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DISRUPTIVE CHANGES IN THE TRANSPORT SYSTEM - FROM CAR-REGIME TO SUSTAINABILITY

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Abstract

Achieving the climate goals depends to a large extent on the reorganization of the transport sector at all levels. The initiation of a paradigm shift in transport policies must be understood and take place primarily as a result of a change in structures. Besides the transport infrastructure, this also includes the financial and legal system. It is necessary to include the procedures and processes of transport policy decision-making in a comprehensive transition management. The implementation of specific national objectives in the respective administrative levels across the federal states to the municipalities would be a first necessary step. However, initiating necessary radical changes in the transport sector will require disruptive changes to the established structures. The paper discusses such changes in the transport system by introducing theories of sustainability transition and political economy. The role, dependencies and influence of actors in planning processes are prototypically analysed, drawing on the situation in Austria. We further examine how structural barriers suppress or delay measures supporting environmental sustainability. The limits of bottom-up and classic top-down processes are shown and their effectiveness as a contribution to the mobility transition is critically questioned.

Keywords: systemic change, transformation, policy, sustainable infrastructure, multi-level perspective

1 Introduction

"Sustainability and transport" is an increasingly obvious contradiction when looking at current developments and transport policy decisions worldwide. Particularly regarding the climate crisis, change is overdue. Global CO_2 emissions in the transport sector have risen by 250 % between1970 and 2010, where road transport accounts for the majority [1]. Emissions are still rising in many European countries. In Austria, for example, transport emissions have continuously risen again since 2014. Between 1990 and 2019 they increased by 74.4 %, cancelling out all reductions in other sectors [2].

More and more analyses and simulations on resource use and planetary boundaries (climate change, biodiversity, availability of resources) conclude that sustainability goals can only be reached if there is radical change in the transport sector. Purely technically oriented solutions and trends that continue to rely on motorized individual transport, such as e-mobility, car sharing or autonomous driving, can only make a moderate contribution towards achieving the climate goals.

de Blas, et al. [3], for example, analysed worldwide scenarios of a shift to electric mobility. They conclude that it is not possible to decarbonize the transport system through electrification of vehicles under the current growth paradigm. Their simulations show only one sce-

nario where climate targets are met and it includes not only a shift to lighter electric vehicles and non-motorized transport modes but also a strong decline in transportation demand. Millward-Hopkins, et al. [4] showed in a global scenario that it is possible to provide decent living for all people with minimum energy, which makes it possible to live within planetary boundaries. Concerning transportation, this entails an "(ambitious) combination of non-motorised transport, public transport, and limited private vehicle use and air travel". Especially for the Global North, this means that passenger km travelled with private motorized vehicles have to decrease significantly.

For Austria, Heinfellner, et al. [5] assessed how national climate targets in the transport sector can be met. Their simulations show that the goals cannot be achieved solely with technological changes. In the study, they also identified the most effective measures for decarbonisation. They include higher fuel taxes, lower speed limits, cordon charges, better quality infrastructure for walking and cycling, spatial planning measures such as more compact settlement structures and expansion of public transport services. Even though these measures are known, they have not been implemented and, following the political discourse, it does not seem likely that they will be implemented anytime soon. Banister and Hickman [6] call this observation an "implementation gap" and Gössling and Cohen [7] forecast that EU climate policy will fail due to "transport taboos" – "barriers to the design, acceptance and implementation of such transport policies that remain unaddressed as they constitute political risk".

Measures that are effective in reducing CO_2-emissions require or produce changes in the legal, financial and built structures of the current system. Their implementation is the result of planning and political decision-making processes. It is therefore necessary to include the analysis of such processes in a comprehensive transition management. This is where engineering research focused on transportation infrastructure and modelling of environmental impact has to face its limitations, acknowledge that the challenges cannot be met with existing tools and multidisciplinary research is needed to find out how it is possible to implement the known measures in a manner that makes them socially and politically acceptable.

In this paper, we introduce theories of sustainability transitions to the field of transport infrastructure research. We analyse why a multitude of known problem diagnoses, suggested strategies and calls to action have shown little impact so far and why a transformation in the sense of a paradigm shift did not happen yet in the transport sector. We show the roles, dependencies and influence of actors in planning processes in a prototypical way, drawing on the situation in Austria. We further examine how structural barriers suppress or delay the diffusion of measures supporting environmental sustainability and show where possible points to intervene lie.

The rest of the article is structured as follows. In Section 2, we describe theories of systems, regimes and sustainability transition and link them to transport planning and policy. Section 3, discusses the role of structures and agency in planning processes, referring to the Austrian transport system in particular. In Section 4, we draw our conclusions.

2 Theory of systems, regimes and sustainability transition

2.1 Human needs and systems of provision

Mattioli [8] proposed a framework connecting human needs theory and systems of provision, which was extended by Brand-Correa, et al. [9] to show possible places to intervene in the currently non-sustainable transport system. Basis for their assessment is the order of need satisfiers, with the private car as an example. Humans have basic needs that they satisfy with need satisfiers. While car use is not a need itself, it serves as a need satisfier of higher order. We can look at the basic need for subsistence as an example. People need to earn money

to make a living. For this, they have to get from their home to their workplace. First order satisfiers are socio-technical systems of provision such as infrastructure (e.g. a road that connects home to workplace). Second order are activities, third services and fourth specific products (such as the car).
While first order need satisfiers are the most effective places to intervene, they are also the hardest to change. This can be illustrated with a cog-metaphor (see [9]) or as leverage points (see Figure 1). A first order intervention to move away from a car-oriented system would include "a shift in the provision of non-automobile infrastructure, improved and integrated public transport systems and changes to urban planning and design, including a relocation of workplaces to more easily accessible areas" [9] – and therefore a change in the system structure. While a fourth order intervention could look like a change to cars running on biofuel (change of only one parameter), which presents a much easier task but is not nearly as effective in terms of climate mitigation.
However, socio-technical provisioning systems not only entail physically built infrastructure but also institutions and economic and political logics - ultimately mindsets and paradigms. Addressing these might seem like an unsurmountable challenge and actors in transport might take this as an excuse for inaction. While it is out of scope of this study to analyse fundamental economic and political logics that determine conditions for transport in detail, it is still necessary to address all aspects of the socio-technical provisioning systems. In this work, we focus on the infrastructural part as well as the legal and administrative bases that enable or inhibit decisions in infrastructure planning. It is true that these aspects alone cannot trigger disruptive change in economics and politics, but on the other hand, radical change in these fields of practice is not possible without changes in the transport system and its infrastructure.

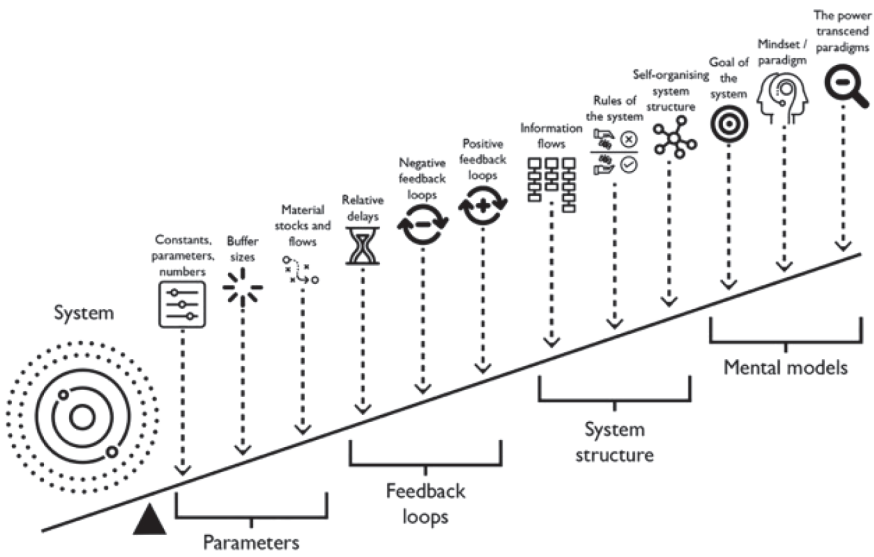

Figure 1 Places to intervene in a system with increasing leverage to the right, figure from [10] based on [11]

2.2 Theories of sustainability transition: Multi-level perspective

Markard, et al. [12] describe the emergence of sustainability transition research and its importance. In many sectors such as energy, agriculture and the transport sector, ecological, social and economic problems are imminent. In the transport sector, these problems are apparent in the form of local air pollution, depletion of fossil fuels, CO_2-emissions and traffic accidents. Due to past developments (path dependencies) and lock-in effects, well-established systems only change incrementally and not radically. However, such incremental changes are not enough to rise to the sustainability challenges in due time. This is why transition research deals with the question how radical change of these well-established systems can be supported and steered.
The multi-level perspective (MLP) developed by Geels and Schot [13] is one of the theories that describe transitions of socio-technical systems. It has emerged as being practical to show barriers in the transition of transport systems.

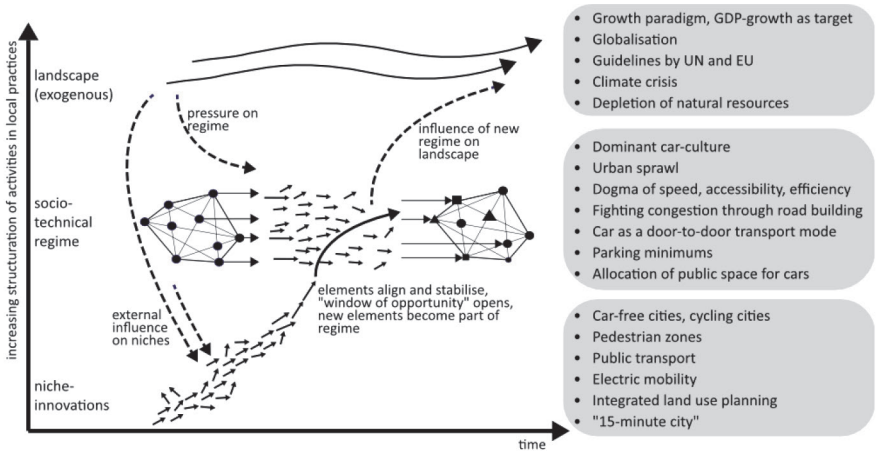

Figure 2 Multi-level perspective, adapted illustration from [14], based on [13]

There are three levels in the MLP: landscape, regime and niches (see Figure 2). The central regime includes the dynamically stable, established and hegemonial practices, discourses, institutions and artefacts [15]. Rip and Kemp [16] define technological regimes as the "rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems". Within the regime, there are three different dimensions of entities: (1) tangible technologies (e.g. road infrastructure, cars), (2) actors and social groups and (3) rules (formal and informal) such as laws, planning guidelines, etc. [17]. Inside the regime, institutional structures connect the artefacts, rules and actors. A transition is defined as a shift from one regime to a different regime. Niches and landscape are defined in relation to the regime [18].
The landscape represents exogenous factors that affect the regime but are not directly part of the regime. The distinction between landscape and regime is discussed in literature, but it is not clearly defined [19, 15]. The distinction depends on the system that is being analysed and the view of the analyst. In the classic approach by Geels and Schot [13], socio-technical systems are in focus and economic conditions are seen as exogenous. Vandeventer, et al. [20] extended the theory and showed that it is also useful to describe changes in socio-economic systems in which economic parameters such as the capitalistic growth paradigm are part of the regime. According to the MLP theory, the landscape can enact pressure on the regime,

which can lead to breaking connections within and the order of the regime. This destabilized state marks a "window of opportunity" during which it is possible to create a new regime order that incorporates innovations or niche developments.
Niches are defined as technologies or practices that deviate substantially from the existing regime. They can support the regime or be seen as opponents. On the regime level, there are multiple individuals and groups that act independently and in an uncoordinated way. They can form networks and align their actions to create a dominant stable form, which makes it more likely that they make the leap to the regime in times of an opportunity.
The MLP can be used as a tool to define regime components and discern landscape and niche components as well as to describe path dependencies. MLP has been used multiple times for examining aspects of sustainability transition in transportation. Vogel [15] used it for analysing sustainable urban mobility, Zijlstra and Avelino [21] for a socio-spatial analysis of mobility and Sheller [22] for describing the cultural dimension of mobility. In this work, we apply a transport infrastructure and policy perspective on a national scale, with examples drawn upon the situation in Austria.

2.3 The "car-regime" and barriers for change

In most countries in the Global North, the established transport regime can be described as a "car-regime" [21, 23]. The private car with combustion engine is favoured as a transport mode and (legal, financial and built) structures are oriented towards its use. This inhibits the implementation of measures that are effective in reducing CO_2-emissions and therefore in mitigating climate change. The current regime puts conditions in place that still enable the planning, financing and building of infrastructures that have been demonstrated to lead to drastic and continuing increase of CO_2-emissions. Mattioli, et al. [24] describe the current system of car dependency based on six systems of provision: the automotive industry, car infrastructure, car-dependent land use patterns (urban sprawl), (undermining of) public transport and cultures of car consumption. They are interconnected and work in positive feedback loops as a self-reinforcing system.
The phenomenon of this regime not having changed in the direction of sustainability (despite such efforts in the past), has been described in literature by several different terms. In the field of System Dynamics, it is described as "policy resistance" [25, 26]. Driscoll [27] writes about "carbon lock-in", Mattioli, et al. [24] about "political economy of car dependence", Blühdorn, et al. [28] about "sustainable non-sustainability" and Marletto [23], Zijlstra and Avelino [21] use the term "car-regime" to describe a system of interrelated and self-reinforcing entities that make it impossible to change by standalone policies or reformative approaches.
Ultimately, they all describe similar problems that can be illustrated using the MLP. Over time we have created a complex system that is made up of self-reinforcing elements that generate a growing dependency on cars ("political economy of car dependence" [24]). Individual measures do not show the desired effect but are weakened by the system's response ("policy resistance", [25, 26]). Often we have to deal with short-term false solutions that provoke a long-term effect that reinforces the problem. One example for this is the reaction to congestion with increased capacity such as building more roads, adding lanes or implementing ITS (intelligent transport systems). In the beginning there might be some level of traffic relief but in the longer term more traffic is induced and the traffic load is increased compared to the initial situation [29].
Decisions in transport policy are mostly based on theories and principles that have not been critically challenged. They are the basis for defending the status quo and maintaining a hierarchy of values that is in some cases even formally defined in legal regulations and industry standards. Dogmas such as "accessibility", "design speed" or the mostly monomodally

discussed “elimination of capacity bottlenecks” are defended at all cost for stabilising the regime. It is pretended that there exists technical objectivity, even though the underlying assumptions are not explicitly voiced and are often not public. Different assumptions that challenge the status quo are referred to as unrealistic [30].
In this way, it is made impossible to create an ecologically and socially sustainable transport system beyond individual niche solutions. Some scholars speak of an “implementation gap” [6]. Research constantly creates new findings that show how the system should change to enable sustainable mobility. But this knowledge is not adopted by the regime, at most, it is tested in niches. Necessary changes in the system structure however are “transport taboos” [7] – measures that are unthinkable for the majority of actors. Therefore, they are not addressed by the established regime and are being disqualified for being too radical or politically not feasible.

3 Structures and agency in planning processes

(Transport) planning can be described as the mental anticipation of actions that seem necessary to reach a goal. This is a process that results in an abstract (simplified) illustration or model of the expected reality [31]. The basis for a change of behaviour (in transport systems) is the change of structures. Following the structuration theory of Giddens [32], on the one hand, structures determine behaviour and on the other hand, structures are the outcome of social actions. Structures are to be seen as all elements that determine or influence behaviour [33]. They can be physically built elements as well as legal and financial regulations, information, social or economic conditions. Particularly in the built environment, they are the result of planning processes. Kloss [34] defines the stakeholders in a planning process on the basis of transport planning in the city of Salzburg as follows:

- Planning authority and administration (city, province, federal government)
- Representatives of public authorities
- External planners (companies and research institutions)
- Citizens and advocacy groups
- Media representatives

Politicians have a central role. They are ultimately responsible for implementing measures that decrease the target/actual difference. Reality is made up of countless interrelated feedback loops and systems. The task of planners is to identify significant feedback loops and to choose system variables and indicators to describe the system in question. Here, it is essential to note that perceived and actual reality often differ and therefore decisions that follow “wrong” goals are made [34]. Long time delays between action and impact reduce the willingness to initiate transformative processes.
Since individuals are embedded in the structures, there is only a limited degree of freedom for them to act. Actions can reproduce and intensify the given structure or work in changing the structure in a different direction. The decisions of individuals are not only influenced by the system structure itself but also by their personal background. Their perceived reality is influenced by individual and biased interpretation, values, education, legal preconditions, technical codes and standards and chosen indicators [33]. This defines what exactly is seen as a problem and in practice this often leads to not addressing actual human needs but perceived needs such as the need for fast travel with a private car. The persistent pursuit of “wrong” goals (e.g. increasing speed or increasing capacity) leads to increasing dependence and lock-in. This is the opposite of what Heinz von Foerster described as his Ethical Imperative “Act always so as to increase the number of choices.” [35].

The step from the perception of a problem to the solution of the problem is not trivial. Even when a problem is recognized, it is not always easy to identify the cause, since problems often appear as symptoms or syndromes and are in many cases treated on that level. We cannot make absolute statements about reality in its entirety because we only ever perceive a certain part of the unknown reality [33]. This perceived reality is influenced by the personal background in education, system knowledge and expertise [36]. Fasching [37] describes this as an objective illusion, based on an intersubjective reality, caused by the scientific methods.

4 Conclusion

The current transport system favours the private car over other means of transport; its structures are oriented towards private cars. This "car-regime" inhibits the implementation of effective climate mitigation measures and ensures that even today, decision makers plan and finance infrastructures that lead to a continuous increase in CO_2-emissions. Niche innovations are only implemented in a regime if they do not change the system behaviour fundamentally. Actors in the car-regime and their values are highly anthropocentric and do not evaluate ecological criteria in their actual relevance.
In the political discourse, there is a lack of realistic assessment of measure intensity to come even close to achieving the climate targets in the transport sector. The measures that have already been quantified to effectively reduce CO_2-emissions (such as in [5]) should be implemented quickly. In addition, further measures focused on process structures must be realized. This could include linking fiscal transfers to CO_2-saving goals, reviewing the spatial and settlement policies and paying fines for climate-damaging infrastructures and surface sealing. Such measures would be systemically relevant and exert a leverage effect since they lead to a change in behaviour of the relevant institutions. However, to initiate the necessary radical changes in the transport sector, the established structures have to be disrupted. This also requires external impulses that question the existing "system", for example by bottom-up initiatives.
A new paradigm sees an abandonment of the current car-regime in favour of planning oriented towards sustainable transport modes (walking, cycling and public transport). The spatial preconditions, the availability and the attractiveness of different transport modes determine the mobility behaviour of people. The built structures as well as legal, financial and organizational structures have to be changed in order to achieve effective changes towards sustainable transport. This is not only about shifting trips from cars to public transport and making cars electric but a fundamental transformation of the transport system under consideration of socio-economic, cultural and spatial dynamics. To achieve this, it is necessary that such a paradigm shift arrives in people's minds, especially in those of politicians, planners, administrators and researchers, since they create or influence conditions, decision-making tools and have to define and implement measures.

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