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How to Plan for Transformative Change in light of New Mobility Technologies? A Discussion on Reflexivity as a Planning Principle and the Format of Real-world Laboratories

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The fundamental uncertainty that accompanies innovation and transformation processes has influenced a growing body of literature on adaptive, explorative and reflexive planning. Such notions take stock of the complex interdependence in technological, social and spatial development. The article explores notions of reflexivity in urban planning and expands three dimensions with respect to the ongoing mobility transition: Openness and flexibility; learning and exploration; and embedding of initiatives. In this context, the article further reviews real-world laboratories as a format to structure learning processes and transdisciplinary collaboration for alternative mobility futures. In the wake of a rapidly growing new mobility sector in cities, aspirations of problem-solving through technology prevail. Yet urban planners and policy makers are challenged to evaluate opportunities and risks in relation to existing urban development goals. Reflexive strategies encourage long-term thinking, anticipation of unintended consequences and short-term explorations. A systematic integration of reflexivity can enable urban planners to intentionally guide change processes, while also facilitating the agency of others.

Keywords: Reflexive planning, new mobility technologies, learning processes, entrepreneurial action

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Introduction

Within the emerging discourse on new mobility technologies, such as 'Mobility as a Service' (MaaS), micro-transit and self-driving cars, urban and societal implications have only recently gained attention. So far, industrial research and design strategies (R&D), legislative actions, regional economic policy, and traffic system analysis have been the primary fields of concern. However, urban planners, architects, and municipal public administrations increasingly question the impact of future mobility on the liveability of cities. The need to understand and evaluate how new mobility technologies might affect the design of public spaces and urban form, as well as changes in land use, infrastructural investments, property values or active mobility modes, is increasingly recognized (Howell *et al.*, 2019; Ionescu *et al.*, 2019, Mitteregger *et al.*, 2019). Most pertinently so, as it remains difficult to identify and prioritize most effective policy actions.

The challenge at hand lies in envisioning possibilities for urban transformation that utilize the technologies' potentials in line with existing urban development goals (Heinrichs *et al.*, 2019). Given that many cities face limits in infrastructural capacity, increasing environmental pollution, and continued urbanization, prospects of technological problem-solving within the transportation industry appear as welcome resolutions to complex urban challenges. Paradoxically, history has shown that 'improvements in efficiency spur demand' (Goulden *et al.*, 2014, p. 145). Rather than bringing about savings or environmental relief, infrastructural enhancements such as road network expansions have instead shown to reinforce resource-intensive ways of life (Sonnberger & Gross, 2018). Research on fully automated traffic systems has correspondingly concluded that an increase in convenience, affordability, and value of time could cause the number of trips and levels of congestion to increase (OECD, 2015). Moreover, recent assessments of on-demand ride services, which are considered a 'bridge technology' for automation, have shown that urban congestion levels in large American cities have increased over the years since their introduction (Erhardt *et al.*, 2019; Schaller, 2017).

As new service providers and technological pilot projects gain presence in cities, it has become paramount for public administration and planning departments to engage in multi-stakeholder dialogues, develop agendas, and implement policies (Hoadley, 2018; Heinrichs *et al.*, 2019). However, it is important to note that cultural mobility practices and spatial morphology contribute to a 'remaking of the system of automobility' (Urry, 2004, p. 32), as much as vested stakeholder interests or established planning procedures and institutions (Pflieger *et al.*, 2009). The introduction of new urban mobility options thus requires planning approaches, which incentivise active mobility modes, public transit, and shared ridership of on-demand services, while mitigating negative effects such as economic displacement and urban sprawl. After all, mobility equity and sustainability issues are unlikely to be improved by new technologies on their own. Instead, the increase in comfort of automated transportation is expected to cause a decline in active mobility modes and the viability of public transit (Stead, 2019). Increasing economic, social and environmental costs (*ibid.*) could particularly affect those who are financially most reliant on affordable mobility access. Positive future scenarios thus require collaborative learning about opportunities and risks, as well as reflection on existing planning approaches and institutional structures that have previously caused the system of automobility to evolve. But how can urban planning contribute to systemic change and envision corresponding urbanity?

Against the backdrop of uncertainties and unforeseeable developments that commonly accompany innovation and transformation processes, the discourse on flexible and exploratory approaches has expanded within planning theory and practice (Balducci *et al.*,

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2011). In order to tackle complex urban challenges, 'evolutionary approaches' (Bertolini, 2007, p. 1999) and 'adaptive approaches' (Rauws, 2017, p. 35) recommend an incremental development and loose rules rather than detailed regulations. With regards to the ongoing mobility transition, explorative and reflexive planning practice have gained increased attention (Freudendal-Pedersen & Kesselring, 2016; Hopkins & Schwanen, 2018). In this context, the present paper acknowledges the need for proactive planning action and policy implementation, but questions means of guiding transformative change.

The main question of the article thus concerns the means by which reflexivity can be systematically integrated into planning processes in order to guide a considered change in an early phase of technological transition. Building upon literature from transition studies as well as social and planning theory, I argue that reflexive planning strategies can be of threefold relevance to urban planning when preparing for urban deployment of emergent mobility concepts. It is worth examining established formats that used to structure learning processes and transformative change by harnessing the potential of stakeholder collaboration and social entrepreneurship. The aim of this article is to contribute to the discourse on urban planning strategies for new mobility technologies and means of guiding transformative change through civic engagement by providing a theoretical discussion on:

- (1) selected notions of reflexivity from governance and urban planning literature;
- (2) three dimensions of reflexive planning, which are proposed as conceptual extensions in the wake of new mobility technologies;
- (3) the concept of real-world laboratories as a format to structure learning processes and transformative change by establishing a reflexive framework and incorporating social entrepreneurship.

Theories on reflexivity: embracing ambivalence & change

'Acting in uncertainty – this is what the philosopher Ludger Heidbrink once called the new reflexivity' (Schwarz, 2014, p. 206)

The following section introduces theoretical notions on reflexivity from the literature on transition studies, social theory, and planning theory in order to then elucidate the relevance of reflexivity as a planning principle when dealing with the complex dynamic of change, in light of new mobility technologies. At the turn of the century, Voß *et al.* (2006) describe reflexive governance, as 'an emerging path of thinking and practice in societal governance and problem solving' (p. 419) called for by a growing discourse on social, environmental, and economic sustainability. The authors suggest a crucial differentiation of the concept. First, referring to the discourse on reflexive modernization as introduced by Beck (1994), reflexivity is understood as the condition of governance in the modern world, which is perpetually faced with the task of repairing unintended consequences induced by prior developments (Voß *et al.*, 2006). Modernity is confronted with its destructive, even self-destructive, potential, its risks and its limitations (Schwarz, 2002). This first notion thus implies a material rather than cognitive self-confrontation. The second reading, which Voß and Kemp (2006) introduced as 'second-order reflexivity' (p. 7), refers to specific strategies, processes, and institutions, which emerge due to the condition of self-confrontation. Actors' cognitive reflection is meant to prompt a 'corresponding adaptation of problem-handling practices' (Voß *et al.*, 2006, p. 437). Alternative strategies therefore actively explore uncertainty, ambivalences, and distributed control of problems, which become apparent in the confrontation of different rationalities (Voß & Kemp, 2006). The strategic elements Voß and Kemp (2006) propose for reflexive governance encompass (p. 17-20):

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- integrated (transdisciplinary) knowledge production,
- adaptivity of strategies and institutions,
- anticipation of the long-term systemic effects of action strategies,
- iterative participatory goal formulation,
- interactive strategy development.

In contrast to modern means of problem-solving, built upon scientific certainty and definitiveness, reflexive problem-solving remains inconclusive and temporal (Schwarz, 2014). By doing so, principles such as precaution, experimentation, tolerance of mistakes, and learning gain significance (Voß *et al.*, 2006; Schwarz, 2014). Acknowledging that there is not one, but several possible ways, with often contradicting futures, reflexive strategies are vital for interdisciplinary and transdisciplinary processes which pursue alternative trajectories (Freudendal-Pedersen & Kesselring, 2016).

Lissandrello and Grin (2011) introduced one example of how reflexivity can be integrated into urban planning practice which they framed 'as a new tool for generating critical knowledge and dialogue' (p. 223). The multi-stakeholder 'region dialogue' on sustainable developments in the Port of Amsterdam served as a case study for a planning process in which various stakeholder perspectives were synthesised and past, present, and future developments were reflected. Through an open and deliberative setting, participants were encouraged to reconsider established planning practices and their institutional context. Assuming reflexivity, stakeholders' imagination could be redirected 'towards new visions of the future based on a redefinition of their past understanding' (Lissandrello & Grin, 2011, p. 243). The role of planners in the process lay in facilitating stakeholder interaction, confronting differences, and redirecting imagination towards possible futures. While urban planning projects often develop reflexively, that is, through a perpetual coordination of a multitude of stakeholders and their respective forces (Jessen *et al.*, 2008), the cited example of second-order reflexivity transcends mere cognitive actualisation. Instead, it explores the capacity for change through a social learning process grounded in intentionality and consciousness (Lissandrello & Grin, 2011). The approach is valuable to further considerations on guiding urban mobility transitions, as it emphasizes the 'transformative potential of agency' (Lissandrello & Grin, 2011, p. 224). As illustrated above, reflexive practices bear the potential to instigate social learning through self-confrontational interaction and to trigger structural changes through an inter-subjective redefinition of social realities (Freudendal-Pedersen & Kesselring, 2016; Schneidewind *et al.*, 2018).

Considering Reflexivity in Urban Planning with Emerging Mobility Technologies

To continue, I will deduce three dimensions of reflexivity from the literature on transition studies, planning, and social theory in order to elaborate their relevance for urban planning in the wake of new mobility technologies.

Openness and flexibility in the age of digital connectivity & automation

With the influx of on-demand mobility services, sensor-based connectivity, and self-driving vehicles, the rationalisation of urban flows and processes proliferates. After all, data-based mobility services, as well as artificial intelligence and predictive analytics, are built upon the conviction that 'better' data or 'better' models can substantively reduce, if not eliminate, uncertainties and risks (Hillier, 2017, p. 300). In contrast to such tendencies, Voß and Kemp (2006) elaborate that 'the more problem-solving is disengaged from the full, messy, intermingled natural reality and oriented towards the worlds of specialists, the larger the share of interdependencies and dimensions of embeddedness ignored in the development and

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implementation of supposed solutions.’ (p. 5). Building on such notions, the discourse on complex urban systems (Portugali, 2012) emphasises the multiplicity and interdependency of urban processes underlying urban transformation. Thus, planning approaches and strategies that embrace ‘non-linear temporalities’ (Hillier, 2017, p. 308) and provide conditions for urban development to take place under varying future circumstances, are gaining relevance, (Rauws, 2017). But how can such openness be translated into urban planning approaches with new mobility technologies?

The adoption of new mobility technologies could lead to both advantageous and disadvantageous changes in urban fabric and street design. Studies suggest that high numbers of shared automated vehicles could potentially reduce the need for parking areas, enabling the reclaiming of space for public usage and active mobility modes (Zhang *et al.*, 2015; OECD, 2015). However, such effects are strongly dependent on the degree of technological adoption and public acceptance of shared ridership. A contrary effect could be that convenience and affordability influence the increase of urban trips, which could further cause congestion rates to rise and spatially separate urban streetscapes. The urban environment could thus become less accessible and permeable for pedestrians and cyclists (Stead, 2019). Ultimately, it remains unclear to what extent a safe and undisrupted operation of self-driving cars will require infrastructural adaptations such as separated lanes and whether respective investments will be publicly or privately covered.

Openness and flexibility in spatial and infrastructural terms thus imply a functional under determination instead of a tight fit, as well as an adaptive and tentative approach when adopting new mobility services. Considering the vast insecurity with regards to public acceptance and the secondary effects on urban development, maintaining an openness to ‘what might emerge’ entails the capacity for future change (Hillier, 2017, p. 310). As the landscape of new mobility technologies will continue to evolve, responsive policies will be necessary (Howell *et al.*, 2019). When planning new mobility systems, Bertolini (2017, p. 156) argues in favour of variations and selection processes throughout preliminary explorations, as well as later planning phases, in order to learn and adjust. However, any short-term experimentation is in need of a frame of reference. Hillier (2017, p. 309) thus suggests to complement overarching visions and strategic trajectories, which provide ‘justification and navigational context,’ but leave the ends of each line of knowledge open to extension with short-term, location-specific urban acts.

Learning – exploration – discourse: grounded in pluralism

The aforementioned short-term location-specific urban acts (Hillier, 2017) can constitute valuable niches that push the boundaries of what is possible (Abbott, 2005). While much of the knowledge production on new mobility is currently reserved for industry, research institutes, and selected transit agencies, further knowledge production and exchange is necessary beyond these realms. Public administration and planning departments are urged to build the competence necessary in order to harness potentials and mitigate risks of new mobility technologies. Questions regarding urban implications and social equity can be integrated into explorative testing and open discourse, but cities need to first define desired outcomes and then assess effective policies. Collaborating on short-term explorations can produce valuable knowledge about desired or undesired effects and allow evaluation of outcomes and necessary regulation (Howell *et al.*, 2019).

As Huxley (2002, p. 152) suggested, ‘planning practice has to confront the inescapable aspects of control’ inherent to liberal strategies, but also to technological solutions and optimization. Reflexive practices are therefore ‘geared towards continued learning’ rather than

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'towards complete knowledge and maximisation of control' (Voß & Kemp, 2006, p. 2007). Learning environments could provide the necessary setting for an exchange of perspectives and evaluation of appropriateness or necessary course correction. Furthermore, the involvement of diverse actors, particularly of community groups, can introduce 'new ways of seeing things' (Abbott, 2005, p. 249) into the process of developing mobility solutions.

Yet, multi-stakeholder processes are often faced with the crucial challenge of motivating collective interest and cooperation (Voß & Kemp, 2006). Smith (2006, p. 327) elaborates that 'actors come together with different motivations, perspectives and expectations; and, as a result, social learning will be plural and unlikely to be integrated automatically'. Transdisciplinary processes might thus entail cultural and epistemic confrontations or participants who are reluctant to give up established practices (Singer-Brodowski *et al.*, 2018). The diversity of worldviews may be viewed as a limitation that can erode action capacity (Voß & Kemp, 2006). Collaboration should, however, focus on engagement and negotiation rather than consensus and resolution (Hillier, 2017). A discourse in a reflexive manner, is less a consensually directed rational argumentation, but instead, a mutual adaption of actors' knowledge towards a shared view on reality, allowing for dissimilar problem definitions, goals and strategies (Voß *et al.*, 2006). Stirling (2006, p. 260) elaborates that the essence of reflexive strategies addresses 'the inherently "plural and conditional nature," both of scientific understandings and of technological potentialities'. A more sustainable technological development, thus, requires exploration and a plurality of perspectives precisely because its aim is to establish 'a broader knowledge base and more effective social learning in order to achieve "better outcomes"' (Stirling, 2006, p. 258) or better yet, alternative trajectories.

Embedding of initiatives and actualizing local change

While reflexive planning strategies can enable the adoption of various perspectives, they also aim at balancing multiple truths (Voß & Kemp, 2006). Hence, it needs to be recognized that any endeavour to locally embed technological deployment does not exclude any other modality. Nonetheless, by taking local knowledge and culture into consideration, both urban and social potentials can be mobilized to generate innovative solutions for social practices, technological adaptation and urban development. By being locally present, an understanding of social relations, processes, and resources can be gained and local ties established (Jack & Anderson, 2002). When it comes to actualizing the mobility transition, which involves 'pattern-breaking systemic changes' (Hulgård, 2010, p. 297) such as the increase in shared ridership and use of active modes, the reduction of car ownership, and the reclaiming of public space, a key question is how to involve the affected communities.

To Martin and Upham (2016), sustainable initiatives depend on more than a mere participatory potential. They argue that the continuity of any grassroots movement essentially depends on a community's values and convictions. Values, beliefs, and visions are only shared among community members, if power and resources are equally distributed (Kummitha, 2017). While participatory processes can be socially anchored through their physical manifestation (Finkenberger, 2018), lasting adoption further depends on the extent to which participatory action can be sustained beyond the duration of a project phase. Building upon the aforementioned 'transformative potential of agency' (Lissandrello & Grin, 2011, p. 224), the self-empowerment of local communities or social entrepreneurs could be key to actualizing change. 'Social entrepreneurs' are understood as actors who commit themselves to developing local communities and stakeholder networks by 'creating social value through innovation' (Hulgård, 2010, p. 297). In this case, innovation implies the development of new approaches to social challenges, which can include economic activity (Hulgård, 2010). With regards to new mobility technologies and their urban integration, social entrepreneurs and

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their areas of action can be conceived of as niches in which social practices are developed in line with local challenges and needs. As groups or individuals, they become precedents for change and increase awareness of its opportunities. Whether such initiatives are able to create social and cultural value, however, depends on their innovative nature and the level of trust they can build within the local community (Hulgård, 2010).

Real-world Laboratories as a Reflexive Framework for Transformative Change

Yet, when considering reflexivity in urban planning processes, the question remains, on which planning scale should such practices be included and further adapted to suit a particular setting (Voß *et al.*, 2006). Voß *et al.* (2006, p. 433) argue that reflexivity needs to be integrated on all levels of government and suggest a 'sequential opening and closing' of governance processes in phases of problem analysis, goal formulation, strategy implementation or actor participation. They understand *opening up* as the integration of additional factors into problem understandings, goals or strategies, as well as the extension of participation and increase of diversity (Voß *et al.*, 2006).

In the following section, I will elaborate on the concept of real-world laboratories, which has gained popularity within research on innovation and transformation processes oriented towards sustainable change. I endeavour to highlight how transformative change is structured by establishing a reflexive framework. A real-world laboratory set in the city of Stuttgart, Germany, is then described as an exemplary case due to its thematic focus on sustainable mobility transition, its methodological emphasis on transdisciplinary learning and on pioneers of change, who could be considered entrepreneurial agents within this transition process.

The format of real-world laboratories

The concept of 'real-world laboratories' (German *Reallabore*) belongs to a family of experimental and transdisciplinary research approaches, which have gained significant attention within the scientific community and public administrations in recent years (Heyen *et al.*, 2018). Considered a methodological novelty within natural sciences, real-world laboratories have been inspired by the experimental turn in social and economic sciences, as well as by collaborative participatory planning processes (Schneidewind, 2014). Within sustainability studies, it has become pertinent to understand the complexity of technological, economic, institutional, and cultural interdependencies through scientific observation and abstraction, but also to explore means of catalysing and attending transformative change (Schneidewind, 2014). Schneidewind and Singer-Brodowski (2014, p. 69) thus differentiate 'transformative science' from 'transformation science' by specifying that the former takes an active role, as scientists are intrinsically involved in the change processes they study. 'Transformative science' thereby builds upon scientific debates on transdisciplinarity as well as action research (Schneidewind, 2015, p. 88). A real-world laboratory is thus understood as a tool and an institutional framework in which knowledge is produced and change initiated by facilitating a process 'from knowledge to action' (Schäpke *et al.*, 2017, p. 9). Through co-production and continuous methodological reflection, context and actor-specific knowledge can be generated that is further differentiated into system knowledge (on what is), orientation knowledge (on what should or should not be) and transformation knowledge (on how change processes could be designed) (Schneidewind, 2014). A distinct feature are 'real-world experiments' (Wagner & Grunwald, 2015, p. 26) which are realised within an institutionalized setting in order to explore sustainable solutions to given challenges and produce action-guiding knowledge. However, the normative orientation of transformative science towards sustainability has been criticized within the scientific community. Strohschneider (2014) questioned whether it would depoliticize democratic decision-making and blur the difference

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between factual knowledge and morally justified action. Representatives of the field conversely argue that transformative science intends the approximation of science towards society through an institutional readjustment, fostering transdisciplinarity and co-production of knowledge, in order to tackle the societal challenges pertinent to reflexive modernity (Schneidewind, 2015).

Due to various research funding programs at European and national levels, similar concepts have spread internationally in the form of (urban or sustainable) 'living labs', 'urban transition labs' or (sustainable) 'niche experiments' (Schäpke *et al.*, 2017, p. 30-35). These concepts are generally understood as temporary spaces set up by scientific units in order to explore alternative practices and create new knowledge through multi-stakeholder processes (Heyen *et al.*, 2018). Their objectives, as well as temporal and structural embedding, differ and often depend on local funding policies (Scholz, 2017). Living labs were originally introduced in an effort to realize more sustainable products and services by integrating user feedback into the development of prototypes. So-called 'open innovation' (Chesbrough, 2003, p. XXIV) settings, whereby businesses profit from users' creativity and ideas, have since been called into question with regards to their claim of co-production, since civic participation is often limited to consultation and surveying (Schäpke *et al.*, 2017). Urban transition labs, meanwhile, build upon theories of 'transition management' and address greater processes of change with regards to sustainability issues or societal change beyond socio-technical innovation, often embodied by so-called 'frontrunners' (Loorbach, 2010, p. 172). Finally, niche experiments derive from the discourse on 'strategic niche management' (Schäpke *et al.*, 2017, p. 28), which argues that socio-technical innovations originate in alternative niches before evolving into the mass market and societal mainstream. Niche experiments share a wider governance approach with urban transition labs, but differ inasmuch as scientists take a consulting and observing role instead of being actively involved (Schäpke *et al.*, 2017). Real-world laboratories differ from the last two examples in that they lack a systematic embedding into a larger governance approach (*ibid.*). Stabilization within the scientific landscape and upscaling of the format, as well as its knowledge transfer, are some of the central recommendations needing further development (Parodi *et al.*, 2018).

'Real-world laboratory for sustainable mobility in Stuttgart'

The following example is the *Future City Lab – Reallabor für Nachhaltige Mobilitätskultur* (henceforth RNM), held by the Faculty for Architecture and Urban Planning at the University of Stuttgart. It is one of 14 real-world laboratories initiated in 2015 through funding by the State Ministry of Science, Research and the Arts in Baden-Württemberg, Germany (Gantert & Stokman, 2018). Being home to one of Europe's most important automotive clusters, Stuttgart has long suffered from environmental pollution and infrastructural capacity limits. While stakeholders conceded to transition towards a sustainable mobility region, development initiatives addressing technological innovations or infrastructural enhancement have lacked effectiveness (*ibid.*). Urban and regional politics are challenged to strategically negotiate diverging interests concerning current and future mobility (Gantert & Stokman, 2018). Acknowledging the complexity of the matter, the research consortium RNM set out to address 'how [Stuttgart] wants to be mobile in the future' (Alcántara *et al.*, 2018, p. 109) by tackling the previously neglected dimensions of mobility culture, habits and everyday practices (Gantert & Stokman, 2018). The goal has been to instigate debates, visions and projects on a good and sustainable mobility life by providing an institutional framework and forum for stakeholders to meet, learn, and establish alliances. The project's research funding has since been extended for a second phase to March 2020.

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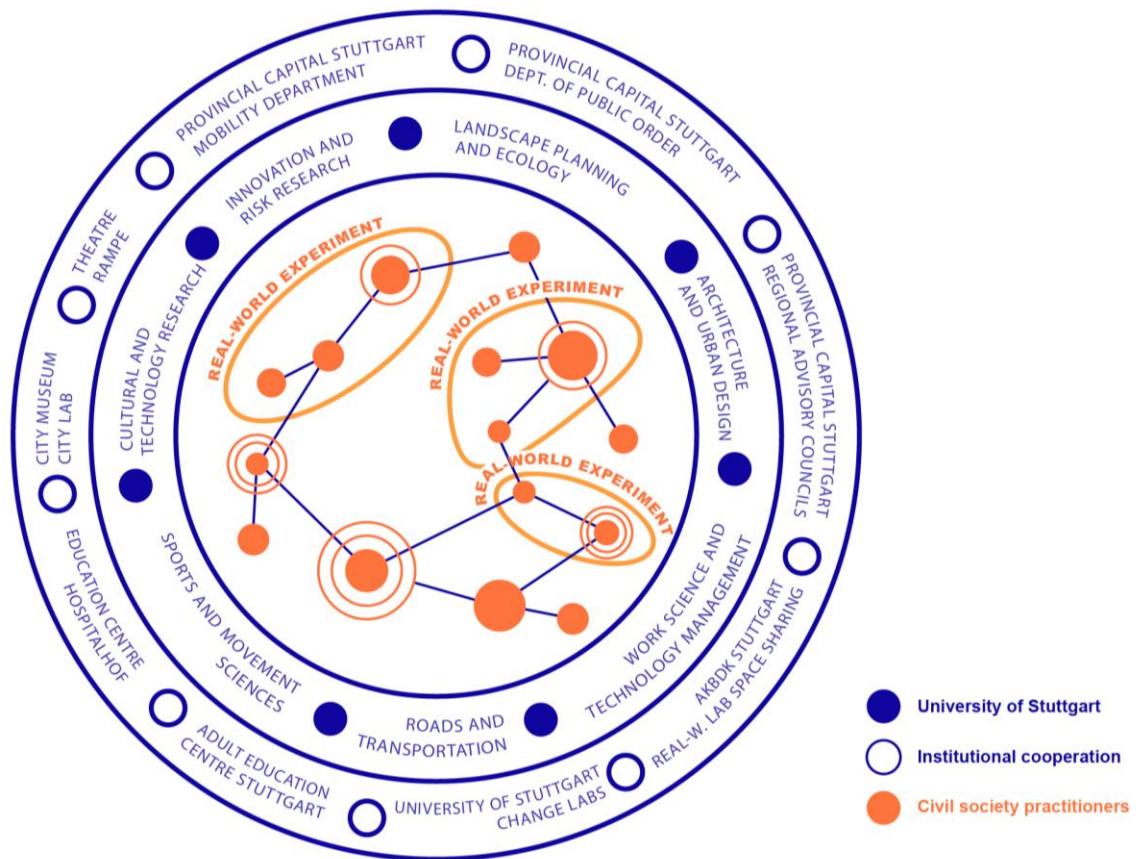


Figure 1. Research within multi-actor-constellations together with civil society practitioners based on real-world-experiments. Source: Author's translation based on *Reallabor für nachhaltige Mobilitätskultur* (2018, p. 18).

Stakeholder networks & learning environments

To address the complexity of a sustainable mobility transition, the project set out to transcend disciplinary boundaries, as well as the boundary between science and society (Alcántara *et al.*, 2018). Various institutes from the University of Stuttgart (encompassing scientists from traffic planning, technology management, architecture and urban design, sport sciences and sociology) were brought together with cultural initiatives, businesses, politics and public administration as well as with actors from civil society (Figure 1.). The three-year project period was structured in four main phases (Puttrowait *et al.*, 2018, p. 200): 1. the identification (of ideas and concepts for real-world experiments), 2. the implementation planning, 3. the implementation and, 4. the evaluation (and reflection of effectiveness). Continuous documentation and public outreach, as well as an educational program framed the project phases. An effort was made to conceptualize and explore the potential of transdisciplinary 'teaching for sustainability' (Uhl, 2018, p. 125) and utilize the framework of the RNM as a 'learning environment' (Singer-Brodowski *et al.*, 2018, p. 24). A course programme that was both interdisciplinary and bound to specific curricula enabled students at the University of Stuttgart to join the participatory process of the RNM. Students could learn from various formats and contribute by collaborating in real-world experiments or developing urban design visions (Uhl, 2018).

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Within each of the project phases, transdisciplinary workshops provided a setting for different forms of collaboration. The initial stakeholder workshop focused on developing a joint problem understanding and facilitating an exchange of perspectives regarding sustainable mobility cultures (Dietz *et al.*, 2015). Thirty representatives from public administrations and universities, nature protection and mobility associations, student initiatives and pioneers of change took part in determining project initiatives and establishing project collaborations (Dietz *et al.*, 2015). The second and third workshops served as a visioning process that encouraged an understanding of a shapeable future (Lindner *et al.*, 2017; Alcántara *et al.*, 2018). As a first step, citizens developed preferable scenarios, which were then scientifically extended, publicly shared, and discussed. The transformative outset of the RNM influenced the workshop's orientation, which was meant to stimulate a change in mindsets and provide the necessary knowledge on transformative processes (Alcántara *et al.*, 2018). Finally, an exhibition was curated in order to reflect on the results from the scenario process, the public debate, and insights from the various real-world experiments.



Figure 2. Real-world experiments realized by civic groups: parklets (left), citizen-rikshaw for elderly riders (right). Source: Reallabor für nachhaltige Mobilitätskultur (2018, p. 72; 101).

Real-world experiments & entrepreneurial change agents

Pivotal to the RNM have been so-called 'change agents' (WBGU, 2011, p. 256), whose initiatives for sustainable mobility practices were meant to create public awareness of existing challenges and serve as role models for a long-term societal transformation. Within the identification phase of the RNM a three-step process facilitated the formation of alliances between civil society initiatives and established actors from public administration, politics, business and science (Puttrowait *et al.*, 2018, p. 205-220): first, a stakeholder workshop; second, a 'market of ideas'; and third, a jury meeting. Over the course of 18 months, four real-world experiments could be developed and temporarily implemented (*ibid.*). In order to empower these change agents to actualize their concepts and reach a wider audience, new structures for cooperation and participation were necessary (Gantert & Stokman, 2018). Supporting measures such as public outreach or financing were determined. The individual projects maintained an explorative character in order to adapt to unexpected challenges and emerging opportunities, thus embracing the risk of possibly failing. Key to collaboration between diverse stakeholder groups lay in the establishment of a respectful atmosphere and appreciation for diverse competencies, motivations and approaches (Puttrowait *et al.*, 2018).

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The realized projects encompassed a self-organized club of bicycle rickshaws for the elderly, parklets in public space, an urban mobility school, and a cargo bike-sharing platform (Figure 2.). The 'Parklets for Stuttgart', to illustrate one example, was a public intervention by University students, who temporarily re-appropriated on-street parking lots in order to publicly question the justice of public space distribution within the city (Puttrowait *et al.*, 2018). For three months, self-built installations such as street furniture, urban gardening lots or playgrounds were set up and provided for public use.

Debate

Finally, which insights can be deduced from the cited example of real-world laboratories when planning for the urban adoption of new mobility technologies? What role do empowerment and entrepreneurial action play in transformative change? How relevant is reflexivity in the ongoing transition period?

The premise of real-world laboratories within sustainability sciences is not merely to transcend the boundaries between science and society, thereby acknowledging practitioners as experts, but rather to initiate transformative change processes within socio-technical systems. The format can be understood as long-term 'research infrastructure' (Jahn & Keil, 2016, p. 249) or institutional framework, which facilitates the analysis and reflection of structural changes emerging over time (Schneidewind *et al.*, 2018). Beecroft *et al.* (2018) further argue that the framework supports interdisciplinary projects by providing an overarching target horizon and boundary conditions to align individual project initiatives, e.g. means of data acquisition or evaluation (p. 77). It is this structural embedding of research, learning and evaluation that characterizes the reflexive dimension of the format. While Voß and Kemp (2006) emphasized reflexivity as a concept serving to put varying local and problem-specific practices into relation, Schneidewind *et al.* (2018) build upon Giddens' (1984) understanding of duality between structure and action to propose a structural reading. To that effect, the transdisciplinary activities throughout the course of a laboratory can trigger change processes in the structural dimensions within which they are embedded (*ibid.*). The RNM in Stuttgart chose a particular approach emphasizing the role of change agents who develop 'alternative and resilient strategies for actions' and thereby pioneer a cultural shift (Schneidewind, 2018, p. 454). Whether change agents are involved in a project for its entire duration or merely during specific phases, and whether they participate as part of the research team or as external contributors greatly varies between transdisciplinary process designs (Defila & Di Giulio, 2018). Nonetheless, temporary urban interventions such as parklets can trigger the imagination regarding possible alternatives and be a first step in the service of change (Freudendal-Pedersen & Kesselring, 2016). Such initiatives may also stir polarizing debates on the right to public space, which might not conjure certainty on how to solve traffic hazards in the short term, but in terms of their discursive capacity, can lead to an awareness of the urgency to act (Schwarz, 2014).

The German RNM constitutes a relevant example for establishing an institutional framework and multi-stakeholder network. By involving university and research institutes, it incorporated a variety of disciplines with valuable perspectives on the complex issue of sustainable mobility transition. Learning environments can provide the necessary setting to confront researchers and practice experts with the challenges at stake and make interdependencies of developments transparent. Previous real-world laboratories in Baden-Württemberg have shown that the integration of scientific and practice-based knowledge cultures enables the reflection of potential effects and consequences of planning actions (Schäpke *et al.*, 2017). As described by Lissandrello & Grin (2011) regarding the regional dialogue in Amsterdam, self-confrontational interaction can trigger social learning about alternative trajectories.

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With regards to new mobility technologies, the establishment of stakeholder networks and collaborative approaches between public, private, scientific and civil society actors is key to anticipating potential impacts. Particularly so, as spatial and social dimensions have been difficult to assess due to a lack of empirical case studies and necessary data. Despite prevailing uncertainties regarding urban implications, policy-makers and public administrations are required to define infrastructural standards and spatial circumstances for urban adoption. While the adaptation of regulatory frameworks is crucial for any kind of urban experimentation, it can pose a particular challenge to public administrations, not least due to the polarizing question regarding the right to public space. Nonetheless, facilitating temporally and spatially constrained interventions can generate practical knowledge of unintended consequences, possibilities for knowledge transfer and requirements for policy development (Beecroft *et al.*, 2018). It is, however, paramount to consciously assess who acquires the right to generate knowledge and therefore strategic advantages, what are the circumstances, and who bears the risks? Institutionalizing a framework for reflection can support the evaluation of societal and urban relevance of research questions and the collaborative selection of projects (Beecroft *et al.*, 2018).

This is not to say that the outlined format is without limitations or constraints. The methodological challenges of real-world laboratories in the sustainability sciences concern the format's threefold objective: 1. the scientific goal to generate new insights and knowledge, 2. the transformational goal to initiate social change processes, and 3. the educational goal to facilitate learning (Defila & Di Giulio, 2018). An equal treatment of these dimensions can cause non-scientific actions to prevail, while also demanding more specific criteria for selecting participants (*ibid.*), essentially determining the openness or exclusivity of the format (Peer, 2016). In the case of the RNM, the thematic focus on sustainable mobility cultures predefined which social groups would be considered change agents, and which were excluded or self-excluded through lack of identification. While transdisciplinary practices as part of reflexive strategies demand an immense effort from all participants, a crucial learning for urban planners could be, how to facilitate such processes with 'projectivity, creativity and change' (Lissandrello & Grin, 2011, p. 245). Initiating change through explorative actions entails an ethical responsibility for unintended consequences and challenges scientists to remain unbiased and open (Schäpke *et al.*, 2017). Hence, it is crucial for such processes to continuously reflect on the social acceptance and legitimization of process design, objectives and outcomes (*ibid.*).

Conclusion

While notions of reflexivity do exist in social science, transition studies and urban planning theory, the aim of this paper is to argue its relevance particularly in light of new mobility technologies and uncertainty about its long-term effects. Firstly, in order to embrace the complexity of interdependent social, spatial and technological processes by integrating flexibility and responsiveness into planning for new mobility. Secondly, to produce knowledge about opportunities and risks by integrating stakeholder perspectives and transdisciplinary explorations. Thirdly, to adapt new mobility technologies to local challenges, requirements and needs, by exploring novel practices within the affected communities, and facilitating social entrepreneurial action. After all, the novelty of technical innovations such as on-demand mobility services or self-driving cars does not yet say much about their contribution to the liveability of cities.

The level of integrated planning as well as urban policies and designs, which encourage or discourage specific mobility practices, will influence the extent to which the social,

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environmental and urban opportunities of new mobility technologies are actualized. Public, private, scientific and community actors thus need to negotiate what good emerging mobility technologies could do in a given context, and for whom. Raising questions concerning the outcomes of new mobility regulations and their alignment with existing urban development goals can clarify the need for planning revisions and the incremental exploration of effective policies. In this process, the transgression of disciplinary boundaries and integration of perspectives can foster collective learning and building of coalitions.

Cities and urban planners need to reflect: How can the transition period towards new mobility be structured at regional, city and neighbourhood scales? Do existing policies and planning measures achieve desirable outcomes? How can local initiatives, research endeavours and pilot projects be connected, in order to establish synergies, transfer learnings and leverage resources? With this article, I endeavoured to explore the notion of reflexivity, its previously recognized value in transition studies and planning theory, and potential relevance with regards to the transition period at hand. I suggest that urban planners engage in reflexive processes by facilitating and structuring dialogue, as part of institutional frameworks or short-term explorations. While Schwarz (2002) suggested that a notion of reflexive modernity, as a condition, is neither affirmative nor a system critique, second-order reflexive strategies as a response to unintended consequences, call existing concepts, practices and institutions fundamentally into question (Voß & Kemp, 2006). It is perhaps not yet a revolution, but a different society in a state of becoming (Beck, 1994).

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