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Assessing Change Agency in Urban Experiments for Sustainability Transitions

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Abstract

This thesis addresses a lack of engagement with the role of agency in the literature on urban sustainability transitions and urban experiments. By introducing the trinity of change agency framework from economic geography a hypothesis of how agentic processes can be conceptualized for urban sustainability transitions is developed. The framework allows to address the shortcomings of the existing literature which fails to address why UST take place in specific locations and tend to prescribe specific roles to actors based on their position in socio-technical systems. The hypothesis is tested in a case study of the ElectricCity project in Gothenburg, Sweden, an urban experiment aimed at developing and testing the use of electric busses in order to induce change in the city's transport system. The case study reveals that processes in urban experiments can be well explained by a combination of place-based leadership, institutional and innovative entrepreneurship. However, actors take ambiguous roles, implying that they can not be pre-ascribed specific types of agency.

Keywords: Change Agency; Urban Sustainability Transitions; Urban Experiments

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Abbreviations

BRG – Business Region Göteborg
CoG – City of Gothenburg
EU – European Union
MLP – Multi-Level Perspective
NGO – Non-Governmental Organisation
R&D – Research and Development
SEA – Swedish Energy Agency (Energimyndigheten)
SNM – Strategic Niche Management
TM – Transition Management
UN – United Nations
ULL – Urban Living Lab
UST – Urban Sustainability Transitions
VG – Västra Götalandsregionen

1 Introduction

The threat climate change poses against life around the globe forces societies to rethink and recalibrate current practices in virtually all aspects of society. A major transformation of technological, social, environmental and political practices is necessary in order to reduce greenhouse gas emissions, build resilience against the unavoidable consequences and prevent further damage from climate change. At the same time a global demographic change leads to massively growing urban areas. The UN expects 70% of the world population to live in cities by 2050. This means that cities have a particularly important role in the shift towards more sustainable practices. These structural changes in cities are referred to as Urban Sustainability Transitions (UST) (Frantzeskaki *et al.*, 2018). UST are understood as deliberate actions in cities that aim at shifts in socio-technical systems toward more economically, ecologically and socially sustainable practices. Examples of such transitions include shifts in the production and consumption of energy and mobility which are the two largest emitters of greenhouse gases in the EU (EEA, 2021). Within the wider field of sustainability transitions multiple research strands have formed around different aspects of urban sustainability transitions. Governance of transitions is one such strand that applies a variety of frameworks, among them strategic niche management and transition management. A common approach in practice is to foster the development of new socio-technical configurations through urban experiments, i.e. protected spaces where a new technology or practice can be developed, tested and established protected from market mechanisms, in collaboration of users, private sector and governments on all scales and in a real-life environment. These experiments are carried out in a variety of spatial settings on differing scales that are shaped by various institutional set-ups, social networks, infrastructures, resource endowments and actors. These factors, among others, are used to understand the spatial variation of sustainability transitions. While these factors are increasingly well understood, the way agency shapes urban experiments and the shapes agency can take is a field that requires further research and frameworks (Köhler *et al.*, 2019). The aim of this thesis is thus to propose a conceptualization of agency in urban experiments for sustainability transitions. This provides an opportunity for further connecting the literatures of economic geography and urban sustainability transitions.

Within economic geography one strand of research has recently turned attention from the role of structures for regional economic development toward the influences of individual actions, i.e. individual agency. One approach has identified three types of change agency (place-based leadership, institutional entrepreneurship and innovative entrepreneurship) that actively shape

regional development paths on different scales (Grillitsch and Sotarauta, 2019). This framework has already been applied to regional economic transitions (Jolly, Grillitsch and Hansen, 2020) and could also provide insights into the ways agency shapes urban experiments for sustainability transitions. The aim of this thesis is to investigate how change agency can be understood in the context of UST. To do so a case study focusing on a project of urban mobility transition in Gothenburg, Sweden is employed. The ElectriCity collaboration is understood as an urban experiment lead by Volvo and the City of Gothenburg aiming at developing and testing sustainable solutions for urban public transport, first and foremost electric busses.

The thesis is structured as follows. The next section comprises a literature review focusing on the dominant approaches in transition studies, the spatial and specifically urban aspects of sustainability transitions and the roles different actors have in them as well as introducing the trinity of change agency concept. In a summary both approaches are compared, a hypothesis of how change agency can be applied to urban experiments is developed and specific research questions guiding the case study are derived. Section 3 then introduces the methodology and the case ElectriCityGothenburg. Section 4 presents the results and section 5 discusses the results and limitations of the case study and the applicability of the trinity of change agency concept to urban experiments. Section 6 then presents a conclusion.

2 Theory and Literature Review

2.1 Multi-Level Perspective

The Multi-Level Perspective (MLP) introduced by Geels (2002) is a well-used theoretical framework in transition studies to conceptualise socio-technical change. The socio-technical concept of change acknowledges that sustainability transitions are not addressed sufficiently through changes in technology but require changes in the consumer practices, policies, infrastructures, institutions and business models they are embedded in (Geels, 2019).

The MLP aims to explain socio-technical change as the result of developments on three different levels: landscapes, regimes and niches. Socio-technical landscapes are the macro level that provides the wider context for regimes and niches. These can be understood as structural factors and developments like demographics, societal concerns or macro-economic trends but also external shocks like war or financial crises.

On the meso level socio-technical regimes can be understood as systems of specific societal functions, e.g. mobility or energy systems. These systems are stable alignments of technologies, infrastructures, institutions and user-patterns. A regime must thus be understood as a complex network of multiple actors, e.g. users, developers, law-makers, and their practices that evolve around a technological trajectory and enable, reproduce and maintain it. This causes various

lock-in mechanisms that in turn lead to path dependence. The path dependence implies a level of stability within the regime where innovative activity and improvements only happen incrementally, because the search for solutions to emerging problems is limited to solutions within the regime.

While incremental improvements to existing technological trajectories happen on the meso level, radical changes and new technological trajectories emerge on the micro level, the niche. Here radical innovations can be tested, protected from market selection mechanisms. This is necessary because new technologies are usually connected with high costs and need further improvement. Niches are ideal for these improvement processes because they provide the opportunity for learning while doing, using and interacting. Niche developments are usually aimed at solving problems within the existing regime. Thus, technological transitions emerge from the niche and are scaled up if there is enough pressure for change on the regime from the landscape and niche levels (Geels, 2002, 2019; Köhler *et al.*, 2019).

2.2 Strategic Niche Management and Transition Management

The MLP is the conceptual basis for Strategic Niche Management (SNM) which is an approach in transition studies to explain and manage the emergence of path-breaking socio-technical innovations. The approach combines thinking from evolutionary economics and sociology of innovation (Kemp, Schot and Hoogma, 1998; Schot and Geels, 2008; Köhler *et al.*, 2019). SNM tries to solve the problem that is posed by the existence of socio-technical regimes that prevent the emergence and exploitation of new more sustainable solutions by assuming that transitions can emerge from niches. Since rooms for the application of radically new or socially desirable technologies that are protected from the incumbent regimes are not readily available, public policy-actors must create such rooms for experimentation from which the tested technologies can eventually be scaled up and lead to a regime change. Niche creation is thus seen as a measure to steer technological development into a socially desirable direction. Niche experiments as such are aimed at learning about characteristics of new technologies as well as enhancing their further development and rate of application (Kemp, Schot and Hoogma, 1998). Over time these aims were extended to account for the institutional change that is necessary to achieve regime-change (Fuenfschilling and Truffer, 2016). To do so, three niche internal processes are crucial. First, building a constituency, i.e. a social network of supporting actors around a new technology, second, articulation and agreement on expectations and visions among actors to provide directionality and third, learning processes about user behaviour and

cultural implications, technical specificities, regulational and infrastructural requirements (Geels and Raven, 2006; Schot and Geels, 2008).

The transition management (TM) approach provides a second framework for the governance and management of transitions. The framework emphasises the importance of heterogenous actor networks with common visions and institutional change for successful change in incumbent regimes and highlights the role policy makers have in organizing transition processes and providing opportunity spaces for new actors. It identifies four relevant governance activities. First, strategic activities are aimed at developing visions and long-term goals. This happens in transition arenas, i.e. small networks of progressive actors. Second, tactical activities seek to adapt established structures, institutions, routines etc. to the goals. Here, resistance from vested interests and institutional fragmentation can pose hindrances. Thus transition managers must include actors with authority to overcome these resistances. Third, operational activities comprise the actual applications of innovative solutions in experiments that are aimed at learning, reflecting the thinking of the MLP and SNM that innovations need to be fostered and scaled up from niches. Fourth, reflexive activities include monitoring and evaluation in order to adjust visions and ongoing processes (Loorbach, 2010; Köhler *et al.*, 2019).

The two approaches differ in a few aspects, two of which are important here (for a further discussion see Loorbach and van Raak, 2006). First, while the object of study in SNM is a socio-technical regime, with an emphasis on technological change, TM studies societal systems, emphasising actor constellations and visions. Second, this leads to differing understandings of how change is best facilitated. While in SNM niche experiments are used to test and learn about specific technologies, TM facilitates a variety of bottom-up experiments that eventually lead to change according to the predefined vision. However, combining the concepts promises insights into the processes in urban experiments. Here, SNM provides a perspective on the change of socio-technical regimes through experimentation, emphasising the relevance of institutional change and technological development, while TM informs the understanding of the interactions between and agendas of participating actors (Loorbach and van Raak, 2006).

2.3 Geography of Sustainability Transitions

SNM, MLP and TM are aspatial concepts, eventhough using at times spatial vocabulary like 'global' and 'local'. This disregard for the role of space was seen as an opportunity to introduce geographical concepts to research on sustainability transitions. At the same time economic geography was preoccupied with research on aged industries and existing paths and aspects of environmental innovation or sustainability were rarely considered. Thus the combination of

sustainability transitions and economic geography was seen as fruitful for both disciplines (Coenen, Benneworth and Truffer, 2012; Truffer and Coenen, 2012). Two conceptual additions from economic geography to transition studies are seen as crucial. First, the acknowledgement of institutional embeddedness, meaning that institutional arrangements vary spatially. As institutions to a large part influence what actors are able to do, they have a significant influence on how socio-technical regimes vary across space. Consequently, institutional arrangements can also explain the spatial unevenness of sustainability transitions. Second, transition studies must pay attention to issues of scale. A relational perspective that sees local actors embedded in global networks can contribute to assess powers of local actors and dependencies between places. Furthermore, the locus of niche formation and transition processes is considered. Here, cities and regions play a crucial role (Coenen, Benneworth and Truffer, 2012; Truffer and Coenen, 2012).

Work that considers these spatial aspects focuses largely on the geography of niche development. Here, the role of local formal and informal institutions as well as urban and regional visions and policies are considered. Localised institutions are found to condition the development and diffusion of environmental innovation, to influence the adoption of regulative environmental policies and to embed niche formation. Furthermore, informal institutions can also vary within places and thus have negative impact on sustainability transitions. Local urban and regional policies facilitate the diffusion of niche technologies. At the same time, policies are always the result of compromise between different private and public local actors. The same applies to visions and expectations that are contested between different stakeholders (Hansen and Coenen, 2015). Essletzbichler (2012) emphasises multiscalarity in the role of policies. Regional policies are an important addition to national and international policies because they can be better adapted to specific local conditions and regime configurations. This is seen as benefitting the creation of common regional vision and the enrollment of more local actors that can facilitate path creation. Furthermore, regional policies can be used to facilitate niche development and influence selection mechanisms, e.g. through incentives or R&D policies.

Cities as arenas of sustainability transitions receive growing attention under the term urban sustainability transitions (UST). Several aspects of cities improve their ability to initiate socio-technical change. First, the concentration of actors and resources in cities benefits institutional and technological change but can also prove a source of conflict resulting from differing rationales among actors. However, if resolved, this institutional plurality can also improve innovative capacity. Second, cities are ecologically, socially and technologically complex and institutionalized which can slow progress and lead to path dependence but also bear potential

for synergies and change if specific configurations and institutional arrangements can be identified as positive and used as blue prints for change in other places. Third, the multi-scalarity of cities enables testing of new socio-technical configurations on small scales such as the neighborhood but also allows to gather resources from global networks (Fuenfschilling, 2018). Rohracher and Späth (2018) find that niche and regime structures meet in cities, networks and alliances are formed across niche and regime structures. Furthermore, research on urban sustainability transitions shows that urban socio-political regimes significantly influence regimes and niches. This means that present niche processes are also shaped by other city internal and external societal processes, agency, actors, interests and previous transition processes than transition targets or visions. In this context, inquiry into local historical transition pathways, change of practices and their embedding in the urban context as well as the roles different kinds of actors play are relevant (Fastenrath and Braun, 2018a; Rohracher and Späth, 2018).

2.4 Urban Experiments

A common way to operationalize the concept of niche developments in cities is through conducting experiments. These can have a variety of organizational forms but are usually aimed at testing and diffusing new socio-technological solutions, diffusion of policies, providing space for interaction of actors and the building of social networks, reflecting the understanding of SNM and TM (Bulkeley and Castán Broto, 2013; Bulkeley *et al.*, 2019; Fuenfschilling, Frantzeskaki and Coenen, 2019). Most experiments intervene in the urban infrastructure, building practices, transport or urban planning. The focus is usually on developing means to reduce the climate impact rather than adapt to the effects of climate change (Bulkeley and Castán Broto, 2013). Sengers, Wieczorek and Raven (2019) identify a variety of terms for these experiments originating in different conceptual understandings. In niche experiments emphasis is on the role of nurturing processes like the building of networks, articulation of expectations and learning. Furthermore protective processes like shielding (referring to protection from selection mechanisms), nurturing (supporting the development of radical innovations) and empowering (enabling competitiveness between niche innovation and regime). Main actors in niche experiments are users and regime-outsiders.

In transition experiments focus is on three processes. First, deepening is about learning about an experiment and its conditions which is facilitated by the provision of space for experimentation in specific contexts. Second, broadening refers to learning from related or similar experiments that were conducted in different contexts. This process profits from the

provision of resources and increasing interaction and improving networks between projects. Lastly, scaling-up implicates learning about regime change and broader developments by including frontrunners, individuals that have the motivation and ability to drive change, are involved in the challenge the experiment addresses and transcend organizational boundaries.

Sustainability experiments focus on linkages between actors, technology, knowledge, capital and institutions. The authors argue that a specific experimental project could be described by all the identified concepts that thus serve rather as different analytical lenses on experiments.

Another common mode of experimentation that has recently gained more attention is the Urban Living Lab (ULL). These are characterised by their geographic embeddedness in an urban context, the participation of users, the intention to learn, evaluate and improve. Important processes in this context are the development and testing of technologies, the building of capacities necessary to adapt the tested technologies and the connection to the local context, i.e. addressing specific problems in the place the Lab is located. Examples include public-sector led and co-financed projects aimed at achieving transformation where private-sector actors can test products in the real-life environment of the city (Bulkeley *et al.*, 2019). Three types of diffusion processes, through which ULL could affect broader systemic change are currently identified. First, embedding refers to the adoption and integration of parts of an ULL into existing structures. This can be facilitated through the activation of network partners. Second, translation refers to a horizontal diffusion where the ULL or specific elements of it is reproduced in a different (spatial) context. Common strategies for translation are the replication of lab structures as well as education and training of ambassadors. Third, scaling describes the (spatial) growth of a ULL that can entail an extension of resources or toward more actors (von Wirth *et al.*, 2019).

In the following, no distinction will be made between the different types of experiments identified here. Instead, the term urban experiment will be used to describe “an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity” (Sengers *et al.*, 2016, p. 21). This definition emphasises the ambition of urban experiments to lead to system innovation, i.e. reach further than mere technological innovations. This system innovation is achieved in an inclusive, that is multi-actor process, including among others the public sector, firms, users and academia and through social learning. Social learning again emphasises that an urban experiment is not limited to technological learning but includes institutional learning such as the development of business models, regulations or user and social practices. Furthermore, an urban experiment is practice-based, meaning it is carried out in real-life conditions, and oriented to

solve a societal challenge. This societal challenge can be seen as a problem frame formulated by the participating actors. Finally, urban experiments are carried out under the conditions of uncertainty and ambiguity. Ambiguity is the result of inclusiveness that entails that multiple interests, motivations and values that may be conflicting are combined in the experiment. Uncertainty is connected to problems, solutions and changes that emerge during the experiment (Sengers *et al.*, 2016). In sum, this definition allows to analyse urban experiments without limiting to a specific concept but rather include aspects of all of them.

2.5 Actors and agency in transitions

As should be clear by now, sustainability transitions and urban experiments in particular are multi-actor processes (Bulkeley and Castán Broto, 2013). While often not the focus of case studies about UST, relevant actors and actor networks can be identified in many of them. Avelino and Wittmayer (2018) review case studies with a multi-actor perspective distinguishing between formal and informal, profit and non-profit and public and private actors. Governments on different scales, community, the market and the third sector comprising intermediary organizations are considered relevant categories of actors. They find that in most of the reviewed cases a variety of actors is actively pushing for change, however, the public sector is most often taking a strong position as facilitator of change and niche experimentation. The same is true for the civil society which is found to push for institutional change and regulative exemptions. However, actors can also oppose change depending on their interests and motivations. This means that UST are as much a socio-political process as they are a socio-technical process. The authors conclude that “urban sustainability [is] the result of power relations, negotiations and dependencies between different actors” (Avelino and Wittmayer, 2018, p. 280).

In another literature review Fischer and Newig (2016) find that in the literature on sustainability transitions actors are often categorised according to their systemic position. i.e. niche, regime or landscape actors. While niche actors are expected to develop new radical socio-technical configurations and dedicate to entrepreneurial activities, regime actors can be both opponents but also supporters of transitions. However, the incentive for change is seen in a combination of niche activity and government support.

Späth, Rohrer and Von Radecki (2016) provide a somewhat opposing view to this in a study on transitions in the mobility sector in Stuttgart, Germany. The region has a strong focus on the car industry and thus a strong presence of incumbent actors that have vested interests in the current mobility regime. However, they find that automobile manufacturers and suppliers take an active role in developing new sustainable mobility solutions and dominate the discourse

around sustainable mobility, while niche actors are a neglectable part of local initiatives. Manufacturers stressed the importance of demand dynamics for their changed strategy.

Concerning actors in urban experiments, Bulkeley and Castán Broto (2013) find that actors from the public sector in most of the observed cases are the leaders or initiators of such experiments, while partners that are involved in the project without a leading role are more diverse. Furthermore, the type of leader is related to the type of intervention (e.g. private-led projects focus on projects intervening in the urban infrastructure). However, it is also found that a great plurality of involved actors can negatively impact the outcome of the experimentation project (Madsen and Hansen, 2019).

Apart from the heterogeneity of actors, the relevance of specifically local actors is stressed. These are seen to facilitate path creation and develop a network of other actors with a common vision (Essletzbichler, 2012). This reflects the strategic activities in the TM approach. Fastenrath and Braun (2018b) find that in the transition toward energy efficient building in Freiburg, Germany, actors from civil society and third sector played an important role in initiating change and creating pressure that finally led the municipality to experiment with strict guidelines for newly built areas. These guidelines posed significant challenges for developers and architects as they required a change of practices and knowledge that had thus far not been applied locally. As a consequence some of these actors resisted change which led the municipal government to create a coordination group to improve communication and knowledge exchange between participating actors. The authors further point to the role local innovative pioneers played in promoting the early use of solar energy.

Fuenfschilling and Truffer (2016) focus on the interplay of technology, actors and institutions in socio-technical transitions. They argue that since socio-technical regimes are to a large extent maintained and reproduced by institutions, a transition can also be understood as institutional change. Actors are in this context constrained by the dominating regimes' institutions that determine the scope of their actions. However, through institutional work they mediate between new technologies and institutions, contribute to deinstitutionalization of regime structures and institutionalize new principles connected to new technologies. This makes clear that institutions not only constrain actors but that they can be shaped and also enable actors and technologies.

De Haan and Rotmans (2018) propose a framework to conceptualize agency in sustainability transitions. They distinguish between frontrunners, who develop new solutions based on their values, connectors, who extend networks, topplers who introduce change by phasing out institutions and lastly supporters who adopt and endorse new solutions. However, their framework neglects the role of incumbent actors in initiating change by focussing on

frontrunners from the niche. Furthermore, this framework is aspatial, meaning it does not contribute to an understanding of how agency contributes to where urban sustainability transitions happen.

While the relevance of heterogenous actor networks comprising of organisations and individuals for UST and urban experiments is well established, it remains unclear how individual and firm level agency shapes their initiation and outcome. The following section introduces the trinity of change agency as a concept from economic geography that could be used to address these shortcomings.

2.6 Change Agency

One strand of research in (evolutionary) economic geography focusses on the conditions of regional economic growth and change. While traditionally structural variables are employed to explain regional variation in growth more recently researchers have turned to more place-specific factors, and actions of individual actors in particular and their intended and unintended consequences in particular (Grillitsch and Sotarauta, 2019; MacKinnon *et al.*, 2019; Jolly, Grillitsch and Hansen, 2020). MacKinnon *et al.* (2019) suggest to investigate the impact actors, constrained and enabled by a multiscalar environment have on regional path creation. Grillitsch and Sotarauta (2019) develop a typology of agency in regional path development. They define agency according to the Dictionary of Human Geography as “the ability to act, usually regarded as emerging from consciously held intentions, and as resulting in observable effects in the human world” (Gregory *et al.*, 2009, p. 347). The types of agency driving regional path development they define are innovative entrepreneurship, institutional entrepreneurship and place-based leadership.

Innovative entrepreneurship refers to actions that lead to radical innovations that have path-breaking potential. These innovations are not discovered by chance but are the result of willful economic actions, i.e. new knowledge and resource combinations and search for unrealized potentials. Innovative entrepreneurship thus implicates the taking of risks since the outcome of innovations is uncertain. In the context of innovative entrepreneurship, two concepts of innovation must be distinguished. Radical innovation refers to the Schumpeterian understanding of innovations as path-breaking, novel products while incremental innovation refers to the continuous development and improvement of existing products. In the trinity of change agency framework radical innovation is expected to lead to path development (Grillitsch and Sotarauta, 2019). However, continuous incremental innovation over time can also lead to change from established paths (Grillitsch, Rekers and Sotarauta, 2021).

Institutional entrepreneurship acknowledges the idea that (economic) actions are embedded in and constrained by the social sphere made up of formal and informal institutions. Institutions are the place-specific rules of the game (Gertler, 2010). Institutional entrepreneurship is thus aimed at transforming or creating new institutions so as to accommodate and influence innovative entrepreneurship and regional development.

Place-based leadership refers to ‘actions that aim at transforming particular places by pooling competences, powers and resources to benefit both agents’ individual objectives and a region more broadly’ (Grillitsch and Sotarauta, 2019, p. 5). This type of agency accounts for the idea that regional growth requires cooperation of a variety of actors with different motives and backgrounds. Place-based leadership is thus required to coordinate activities between actors, acquire resources and maintain directionality. This requires collective abilities that go beyond individual ambitions to find solutions benefitting multiple participating actors as well as the region as a whole (Grillitsch and Sotarauta, 2019).

To account for the structural embeddedness of agency the framework uses the notion of opportunity spaces. It differentiates between time-specific, region-specific and agent-specific opportunity spaces that enable and constrain agency. Time-specific opportunity space refers to the possibilities with the global stock of knowledge, resource and institutions available at any given time. E.g. scientific progress in battery-technology can provide opportunities for innovative entrepreneurship. Region-specific opportunity space reflects the local preconditions shaping experiences and encounter of actors. This includes the industrial and sectoral structure, the institutional environment, the diversity of knowledge available or linkages in global value chains. Lastly, agent-specific opportunity space considers the individuals’ capabilities and perceived opportunities to invoke change. These capabilities are influenced by the agents’ position in social networks, their expectations and past encounters and experiences (Grillitsch and Sotarauta, 2019).

External to the trinity of change agency but still relevant for regional path development, structural maintenance is agency that is directed against change and focused on reinforcing existing structures and institutions. These actions can create competition to change agency if they create competing goals that distract actors, resources and capabilities from change processes (Jolly, Grillitsch and Hansen, 2020).

2.7 Summary

The literature around urban sustainability transitions and urban experiments revolves around a number of core aspects. Sustainability transitions are described as regime shifts toward practices that are perceived as more desirable and away from established unsustainable

practices (Fuenfschilling, Frantzeskaki and Coenen, 2019). The regime shift entails a change of localised informal and formal institutions on multiple scales. Routines, habits and cultures around established socio-technical configurations must be broken up and transformed. Laws and regulations on municipal, regional and national levels must be adapted to achieve regime shifts. According to the MLP new socio-technical configurations usually develop in niches and diffuse from there. This concept can be operationalised through urban experiments where new socio-technical solutions are developed and improved in real-life situations through interaction between users and developers, however protected from market mechanisms. UST are furthermore multi-actor processes. Most commonly actors from the public-sector, private companies, civil society and intermediaries are involved. The TM approach emphasises the complexity of these networks and the importance of actors that organize transition processes and create a common vision among the participating actors. This points to the role of individuals and agency in UST that currently is not well understood (Hansen and Coenen, 2015; Fuenfschilling, Frantzeskaki and Coenen, 2019; Köhler *et al.*, 2019).

The trinity of change agency provides a framework to account for the role of individual agency in regional path creation. It revolves around three types of agency, institutional entrepreneurship, innovative entrepreneurship and place-based leadership. Furthermore, structural maintenance is considered as agency that opposes change.

There are a number of similarities but also differences between the approaches of UST and change agency. Similar is the emphasis on institutional change. Both concepts see institutional change as crucial for successful path creation and regime transformation. Furthermore, the relevance of dedicated local actors that connect other actors, build networks and create visions of change can be associated with the understanding of place-based leadership. The aspect of structural maintenance can also be found in both concepts. In UST this is expected to be exerted by actors with vested interests in the dominating regime.

One difference concerns the view on innovation. In UST the development of new socio-technical solutions is not considered as an entrepreneurial process started by specific individuals or actors but rather as an evolutionary process of co-creation between users and developers. The concept of innovative entrepreneurship however, conceptualises the development of new technologies as a process demanding specific knowledge, resources and capabilities and connected with substantial risk that only specific individuals have and are willing to take. The notion can however be approximated by the actions of private sector actors in urban experiments that developed specific technologies to test and improve within these projects.

The second difference pertains the role the civil society or third sector often take in UST. These groups often create pressure on the public sector that forces it to act and start experimenting with transformative socio-technical configurations (Fastenrath and Braun, 2018b). The trinity of change agency framework does not exclude civil society actors from becoming change agents in general. However, the framework does not account for such agency that is external to the actual process of path development and rather initializes a broader change process that includes multiple other actors.

Furthermore, the different types of change agency can be linked to internal processes in the different perspectives on urban experiments as shown in Table 1. In niche experiments, the articulation and agreement of expectations and visions is a process that can be connected to place-based leadership since it requires coordination of participating actors and the provision of directionality. Learning processes involve both innovative and institutional entrepreneurship. Innovative entrepreneurship is involved in learning about the technology and adapting it, while institutional entrepreneurship is needed to use the results of learning processes in order to initiate institutional change to accommodate socio-technical change. Constituency building is inherently connected to place-based leadership. Growing the social network of actors both locally and on higher scales to improve local capabilities is connected to this type of agency. The three protective processes, shielding, nurturing and empowering can mostly be related to institutional entrepreneurship as they require formal protective mechanisms.

In the transition experiments perspective, deepening processes can be connected to innovative and institutional entrepreneurship. Again, the point of this process is to learn about the experiment and conditions for the broader application of the experiments' subject. Broadening can be associated with all three types of change agency. Place-based leadership in this context might connect actors to networks in other places, participating in similar experiments. Institutional entrepreneurship can be involved in initiating institutional change based on learnings from other similar experiments and innovative entrepreneurship might adapt technological aspects of similar experiments. Lastly, scaling-up processes could be linked to institutional entrepreneurship and place-based leadership. Here, place-based leadership could be used to extend the actor network toward more powerful regime-actors.

In the ULL perspective, capacity building can be linked to institutional entrepreneurship and place-based leadership, the former focusing on facilitating institutional capacity and the latter providing resources and linking actors. Testing and developing processes can be connected with innovative entrepreneurship. Connection to local context can be associated with all three types. Institutional entrepreneurship might work to change specific local institutional settings, place-

based leadership might initiate lab processes and connect local communities with other and innovative entrepreneurship can be involved in developing solutions to address specific local problems.

Table 1: Connecting processes in perspectives on urban experiments to the trinity of change agency.

Types of Change Agency	Internal Processes of Urban Experiments		
	Niche Experiments	Transition Experiments	Urban living Labs
Institutional Entrepreneurship	Learning	Deepening	Capacity-building
	Shielding, Nurturing, Empowering	Broadening	Connection to local context
		Scaling-up	
Innovative Entrepreneurship	Learning	Deepening	Testing and Developing
		Broadening	
Place-Based Leadership	Articulating and agreeing on expectations and visions, providing directionality	Broadening	Capacity-building
	Building constituency/social networks	Scaling-up	Connection to local context

Figure 1 merges the aspects of UST and change agency described above. The urban experiment is characterised by a variety of participating actors that work toward a common vision. Institutions on multiple scales act as barriers to the fulfillment of the common vision. Furthermore, new socio-technical configurations must be found in order to change current regimes in accordance with the vision. Place-based leadership in this context is responsible for the development and sharing of the common vision and coordination of participating actors. Institutional entrepreneurship is necessary to overcome institutional barriers while innovative entrepreneurship is needed to develop and improve new socio-technical configurations. Within the MLP these processes are located across the niche and regime levels, reflecting the understanding of Rohracher and Späth (2018).

From this understanding of change agency in the context of urban experiments for sustainability transitions the following questions emerge. First, how are processes in urban experiments shaped by change agency? Second, are the types of agency connected to specific actor groups and scales?

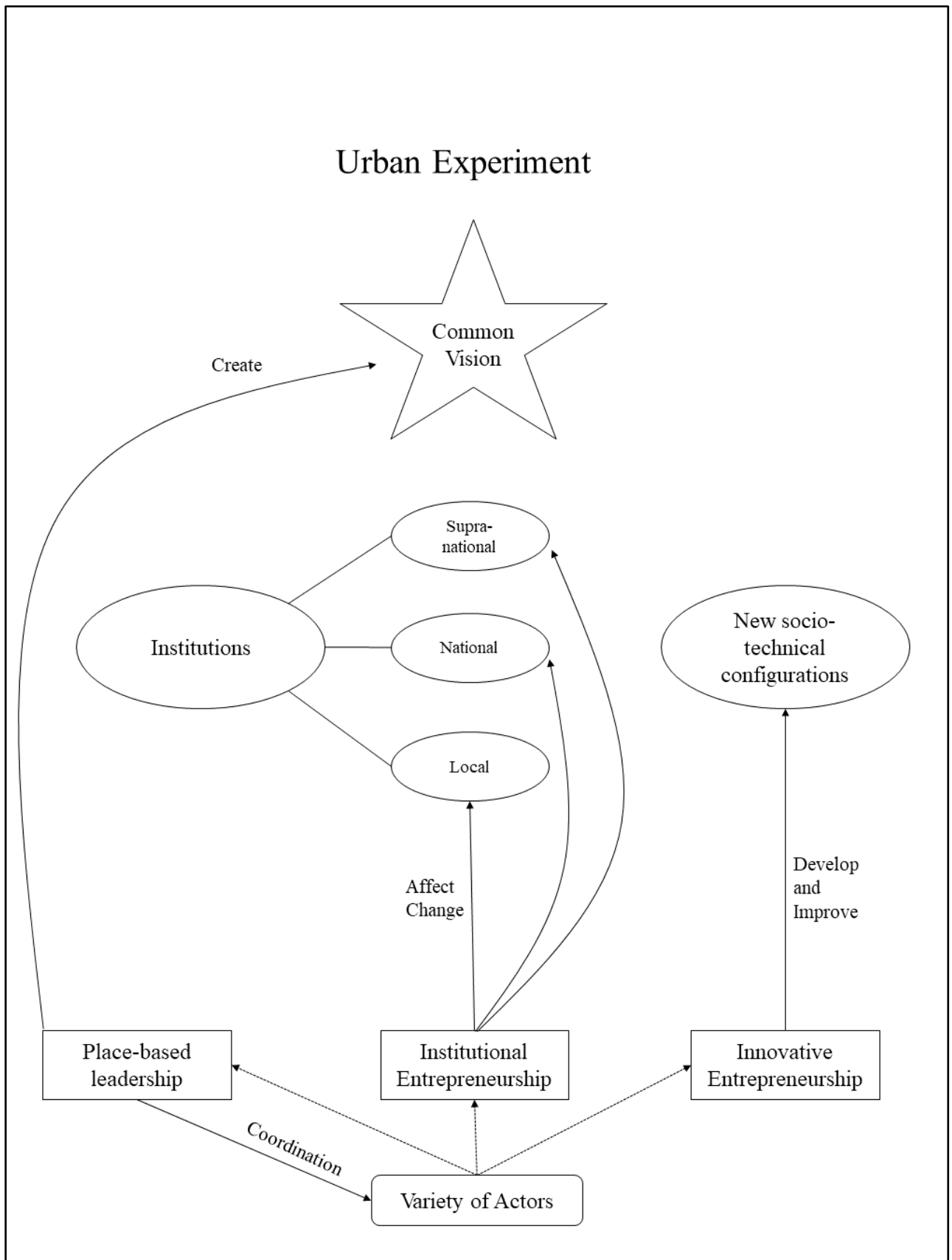


Figure 1: Change Agency in Urban Experimentats. (Author's work).

3 Methods and Case

The way change agency shapes urban experiments for sustainability transitions is examined in a qualitative case study of the “ElectriCity” project in Gothenburg, Sweden. Using a qualitative approach allows a deeper understanding of the historical trajectory of the case at hand. In this case the identification of interlinkages between agents and structure is crucial and can only be achieved by understanding the historical context of the project (Grillitsch, Rekers and Sotarauta, 2021). In urban sustainability transitions it is particularly important to acknowledge the institutional as well as technological context of an intervention since they form the background that both informs but also constrains what change agents do. A case study is the method of choice when a phenomenon needs to be studied in its context while the boundaries inbetween are not immediately clear (Yin, 2003). The aim of this thesis is to identify how change agents influence processes in experiments for UST and to clarify if the different types of change agency can be connected to specific groups of actors. To answer these questions a two step research design was chosen.

1. Archival sources and documents were used to understand the chronological development of the project and related contextual developments. Furthermore, these sources were used to identify key actors both in the projects’ initiation as well as over the future course.
2. Representatives of the key actors identified in the first step were interviewed about their roles in the project as well as their personal and organizations’ view on the projects’ phases, specific challenges, drivers and effects.

In the first step, process tracing was used. The first aim here was to inform the further research about the timeline of the project. Key developments, or critical junctures, were identified that influenced the trajectory of ElectriCity’s future development. This included examining events that led to the start of the project itself to identify actors’ intentions and motivations. In this context it was important not to limit research on data on the actual case but to gain a broader understanding of events that may have influenced the project such as market or other institutional developments. Such institutional developments include e.g. new transport plans or previous examples of projects with similar aims in the region. Furthermore, process tracing helped to identify important actors and determine the causality of their actions at critical junctions on the subsequent process (Collier, 2011; Bennett and Checkel, 2014). Here, the

interactions between different actors, their intentions and interpretations were of specific interest (Grillitsch, Rekers and Sotarauta, 2021).

In the second step, crucial actors identified through the document analysis were interviewed to gain deeper insights into their interactions, intentions and actions. Here, a semi-structured approach was used to allow interviewees to speak freely about their actions and perceptions. Following Grillitsch et al. (2021) the questions revolved around why actors were involved, what their roles were, who they worked with and why, and what their competences and motivations were. Furthermore, participants were asked about specific challenges they perceived in the course of the project and how they were resolved, what they perceived as supporting mechanisms and the broader effects of the project. This was often facilitated through prompting at specific events identified in the process tracking phase. Interviewees were also asked about suggestions for further persons to interview.

3.1 Data collection and analysis

The process tracing was based on an analysis of material about the Electricity project, such as status reports and websites published by the project itself, newspaper articles and planning documents published by Region Västra Götaland and Göteborgs Stad. In this context it was important to define a time period to find relevant documents (Yin, 2003; Grillitsch, Rekers and Sotarauta, 2021). A very narrow focus on the official launch date of the project would have meant that information regarding the projects' context would not be included. Thus the decision was made to also include developments in previous years so that the earliest document considered dates to 2009. The material included both English and Swedish language resources. These were downloaded, cataloged and analysed. From the analysis a timeline of events was developed that allowed an overview of the developments that led to the initiation of the ElectricCity project as well as over the course of the project to its current point in the beginning of 2021 (see also Figure 3).

The interviewees identified through the document analysis were contacted via e-mail and asked about their willingness to participate. Of the six persons contacted in the first attempt, five offered their cooperation and provided dates. The interviews were then conducted via video call. All but two interviews were recorded with the consent of the interviewees and lasted between 30 and 90 minutes. In addition to the recordings detailed notes were taken, which was especially relevant in the two cases where recordings were not possible. Immediately after each interview a protocoll was filled out, summarizing its content. The protocoll also included a matrix to record hints at the different kinds of change agency that became apparent in the course

of the interview. Furthermore, the protocols allowed to identify recurring motives in the different interviews. Due to the fact that the interviews were predominantly aimed at acquiring knowledge about processes from the interviewees the decision was made not to fully transcribe all interviews.

In total eight interviews were held. This allowed to talk to representatives from the most important involved organizations. Furthermore, each interview after the initial five provided a decreasing amount of new information so the decision was made to stop data collection. Table 2 shows the anonymised interviewees and their positions.

Table 2: Interviews

Interviewee	Position	Date
I1	Project coordinator, Science park	31.03.2021
I2	Project coordinator, Business Region Göteborg	01.04.2021
I3	Project coordinator, City of Gothenburg	01.04.2021
I4	Project coordinator, Volvo Busses	06.04.2021
I5	Consultant	07.04.2021
I6	Project coordinator, Ericsson	14.04.2021
I7	Project coordinator, Energi Göteborg	21.04.2021
I8	Traffic planner, Västtrafik	28.04.2021

In order to be able to draw conclusions from the data a method had to be found that enables a certain degree of analytical generalizability. First and foremost, both data collection and analysis were conducted relying on the theoretical propositions. In practice this was operationalized by categorizing the data according to their information about the different types of change agency and connected actors, the processes in urban experiments identified in the theory section above and contextual developments. The matrix used for categorizing change agency and connecting it to the actors and processes can be seen in Figure 2.

	Scaling-Up Phase	Place-Based Leadership	Innovative Entrepreneurship	Institutional Entrepreneurship	Structural Maintenance
Actor 1	Development of			Shielding, Nurturing	
Testing and Learning Phase	Place-Based Leadership	Innovative Entrepreneurship	Institutional Entrepreneurship	Structural Maintenance	
Actor 1	Development of			Shielding, Nurturing	
Initiation Phase	Place-Based Leadership	Innovative Entrepreneurship	Institutional Entrepreneurship	Structural Maintenance	
Actor 1	Development of Vision		Shielding, Nurturing		
Actor 2	Development of Vision	Developing			
Actor 3		Developing			change
Actor 4	Capacity-Building		Nurturing		ge
Actor 5	Building Constituency				
Actor 6					Opposing change

Figure 2: Exemplary matrix used for categorising change agency, actors and processes (adapted from Jolly et al. 2020).

Contextual developments were collected in a separate document. This facilitated a pattern matching whereby the insights emerging from the data could be compared to the theoretical assumptions made above (Yin, 2003). However, due to the fact that the trinity of change agency concept was developed to address a different context, rival explanations had to be considered as well. This meant that data that did not match the initial categories, e.g. when actions were described that do not fit to the trinity of change agency, alternative explanations or categorizations had to be found.

Secondly, as mentioned above, the data about change agency and the contextual developments was brought together into a chronological order to facilitate an analysis of events over time. Furthermore this simplified the analysis of causes and effects, a major challenge when analysing change agency (Yin, 2003; Grillitsch, Rekers and Sotarauta, 2021). The chronological data was then segmented into three phases that describe the status of the ElectriCity project at the time. The three phases and a timeline of events are visualized in Figure 3.

The chronology and the information about change agency were then brought together in a narrative approach that allows to provide a detailed description of change agency in the context of urban experiments and go beyond “an idiosyncratic story of marginal interest” (Langley, 1999, p. 697).

3.2 The case: ElectriCity

The unit of analysis is a crucial component of a case study research design (Yin, 2003). In order to address the research question a project experimenting with a technology aimed at transforming

the existing way of doing things toward a more sustainable one had to be found. Furthermore, this project should include a multiplicity of actors and be located in an urban area. The project ElectriCity was initiated as an effort to test the use of fully-electric buses in the public transport system in Gothenburg, Sweden. It was initiated in 2013 by Volvo and the City of Gothenburg and includes a variety of actors from regional and national government, academia and the private sector. The major component of the project was Route 55, a route dedicated to the testing of fully-electric buses and related infrastructure such as charging facilities and indoor bus stops. Furthermore, various new technologies were tested on the route that was fully integrated into Gothenburg's public transport, e.g. a zone management system that uses geofencing technology to control the buses' speed depending on their location. In addition to Route 55 the project comprised an innovation platform that was designed to allow external companies to use data generated by the project to develop new technologies. In 2016 a second line was added (Route EL16) where high capacity, articulated electric buses were tested. The project allowed insights into the technologies necessary to operate fully electric public transport, consequences emerging for urban planning as well as benefits and downsides that are connected to electric busses. Furthermore, researchers from the local Chalmers University used ElectriCity in a project to study the management of open innovation platforms. By the end of 2020, Route 55 was terminated and the project culminated in an order of 160 new electric buses for widespread use in the City of Gothenburg. However, this did not mark the end of the ElectriCity cooperation. Now the participating organizations turn attention to other parts of Gothenburg's transport system, testing fully electric and autonomous ferries as well as delivery trucks and utility vehicles.

ElectriCity can be seen in the context of several developments in Gothenburg and the region Västra Götaland. In 2009 the region approved a new transport strategy that set the goal to reduce the share of car traffic and grow public transport to 40% of all journeys taken by 2025. This goal was taken up by the City of Gothenburg's transport strategy approved in 2014. The strategy recommended to disincentivize car usage and create a more attractive urban environment by focusing on and making walking, cycling and public transport more attractive. It also ascribes an important role to the public sector as facilitator of innovation in public transport and recommends to use the city as testing ground for innovations. Similarly, the regional development and growth strategy VG2020 recommends the development of test- and demonstration arenas to practically test innovations in order to remain internationally competitive. Furthermore, investments in transport infrastructure and the improvement of

public transport through new solutions and technologies are mentioned and the public sector is ascribed a central role in this field as the procurer of public transport.

As mentioned above, for the sake of the later analysis the ElectriCity project was sectioned into three phases, the initiation phase, the learning and development phase and lastly the scaling-up phase. The initiation phase started in 2012 when Volvo and the City of Gothenburg signed a memorandum of understanding to start a collaborative project. Activities in this phase focused on formulating a vision, setting goals and developing an organizational structure. Furthermore, relevant organizations had to be included in the project and the regulational, technological and infrastructural requirements for running the test line had to be figured out and built. The initiation phase ended in 2015 with the start of route 55. This event marked the beginning of the learning and development phase where activities focused on running the two test lines, learning about and developing the tested technologies, finding new business models for the provision of electricity but also redeveloping the collaborations' organization. The learning and development phase ended in 2020 with the termination of route 55. However, the end of the learning and development phase and the beginning of the scaling-up phase can not be clearly separated. Västtrafik's order of 150 fully-electric busses precedes the termination of route 55 but marks the beginning of the scaling-up phase where the electric busses were used to replace older diesel busses. Furthermore, the partners of the ElectriCity collaboration turned their attention toward electrifying other means of urban transport.

Figure 3 shows the projects' timeline with important events and visualizes the three phases. It also includes relevant environmental developments.

Several aspects of experiments for urban sustainability transitions can be found in the ElectriCity collaboration. First, the project addresses a societal challenge. Both initiating parties, Volvo and the City of Gothenburg, formulated a common vision before commencing the project thus reflecting the idea of transition management. This vision included seeing electric buses as a means to raise the attractiveness of public transport and thus reduce the use of cars. Furthermore, Volvo saw the opportunity to develop a new product, so far unavailable on the market. Secondly, ElectriCity is aimed at system innovation by not focusing on developing only an electric bus but also changing infrastructure, surrounding technologies and use-patterns. Thirdly, the project is inherently inclusive. From the beginning the two initiating organizations planned to include further actors from the public sector, other companies and later on academia. Furthermore, the users are implicitly involved by using the test line and participating in surveys. This leads to the fourth point, practice-basedness. ElectriCity is a project dedicated to test technology in real life conditions and thus facilitate learning that can not be achieved in a

laboratory environment. Fifth, social learning is an explicit part of the project. The project is not limited to testing and developing the busses but also aims at learning about technologies facilitating their use, business models as well as new possibilities for urban planning that become available by switching to electric buses. Lastly, the aspects of ambiguity and uncertainty become obvious in the different objectives of the project. Developing a new bus and learning about the technological changes necessary to allow a broader implementation is mostly relevant for Volvo and other private companies, but in turn they might not be as involved in learning in fields outside their responsibility and capability, e.g. urban planning and the transformation of urban traffic. Uncertainty becomes apparent when considering the projects' funding. The initiating parties invested considerable resources in a project with uncertain outcome. Especially Volvo invested in developing a new technology without sufficient demand and insufficient knowledge about its future development. Here, the project acted as a niche where the busses could be used, protected from the market.

Timeline of events in the ElectriCity-Project

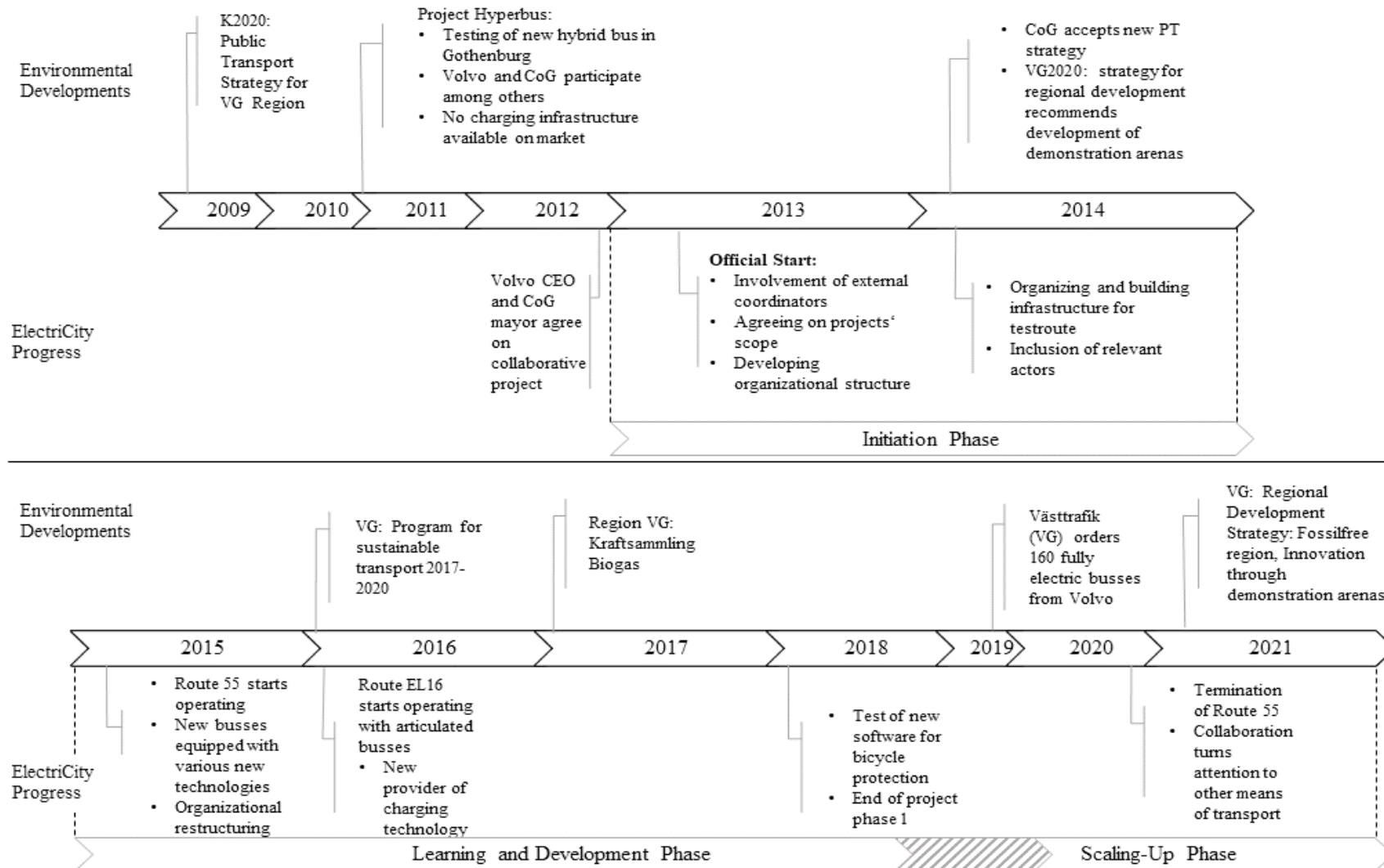


Figure 3: Timeline of ElectriCity and visualization of the three phases (Author's work).

4 Results

The following subsections are dedicated to describing and analysing how the three types of change agency as well as structural maintenance influenced the progress of the ElectriCity collaboration during the three phases described above. Within the three phases, the subsections are arranged according to their relevance for the progress. Furthermore, the influence of structural developments is considered.

4.1 Institutional Change preceding ElectriCity

Two events preceding the initiation of the ElectriCity experiment must be considered as context for the project. First, in 2009 the Västra Götaland region published the new public transport strategy 'K2020' (Göteborgsregionens Kommunalförbund *et al.*, 2009). This strategy marks a point of change in thinking about transport in the region. The car-based individual traffic is described as unsustainable and responsible for pollution and congestion in the regions urban areas. As a consequence, the strategy recommends to reduce the share of car traffic in the modal split and instead grow the importance of cycling and public transport. This is to be achieved through restrictive measures, like fees for using cars in specific places in Gothenburg, but also through incentives such as making cycling and public transport more attractive through restructured networks, improved services and infrastructure but also explicitly through improving the vehicles used for public transport. K2020 can be interpreted as a first vision of the future of urban transport, requiring both institutional as well as technological change. Thus, innovation can be seen as crucial to reach the target of a 40% modal share of public transport by 2025 (Göteborgsregionens Kommunalförbund *et al.*, 2009). This call for innovation met fertile grounds in the region that has long had a strong presence of firms in the transport sector, first and foremost led by Volvo and its' various branches but also smaller suppliers and research facilities. In 2011, Volvo initiated the project HyperBus in Gothenburg in order to test a newly developed hybrid bus in cooperation with the local development agency, the energy agency Energi Göteborg, the city's traffic department and the regions' public transport company, Västtrafik (N.A., 2011). This project was described as crucial experience in collaborative projects between the public and private sector by several interviewees (I2; I4).

Second, starting in 2012 the City of Gothenburg developed a new transport strategy that was completed and published in 2014. However, several documents that contributed to the final strategy were published in advance. In one of these publications scenarios for the situation of transport in Gothenburg in 2050 were developed according to the direction of economic growth

and technological development. One scenario describes a situation that results of positive economic growth and technological development towards alternative means of mobility where the significance of cars is greatly reduced and public transport has a high status and the most important means of transport. Other scenarios raise concerns of a car dominated city in the case of economic downturn and lacking technological development. To steer the development in preferable directions the document ascribes an important role to political planning (Hellberg *et al.*, 2012). The final transport strategy sets several main objectives for the future of transport in Gothenburg. These are easier accessibility to transportation, transportation as a means to contribute to a more attractive urban environment, consolidation of Gothenburgs' position as the Scandinavian logistics centre and the support of innovations and new solutions. In the context of the last aim, the strategy specifically mentions using the city as a real-life testing ground as a principle for the implementation of new solutions (Hellberg *et al.*, 2014).

These developments show that on both the regional as well as the local scale an institutional change has happened that concerned the vision of what good and sustainable transport entails. The predominance of the car as the primary means of mobility was broken up and more weight is put on new solutions to make public transport more attractive. Furthermore, the strategies ascribe an important role to political steering and collaborative innovation. This marks a discontinuation with the previous thinking that the public sector merely accommodates the innovations developed by private firms and instead requires public actors to responsibility and a leadership role. Lastly, the strategies also develop a vision of a future situation toward which planning can be oriented.

The initiation of the ElectriCity collaboration must be seen in the context of these institutional changes and was itself made possible through place-based leadership, institutional and innovative entrepreneurship.

4.2 Initiation Phase (2012-2014)

The initiation phase was mainly shaped by institutional developments that preceded the actual initiation of the ElectriCity collaboration and were described above. In the following progress of the phase innovative entrepreneurship, place-based leadership and institutional entrepreneurship shaped the course of the project.

4.2.1 Innovative Entrepreneurship

Innovative entrepreneurship in the initiation phase can mainly be connected to firms from the private sector and focused on development processes. The institutional changes described above opened an opportunity for the market to provide new technologies to meet the demand for more

sustainable, less polluting public transport. At the time, several varieties of electric buses existed. These were primarily trolleybuses using overhead wires, similar to a train, without the ability to store energy on the bus. Thus these buses are dependent on an extensive wire infrastructure and consequently their operationality is constrained. On the other side of the spectrum, fully-electric buses with large batteries that allow saving energy for a whole shift of operation were produced by Chinese manufacturers. One downside of these busses was that the required batteries were expensive and heavy, making the operation of those busses inefficient (I1, I4). This situation provided an opportunity for Volvo as a well established European manufacturer to develop a new fully-electric bus, based on the knowledge gained from operating the hybrid busses. A substantial part of this development was the design of a new fully-electric powertrain that marks a radical change from the previous design based on combustion engines (Nordin, 2018). The new busses are furthermore based on opportunity charging. They are equipped with smaller batteries that allow the bus to be operated over the length of the route at the end of which it has to be recharged (N.A., 2016, I2, I4).

For the purpose of charging Volvo developed a new system that is based on a rail mounted on the busses' roof and a pantograph that is lowered from the charging station onto the rails, delivering the energy. This system is called OppCharge and the intention was to market it as an open interface in order to enable other manufacturers to use the same system (N.A., 2016; I1; I4; I7).

The development of the new type of bus using the OppCharge system also required a new type of charging infrastructure that was not available on the market. For this purpose, several manufacturers designed charging stations that could be included in bus stops. In the initiation phase the German firm Siemens was chosen to deliver the technology (N.A., 2016, I7).

4.2.2 *Place-Based Leadership*

Apart from the economic motivations and institutional changes, place-based leadership was crucial in the formation of the ElectriCity experiment. Here, the City of Gothenburg and Volvo can be identified as the key actors. At first, Gothenburgs' mayor and the CEO of Volvo merely agreed on starting a collaboration (I4). However, at this point the thematic focus was not clear. Both, the city and Volvo were motivated by using the project to grow Volvo's and the broader regions international competitiveness and attractivity. In this context, Volvo stressed the importance of carrying out the project in its hometown (I1; I2; I4). The City of Gothenburg on the other hand is financially dependent on Volvo and thus has a strong interest in the companies' economic future (I2; I5).

For the coordination of the initiation phase the city and Volvo employed an external consultant firm. The consultants had previous experience of projects around public transport and the local industry. In cooperation with Volvo and the city they developed a vision for the project, concretized the idea of focusing on testing, demonstrating and learning about electric busses (I5; I4).

In the later course of the initiation phase place-based leadership was also used to mobilise new actors and resources. First and foremost this was a task of the external consultancy firm. Through their previous projects around public transport the consultancy had a good knowledge of the local companies but also of the ways the participating parties were organized. The consultants actively introduced new organizations to the project that they thought were crucial for the projects' success. The inclusion of the region Västra Götaland and its transport company Västtrafik can be traced back to this engagement (I5). However, Volvo also actively extended the collaborations' network. One example of this is the inclusion of Ericsson, a Swedish telecommunications and network company . Ericssons inclusion is connected to the digital innovation platform that formed a part of ElectriCity. Here, structural and real-time data gathered in the project was made accessible to enable tertiary firms to develop products based on the data. Ericsson was tasked with developing this database (I6).

The inclusion of the Chalmers University of Technology was also facilitated through place-based leadership. While the university was initially not considered as a relevant participant by the initiating organizations, in the course of preparing the launch of route 55 it became apparent that the university owns land that could be used for the test bus stops. The science parks and external consultants then worked together to include the university in the collaboration. This process resulted in the design of a research project that could be carried out in cooperation with Chalmers (I5).

The funding of ElectriCity can also be connected to place-based leadership. The project was mainly funded by the region Västra Götaland, the City of Gothenburg, Chalmers University and Volvo (N.A., 2016). For this purpose Volvo was granted financial support from the Swedish Energy Agency (Energimyndigheten, 2014). This funding profited all participating parties, as can be seen using the consultants as an example. These were initially funded by Volvo and the City, while later on Volvo continued to finance their work. However, the consultants worked for both paying and non-paying participants (I5).

Thus, place-based leadership in the initiation phase focused on processes of capacity and constituency building as well as the articulation and development of expectations and vision. Here, firms and local governmental actors took leadership roles.

4.2.3 *Institutional Entrepreneurship*

Institutional entrepreneurship in the initiation phase can be connected to both the private as well as public actors that engaged in ElectriCity. The actions were mostly aimed at nurturing and empowering a new way of thinking about urban transportation.

The first instance of institutional entrepreneurship regards the codification of a new thinking about both doing innovation as well as mobility. While the new thinking about mobility has already been described above, the new way of thinking about innovation and the public sectors' role in it is covered in the regional development strategy VG2020 (Västra Götalandsregionen, 2013) and the smart specialization strategy (Västra Götalandsregionen, no date). Here, the region emphasised the responsibility of the public sector to support development of sustainable innovations through procurement. Furthermore, both strategies ascribe an important role to testing and demonstration arenas where new solutions can be tested in an environment that includes all relevant groups.

Another aspect of institutional entrepreneurship concerns the collaborative testbed mode of innovating. For Volvo, the testbed strategy and active collaboration with the public sector was a new mode of innovating. While the company had previous experience in collaborative projects, the scale of ElectriCity exceeded these previous projects (I4). This is also true for the public actors like the City of Gothenburg and BRG (I2).

4.2.4 *Structural Maintenance*

For Västtrafik the ElectriCity project posed a challenge. The public company previously had not fostered a culture of innovation and consequently had problems to enable learning from the participation in ElectriCity (I8).

4.3 Learning and Development Phase (2015-2019)

In the learning and development phase events were shaped by institutional entrepreneurship and place-based leadership. Instances of innovative entrepreneurship can also be found but were not as pronounced as in the previous phase.

4.3.1 *Institutional Entrepreneurship*

Institutional entrepreneurship in the second phase of ElectriCity can be connected to firms as well as regional governmental actors and focused on learning and deepening processes. These processes were both internal to ElectriCity but also external events that supported the developments within the project.

In 2016 the region Västra Götaland published a ‘Programme for Sustainable Transport 2017-2020’ (Västra Götalandsregionen, 2016). The programme provided funding with the target of achieving a fossil fuel free transport sector by 2030 and acknowledges that in order to reach this target the current energy use of the transport sector had to be cut by a third. Electrification of transport was mentioned as the factor that would lead to the biggest increase in energy efficiency. Furthermore, the program also recommends an integration of urban planning and public transport and the collaboration of transport planning with other actors, specifically from the private sector. The latter is framed as a way to develop and export internationally competitive technologies that reduce the use of fossil fuels globally but also secure the economic future regionally. Again, the programme stresses the importance of developing, testing and demonstrating new technologies in collaboration with external partners.

The programme for sustainable transport can be interpreted as another instance of the regional government attempting to institutionalize collaborative demonstration arenas and the electrification of urban transportation and thus nurturing and empowering the purposes of the ElectriCity collaboration.

Internally, the beginning operation of route 55 required changes in the organizational structure that was previously designed for the preparation of route 55. This entailed that actors were previously tasked with delivering specific components of the new line, like bus stops or integrating line 55 into the existing PT system. In the new organizational structure, operation of route 55 on the one hand and learning and development functions on the other hand are clearly separated but are coordinated by a steering group, comprising of the region, the city, Volvo and Chalmers. A partner group with all participating actors coordinate specific focus areas, like city development, automation or connectivity that enabled learning about specific aspects of electrified urban transport. Furthermore an operating group had the responsibility over the actual operation of route 55. This entailed that organizations like the university’s property company, that were not previously involved in public transport, had to adapt to new practices and learn about the development and operation of bus stops. The reorganization was driven by the external consultants as well as researchers from Chalmers (N.A., 2016; Webb, 2018).

4.3.2 *Place-Based Leadership*

Place-based leadership had a considerable role in the learning and development phase. Here, the maintenance of directionality, the extension of networks and constituency as well as capacity building were important processes that can mostly be connected to private sector actors like Volvo and external consultants.

Over the course of the second phase new actors were continuously included in the project mainly to gain further capabilities that previously were not represented in ElectriCity. An example of this is the joining of ABB in order to provide the charging infrastructure for route EL16. In this case Göteborg Energi suggested to involve the company instead of Siemens who produced the chargers for route 55 and who was not able to provide the high-powered technology required for charging the new busses (I4, I7).

While this decision was motivated by technological necessity, in other instances the regional development agency actively engaged to open the project for new participants in order to enable other regional firms to benefit from the collaboration. This marked a point where the different motivations and intentions of the participating actors became apparent. On one side, the governmental actors wanted the project to benefit the wider regional economic and urban development. While on the other side, Volvos' motivation was merely of economic nature and focus was on developing and learning from the project to later be able to collect rents from the innovations developed here (Webb, 2017; I4). This situation represents one instance of situations where the external consultants were required to coordinate and mediate between the different parties and interests in order to secure progress and maintain directionality. While many interviewees did not connect the consultants' actions to specific outcomes, their coordination and promotion of a cooperative spirit and attitude was mentioned as a decisive factor for the progress of ElectriCity (I3; I4; I6). Furthermore, the consultants appeared to have developed a strong personal commitment to the project that went beyond purely economic motivation (I5).

Another aspect of place-based leadership in the second phase of ElectriCity are the acquisitions of funding. Public funding played an important role in this phase. While the regional government supported the project financially through its programme for sustainable transport (Fogelberg, 2021), Volvo also applied for funding from the Swedish Energy Authority (Energimyndigheten) to develop a demonstration platform for high-capacity buses. This funding then enabled the operation of the articulated busses on route EL16 (N.A., 2020; I4).

4.3.3 *Innovative Entrepreneurship*

Since the majority of technological innovations that ElectriCity aimed to test were developed in the initiation phase and prior to that, innovative activities were not as important as in the first phase. However, some technological as well as business model innovations were developed. Thus innovative entrepreneurship in the testing and learning phase focused on deepening and broadening as well as development and testing processes.

In 2016 a second test route was added to ElectriCity. For route EL16 Volvo adapted the fully electric drivetrain to new larger articulated busses. This development also included the use of larger batteries that allowed the busses to have an energy reserve to avoid recharging in rush hours. Instead, charging happens in a depot over night and during stops on the route when the bus is in service (N.A., 2020; I4). Based on the new larger busses Ericsson took the initiative to develop a cyclist safety system in cooperation with a bike sharing service in Gothenburg. The system uses geofencing technology that measures the distance between a bicycle and the bus in congested areas. In case the distance falls below a certain threshold, both the cyclist and the busdriver receive a warning (I6).

Furthermore, Ericsson cooperated with the city's environmental department to adapt air quality sensors to the busses in operation on route 55. The aim of this project was to map the air quality in Gothenburg in real time using moving sensors (I6).

A second instance of innovative entrepreneurship can be connected to the development of business models. In order to successfully operate route 55, Energi Göteborg, the local energy supplier, developed a business model for the supply of electricity to the public transport operator. In this model, Energi Göteborg provides the charging infrastructure for the operator of public transport. Cost for the electricity used is then invoiced to the operator who in turn charges Västtrafik as the purchaser of the transport services. The development of this business model can be seen as a crucial step for the later broader scale use of electric busses and other means of electric vehicles since the fueling is a component in electrified transport that is significantly different to traditional vehicles (N.A., 2016; I7).

4.3.4 *Structural Maintenance*

Only one instance of actions that could be interpreted as structural maintenance could be identified in the course of the second phase. The program "Kraftsamling Biogas" by the region Västra Götaland presents an initiative to support the regional biogas sector. Here, using biogas as an alternative renewable fuel for transport is considered as an alternative to electrification, especially for public transport (Ekengren, 2017). While the programme did not have a negative effect on the ElectriCity collaboration, it was mentioned by one interviewee to have caused irritation among the participants (I3).

The struggles about extending the collaboration to include more actors described in section 4.3.2. can also be interpreted as structural maintenance from Volvo. It was against the company's interest at the time to expand the project and instead wanted to focus activities on the development and demonstration of its own product (Webb, 2017).

4.4 Scaling-Up Phase (2020 and onward)

In the scaling-up phase of ElectriCity activities focused on the electrification of a large part of Gothenburg's bus fleet, applying the learnings from the collaboration in other contexts and find new fields of engagement for the project. Accordingly, this phase was mostly shaped by institutional entrepreneurship and place-based leadership.

4.4.1 Institutional Entrepreneurship

Institutional entrepreneurship in the last phase focuses on scaling-up various elements of the collaboration through new applications and standardization. Furthermore, the participants adapt their practices to the learnings from the experiment. Here, both firms and participants from the public sector are active.

An important aspect of ElectriCity is its organizational structure. Several interviewees named this as a unique factor that was radically new at the time of initiation (Mattsson, 2021). Consequently, several participants actively work to apply similar structures to other projects. Examples for this are the activities of Lindholmen Science Park, who coordinate a number similarly structured collaborative projects (Lindholmen Science Park, 2021; I1). Furthermore, the regional development agency actively advertises and supports testbed initiatives (I2). For this purpose the programme 'testbädd göteborg' was started that allows small and medium sized companies to test products and solutions in a collaborative, real-life environment (Bern, 2021). Similarly, the new regional development strategy published by the region Västra Götaland recommends demonstration platforms and real-life arenas for learning about, implementing and scaling up innovations for sustainable development. In addition to institutionalising this organizational structure, the strategy also targets an electrification of industry and transport, thus reaffirming the regional development path toward electrified transportation (Västra Götalandsregionen, 2021).

A second aspect of institutional entrepreneurship is connected to up-scaling technologies developed and tested in ElectriCity through standardization. Here, Volvo has worked together with the European Automobile Manufacturers Association ACEA to develop a recommendation for a standard charging method for electric commercial vehicles. The ACEA now recommends a technology that resembles OppCharge (ACEA, 2017). A similar standardization was also established for the American market by the Society of Automotive Engineers SAE, identified as SAEJ3105/1 (SAE, 2020). Apart from Volvo, other European and American bus manufacturers have adopted the standard and the technology is rolled out in other European cities (Volvo Bus Corporation, 2021).

The third aspect of institutional entrepreneurship concerns the way Volvo changed its marketing practices. The company now uses ElectriCity as part of its marketing strategy. Being able to show a successfully electrified public transport system is seen as valuable when it comes to convincing customers of the feasibility of electric busses. As a consequence of ElectriCity, Volvo and its partners are now able to sell a packaged solution including both busses and the charging infrastructure. In this context, Volvo interpreted ElectriCity as “a way of preparing the market” (I4).

Lastly, the ElectriCity collaboration triggered changes in the organizational structure of some of the participating actors. Especially Västtrafik was initially troubled to foster an innovative culture and enable learning from the project. For the company, ElectriCity was the first time a new technology could be tested and co-developed in a testbed environment before it is acquired. This required changes in the company’s culture toward accepting risk and uncertainty. The lack of these had prior been criticised internally and Västtrafik’s coordinator was able to push parts of the organization toward change (I8).

4.4.2 *Place-Based Leadership*

Place-based leadership in the scaling-up phase was connected to capacity building processes that enabled both the up-scaling of electric busses but also the broadening of ElectriCity toward other fields of activity. In 2019, Västtrafik provided the funds for a tender that aimed at acquiring 160 new fully-electric busses for public transport in Gothenburg and the region Västra Götaland. This tender initiated a scaling-up from the experimental use of electric busses on two lines in the context of ElectriCity to their broad use in operations on several lines. The tender was won by Volvo and the first busses were delivered and started operating by the end of 2020 (Bussmagasinet, 2019; N.A., 2020). This event also marked the end of ElectriCity’s focus on electric busses. However, the participants were convinced that continuing the collaboration could prove fruitful for the future. The idea was to shift attention to other means of urban public transport. In this context, the City of Gothenburg suggested a project to develop autonomous electric ferries in cooperation with Ericsson (I7). In the same environment Volvo Penta, the company’s heavy- and marine industry subsidiary, ABB and Chalmers University acquired funding from the SEA to test electric fast-charging ferries (N.A., 2020).

4.4.3 *Innovative Entrepreneurship*

Innovative entrepreneurship is not as pronounced in the scaling-up phase as in the earlier phases. Activities in this area took place in the context of extending the collaborations fields of

activity. Here, Volvo and ABB cooperate in order to electrify a ferry previously run by combustion engines. The plan is to adapt electrify the ship's powertrain and charge it with an HVO-run generator on board. In a second phase, the companies are planning to adapt the fast charging technology developed for the bus routes in ElectriCity to charge the ferry (N.A., 2020). Lastly, developing an electric drivetrain and focusing development and production on electric vehicles required Volvo to deeply restructure its operation. Thus far, the production system was tailored to the development of diesel fueled busses. Producing electric busses however, requires different machinery, different suppliers and different knowledge. Thus significant organizational changes had and will continue to be made in order to accommodate the large scale production distribution of electric busses (Nordin, 2018).

5 Discussion

5.1 Change Agency in Urban Experiments

This thesis attempted to find answers to the following questions: First, can the trinity of change agency concept be applied to urban sustainability transitions and which processes are shaped by change agency in urban experiments? Second, are the types of agency connected to specific actor groups and scales?

Section 2.7. provided a hypothesis of how agency in experiments for urban sustainability transitions could be conceptualized using the trinity of change agency framework that distinguishes between place-based leadership, institutional entrepreneurship and innovative entrepreneurship as actions directed toward change and structural maintenance as change resistant activities. The case study of the ElectriCity collaboration in Gothenburg then aimed at firstly, empirically testing how the three types of change agency shape processes in urban experiments and secondly, if specific actors or actor groups can be connected to specific types of change agency.

The case study showed that place-based leadership was crucial in the initiation of the project and furthermore shaped processes such as the extension of the actor network, capacity building, i.e. provision of resources, the development of a vision and maintaining directionality toward that vision as well as broadening the experiment and scaling-up from the experimental context in the end. Actors that could be identified as place-based leaders are Volvo as a private company, the coordinator-consultants, science parks and various actors from both local as well as regional government, such as the regional development agency, the mayor and Västtrafik. In some instances their actions were facilitated by funding provided from the SEA, a national institution. This result is interesting in multiple ways. First, on the one hand, it supports the assumption that the public sector often is a leader or initiator in urban experiments (Bulkeley

and Castán Broto, 2013). On the other hand, it contradicts the assumption that main actors in urban experiments are regime outsiders and users (Sengers, Wieczorek and Raven, 2019). Quite to the contrary, Volvo can be seen as an actor with vested interests in the old regime but nevertheless initiated a change process, resembling the activities of car manufacturers in Stuttgart, Germany (Späth, Rohracher and Von Radecki, 2016). Second, it emphasises the relevance of specifically local actors in initiating urban experiments. Third, it reveals that place-based leaders can have different motivations for their actions and visions guiding them, contradicting the assumption of transition management that a single vision is crucial. While Volvo was for a large part motivated by economic self-interest, the region and the city were motivated by benefitting the wider region. However, this constellation proved to be problematic when Volvo used its dominance to resist the extension of ElectriCity. Here, their self-interest collided with the project's general vision.

Innovative entrepreneurship was the basis for the project. Here, two developments are central: First, the new electric drivetrain and second, the OppCharge charging technology. Thus, innovative entrepreneurship can be connected to processes such as development and testing of new products, deepening and broadening as well as scaling-up. These processes were the exclusive realm of private actors, first and foremost Volvo, but also Ericsson, ABB or Siemens. This result underlines the differing views on technological innovation between the literature on sustainability transitions and that on change agency mentioned in section 2.7. In ElectriCity, the technological innovation were also not developed in co-creation between users and manufacturers. Furthermore, this again underscores that new technological configurations must not necessarily be developed by niche actors. In this case a regime actor created a niche in cooperation with governmental actors in order to develop and test a new socio-technical configuration, resembling the SNM-approach.

Institutional entrepreneurship enabled ElectriCity through nurturing and empowering processes, such as institutionalising a new culture around urban transport as a whole and public transport in particular. Furthermore, institutional entrepreneurship was active in learning and deepening processes. These led e.g. to structural changes in the participating organizations. Lastly scaling-up processes were crucial when actors worked toward the standardisation of the solutions developed in the collaboration. Influential in this regard were both public and private actors: Volvo, the City of Gothenburg, Energi Göteborg, Västtrafik and the region Västra Götaland. Again, this result is in line with Fuenfschilling and Truffer (2016) who found that socio-technical transitions are enabled through institutional work that aims at institutionalizing new principles, practices or standards. Furthermore, the result support Essletzbichler (2012) by

showing how local and regional governments in particular are able to foster niche creation through their policies.

The influences of structural maintenance that this case study was able to detect were few and insignificant. However, it is interesting to notice that the few instances of structural maintenance were connected to actors that otherwise actively contributed to change, like the region Västra Götaland. This resonates with the results of Jolly, Grillitsch and Hansen (2020) who find similar dualistic roles and caution against pre-assigning types of agency to specific types of actors.

Table 1 connected the three types of change agency to relevant processes identified in the different perspectives on urban experiments. It showed that theoretically, all three types of change agency could influence processes in niche experiments, transition experiments and ULL. Empirically, the case study showed that these assumptions were mostly accurate: Place-based leadership influenced the articulation and agreement on visions, directionality, constituency building, broadening and scaling up. Innovative entrepreneurship was connected to learning, deepening, broadening and testing and developing processes. Institutional entrepreneurship was active in learning, nurturing and empowering, deepening, scaling-up and capacity-building processes. However, scaling-up processes were not only shaped through institutional entrepreneurship and place-based leadership but also through innovative entrepreneurship. Furthermore, institutional entrepreneurship could not be connected to broadening processes. The process of connecting to the local context could not be identified within ElectricCity, which can be explained by the strict focus of the project on a specific theme. Consequently, it was not necessary nor possible for actors to address further local issues.

Interestingly, the interviewees have not ascribed a crucial role to the participants from the academic realm. While the Chalmers University was involved in the project, focus was less on accompanying the project scientifically but rather on the university's ownership of land that was needed to build infrastructure.

The results reveal a few further points about urban experiments in general. First, the fact that the regional government was actively engaged in the project but at the same time also supported activities that work in an opposing direction, such as the biogas initiative, points to the difficulties governments can face when they try to steer innovation and socio-technical change. Governments, other than private firms, need to negotiate between different interests and try to stay open for alternative developments in situations where the outcome is uncertain. This strategy of distributing risk however, may itself bear the risk of undermining progress in an urban experiment.

The second point regards the role of private firms in urban experiments. First, usually urban experiments are co-financed by governments and the private sector. In case a specific product is developed and tested within the experiment this implies that private firms can use the experimental setting as an instrument to reduce financial risk by sharing it with other parties. On the other side, this instrument leverages the profit that can be gained in case the innovation can be scaled up from the experimental scale. Thus, urban experiments can also be interpreted as an instrument for regional development. Second, as the case study has shown, private firms may take roles of place-based leadership within urban experiments. This can raise issues when firms become too dominant and come in a position that enables them to direct governments and administrations, e.g. in regards of funding and dominate the discourse as was the case in Stuttgart (Späth, Rohrer and Von Radecki, 2016).

Furthermore, the case study revealed theoretical shortcomings. The trinity of change agency framework was developed to analyze processes of regional industrial change from an evolutionary economic geography perspective. The sustainability transitions literature however, focusses on socio-technical system change in general and urban experiments are usually concentrated on changing a specific socio-technical system in a specific place. While there are similarities between the two approaches, differences remain for example with regard to the directionality and predictability of change processes as well as actors and their motivations. Urban experiments are oriented toward a vision and provide a niche from which a new socio-technical configuration is supposed to be scaled and include a limited number of actors whose intentions may be altruistic but can also be purely economic. Regional change processes however, are usually not as focused on a specific outcome, include more actors and are often subject to a certain degree of top-down steering that is intended to profit the region economically. In the case of *ElectriCity*, the collaboration was used, by some actors, for the purpose of developing and marketing a new product that was intended to address a predictable demand. Thus, some types of urban experiments could also be characterised as closed projects. Consequently, not all actions within these projects may be categorised by the three types of change agency or structural maintenance. In the case study, actions like the extension of networks were categorized as place-based leadership, however they often were also motivated by purely economic interests or technological necessity. Thus, they could also be described as 'project management activities'. Such actions were apparent in all phases, however, in the scaling-up phase, it became apparent that change agency began to have a decreasing relevance. Instead, the project initiated changes to business models and practices of the participating organizations that after their successful implementation were merely used and managed. This

allows the assumption that after an urban experiment change agency can be replaced by a management of the initiated changes and thus a new phase of ‘maintenance’ begins.

5.2 Limitations

Methodologically, the thesis has a few limitations. First, the empirical base for the case study is limited, especially with regards to insights gained from interviews. These were held mostly with coordinators that were designated to the ElectriCity project from their respective home organizations. Consequently, the insights gained are limited to an internal perspective of ElectriCity. Furthermore, there have been a number of staffing changes over time which meant that representatives from the crucial organizations Volvo, City of Gothenburg and Västra Götalandsregionen/Västtrafik have changed and that interviewees from those organizations could not provide insights into the crucial early phases of the demonstration arena. This furthermore made it difficult to determine the influence of programs like K2020 or Gothenburg’s transport strategy on the project. Second, the case itself did not provide the opportunity to investigate the role of civil society in urban experiments. In ElectriCity the public was not actively involved but rather interpreted as users who contributed to testing through surveys. Furthermore, coverage of the project in local newspapers was limited to reporting about the project’s progress and did not engage critically. This leads to the third point, that regards the outcome of the bus-focused part of ElectriCity. Urban experiments aim at achieving socio-technical change. In this case technical change has successfully been achieved. However, it remains to be seen if this also leads to a social change in the form changing transport usage patterns.

6 Conclusion

In spite of these limitations, the thesis adds to an understanding of agency in urban experiments for sustainability transitions and provides another connection between concepts from economic geography and urban sustainability transitions. The trinity of change agency framework can provide insights into actions that shape the initiation and progress of urban experiments. Furthermore, it can be used to explain why urban experiments ‘take place’. Agents that influence the institutional landscape and place-based leadership are important in the initiation of such projects. Here, both the specifically local private sector as well as local and regional government were crucial. National agencies were also important enablers through the provision of funding. Furthermore, innovative entrepreneurship is necessary for the actual development of new technical configurations. Interestingly, the study showed that actors with vested interests in the old regime were actively involved in the transition. With regard to scaling up from the

experimental level place-based leadership and especially institutional entrepreneurship are crucial. Further research could provide insights from more diverse urban experiments that also include the civil society. It would also be interesting to inquire whether similar actor-agency configurations can be found in experiments in places that lack endogenous resources, i.e. places without existing firms that can initiate such programs and provide resources and technology as was the case with Volvo in Gothenburg, and how these places compensate for that lack.

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