considered as work in progress as they will be refined by integrating our own experiences over the course of the project. As for now, they are serving as the description of the structural conditions and resources necessary for developing successful bottom–up civil society driven projects for sustainable mobility within neighborhoods.

2.4. Understanding Context: Socio-Material Network Analysis

One of the major problems of living labs and other initiatives aiming at facilitating and implementing new mobility solutions is how to contextualize projects in urban environments. MobiQ has further developed the method of "socio-material network analysis" [50], which has been successfully applied in the "mobility pioneers project" within the special research area "Reflexive Modernization" (see [29,51]). Based on interviews and social as well as geographical network mapping data, the research team conducted a comprehensive analysis in order to gather key information on how to embed the projects of the living labs into the local socio-cultural, spatial, and infrastructural contexts.

As previously mentioned, the living lab is divided into three study sites, one urban, one peri-urban, and one rural environment. Thus, data needed to be collected for each sub-lab (Stuttgart, Geislingen, Waldburg) through a minimum of fifteen structured in-depth interviews per location with residents, potential organizers, and stakeholders (including ego-centered social and geographical network maps). The interviewees were recruited directly from the local context. The narrative interviews connected the results from the analysis of the spatial context conditions with individual data, reflections, interpretations, and the like [52]. However, this still does not comprehensively explain the realities of the citizens' lives on the spot, since people "develop complex socio-material network structures in which social relations, geographic locations, and virtual 'localities' are interconnected." [51] (p. 342). This is where the combination of geographic and social network maps enable researchers to reveal the mobility potentials of social network structures in the specific neighborhoods. Socio-material network analyses can identify the actual movement patterns and show connections between social networks and travel routines. The method allows for an initially type-specific and then case-/persona-specific approach to the mobility patterns of participants [50]. It is important that in the course of case selection in the research process, documentation is created in the form of dossiers of the interviewees [53].

3. Results

The three study sites (Stuttgart-Rot, Geislingen an der Steige, and Waldburg) differ greatly in terms of traffic, settlement structure, urban development, social structures, and socio-economic situations. Based on the socio-economic, socio-spatial, and socio-material analyses of the three locations and the relevant neighborhoods and guided by the sophisticated analyses of best practice, the three sub-labs had developed very clear problem definitions and started the process of generating context-sensitive solutions.

In the following, we present the results of our context analyses (Sections 3.1, 3.3 and 3.5) together with the outcomes of the co-production of problem definition and solution generation (Sections 3.2, 3.4 and 3.6) for each of the three study sites.

3.1. Socio-Economic Context in Stuttgart-Rot

Stuttgart is the state capital of Baden-Württemberg with 630,000 inhabitants. Stuttgart-Rot, the urban study site of MobiQ, is a district of Stuttgart and accommodates about 10,500 people. It was built after the Second World War as a large housing estate for several thousand residents [54]. Rot was created after the Second World War as a large housing area on the northern outskirts of Stuttgart. Demographically and culturally, it is characterized by a high proportion of elderly people (over 65 years) and almost two thirds of people with a migration background (64%) [55].

The majority of the buildings in Rot are three-, four-, or five-story row houses (see Figure 4). The distinctive *Romeo and Juliet* high-rise buildings by architect Hans Scharoun are listed as historic monuments and characterize the western entrance to the neighborhood. Most of the apartments in the row buildings are owned by housing associations including the municipal housing company and building cooperatives with a social orientation. Private housing is located mainly in the peripheral area, where detached houses can be found. In the course of the International Building Exhibition StadtRegion Stuttgart 2027 (www.iba27.de), further housing offers with a high urban, architectural, and social standard will be created.

Figure 4. Characteristic row buildings at the study site of Stuttgart–Rot (photo: the authors).

Retail and services for daily needs are mainly concentrated in the west of the large housing estate. Consequently, many people have to travel long distances. The district offers a wide range of social infrastructures such as kindergartens and schools. A community center is the central meeting place where public and private events take place. As part of the German Socially Integrative City urban development program, numerous constructions and social projects have been implemented in the district and the infrastructure was further improved (2003–2017). A citizens' association is committed to social life in the district and initiates projects. For example, the Zuffka, a bicycle rickshaw, is a special mobility service provided by volunteers. The interviews conducted show, on the other hand, that the willingness in the district to share (private) vehicles of all kinds is considered to be rather low.

A tram connects Rot to Stuttgart's railway station and the city center every 10 min. Although the public transport service is supplemented by two bus lines, residents sometimes have to walk longer distances to the stops. Despite a rental station for car-sharing vehicles, the share of new registrations of private cars has risen continuously in recent years [55]. The close-meshed street network in Stuttgart–Rot follows the basic principles of organic urban design of the 1950s, with stationary traffic dominated the street space.

3.2. Co-Production in Stuttgart–Rot

In April 2022, the living lab in Stuttgart–Rot commenced its co-creation phase with a workshop for citizens. Around 30 participants attended the event, which primarily revolved around the question "where the shoe pinches" to define the needs of the inhabitants regarding mobility and provisioning. Despite the detailed preparatory work to characterize the neighborhood, the profound local knowledge of those who live there and who experience opportunities and risks on site proved to be indispensable for the further progress of the project. The sheer volume of passenger cars and the stationary traffic were soon identified to be the central challenges of the neighborhood. In addition, participants complained about the anonymity within the urban district, which they attributed to its size and the urban context. To address these challenges, the project team facilitated the creation of ideas about how the inhabitants could co-organize shared mobility to improve social

cohesion and support access to the collective. Several follow-up meetings of a growing number of engaged citizens and representatives of various organizations (municipality administration, construction cooperatives, welfare organizations, church congregation, the civic trust, associations, etc.) further developed these ideas.

Stuttgart–Rot is dominated by motorized individual transport. The use of the street for driving and parking, however, neglects its potential as space for social interaction. Together with the citizens and other engaged people of the neighborhood, the research team seeks to harness this potential to make room for active mobility, play, amenity, exploration, encounters, exchange, and participation. The high level of intrinsic motivation, great endurance, and pooled resources has enabled the organization of the incubator event "110 m of Fleiner future". During the city-wide mobility days in 2022, motorized traffic was banned from one segment of Fleiner Street for one entire day. Different actions, information, and games for all ages were organized around the topic of sustainable mobility.

Adults could test walking bikes, a rollator rally was organized, and rickshaw rides offered. Furthermore, visitors could take a look at the local projects currently running in the wake of the International Building Exhibition, which will be hosted by the city of Stuttgart in 2027. Green spaces, seating accommodation, food, music, literature, donkey rides, and a dance created an atmosphere that encouraged people to stay, talk, make contacts, and think about creative ways to design and organize the street. All activities and catering were organized and funded by the different participants of the living lab.

This easily accessible and inclusive event organized in the public helped people to experience the value of a car-free street and displayed the engagement of the multitude of active citizens in the neighborhood. The incubator for the "110 m of Fleiner future" can be considered the kick-off of a transformation process, since it raised the awareness of people from different social milieus in terms of innovative mobility modes and alternative ways to use the public space on streets. A number of visitors provided positive feedback and committed to future activities within the living lab.

The next workshop was held in December 2022 in Stuttgart–Rot. Together with the citizens, the research team will review the past year and discuss possible scenarios to follow-up on the great success of "110 m of Fleiner future" in 2023.

3.3. Socio-Economic Context in Geislingen

The study site *Upper City in Geislingen* is located in the district town and university city of Geislingen an der Steige, a medium-sized town of 28,000 inhabitants on the eastern edge of the Stuttgart region. This medium-sized town is in an economically challenged situation with an unemployment rate of 4.3% [56]. Geislingen is part of two commuting areas—to the regional capital of Stuttgart to the northwest (about 650,000 inhabitants) and to the city of Ulm to the south (130,000 inhabitants). The mobility situation in Geislingen is characterized by a negative commuter balance, which means that more people are commuting out of the city than into it. In addition, there is heavy transit and delivery traffic that goes right through the city center and its most valuable spaces. Most of the destinations for commuters are located along the Stuttgart–Ulm railroad line or are easily accessible via bus connections. Geislingen is spread over a total of five deep valleys on the ridge of the Swabian Alb (see Figure 5). Due to its topographical location with several places of interest in the surrounding area and the relatively good train connections, the town is a destination for tourists, especially on weekends. The local University of Applied Sciences is based in the *Upper City* (Obere Stadt) next to the train station and a park, and is five minutes away from the pedestrian zone. It provides good conditions for commuting for students by car and by train.

The federal road not only brings noise and air pollution to the town, it also works as a strong spatial structuration of the entire city as it literally separates it into two halves. This has significant effects on the urban atmosphere and the livability of Geislingen. The historic old town lies roughly southeast of the federal highway. It is characterized by a heterogeneous, medieval building structure, with half-timbered houses, which slowly

changes into a block structure toward the north. These inner-city residential blocks largely date back to the turn of the century around 1900 and were built for employees and workers of the Württembergische Metallwarenfabrik (WMF) and the Maschinenfabrik Geislingen (MAG). WMF and an Outlet City attract people from outside the town. On the slopes of the valley basin in the west, single- and multi-family houses were built in the second half of the 20th century, while in the east, especially around the train station, larger historic villas and spacious buildings originally planned as single-family houses were built.

Figure 5. View over the study site of Geislingen and into the valleys (photo: the authors).

Around 6000 people live in the neighborhood. The population structure is heterogeneous and culturally diverse. The proportion of migrants in the neighborhood from, for instance, Bulgaria, Croatia, and Turkey, makes up about 45 percent. The largest age group is 30–45 year-olds with about a 21% share of the total population. The active part of civil society is organized in about 200 associations. There is a large range of social institutions as well as a youth community council and an integration council, affiliated with the city council. A central node of the local civil society and an important social meeting place in the neighborhood is the multi-generation house. In this facility, groups meet for a wide variety of activities without having to form extra associations for this purpose. The multi-generation house was identified as the most important multiplier and starting point for civic activities.

3.4. Co-Production in Geislingen

The co-creative work in Geislingen was also propelled by a half-day workshop in March 2021. Almost 50 citizens took part in the workshop. Participants were given four different problem scenarios, based on prior research. These scenarios were supposed to help them to delve into the topic quicker, as it was assumed that "mobility" could be too open. Interestingly, a majority did not bother with the problem scenarios and the personas, but started to work with "their" topic immediately. This could be one takeaway from the workshops in Geislingen, that people went into the working phase with a very specific

topic that they care about and that they want to work on. A prior formulation of topics is not necessary; they are the experts of their mobility.

In the workshops, problem formulations the groups came up with during the first phase of the workshop were mostly around issues connected to mobility poverty. In particular, senior citizens feel disconnected and "put on the sidetrack".

Structural changes in Geislingen have led to the situation that the old town with its pedestrian zone and about 6000 inhabitants has lost much of its attractiveness and livability. Planning decisions of the past, which include the car-friendly relocation of supermarkets toward the outskirts and the design of a new artificial city center, which is a shopping mall, have led to the absence of a discount supermarket in the neighborhood and causes complicated trips, specifically for mobility impaired people and for people without their own car. Many of the participants indicated that this was a major problem and therefore much attention has been given to developing possible solutions for this. Therefore, a pilot shuttle bus service from the neighborhood to the two grocery-shopping locations started in October 2022, operated by volunteers with the support of the local district youth council association. Here, the self-identification of MobiQ as an actor in the existing social network who identifies and uses existing social connections and creates new ones, became obvious.

In addition to the project of initiating and operating a shuttle bus system for grocery shopping, the Geislingen lab is working on conceptualizing and designing a mobility station in the city center in order to provide a differentiated supply of sustainable mobility devices. Here, a thorough analysis of possible locations has been undertaken and a concept of a network of such stations has been put forward. Furthermore, the design of the mobility stations was produced in a participatory way.

Another group of citizens interested in public transport is currently working on a vision for the deployment of a demand-driven public transport concept in Geislingen. Another group is working on the improvement in bicycle facilities in the inner parts of the city, in order to make the city more bicycle friendly. The latter two groups are currently struggling with gaining a critical mass, in order to be able to bring something to life in 2023.

This shows that in a car friendly place, even if the problems of city-planning for cars have become obvious to many people, it seems to be a challenge for laypeople to imagine and bring to life solutions that go beyond a continuation of the current system (of automobility) and would demand interventions.

3.5. Socio-Economic Context in Waldburg

Waldburg is a village community with about 3000 inhabitants on the edge of vibrant economic and scientific centers (Ravensburg, Weingarten, Friedrichshafen) and the tourist regions of Lake Constance and the Allgaeu Mountains. Until a few decades ago, the economy was mainly based on agriculture. Today, the town can be described as a rural region with local recreation destinations, residential areas, and a strong local manufacturing industry. Waldburg has a high car density and inhabitants feel dependent on their cars. Thus, almost everyone has access to a car. The topography and the climate raise enthusiasm for active modes of transportation such as cycling or walking. Access to the next larger city, Ravensburg, can be described as adequate (a bus runs every half hour during the day), but other points of interest around Waldburg (e.g., other cities and shopping opportunities) are not (easily) accessible by public transport.

In terms of urban development, the town is characterized by a growing and scattered development of primarily detached houses (see Figure 6).

Associations play a central role in Waldburg's social network. Starting points for innovative formats of social interaction are, for example, intergenerational forms of living, a digital neighborhood network, and a repair café. There is a great interest in and awareness of sustainability issues. Nevertheless, car-centered mobility behavior prevails in many cases, as could be determined in interviews, among other things. There is a pronounced and growing number of commuters to work and school. Many residents do not perceive the public bus connections as sufficient. Bicycles or pedelecs are mostly used for leisure activi-

ties or short errands within the town, and rarely for long-distance trips to work or school. An important reason for this are gaps in the local and supra-local bike path infrastructure.

Figure 6. Detached houses and green spaces in Waldburg (photo: the authors).

From the network analysis, it became clear that shared mobility is already taking place, for example, by people working in the business park. Vehicle sharing in the closer social environment is already practiced. A broader application seems to fail due to restrictions on personal flexibility in combination with a simultaneously low problem pressure connected with the use of private vehicles. The interviewees also suggested additional flexible on-demand public transport services as possible solutions.

3.6. Co-Production in Waldburg

The co-production of sustainable mobility in the small municipality of Waldburg faces some unique circumstances. Following extensive desk research, the mapping of points of interest in the Waldburg region, and numerous interviews with people who work or live in Waldburg, the project team identified five key challenges: (1) Commuting for seniors; (2) daily commutes for the general population of Waldburg; (3) work-related commutes from Waldburg; (4) work-related commutes to Waldburg; and (5) public transit accessibility.

In March 2022, the first MobiQ workshop was held, open to all people who live or work in the Waldburg region. More than 20 people attended the workshop, which was opened with a speech by the local mayor. Participants chose one of the key challenges presented above to work on during the workshop. Of the many project ideas that emerged during the March 2022 workshop, three were promising enough for the participants to form project groups. One group started to work on the idea of launching a social transportation service operated by volunteer drivers using their own cars to transport local people. Another group began looking at improving the accessibility of the local industrial area. A third group focused on launching a free cargo bike-sharing service. Over the next several months, the research team advised the separately working project groups on how to develop and implement their project ideas. A second plenary workshop was organized in October 2022. The opportunity was given to new project team members to come on board and perhaps bring in new ideas. This workshop brought all project ideas closer to the pilot and implementation phase, which was expected to happen between winter 2022 and spring 2023.

4. Discussion

One of the main interests in MobiQ is to better understand the specific conditions, limitations, and potentials of participatory mobility development and co-design processes in urban, peri-urban, and rural environments. Differences between the three locations of the living lab have become quite clear and transparent. This applies specifically in relation to the socio-demographic, spatio-structural as well as the infrastructural and cultural framework conditions. This is particularly evident in Waldburg, where distances are short—not only in the sense of travel, but also in terms of social proximity. The evidence for the characterization of a social network like the one in Waldburg would not be possible to elaborate based solely on desk research or through photo documentation. For a deeper understanding of how the neighborhood functions on a social level, the researchers must engage and involve themselves into the social fabric of the study site.

The civil society in Waldburg, for instance, is based on social proximity. People know each other and often have a common history. Active people and the political and economic leaders are known in person and are accessible. The social thresholds are low. The local research team encountered a social situation of high commitment and that was ready for action and change. In Stuttgart–Rot and Geislingen, the situation was different. This has to do with the complexity and size of the neighborhoods and the fact that we are dealing with urban structures instead of rural contexts. The task of identifying potentials for social commitment in order to shape sustainable mobility in the first place and then to activate it in a project-specific way is different, but not necessarily more complex.

Grounded in the evidence of the socio-material network analyses, it was possible to identify the key players in each of the sites. This made it possible to reduce the high level of social complexity in the field to a level beneficial to initiating collaborations and synergies between individuals, associations, initiatives, non-governmental organizations, and so forth. The analysis confirmed, for example, that the aforementioned multigenerational house in Geislingen was a major social node within the urban society as it functions as a hub, connector, and incubator of social innovation, activities, and commitment in the city.

The situation in Stuttgart–Rot looks quite similar in many ways. Here, the community center, thoroughly renovated and newly expanded, has proven to be an important hub and node in the neighborhood. A committed citizens' association and a wide range of actors from the social sector and the socially oriented housing industry have been identified as key players. An already established mobility project is based on a service idea for people who are not able to make their own way around the district. In the interviews conducted so far, there is a tendency of skepticism toward the idea of sharing (private) vehicles with neighbors.

The methodology applied within MobiQ proved to be instrumental in identifying strong social networks. It lays a foundation and builds the evidence base for efficient and resilient co-production activities within the social context of the living lab. Whether we could really harness these networks of civic actors to contribute to a cultural change in mobility practice is hard to tell at this point. Emerging activities like the street festival in Stuttgart–Rot, or the grocery shuttle in Geislingen may appear as quite isolated events. Nevertheless, they certainly qualify as valuable points of entry without which a cultural change would be less likely to happen. In connection with the upstream analysis of examples from other cities and municipalities as well as from the international context in the real laboratory and on the basis of the network analyses, context-sensitive approaches for mobilizing civil society for sustainable mobility can be generated step-by-step in a further process.

5. Conclusions

Research in living labs is a complex and sometimes tedious task. In the course of MobiQ, we often came to a point where the activation of the energetic society left us exhausted and frustrated. However, events such as the incubator "110 m of Fleiner future" in Stuttgart–Rot, or the kick-off of the grocery shuttle in Geislingen, were moments that

encouraged us and strongly supported our conviction: Interventions to change mobility systems can increase their impact significantly when planned and implemented in cooperation with the citizens and other stakeholders. They are the problem-owners, the local experts as well as the ambassadors for enduring solutions, regardless of how small-scale and local they may appear at first. The importance of context sensitivity and co-creation becomes clear once we look back at the interventions described in Section 3: a grocery shuttle would have been as useless in Stuttgart–Rot as a blocked road would have been in Waldburg. The entire scientific knowledge, sociological theories, and socio-economic analyses would have been useless without researchers translating it into the specific context and listening to the needs and desires, the challenges, and the barriers of the local citizens.

The European Union, Germany, and especially Baden-Württemberg have set themselves ambitious goals to fight climate change. To reach these goals, fundamental change must happen in many domains. In other words, it requires an energetic society to propel and resonate with the dynamic processes aiming at sustainable mobility transition. As argued above, it has become clear that this transition of the mobility system, or of any socio-technical system for that matter, can only be achieved by fundamental shifts in practices and cultures. Living labs precisely address these shifts from three different perspectives: they activate citizens and their practical knowledge, they structure and generalize this knowledge for use in different contexts, and they finally serve as a showcase for imagining different and more sustainable futures.

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