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TRIPLE HELIX 9 (2022) 216–238

TRIPLE
HELIX
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Transformation Pathways Towards Climate Resilient Cities: A Comparative Analysis of Halle (Saale) and Mannheim, Germany

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Abstract

This article explores the enabling factors and actors involved in the transformation pathways towards climate resilience of two German cities: Halle (Saale) and Mannheim. A specifically developed analytical framework served as basis for making the complex developments of the transformation paths of the two cities visible and comparable. The analysis has shown that despite strong similarities in terms of climate change impacts, the cities acted under very different political and economic conditions and thus applied particular strategic and tactical approaches and steering instruments. It can be stated that preparation of climate strategies, creation of a supporting central unit for climate issues and exemplary implementation of selected measures by the administration, as well as awareness-raising and cooperation with the stakeholders and citizens have played a key role in the cities' transformation. In both cities, the

city administration took the role of innovation organiser and orchestrated the pathway towards becoming climate resilient.

Keywords

Case studies – Climate resilience– Resilient cities – Transformation pathways – Triple Helix – Urban climate governance

1 Introduction

The local implementation of the transformation towards a climate neutral society is a process that involves a wide variety of actors and solutions depending on the starting situation, framework conditions and available resources. Such a transformative urban governance includes actions by state and non-state actors and institutions (Triple Helix) with the aim of organising the local affairs of a city and its society aiming at a wide-ranging transformation of cities towards sustainability (WBGU 2016: 17). A transformation pathway always depends on individual local conditions and cities play a significant role in it as agents for change. Therefore, there can be neither one ideal state for cities to strive for, nor one ideal-typical path for implementation. Accordingly, cities have to develop individual transformation pathways (UBA 2016: 31).

The necessary governance processes are shaped by the requirements that arise from the special nature of climate change and thus urban climate change governance (Engels et al. 2018: 267f): acting despite uncertainty, under conditions of a long-term perspective and by means of cross-sectoral and cross-level approaches. These requirements encounter cities with a political and administrative system that is characterised by action in short-term electoral periods, thinking in organisational structures and routines, working in clearly delimited departments and powerful and often non-innovative stakeholder-networks (UBA 2016: 67).

The analysis of urban transformations towards climate resilient cities complements the scientific urban climate governance discussion with knowledge about the individual solution paths of cities and enables derivation of generalisable insights on transformations. At the same time, it increases the understanding of the respective spatial context, the influencing framework conditions and their interplay at the local level and makes this knowledge accessible for further cities (Eckart et al. 2019).

Studies conducted in the area of urban transformations, urban climate governance, as well as Triple Helix constellations provide important insights for

understanding transformations towards climate resilient cities, at the same time pointing out some research gaps. As Van der Heijden (2019) argues, there is a need for more empirical research in the area of factors enabling city governments and others to govern local climate action more effectively. There is a need for a framework with a set of criteria that would reduce complexity and allow for a systematical analysis of individual solution paths, including actor constellations (Van der Brugge 2009). It is generally considered that collaboration between governmental and non-governmental actors (i.e. industry and business sector and university) and the participation of a wide range of stakeholders improves the outcomes of urban climate governance (Böcher and Nordbeck 2014; Leydesdorff and Deakin 2011; Sato 2017; Ranga and Etzkowitz 2013; Van der Heijden 2019). Still, more research could be beneficial in the area multi-stakeholder actor constellations with particular focus on what actors are orchestrating the pathway towards sustainable urban development (Gebhard 2020).

In order to fill the gap outlined above, an analytical framework was developed within the BMBF research project SMARTilience – Governance Model for a Climate Resilient Smart City. The conceptual research was applied within Living Labs in the German cities Halle (Saale) and Mannheim, which are comparable in size, but differ in many aspects affecting their climate actions.

This article aims to answer two research questions:

- 1) How can cities' transformation paths towards climate resilience be made comparable?
- 2) What enabling factors and actors played a key role in the transformation pathways in Halle (Saale) and Mannheim?

For this purpose, the article starts with explaining the analytical framework that was used for comparing the case studies. It makes their transformation paths readable and thus enables appraisals about differences and similarities. The aim is to present the influencing framework conditions, actors involved and the role of Triple Helix cooperation, strategic priorities and tactical approaches of urban action of both cities, as well as how they changed over time. The tactical approaches refer both to the governance instruments used and to the constellations of actors included in the process and targeted in strategies. The case studies are presented in a comparative manner so that the results can be discussed in the concluding section.

2 A Framework for Analysing Cities' Transformation Paths Towards Climate Resilience

The heuristic developed by Van der Brugge (2009) to explain transformation dynamics in Dutch water management serves as basis for the analytical

framework applied for the case study research. It explains the transformation dynamics by means of a theory of transition (transformation), which incorporates the following four approaches (Van der Brugge 2009: 20):

- Multi-level concept;
- Multi-phase concept;
- Multi-pattern concept;
- Transition management.

The multi-level concept was originally developed to understand technological innovations and their breakthrough (Geels 2002). Transferred by Van der Brugge (2009) to the analysis of transformation processes, it distinguishes between the macro-level landscape, the underlying meso-level regime and the micro-level niches. This study focuses on the meso-level. The multi-phase concept divides transformations into four phases: pre-development, start-up, acceleration and stabilisation phase (Loorbach 2007: 18). Thus, it links transformations with the time dimension and allows conclusions to be drawn about the current situation of a transformation and associated framework conditions. In this study, the multi-phase concept is used to roughly classify the transformation paths of Halle (Saale) and Mannheim based on examined data. The multi-pattern concept completes the picture by asks about the nature and manner of changes in a particular level of action of the socio-technical regime. Of importance are here the art of interaction between the different levels (Do the macro-level and the niche put pressure on the regime or do they enter into a symbiotic interaction with it?) and the timing (Is the niche mature enough to replace the regime when the macro-level developments occur?) (Geels and Schot 2007: 405). The theoretical concepts provide information on whether and to what extent a regime is changing and which processes are taking place within the regime.

Transition management aims to identify options for managing transformations. Loorbach (2007: 282) describes transition management as a new governance approach for sustainability that can resolve ongoing societal problems. This approach is based upon the assumption that a transformation cannot be fully controlled, but its speed and direction can be influenced (Rotmans and Loorbach 2007: 81). To this end, content and process are linked via a cooperative process, and three innovation spheres are distinguished: strategic, tactical and operational. The strategic sphere aims at changing cultural aspects such as values and identity, thus focuses on activities such as visions' development or setting goals. The tactical sphere aims at changing structures, such as resource allocation, incentives, laws or institutional arrangements. The operational sphere involves the implementation of practical experiments. In the analysis, the strategic and tactical spheres are of particular relevance due to the regime's observation level.

In line with the theoretical concepts described above, the analytical framework comprises three levels: environment, strategy and tactics. Environment refers to the concrete framework conditions of the regime (political, administrative, economic and cultural system of a city) and its respective local context. Strategy encompasses political and institutional structures and provisions at state and city levels and thus links to the concept of transition management. Tactics deals with both short and medium term activities of city administration: on the one hand with applied steering instruments and on the other with targeted actor arrangements for steering implementation of existing strategies that work towards climate resilient city development. The individual analysis modules environment, strategy and tactics will be further operationalised through approaches from political, administrative and spatial sciences (Jänicke 1996; Van der Brugge 2009; Sohre 2014; UBA 2016).

Table 1. (see below) compiles investigative aspects of the developed analytical framework that allow for analysing cities' transformation paths towards climate-resilient urban development. The analysis factors, criteria and related research indicators are explained in more detail in the following sections of this article.

TABLE 1 Investigative aspects of analysing cities' transformation paths towards climate-resilient urban development.

Analysis factors	Criteria	Indicators
Environment		
Ecological factors	City's climate change impacts	Observed climate changes and their effects on city level
Demographic factors	City's demographics	Population's development (prediction) Average age Percentage of inhabitants over 65 years old
Socio-economic factors	City's budgetary situation	GDP (Gross Domestic Product) Unemployment rate Tax revenue per inhabitant
Political-institutional factors	Political majorities in federal government (Bund)	Election turnout Vote shares of parties in elections/ ruling party Vote shares of green party (Bündnis 90/Die Grünen)

TABLE 1 Investigative aspects of analysing cities' transformation paths (*cont.*)

Analysis factors	Criteria	Indicators
	Political majorities in federal state (Bundesland)	Election turnout Vote shares of parties in elections/ ruling party Vote shares of green party (Bündnis 90/Die Grünen)
	Political majorities on city level	Election turnout Vote shares of parties in elections/ ruling party Vote shares of the green party (Bündnis 90/Die Grünen)
Political-cultural factors	Public opinion on city's climate change impacts	Number of local newspaper articles on climate change related keywords
Strategy		
Federal state level (Bundesland)	National policies on climate change mitigation and adaptation	Existence of a climate law
	National strategies on climate change mitigation and adaptation	Existence of strategies on climate change mitigation and adaptation
	National targets on climate change mitigation and adaptation	Existence and scope of targets on climate change mitigation and adaptation
City level	City's regulations on climate change mitigation and adaptation	State of climate emergency regulation
	City's strategies on climate change mitigation and adaptation	Existence of strategies on climate change mitigation and adaptation at city level
	City's targets on climate change mitigation and adaptation	Targets on climate change mitigation and adaptation at city level

TABLE 1 Investigative aspects of analysing cities' transformation paths (*cont.*)

Analysis factors	Criteria	Indicators
	Degree of measures' elaboration	Determination of implementation periods / prioritisation Determination of responsibilities / implementing actors Determination of finances Description of synergies and conflicts Definition of assessment criteria
Tactics		
Organisational development (long term)	Institutionalised working structures	Establishment of permanent working structures in the administration Establishment of steady working structures with the city stakeholders
	Institutionalised work processes	Design of work processes of the administration regarding climate-neutrality Design of work processes of city stakeholders regarding climate-neutrality
Persuasive instruments (short term)	Information	Collection of information on climate mitigation and adaptation Raise of awareness among administrative staff Raise of awareness among city stakeholders and urban society
	Participation	Making administrative work participatory Shaping cooperation with city stakeholders and urban society in a participatory way
Financial instruments	Generation of funds	Generation of financial resources for climate mitigation and adaptation

TABLE 1 Investigative aspects of analysing cities' transformation paths (*cont.*)

Analysis factors	Criteria	Indicators
	Provision of incentives	Setting monetary incentives for employees Setting monetary incentives for city stakeholders and urban society
Market participation and location development	Constructional measures	Implementation of exemplary measures by the city
Government-industry-academic arrangements	Governance mode of climate mitigation and adaptation at city level	Actors from government, industry and academia involved in strategy development and implementation at city level, their diversity and role in the Triple Helix arrangement

(SOURCE: AUTHORS' OWN COMPILATION BASED ON RESEARCH)

2.1 *Environment*

Environment deals with the framework conditions in which cities and their administrations operate to meet the challenges resulting from climate change. The environment, which links to the macro-level landscape from the multi-level concept, encompasses individual aspects of the so-called megatrends. These are taken into consideration and adapted for further elaboration of the socio-technical regime, in order to enable a consistent analysis. Sohre (2014: 67 after Jänicke 1996: 19ff.) distinguishes between ecological, socio-economic, political-institutional and political-cultural factors that influence framework conditions of actors' actions. The systematisation is complemented by demographic trends, which have been identified by the UBA (2016: 58) as a relevant influencing variable for city's climate adaptation capacity.

Demographic factors, such as population development and age structure, are closely related to climate change impacts, as they determine the proportion of potentially vulnerable groups of people in city's total population (UBA 2016: 60). Socio-economic factors, such as GDP (Gross Domestic Product), unemployment rate or tax revenue per inhabitant, can provide indications of the city's options for action (UBA 2016: 87). Political-institutional factors comprise the will forming structure, consisting of rules, norms and procedures (polity dimension). It matters which political party is currently in power (political

majorities) and whether an institutionalisation of climate change mitigation and adaptation has taken place (Sohre 2014: 68). In our analytical framework, however, the latter is assigned to the building block tactics (see below). Also included among political-institutional factors is the legal system with its existing laws and regulations (Jänicke 1996: 24ff.). These aspects are applied in the category strategy. At this level, political-institutional factors are understood as changes in structures of the administrative authorities. The focus lies on the development of voter turnout, shares of parties' votes in elections, the governing party and in particular the shares of the green party, because the political influence of green and alternative parties can increase the capacity of cities to act on the climate issue (Haupt and Kern 2020: 5). In line with the demands of urban climate change governance in a multi-level system, these aspects have to be considered for the city level, the state and federal levels, because framework conditions on local and higher levels determine the capacities for action and agenda setting within city's transformation pathway (UBA 2017: 49).

Although political-cultural factors are more difficult to be determined, they are relevant for actors' logic of action and serve as external guidelines and patterns of interpretation (Sohre 2014: 66). Thereby, media play an important role, as they generate and develop knowledge and opinions in society through the way they report.

2.2 *Strategy*

Strategy deals with the contents of existing strategies or concepts for cities to implement climate resilient city development. According to the concept of transition management, the strategic sphere includes "activities and developments that aim to change cultural aspects, such as values, identity and ethics. The activities include vision development, strategic discussions, long-term goal formulation, collective goal and norm setting" (Van der Brugge 2009: 32). The analysis level strategy forms the necessary framework for dealing with the respective (urban) starting situation and thus for implementation of climate resilience in cities. Strategies outline the desired target state and the action steps necessary for its implementation (Haupt and Kern 2020: 3). In terms of content, strategies can deal either with climate change mitigation or adaptation, or with both fields of action in an integrated form, whereby synergies as well as conflicts can emerge. Thereby, climate mitigation addresses the causes of climate change, whereas adaptation deals with the impacts of climate change.

Potschin et al. (2010: 66off.), Baker et al. (2012: 131) and Grunow (2017: 32) use the criterion target system, in order to evaluate the content-related quality of spatial strategies. It illustrates the derivation, selection and classification of

solution approaches. The measures defined in strategies serve the purpose of achieving the formulated goals and closely related to them. Thereby, a detailed implementation strategy is required, in order to implement the goals. In accordance with the urban climate change governance, the measures for implementing climate protection and climate change adaptation require cooperation of actors from different administrative levels and sectors (Böcher and Nordbeck 2014: 258). Therefore, implementation requires a designation of actors in charge of implementation for each individual measure (Measham et al. 2011: 417). This applies also to financial resources: each measure requires both a cost estimate and provision of necessary resources (Baer 1997: 338; Grunow 2017: 37f.). In addition, there is a need for a detailed implementation time planning and appropriate monitoring, which allows for adjustments (Potschin et al. 2010: 660; Baker et al. 2012: 131). These are of particular relevance, because of the uncertainties with regard to the long-term nature and consequences of climate change (Reese 2011: 14). Indicators should already be defined as part of the strategy development, in order to enable an ongoing monitoring process (Potschin et al. 2010: 660ff.).

In line with the urban climate change governance (Engels et al. 2018: 266), the strategic approaches at federal and state level are also considered, albeit in less detail. Thus, the existence of climate strategies and targets is being examined (Haupt and Kern 2020: 3). Other strategic framework conditions relevant to climate protection and adaptation include climate change-related laws at higher level and ordinances (in particular climate emergencies) at the municipal level (Engels et al. 2018: 267).

2.3 *Tactics*

Tactics deals with the implementation management of strategies or concepts aiming at climate resilient city development. According to Van der Brugge (2009: 32), activities in the tactical area of transition management refer to changes in structural elements, such as resource allocation, rules and incentives, as well as other institutional arrangements. Grunow (2017: 32), who aims at a systematic analysis of different areas of environmental policy, distinguishes between: target elements, operational and instrumental elements, administrative-structural, procedural elements, and resource-related elements. Objective and resource-related elements (the costs for measures' implementation) have already been considered in the analysis area of strategy. Operational, instrumental, administrative-structural and procedural elements are used to systematically analyse the tactics for making cities climate resilient. In line with Grunow (2017: 34f.) and Selle and Wachten (2012: 1), the following systematisation applies:

- Regulatory instruments,
- Persuasive tools,
- Financial instruments,
- Market participation and location development,
- Organisational development.

The regulatory, persuasive and financial instruments belong to indirect control approaches – they have an indirect effect on space via actors that apply them. Regulative instruments include regulations and requirements resulting from sectoral laws, which are linked to sanctions (Grunow 2017: 34). Since they are already formally regulated and applicable, they are usually not explicitly addressed in the context of strategies, which is why they are not considered in this analysis. Persuasive instruments summarise informative and participatory forms of governance, most of which are informal in nature. The individual approaches differ in the degree of exchange and cooperation (Danielzyk and Sondermann 2018: 964). Financial instruments are used to steer actions of private and public actors in a certain direction. This happens either through positive monetary incentives (e.g. subsidy programmes) or negative monetary incentives (e.g. special levies). Market participation and location development, on the other hand, are instruments that allow public actors to directly influence urban space. For example, they use development of municipally owned land for the purpose of upgrading or acquisition of land prior to creation of planning law, what generates municipal revenues (Selle and Wachten 2012: 3f.). Organisational development encompasses both process design and the organisation of work. In this context, it plays a role i.e. whether an institutionalisation of climate protection and climate adaptation has taken place (Sohre 2014: 68) or whether internal administrative processes are in line with climate protection (Grunow 2017: 36).

The steering instruments for implementing strategies can act both internally and externally to the administration, which is why in the analysis both forms are taken into account. For example, some of the instruments, especially those of organisational development, are aimed primarily at administrative structures and processes. Persuasive instruments have both an inward and an outward effect on city stakeholders and aim at a joint implementation of measures. Financial incentives are not only about distribution, but also about their generation. Market participation and location development cannot be assigned to any of the directions, as they are to be implemented internally by the administration, but still have an effect on the city (e.g. constructional measures).

The tactical sphere also analyses actor constellations in charge of strategies' development and implementation. Actor constellations usually go beyond

the spectrum of classic sectoral planning and require participation of a broad range of society (Böcher and Nordbeck 2014: 258). According to Sato (2017), impacts of climate change can be best reduced through a radical change in traditional consumption patterns and value chains “that can only be reached with constant and pioneering innovations encouraged by governments, led by different players and adopted by various markets” (Sato 2017: 848). Thus, collaboration between various city stakeholders plays an important role in securing a sustainable environment for development of new ideas that can contribute to climate change risks reduction. Thereby, innovation is more probable to occur in cities with higher densities of relations among the key spheres of government, industry and business sector and academia (Leydesdorff and Deakin 2011).

The Triple Helix concept sheds light on the government-industry-academic arrangements (Etzkowitz and Leydesdorff 2000) and their role in emergence of new innovation pathways (Gebhardt 2020). It differentiates between three main Triple Helix configurations: statist, laissez-faire and balanced. In the statist configuration, the government plays the leading role by driving academia and industry, but also limiting their capacity to initiate and develop innovative transformations. A laissez-faire configuration is characterised by industry being the driving force and the university and government acting as ancillary support structures with limited roles in innovation. In a balanced configuration university and other knowledge, institutions act in partnership with industry and government and even take the lead in joint initiatives (Etzkowitz and Leydesdorff 2000). The balanced configuration generates “the most important insights for innovation, because the most favourable environments for innovation are created at the intersections of the spheres” (Ranga and Etzkowitz 2013: 239). The model of three helices can be extended to include further actors, like the public (Leydesdorff 2012), which can play an important role in cities’ transition towards climate resilience. This concept is applied to better understand the design of transformation paths towards climate resilient cities in Mannheim and Halle (Saale) and the role that various actor arrangements play in it.

The analysis of tactical steering approaches and desired governance arrangements provides information about the applied steering mode of the city and helps to identify key actors involved in the implementation of the fields of action and measures. Thereby, governance mode is defined as tactical setting of priorities by the city (e.g. types of instruments used, implementation responsibility/actors involved etc.).

In this article the classification of actors’ groups is based on the categories elaborated by Eckart et al. (2018: 106) and Hirschfeld et al. (2012: 25), namely:

- Policy,
- Administration,
- Economy,
- Interest groups,
- Education,
- Local community.

This classification is more detailed than the three main spheres (governance, industry and academia) from the Triple Helix model, thus allowing for a more differentiated analysis.

3 Methodology

The article is based on two case studies for obtaining detailed findings on implementation of climate resilience in the German cities of Halle (Saale) and Mannheim. The case study method allows a deeper analysis of a phenomenon in a specific context. The application of case studies includes concrete questions, case definition, material collection, their processing and a classification/evaluation of the cases. In this way, case studies can make explorative and descriptive statements about complex issues (Yin 2003). Furthermore, this method reduces the amount of material to the research interest and sets the stage for further interpretation (Blatter et al. 2018: 115ff.). The research results for the two case studies were based mainly on a qualitative content analysis of existing data, in particular strategy documents and statistical data. Following strategy documents (from 1990 to 2019) were analysed:

- Halle (Saale): Energy and Environmental Concept (1992), Climate Protection Concept (1996), Integrated Municipal Climate Protection Concept Halle (Saale) (2013), Integrated Municipal Climate Protection Concept. Update (2018);
- Mannheim: Climate Protection for the City of Mannheim (1999), Climate Protection Concept 2020 of the City of Mannheim (2009), Mannheim on a Climate Course (2015), Adaptation to Climate Change in Mannheim (2019).

A three-stage procedure was applied to analyse the contents of the strategies mentioned above: coding of the data material according to relevant aspects (e.g. what stakeholders are in charge of implementing what measures), description of the cases by using the analytical framework and evaluation of the cases (Kuckartz 2010: 85ff.). The results were completed by evaluating statistical data and relevant strategy documents of higher political levels. In addition, a keyword search in local and national media was conducted to map the development of public discourse on climate issues (climate change, climate

protection, climate adaptation) across the years (1990–2020), albeit this cannot provide a full picture.

Besides, for analysing the transformation paths expert interviews with various city administration departments and other stakeholders were conducted. The interviews generated further information related to the transformation paths, e.g. on the initiation or implementation processes of the strategies or on the assessment of key moments and actors involved. This content could not be obtained through the evaluation of documents and thus complements the qualitative content analysis (Kaiser 2014: 31). Comparability of the interviews' contents was made possible by coding the statements into categories (e.g. key moments/actors, cooperation within city administration/with other stakeholders, influencing factors) derived from the research questions.

4 Comparison of transition pathways of the case studies Halle (Saale) and Mannheim

The discussion on sustainability in the 1990s and the climate protection goals adopted at the federal level as result of the UN Conference in 1992, which were then adapted at the municipal level, acted as important drivers for change in both cities. Halle (Saale) and Mannheim joined international city networks and thus affirmed their will to act. Still, despite great similarities with regard to the impacts and needs for action resulting from climate change, the cities acted under very different political and economic conditions. Since the end of the 1990s the green party's share of votes in local elections has risen, so the increasing political support among the electorate that encouraged taking action on climate issues. However, it must be considered that the party still has a significantly lower weight in the city council in Halle (Saale) compared to Mannheim. The situation was aggravated in Halle (Saale) by a population decrease in the early 1990s, the collapse of the East Germany's economy, and a high loss of tax revenue. In the meantime, however, both cities have experience positive economic development, albeit at different levels, which expands their scope for climate action.

The different framework conditions explain to some extent the respective strategic and tactical approaches chosen by the cities. Halle (Saale), e.g. used the historic transformation in early 1990s to address its outdated supply infrastructure through adopting the Environmental and Energy Concept (1992). The climate strategies adopted in both cities in the second half of the 1990s provided answers to corresponding efforts at the federal level. Mannheim had a thematically more complex strategy with measures that were elaborated to a

high degree of detail. However, in both cities ten years or more passed before another strategy was adopted. Halle (Saale) used federal funding for this purpose. Since the 2010s, activities in both cities have intensified. This was accompanied by the institutionalisation of the climate topic in the administrative structure of both cities. It also emerged from the interviews that the adoption of strategies and the establishment of permanent administrative units in charge of the climate topic are seen as key moments in their transformation pathways. In terms of content, several aspects stand out. Mannheim's climate protection strategies are from the beginning broader in scope and the city dedicated a separate strategy to climate adaptation in 2018. What both cities have in common is that they only took up the topic of urban planning as a field of action at a later stage.

With regard to the applied steering instruments, it can be summarised that in both cities two steering forms are of particular importance for the implementation of the climate strategies: the climate friendly design of work processes in the administration and the exemplary implementation of measures by the administration. The latter was especially relevant for subject areas for which the administration is responsible, such as supply and transport. Furthermore, the steering mode has evolved over time. Whereas at the beginning, the focus across all topics was often on structural and procedural approaches, these were increasingly supplemented with other steering instruments. Informative and participative approaches gained on importance, whereby this was more the case in Mannheim than in Halle (Saale). This was especially true for the fields of supply, economy and private households, but also for urban planning. Financial approaches have recently also been used in Mannheim, while in Halle (Saale) they are rather used to generate financial resources, what is indicative of the strained economic starting position.

In order to analyse the government-industry-academic arrangements and the role of actors involved in climate change mitigation and adaptation in both cities, it is relevant to study the actors involved in the development of strategic documents, as well as the stakeholders in charge of measures implementation.

Almost all strategic documents in Mannheim and Halle (Saale) include a section that describes participatory involvement of stakeholders in its development. However, the detail of information provided differs among the documents and only few strategies provide a detailed list of actors involved, what makes an evaluation difficult. Based on the information provided in the strategic documents of Halle (Saale) and Mannheim, it can be stated that in both cities the stakeholders involved in the strategies' development correspond to a high degree to the ones in charge of implementation (see next paragraph). Thereby, these actors include mainly various departments of the city administration,

representatives of political parties, (city owned) companies and other thematically relevant stakeholders including associations. The public and research institutes/universities were included to a lesser extent. In comparison, Mannheim had more possibilities for public participation in strategy development than Halle (Saale), but Halle (Saale) involved overall more actors from the academia (Martin-Luther-University Halle-Wittenberg, Unabhängiges Institut für Umweltfragen (Independent Institute for Environmental Issues)).

The strategies of the two cities differ significantly in the number and diversity of actors responsible for strategy implementation. Although the city of Halle (Saale) included a large number (63) and wide range of actors in the 2013 strategy implementation, in its update the number fell to 14 actors from administration and business. In comparison, Mannheim has included all groups of actors examined since 1999 and their number has increased continuously over time (most recently 74). The particularly relevant actors result from the thematic priorities of the fields of action. In the field of organisation, administrative actors are most important, especially those responsible for climate issues. In the field of economy, supply and transport the economic actors play a key role. In both cities a city owned energy company is of particular importance: in Halle (Saale) it is the Energieversorgung Halle GmbH (energy company, later replaced by Stadtwerke Halle GmbH) and in Mannheim it is the Mannheimer Versorgungs- und Verkehrsgesellschaft Energie AG (energy and transportation company). Companies in the housing industry or housing cooperatives are also involved in all strategy implementations and are thus of particular relevance in both cities. The constellation of actors is most complex in the topic area of private households. Still, the administrative actors play a central role in implementing the strategies – both in terms of the number of measures for which they are responsible and the cross thematic implementation of the strategies. Other groups of actors such as interest groups have a rather subordinate role in terms of their importance for the strategy implementations in both cities. These business actors include in Mannheim the Chamber of Crafts, Chamber of Industry and Commerce, later the Environmental Forum and the city owned Bundesgartenschau GmbH (garden show company). In Halle (Saale) interest groups are only represented in the strategies of Halle (Saale) in 2013 and include the Energy Community Halle (Saale) association, the Chamber of Crafts, as well as the Consumer Organisation Sachsen-Anhalt. For implementation, actors from politics, education and the local community are also only marginally responsible. In Halle (Saale) these groups of actors were only involved in few measures in 2013. Thereby, only two scientific institutions were mentioned: University Halle-Wittenberg and Fraunhofer Institute for Mechanics of Materials IMW. In Mannheim's strategies these groups of actors

were given implementation responsibility as early as 1999, but only to a small extent. Moreover, education actors lose importance over time: in 2018, only schools are named as actors.

With regard to the Triple Helix constellations, the cities of Mannheim and Halle (Saale) are the closest to the statist model, in which the government plays the leading role (Etzkowitz and Leydesdorff 2000). In both cities it was the city administration that predominantly initiated and organised the transformation process and also has the biggest responsibility in climate strategies' implementation. Thereby, the city administration can be described as "innovation organiser" that acts as coordinator of the process and brings together actors from different organisational backgrounds and perspectives together for the purpose of generating new ideas (Ranga and Etzkowitz 2013: 242). The city administrations have structured the process of climate strategy development and brought relevant stakeholders from the industry, science and civil society together, in order to jointly develop and later implement a pathway towards climate resilient urban development in Halle (Saale) and Mannheim. The city administrations are also leading players in strategy implementation: in Halle (Saale) 52% of actors in charge of measures implementation come from the city administration, while in Mannheim the figure is around 51%. In comparison, industry actors responsible for measures implementation account for about 29% in each city, and scientific actors account only for 1% in Halle (Saale) and 2% in Mannheim. The involvement of actors from industry and business sector and to a limited extend from local community and the scientific sector could be an indication for a slow shift towards a more balanced actor configuration, in which industry and knowledge institutes act in partnership with the government, thus creating a more favourable environment for innovation (Raga and Etzkowitz 2020: 239). Through the years the cooperation between the industry and business sector and the city administration in Halle (Saale) and Mannheim has played an important role in implementing climate resilient urban development. Although both cities have strong universities that could certainly contribute to sustainability transformation, these actor groups played a rather subordinate role in the process what could indicate a missing link between science and city administration in terms of the Triple Helix concept. To some extent, the reason for this could be that the climate strategies in Halle (Saale) and Mannheim often focus on CO₂ mitigation, where the industry and the households have a biggest share. However, the interviews showed that the University Mannheim with its technical faculties is seen as an important player with a lot of (so far rather unused) potential in the area of applied research or the implementation of projects. The slow shift towards a more balanced actor configuration could also be supported by the fact that

the city administrations increasingly involve civil society in the process, since it provides valuable potential and creativity for strategy development and the acceptance and support of the measures by the public is crucial for successful implementation of climate measures. The involvement of civil society in Halle (Saale) and Mannheim could be seen in terms of the civically engaged Triple Helix model as a decisive foundation for shared engagement to sustainable goals that helps align interests and goals among Triple Helix actors (Cai and Eitzkowitz 2020: 21f.).

Despite different framework conditions and differences in transformational paths of Mannheim and Halle (Saale), it can be stated that in both cities the development of climate strategies, the climate friendly design of work processes in the administration (including the establishment of a supporting central unit for the climate topic), the exemplary implementation of measures by the administration, as well as awareness raising and cooperation with the urban society played a vital role in the cities' transformation towards climate resilience. It also became clear that a transition requires an initiator and coordinator of the process that in the case of Halle (Saale) and Mannheim was the city administration (including the political leadership). In addition, the interview results showed that especially the support of the city administration's management level, as well as the technical competence, personal skills and motivation of the persons responsible for the climate topic played a major role in advancing the climate issue in both cities. Moreover, the personal capacities (in terms of available resources) and competences of the administrations, cultural contextual factors (attitudes and values), effective communication and visibility, cooperation with stakeholders, and acting in the multi-level network were also important. These elements might be of high importance also for other cities' transformation towards becoming climate resilient.

5 Conclusion

The objective of this article has been to provide a generally applicable analytical framework with a set of criteria that would reduce complexity and allow for a comparison of transformation paths towards climate resilience in the case study cities: Halle (Saale) and Mannheim. The framework made differences and similarities in approaches of Halle (Saale) and Mannheim visible and pointed out enabling factors and actors that played a crucial role in both cities' transformation pathways towards becoming more climate resilient. The factors enabling cities' transformation towards climate resilience included: preparation of climate strategies, creation of a supporting central unit for climate

issues and exemplary implementation of selected measures by the administration, as well as awareness-raising and cooperation with the stakeholders and citizens. Nevertheless, the framework has its limitations. The proposed analytical categories allow conclusions to be drawn about the quality of the strategic documents studied, but do not provide sufficient information about the implementation process and impact of the individual strategy documents. At the same time, the analysis only allows assumptions to be made about the interrelationships of the aspects considered and their changes over time. Thus, the extension of the methodological approach through interviews with local actors has complemented the information obtained through strategic documents' analysis. In addition, individual aspects are difficult to compare, e.g. as cities choose different reference years and/or scales for their climate-related objectives. The situation is similar to the actors analysis, where the informative value depends very much on the level of detail in the formulation of responsibilities in the strategy documents (e.g. generally City of Mannheim or specific units such as Department of Education). In this regard, a more in-depth analysis of actors involved in strategy development processes (additionally to actors responsible for measures' implementation) would be beneficial, in order to better understand the government-industry-academic arrangements in Halle (Saale) and Mannheim. Application of the framework to other cities would further test the defined analysis factors, criteria and indicators as well as provide more scientific evidence on the identified key factors influencing urban transitional processes.

The article also provided a contribution with regard to multi-stakeholder constellations and the role various actors played in the transformation paths towards climate resilience. The article also contributed to the Triple Helix debate on the definition of the governance concept through depicting governance actors in Halle (Saale) and Mannheim and their role in the transformation process: in both cities it was the city administration that took the role of innovation organiser and orchestrated the pathway towards becoming climate resilient. By taking the lead, the city administration can guide a transformation process and the role of science and industry in it, but this also brings the risk of limiting the capacity to initiate and develop innovative ideas by other actors (Ragan and Etzkowitz 2013: 239) and neglecting important issues and contributions from these spheres (Etzkowitz 2018: 298). The analysis has also shown that scientific actors are barely involved in the implementation process. This "broken link" in terms of the government-industry-academia constellation might constitute a general problem in climate change strategies. Scientific actors are not only responsible for knowledge provision, but they also have a direct influence on the strategy development and implementation processes

in cities (Ragan and Etzkowitz 2013: 239). Science is seen as central component of internal policy advice: the better informed actors are within the strategy development process, the better policy outcome will be achieved (Sohre 2014: 80). Therefore, a development towards a more balanced configuration between governance, industry and business sector and universities would help to enable more targeted and effective actions towards climate resilience through creation of favourable environments for innovation that happen at the intersections of the spheres (Ragan and Etzkowitz 2013: 239). In order for this to happen, the city administrations would have to take a more active role in involving the universities in the urban transformation process, for example through enabling more cooperation in the area of policy development or providing stronger support for government-university-industry collaboration for innovation.

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