Transitioning to a Fab City: A Governance Perspective

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How Transition Management Can Promote Urban Change: Case Study Hamburg

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6.1 Introduction

Cities and metropolitan regions play host to many proposed solutions to global sustainability challenges and the implementation of the Sustainable Development Goals (SDGs). They are well-suited as real-world experimental sites for investigating and testing system innovations for sustainable change (Schneidewind, 2013). The proximity and localization of actors and the high density of institutional structures in the urban context are key factors in these experiments (Loorbach & Shiroyama, 2016; WBGU, 2016; Wolfram, 2014).

There are numerous efforts at the city level, including joining interregional networks, to meet the challenges of climate change with local strategies and to promote sustainable consumption and production in a circular economy (specifically SDGs 11–13). At the same time, it is evident that progress is too slow and that sustainable development efforts are thwarted by the continued production of unsustainable products and unsustainable consumption (IPPC, 2023). There is growing recognition in sustainability research and debate that global sustainability challenges cannot be addressed by optimizing existing systems in the form of incremental improvements and technological fixes alone: transformative change that addresses the underlying systemic challenges and problems is required (for an overview: Heyen et al., 2018; Köhler et al., 2019).

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In recent decades, transformation studies has emerged as a field of research that focuses on the dynamics of fundamental, long-term societal change (Köhler et al., 2019; Zolfagharian et al., 2019; Geels & Schot, 2010). Transformations are radical changes in the structures, cultures, and practices in a social (sub)system. Transformation science assumes that these transformations cannot be directly controlled, but they can be influenced, promoted, and accelerated (Wittmayer & Hölscher, 2017; WBGU, 2011). To this end, various governance approaches have been developed that aim to understand, analyze, and shape transformation processes toward sustainability (Köhler et al., 2019). This article takes a closer look at transition management as a possible form of governance of transformations/transitions.

The transition management approach has so far been applied mainly to energy (Verbong & Loorbach, 2012), water (Van der Brugge et al., 2005), and mobility (Loorbach, 2022; Avelino et al., 2012). Only recently has it been used to describe governance processes in cities and regions (Roorda et al., 2014; Ferguson et al., 2013; Wittmayer et al., 2014, 2015; Evers et al., 2015) and at the local level (Wittmayer et al., 2014).

The City of Hamburg has been part of the transformation effort 'Fab City' since 2019. In contrast to other city initiatives, which are often limited to sectoral improvements or efficiency enhancement and optimization through new technologies (on smart cities: Rumpala, 2021), the global Fab City initiative calls for a fundamental system change: 'What is at stake? The need to redesign the global system' (Armstrong et al., 2022). Fab City sees itself as a new, comprehensive urban model for transforming and shaping cities and regions toward sustainability (Diez, 2016, 2021).

This fundamental and visionary approach combines bottom-up movement, digitalization, and new interactions and interdependencies between different spatial scales, actors, and resources (glocality) to create new patterns of production and consumption. The basis for this is a circular economy built on open-source exchange in which citizens become prosumers, i.e., designers or producers of goods that are designed globally and consumed locally. By 2054, the goal is to have all of the city's consumer goods produced locally (Diez, 2016; Diez et al., 2018).

In order to implement the goals of the Fab City Global Initiative, Hamburg and other Fab Cities are pursuing two closely intertwined strategies: the establishment of Fab Labs and Makerspaces as local production and experimentation sites, and the network idea, which is primarily based on the principle of sharing and exchanging data, information, knowledge, design and codes in local and global networks and is based on the open-source principle.

This article deals with a central question of all Fab Cities: which methods and strategies can be used to successfully transform a city into a Fab City? Using Hamburg as an example, we aim to illuminate how the transition governance perspective can contribute to understanding and shaping a Fab City. To this end, we first provide a brief overview of the concepts of transition research and the transition management approach, and then elaborate on concrete governance challenges and opportunities using Hamburg as an example.

6.2 Transition Management: Theoretical Framework and Practice-Oriented Process at the Same Time

Transition management is first and foremost "an approach that strives to influence the direction and pace of societal change dynamics" (Roorda et al., 2014, p. 54). Although the term 'management' suggests the element of control of the process, it refers in fact to a framework of concrete tools and methods that help to conceptualize and address the necessary and fundamental changes for sustainable urban development. Transition management thereby promotes an understanding of the complexity of the system and how it is to be influenced and changed, and operationally supports the formulation of common long-term goals in order to be able to implement short-term measures (Wittmayer & Loorbach, 2016).

In order to productively apply the transition management approach to the Fab City Hamburg, we focus on the central elements of the application of this approach. As a basis, we draw on relevant literature on the various approaches to transition research, most of which comes from the Netherlands and on which the remainder of this paper is based (Geels, 2002; Grin et al., 2010; Kemp et al., 2007; Loorbach, 2007, 2010).

6.2.1 Characteristics of Transformation Processes

There is broad agreement among experts on the key characteristics of transformations (Köhler et al., 2019; Heyen et al., 2018; Wittmayer & Hölscher, 2017). Transformation/Transition,[1] used synonymously, refer to process change, specifically from an existing, unsustainable, socio-technical system to a new, sustainable system. The transformation process from a linear economic system to an urban circular economy is one example. A system consists of a dense and complex set of relationships of social (incl. actors, norms, culture, policy, regulation) and technical components (incl. technical artifacts and infrastructures, technologies, applications) (Geels, 2002. Change toward sustainable development can only succeed through an interplay of these elements and thus involves technological, social, and cultural change (Geels & Schot, 2010). Therefore, it is also referred to as a "co-evolutionary" change (Rotmans & Loorbach, 2010; Wittmayer & Hölscher, 2017; WBGU, 2011, 2016).

Transitions are a complex, dynamic, non-linear process with uncertainties. It cannot be predicted ex ante which technologies and practices will prevail, what the change will look

[1]The terms 'transformation' and 'transition' have become new fashionable terms in the academic and sociopolitical debate (Brand, 2014), yet the distinction between the two concepts remains blurred (for an overview: Wittmayer & Hölscher, 2017). Transformation is often used to refer to comprehensive, whole-society processes of change, while transition refers to institutional political changes inside social systems (Wittmayer & Hölscher, 2017). Since the transitions between the terms often remain fluid, both terms are included below as subjects of transformation research.

like exactly, and where it will lead, though this will crystallize over time (Bauriedl et al., 2021). The complexity is primarily related to the diversity of actors involved in transition processes and the interactions they enter with each other (Frantzeskaki et al., 2009). Transitions cannot be "managed" from a top-down perspective. Instead, they require the coordinated involvement of many actors and groups of actors from politics, business, academia, and civil society (Heyen et al., 2018). Transitions are, therefore, multi-actor processes. Finally, transitions take quite some time, often lasting for decades, and are either rather incremental or triggered abruptly and radically.

Although the direction of change of societal transition processes is fundamentally open, and the processes cannot be specifically controlled or managed due to their high complexity and dynamic nature, they can nevertheless be intentionally influenced and accelerated (Heyen & Brohmann, 2017; WBGU, 2011, 2016). This is where the transition management approach comes in, which was introduced in research and politics in 2001 as a new governance approach for sustainable transformations (Rotmans et al., 2001; Grin et al., 2010). Transition management is applied as a participatory methodology that assists in challenging the status quo, developing a strategic perspective for the future, and establishing new practices in the local governance context that guide transformation and support it by bringing together and coordinating different actors and networks (Roorda et al., 2014).

6.2.2 Principles of Transition Governance

Based on these insights from analytical and operational transformation theory, a core set of governance principles can be summarized to provide orientation in transformation processes (drawing mainly on: Frantzeskaki et al., 2009; Roorda et al., 2014):

Understand the Current State of the System The system's complexity and dynamics must first be understood before strategies for change can be developed. This is done by analyzing the current situation and questioning existing assumptions, problem perceptions, and generally prevailing solutions.

Aim for System Innovations in Small but Fundamental Steps The goal is not a system optimization but system innovation that entails structural change that must be thought of in the long term (approx. 10–30 years). To minimize resistance from established regimes, focus on incremental changes that allow the system to test and build new structures.

Leave Room for Diversity and Flexibility Goals and strategies should be formulated in a flexible and adaptable way to better respond to change or resistance.

Shape Actions Together The aim is to include and involve diverse perspectives as a basis for formulating challenges and developing solutions, as well as for supporting policies.

Create Space for "Pioneers of Change" Actors who are already applying new and alternative ways of thinking should be brought in. They should be provided with the necessary resources and opportunities to realize their innovations.

Promote Social and Institutional Learning Processes Learning processes are crucial for social change. For this, sufficient time for reflection must be planned and an atmosphere of mutual trust and openness must be created. Social learning in transformation processes stimulates the development of visions, transformation pathways, and experiments.

6.2.3 Application of Transition Management in Urban Processes

These rather abstract governance principles have been translated into a transition management framework (i.e., the transition management cycle), which provides the basis for managing transitions in an operational sense. This framework distinguishes governance activities on four levels and links them to process tools for shaping transformative change (Wittmayer & Loorbach, 2016; Loorbach, 2010), see also Fig. 6.1. A transition management process is steered by a so-called transformation team, a core group whose main tasks are the definition of issue area and desired outcome, the creation of a process plan that is adapted to local conditions, and the driving of the overall process (Roorda et al., 2014). Since transition management processes are usually initiated from the municipal level, the core team is often composed of city government employees (though, in the case of Fab City, a different constellation of actors is emerging). There are four activity levels that characterize the transition management process.

Strategic Level: Transition Arena (Instrument) At the strategic level, the focus is on long-term activities involving the joint development of a vision and future goals. For this purpose, the so-called transition arena was developed as a process instrument. As a setting, the transition arena offers an informal, well-structured, temporary framework in which a small group of pioneers of change – about 10–15 participants – from different backgrounds (authorities, companies, research institutes, NGOs, citizens, intermediaries) come together to work on a vision. Ideally, the participating actors should be able to think beyond existing interests and standard procedures in their organizations and institutions. They form a network of frontrunners who are selected on the basis of their competencies, interests, and background (Loorbach, 2010, pp. 173–174). They do not participate in the transition arena as representatives of their institutions but as private individuals.

In the transition arena process, the actors must first come to a common understanding of the underlying problems and transformation challenges. This is the starting point for the subsequent vision development. The diversity of actors that come together here is key to bring different perceptions of problems and values that lead to new insights and perspec-

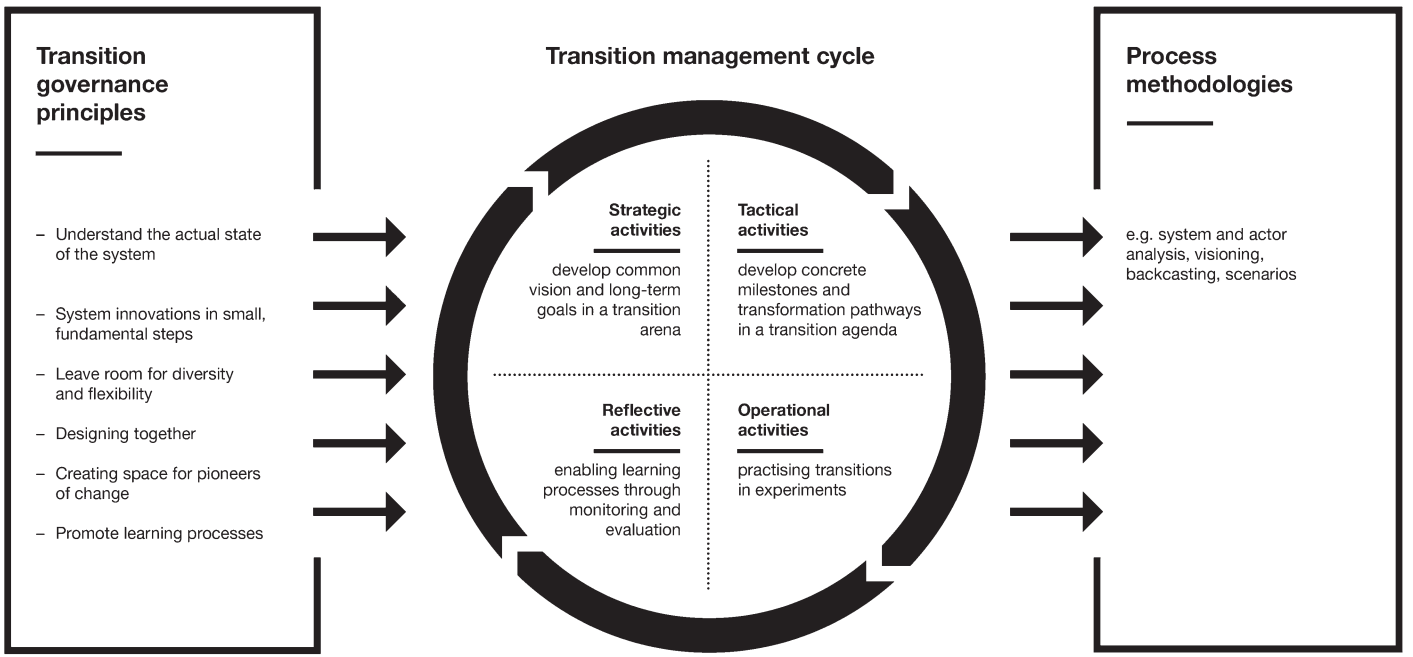

Fig. 6.1 The transition management framework (authors' depiction, based on: Wittmayer & Loorbach, 2016)

tives. The transition management approach is essentially about questioning the stakeholders' assumptions and problem perceptions (Roorda et al., 2014).

Building on the common problem definition, the actors exchange their ideas on different perspectives for the future and develop a common vision based on shared basic principles for long-term sustainable development, while at the same time leaving room for dissent on short- and medium-term solutions, goals, and strategies. The vision is not intended to and cannot predict the future; rather, it points the way forward and creates framework conditions that determine the scope for future transition activities.

Tactical Level: Transition Agenda (Instrument) At the tactical level, the focus is on medium- to long-term activities aimed at changing established structures, institutions, regulations, and infrastructures. Concrete intermediate targets and transformation pathways must then be derived from the long-term goals, showing how to achieve this vision, i.e., the transition agenda. These should be translated into practical measures and regulations. Transformation pathways describe a possible set of steps from the present to the envisioned future. These are not concrete plans or detailed scenarios. They are inspiring action frameworks with short-, medium-, and long-term goals and action ideas identified, for example, using the backcasting method (Quist et al., 2011, 2013) or transition scenarios (Sondeijker, 2009).

The transition agenda serves as a starting point for the expansion of the group of involved actors and stimulates new activities, networks, and collaborations (Roorda et al., 2014). On this tactical level, recruitment should involve actors who have sufficient authority and room to maneuver within their own organization and who know what opportunities their organizations have to contribute to the desired transition process. An important prerequisite for this is that the actors involved are able to "translate" the transition vision and the resulting consequences into their own organization's agenda. As participating organizations and networks begin to adapt their own policies and actions in this way, tensions will emerge between the transition arena and day-to-day political agendas.

The focus at the tactical level is therefore also on the structural obstacles that stand in the way of desired development. Such obstacles can be path dependencies, lock-ins, fears of change, vested interests, as well as issues arising from the plurality and diversity of possible changes, the uncertainty attached to possible solutions, and different norms and values (Wittmayer & Hölscher, 2017). Should these structural obstacles be insurmountable, alignment at the strategic level needs to be reviewed, and a new transition arena may need to be built with some existing, as well as new, actors. At these points, the iterative process of transition management clearly emerges, and it becomes apparent why transitions are societal learning processes that are never fully completed.

Operational Level: Transition Experiments (Instrument) At the operational level, the focus is on short-term activities that concentrate on experiments and actions. A transition experiment is an innovation project that uses a societal challenge as a starting point for

learning to contribute to a transition (Van den Bosch, 2010). Experiments are derived from the sustainability vision and overall goals and fit into the identified transition pathways. It is also possible to link them to innovation experiments that are already taking place – as long as they fit into the context of the transition.

In experiments, actors address the identified societal challenges in practice and therefore experience the real obstacles and drivers of change directly by "practicing" transition (Wittmayer & Loorbach, 2016). Experiments thus provide important insights into desired transformation pathways and the barriers to that transformation. Since transition experiments are costly and time-consuming, it is important that existing infrastructures (physical, financial, institutional) are used for experiments and that their implementation is continuously evaluated and assessed. If an experiment has been successful in assessing the learning experience and its contribution to transition, it can be replicated in other contexts (expansion) and extended from the micro to the meso level (up-scaling) (Loorbach, 2010).

Reflective Level: Monitoring and Evaluation (Instrument) The reflective level aims to evaluate and assess both the transition process and the transition management. The monitoring of the transition process refers, among other things, to changes in the system concerned, niche developments, and movements of actors at the regime level. Monitoring of the transition management includes the actions of the actors within the transition arena, the goals and instruments of the transition agenda, and the findings and insights from the transition experiments. Continuous monitoring is an essential part of the identification and learning process of transitions because changes in the urban fabric and dynamics can only be registered through reflection, the existing instruments be adapted, and new insights be formulated (Wittmayer & Loorbach, 2016). Transition monitoring aims not only at collecting data but also involves interventions based on these data (Taanman, 2014).

The framework's cyclical nature suggests that activities at the strategic level are followed by tactical and operational activities and the cycle is closed with activities at the reflexive level. However, the cycle should be understood as being iterative (Loorbach, 2010). Activities can start at any level of governance and run parallel. For example, they can begin with experiments, and the learning from these experiments can affect the tactical level by highlighting the need for change in instruments or organizational structures and/or at the strategic level by illuminating needed adjustments of overarching goals.

In recent years, the transition management framework and tools have been adapted for urban contexts with process methodologies that can be used either within applied research (Wittmayer et al., 2014; Frantzeskaki et al., 2012) or by local authorities (Roorda et al., 2014) to implement this approach in cities. As an example, we refer to Roorda et al., (2014), who operationalized transition management in a process methodology for municipal decision-makers committed to climate change mitigation in their cities. However, transition processes are context-specific. The process phases, methodology, and tools need to be transferred and adapted to the specific challenges and issues in the local context (Witt-

mayer & Loorbach, 2016). The transition management approach does not offer a silver bullet for implementing ambitious sustainability goals (Nevens & Roorda, 2014) and is not a substitute for other policy interventions (Roorda et al., 2014). Nevertheless, the approach provides an impetus for change by helping to understand complex systems and develop a strategic perspective of the future. It empowers stakeholders to embrace challenges and opportunities for sustainable urban design and to practice new collaborative governance. Finally, the approach provides space for alternative ideas, actions, and social relationships that have the potential to change existing structures, cultures, and practices or transform existing policies over time (Wittmayer et al., 2014).

So far, transition management has been primarily concerned with the pre-development phase of transitions, focusing on strengthening frontrunners and niches (i.e., the process of transition arenas), while the acceleration phase of transitions may require a different focus and a deeper understanding of the institutional and policy context (Wittmayer & Loorbach, 2016). In general, there is no consensus on the importance of frontrunner actors and their selective participation. These are referred to as an "elite group" (Smith & Stirling, 2010), while, at the same time, a legitimacy deficit is seen due to selectivity (Hendriks, 2009). However, transition management is not a decision-making process: "transition management creates a framework for mutual inspiration between social actors in which new ideas, connections, and actions can emerge" (Roorda et al., 2014, p. 26).

6.3 Transition Management Approach and Fab City: Challenges and Opportunities Using Hamburg as a Case Study

In terms of structure and implementation, Hamburg is a 'mature' Fab City by international standards. This assessment is based on the evaluation by the Fab City Foundation and the authors' own empirical studies/interviews, including during the Fab City Summit 2022. In addition to a bottom-up ecosystem of labs and makers that has been active for a long time, EU and national-level funding support have allowed two large research projects and numerous initiatives to be launched in Hamburg and to be embedded in an overarching scientific monitoring and assessment effort. The landscape of actors is diverse and extends far beyond the research projects. Within the Fab City Hamburg, a university is a central steering and networking actor due to its role as lead partner of the research projects and as chair of the board in the association Fab City Hamburg e. V., which was founded in 2020. Fab City Hamburg e. V. is an association of Hamburg fab labs, makerspaces, workshops, innovative start-ups, and research institutions. The authors' access to this first-hand experience with Hamburg's transition has been used in the development of this article.

The Fab City Global Initiative predefines a diverse set of actors for a local Fab City founding coalition, incl. civic society, local government, and a fab lab. Negotiations among these actors requires a high degree of coordination and cooperation and appropriate governance. The transition management approach can help classify and interpret the ongoing processes in a Fab City and shows necessary actions.

Governance of the Fab City Hamburg Strategic Activity Level

While the global Fab City vision is the initiating idea and common framework for all Fab Cities, it must be adapted to local conditions. To this end, a system analysis must first build a common understanding among the actors about the problems to which the local Fab City concept is to provide an answer. Based on this, a jointly supported vision and initial transformation paths (transition agenda) are developed with selected actors in a transition arena, which act as a compass and provide orientation in the implementation of the Fab City. If this vision is communicated in emotionally engaging narratives, it has the potential to motivate the general public (Jacob et al., 2018).

Within the Fab City Initiative, various visioning processes have already been initiated and a Fab City Vision and transformation pathways have been worked on in workshops. However, these processes have involved only a limited group of local actors. In one workshop, it was the scientists from the research project who developed a common basic understanding; in the other workshop, the board of the association (Fab City Hamburg e. V.). These processes have proven to be important for the agreement on a common understanding and motivation, and they serve as orientation for the work within the different organizations. However, they are no substitute for the development of a shared vision for the future that is supported by a broader group of actors, including first and foremost the municipal level.

In Hamburg, shared visioning was attempted in a transdisciplinary 'green paper workshop', to which representatives from the local business community, government agencies and ministries, research institutions, and interest groups were invited. The aim was to develop a common understanding of the local challenges for transformation and a vision for the future Fab City Hamburg. As a result of the workshop, initial premises and assumptions were formulated in a green paper, which constitutes a prologue to further dialog with an expanded circle of stakeholders. The workshop therefore characterizes the starting point for a broader transition management process.

However, the activities have so far not been carried out in a sufficiently systematic way. The first step in a transition management process is the formation of a transformation team that manages the overall process. The second step is a system and actor analysis. Only from this can the circle of relevant participants for the transition arena be derived.

Tactical Activity Level At the tactical level, the collaboration to date has mainly addressed contextual questions from researchers about how local, national, or transnational governance structures would need to change to support the development and implementation of Fab City Hamburg. Initial learning experiences from the operational activities – the projects, existing Fab Labs, and initiatives – have already shown where the obstacles and drivers for transformation lie and which structures, instruments, infrastructures, rules, and regulations need to change. The restrictions that have emerged include investment support, funding programs and innovation policy, regulations on land use as well as the provision

of (municipal) land and premises, and, finally, the creation of exceptions, i.e., experimentation clauses for the testing of new products. This is only a sample of the hurdles already identified.

In addition, there is the question of how the Fab City can be embedded in city and regional governance structures and dynamics. Relevant topics include municipal concepts, strategies, and visions (e.g., climate plans, integrated urban development concepts, inner city concepts or circular economy strategies, educational landscapes), which should strategically and conceptually consider Fab City ambitions. Further topics and activities from the federal, state and EU levels may also be relevant for the local context and the promotion of the Fab City (e.g., European Green New Deal, green public procurement, Right to Repair or the German government's circular economy strategy currently in progress), which calls for a discussion on how these can be addressed and implemented locally. Not all challenges can be addressed and solved at the local level. It has become clear, however, that tactical activities require actors from politics, administration, and business who have sufficient authority and have room to maneuver within their institution or organization and know how to implement change.

Operating Activity Level In Fab City Hamburg, there are a number of initiatives and projects that can be understood as transformation experiments. These include:

- the existing and new open production labs (Fab Labs, Open Labs and Makerspaces). Open Labs have a special status as funded research projects, enabling them to test prototype manufacturing solutions for various trades in a protected space, detached from the usual development and selection mechanisms of the market (Open Lab Circular Textiles, Open Lab Circular Plastics, Open Lab Port, Open Lab Mobile, Open Lab MedTech, Open Lab Agri-Food),
- the Open Lab Starter Kit, which enables self-replicating machines to be built in the Labs,
- the Fab City OS operating system, which aims to bring together global product development with local manufacturing,
- the city-wide Maker Challenges to generate product and design ideas,
- the development of educational formats and the participation of citizens in the context of build workshops, and
- the development of a Fab City Index to capture local production capacities as well as consumption and material flows.

In these sub-projects, fundamentally different ways of meeting societal needs are explored and practiced. These projects already capture local structures and dynamics in parts (e.g., mapping of small production sites), and, thus, contribute to systems analysis, which is the basis of any transformation process. A variety of lessons continue to be learned from the experiments: from institutional aspects, to safety and liability issues to cultural aspects, such as the motivation to design, make, or repair things oneself. These learning experi-

ences must in turn flow into the other levels and contribute to change there. So far, however, there are no platforms and instruments for a coordinated exchange and learning from the experiences of the experiments in the Fab City Hamburg. Introducing a fixed regular time for meetings lika a round table could be suitable format.

Reflexive Activity Level Initial evaluation and monitoring activities have already been established within the framework of Fab City Hamburg: at the level of the individual projects – in the context of the accompanying research on the Open Labs and the build workshops or also in the context of the contributions in this publication – and at the superordinate level of the two research projects. So far, the individual projects are only related to each other to a limited extent. While there are a number of formats for exchange and networking at the superordinate Fab City level, e.g., round tables, working groups, and Fab City Summit, there is too little of this at the local level inside of Hamburg. In order to generate systematic learning processes, there is a need for "horizontal" exchange formats between the various Fab City projects, experiments and initiatives, in which knowledge and experiences are shared in order to draw conclusions for the "vertical" level.

How Can Transition Management Support the Development Towards a Fab City Hamburg?

We have classified the numerous activities in Fab City Hamburg in a transition management approach. From this exercise, it is clear that a structuring framework that brings together the multiple actors and activities in a coordinated process is not yet in place here. In particular, the municipal level has so far only been involved in rudimentary ways – such as the Green Paper Workshop. Politics and the administration are relevant groups of actors in transformation processes because they set socially binding rules at different levels (from local to international) and can thus also improve the framework conditions for other actors (Heyen et al., 2018).

The first step in the transition management process of a Fab City would be the formation of a transformation team to coordinate and steer this overall process. Usually, such a process is initiated by municipal decision-makers, with the city administration also providing the core team. Considering the constellation of actors in Fab Cities, however, this process can and should be steered by a broader group of actors. Representatives from all institutions and organizations that belong to the respective Fab City consortium could be included. As with Fab City Hamburg, this role could be assumed by the Fab City Hamburg e. V. (association), which acts as an interlocutor and takes a mediating role between the various actors and initiatives from the field. The Fab City e. V. is also intended to coordinate the Fab City Hamburg initiative, independent of the funding projects.

The second step in the Fab City transition management process consists of a system and actor analysis to better understand the urban dynamics and enable a co-creation process. With the help of the system analysis, an integrated overview and a better understanding of the selected topics is gained: How do different elements influence each other? How has the status quo evolved? The systems analysis creates a common information base for all stakeholders and a shared understanding of the city (Roorda et al., 2014).

Within the framework of the many projects and initiatives in the Fab City Hamburg, various data have already been collected that are relevant for the system analysis. It helps to define the relevant thematic field-specific actors, who in turn can be considered for the selection of arena participants or for participation in later phases of the transition management. There are a variety of procedures and techniques for conducting the actor analysis, of which a systematic one has still not been done in the context of Fab City Hamburg.

6.4 Conclusion and Outlook

The Fab City approach is one possible way to collaboratively address sustainability challenges in urban spaces. In this article, we explored the question of how the transition management approach can contribute to shaping the transformation to a Fab City, using Hamburg as a case study. To this end, we first outlined the basic characteristics of transformations in order to describe the complexity of the task. Transformations are defined as radical, structural change of a social system toward sustainability as a result of co-evolution of technological, economic, socio-cultural and institutional changes and involving a wide range of actors (Rotmans & Loorbach, 2010; Geels & Schot, 2010). They are complex, dynamic, nonlinear, and usually span several decades. Although transformations cannot be planned or controlled, it has been suggested that they can be influenced in direction and speed (Heyen & Brohmann, 2017; WBGU, 2011, 2016). To this end, various governance approaches have been developed that aim to understand, analyze, and shape transformation processes toward sustainability (for an overview: Köhler et al., 2019). In the article, we focused on the transition management approach in its operational application to a Fab City. Based on a set of transition governance principles that act as orientation and clarify what to look for in transformation processes, the transition management approach was operationalized in the form of iterative governance activities at four levels. Regardless of the specific process design, which must be tailored to the local context, transformation processes should include strategic, tactical, operational, and reflective activities.

Finally, the transition management framework was applied to the case study of Hamburg and used to analyze where the Fab City Hamburg stands in terms of governance activities. The application of the framework for a real-world urban experiment is intended to illustrate the perspective of the transition governance approach. From this perspective, despite numerous activities, comprehensive governance of the transformation to a Fab City Hamburg has not yet taken place. The strength of the transition management approach is to practice a new collaborative governance with the help of the tools (especially the transition arena) and methods (including visioning, backcasting, etc.) by coordinating diverse actors and networks, and building new competencies. The founding constellation of Fab City consortia already provides an important basis for this, on which coalitions can be built. In Hamburg, civil society actors, startups, and research institutions have founded an association to address the transformation goal of the Fab City – to transform the "city" system into a digitally and globally networked Circular City – in a coordinated manner. The

creation of such a collective, association, or similar formal organization helps the local Fab City movement to become active, to be visible, and to appear coherently to the public. Nevertheless, the authors recommend an expansion of the group of actors to include more frontrunners and other groups of actors, especially from the field of politics and administration. This would support the achievement of broader impact in Hamburg and bring about changes, especially at the tactical level, with regard to established structures, institutions, regulations, and other instruments.

A key challenge of transition management is to engage in a long-term, open-ended process that complements political and civil society action. This requires human, financial, and time resources. From the perspective of transition governance, fab cities will only develop their intended transformative effect if, beyond the niche activities of pioneers of the fab movement and research elites, actors from politics and administration as well as from business can also be activated. A moderated transition process using the methods presented in this article could contribute to this and go beyond internal organizational and/or selective exchange.

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