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Transitions of Mobility Systems in Urban Regions: A Heuristic Framework

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ABSTRACT *This article examines the possible contributions that transition studies can make to better understand the problems that hinder attempts to deliver co-ordination between transport and land-use planning and better integration between modes of transport in urban regions. Recent publications focus on barriers of co-ordination between transport and land use and methods to overcome them. Obdurate social and material structures are the dominant obstacles for change. For this reason, transition studies are considered to conceptualize the mobility system. In the article, key theories in transition studies are first considered. Following this, the ways in which these concepts can be used to characterize the system of transport and land-use planning are explored; it is demonstrated that the system and the challenges facing it can be better understood by using these concepts. This has resulted in a conceptual model for the development of the mobility system. A focus-group session in the Noordvleugel region of the Randstad in the Netherlands has been used to test the usability of this model in practice, gauge the participants' reactions to it and to supplement it, if necessary. By combining insights about how to conceptualise change in socio-technical systems and more specific knowledge about transport land-use planning, this article gives new insight into how a transition towards better co-ordination between transport and land-use planning and the transport network could occur, as well as how it could be hindered. It also provides interesting indications of research options examining cases where such transitions have taken place or been attempted.*

KEY WORDS: Transition, mobility, transport land-use, multi-level

1. Introduction

For a number of years, transport research has been devoted to the question of how to manage mobility in urban regions. The question is important because successfully managing urban-regional mobility can greatly reduce its environmental

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impact, decrease energy consumption, ensure that fewer traffic injuries take place and improve economic competitiveness and quality of life (e.g. Banister, 2008; Bertolini *et al.*, 2008; May & Marsden, 2010). The challenge is reaching a balance between reducing the negative effects of mobility and preserving the benefits it has brought society, such as increased quality of life, freedom and economic prosperity. In their efforts to address this issue, researchers have come to realize that co-ordinating transport and land-use planning at the city level can deliver a significant contribution (Banister, 2008; Cervero, 1998; May & Marsden, 2010). The underlying rationale is that if transport options are co-ordinated with the land-use densities and functions that are present at a certain location, and if for each trip, the most efficient choice from an economic and environmental perspective is rewarded, the mobility system can function most effectively (Bertolini & le Clercq, 2003). This is based on the idea that the transport and land-use systems are intertwined and influence each other (Wegener & Fürst, 1999). Consequently, the two systems can be considered as one. We use the term mobility system to describe this combined system. Recent years have seen considerable research about how the co-ordination between spatial planning and transportation planning can be realized (Banister, 2008; Cervero, 1998; Curtis *et al.*, 2009; Dunphy *et al.*, 2003; May & Marsden, 2010). Much is now known about what should be done in terms of design, as well as which measures should be taken and which governance strategies appear to be successful. Furthermore, examples from a number of countries show the results that can be achieved. However, in many contexts, implementation is lagging behind. It has become gradually clearer that the problems hindering a transition are not so much related to a knowledge gap about what should be done, but rather problems in the implementation of this knowledge (Banister, 2008; Bertolini *et al.*, 2008; May & Marsden, 2010).

The Netherlands is a case in point of a country where many attempts have been made to realize the type of integration described in the scientific publications discussed above, but where implementation has proved to be problematic. In the Netherlands, increasing attention has been devoted to improving the conditions for efficient travel choices (both in individual and collective terms) through the integration of all modes in the mobility system and co-ordination between transport supply and spatial development, as well as other incentives such as mobility pricing and marketing. Many of the plans and policy documents published in the Netherlands in recent years emphasize the importance of co-ordination between transport and land-use planning, as well as the integration of different modes of transport at urban-regional level (MVROM, 2008, p. 8, 2010a, p. 15; MV&W *et al.*, 2006, p. 51; OV-bureau Randstad, 2010, p. 8). Essentially, plans aim to develop what can be considered an integral (land-use and transport) and multimodal urban mobility system. Since the turn of the century, two main attempts have been made in the Randstad region of the Netherlands to achieve these goals (by Stedenbaan in the southern part and MRA-Net in the northern part). They aim to achieve better co-ordination of transport and land-use planning, integration between modes of transport and improved quality in public transport in order to address the needs of citizens and firms for increased flexibility while coping with negative impacts of mobility such as congestion and deterioration of the natural and human environment (Goudappel Coffeng, 2010; OV-Bureau Randstad, 2010).

Nevertheless, road and other public transport networks still do not function as a complete, integrated network in the polycentric Randstad region. They offer

sub-optimal connections between the region's urban centres. The poor performance of the transport system has resulted in heavy congestion in the road network, which is seen as a threat to the environment, economy and quality of life of the Randstad (AmCham, 2009; OECD, 2007, 2010). Despite extensive attention to co-ordination of transport and land-use planning and the development of multi-modality with an integrated public transport network as the backbone of the urban region of the Randstad, few of the proposed interventions have been realized. This has served as motivation for much research that both implicitly and explicitly deals with barriers that have hindered the realization of these goals (de Boer, 2010; MVROM, 2010b, p. 25; Spies *et al.*, 2005; Switzer, 2010; Tan & Bertolini, 2010). Related to this research, a number of reports in the Netherlands have increasingly begun to examine how barriers can be overcome (Commissie Everding, 2008; MVROM, 2010b; MV&W, 2008; Raad voor Verkeer en Waterstaat, 2011). Despite this input, implementation is still problematic and practitioners have, as in other countries, increasingly turned to researchers for advice on how to deal with this problem.

There are, as yet, no 'ready-made' answers. Despite the number of scientific publications dealing with ways of overcoming implementation barriers, there is still little insight into how transformative change of an obdurate mobility system can be brought about in a desired and fresh direction. There are, however, interesting insights in other domains, particularly in the area of transition studies. Considerable research has been carried out to understand why bringing about change in existing practices is often so difficult and unsuccessful, and how to deal with this (Geels & Schot, 2007; Grin *et al.*, 2004, 2010; Rotmans & Loorbach, 2010). In this depiction, so-called *persistent problems* obtain their longevity from the fact that solutions tend to focus on new practices or new technologies, but neglect necessary changes in incumbent social (e.g. state and market institutions,1 dominant discourses, norms and heuristics) and material (artefacts) structures, which have inertia and may allow resistance against change in practices. The transition approach, rather than objectifying the socio-technical, opens it up as co-constituted by governance efforts (Smith & Stirling, 2007; for a discussion of some of the intricacies of governing long-term change, cf Voß *et al.*, 2009). Material and social structures are supposed to have co-evolved with each other and with the practices that they facilitate. To bring about change in one element is likely to require changes in other elements over a long period of time. Neglecting this connection, or failing to address it, generates persistence in problems. Conversely, transition studies have yielded insights into the ways in and the conditions under which changes in different elements may come to reinforce each other in a larger, coherent, long-term transformation—a transition leading to a novel 'system state' that privileges different practices.

This article attempts to understand how transition theory can be used to generate relevant insights into the development of the mobility system. In doing so, it hopes to contribute to a better conceptualization of the mechanisms of change in the system and of the possibilities of influencing that change. Additionally, the application of the theories in transition studies to a specific socio-technical system provides the opportunity to test the usability of these theories in a practical case which has only partially and unsystematically been explored thus far. First, central concepts and insights of transition studies will be discussed and supplemented to strengthen the conceptual power of these theories. Following this, a discussion of how the mobility system can be conceptualized as a socio-technical

system will take place. Key in this phase is the combination of the transport land-use feedback cycle, a commonly used conceptual model of how the artefacts in the mobility system evolve, with insights from transition science dealing with how social structures and actors contribute to the evolution of socio-technical systems. Finally, a focus-group session in the Randstad will be used to test the usability of the model in a practice environment. The heuristic framework developed in the article will later be used to analyse and interpret cases of mobility transitions in the past and, finally, to explore strategies to support the attempts to bring about a transition in the Randstad.

2. Transition Studies

In order to remedy persistent problems, mutually coherent changes in all elements are necessary; and this can be achieved with a system innovation. Different system innovations (in different elements) may, together, give rise to a transition of the wider system; a transition, as such, is a structured social change that is the result of changes in intertwined systems that support each other (Grin *et al.*, 2010, p. 1). Transition studies are devoted to understanding the dynamics and governance of transitions. In this section, we discuss the main notions and insights of these issues that may help understand how to deal more effectively with persistent problems.

2.1 *The Conceptual Foundations from the Transitions Perspective*

The concept of co-evolution forms part of the basis of transition science. This means that the development of various sub-systems that make up a socio-technical system influence the development of other sub-systems in a way that is irreversible (Kemp *et al.*, 2007). According to Geels (2005a), these sub-systems are: socio-cultural, users, market, technological, policy and scientific.

A widely used concept from transition studies is the multi-level perspective (MLP) (Geels & Schot, 2007) (see Figure 1). Its basic claim is that 'transitions result from the interaction between innovative practices, novelties, incremental change induced by actors who operate at what we call the regime level and quasi-autonomous macro-dynamics, or the "landscape" level' (Grin *et al.*, 2011). In MLP terms, transitions occur due to prolonged (typically several decades) co-evolution between and within various levels.

As discussed in more detail by Grin (2008), transition studies are rooted in socio-technical studies—more specifically, in studies of historical processes of socio-technical change (Geels, 2005b; Schot, 1998), as well as in a review of a range of theories about societal and technical change (Rip & Kemp, 1998). Common to both origins is the (loose) use of especially early evolutionary theory (e.g. Dosi, 1982; Nelson & Winter, 1977, 1982) as a canvas, as well as the notion of structuration—that structure is both the medium and the outcome of action (Giddens, 1984). The three 'levels' must, therefore, be understood not as geographical levels, but rather as levels of structuration and temporal scale. In line with such understanding, the unit of analysis may be chosen in a way that meets important criticisms of this point (Genus & Coles, 2008). Points of departure are the specific, interrelated set of practices one is interested in; regime and landscape may then be identified on a basis of how they express themselves in these practices (Grin, 2008). The fact that our choice for the mobility system in an

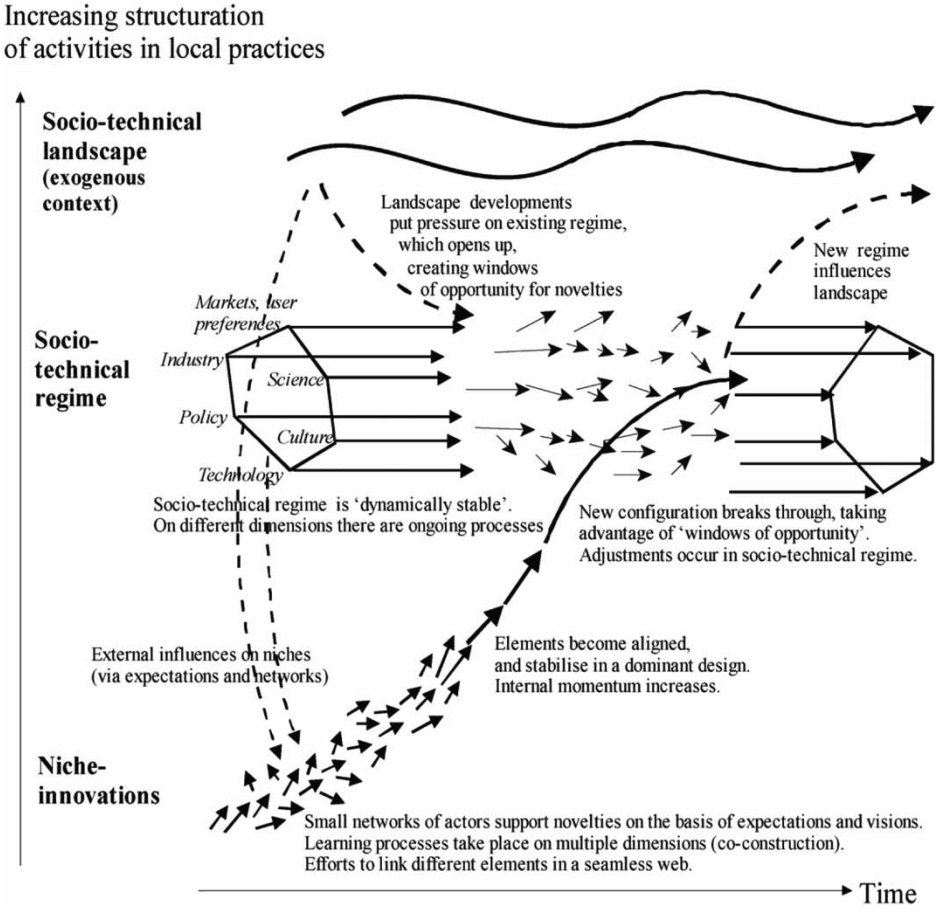

Figure 1. The multi-level perspective (Geels & Schot, 2007).

urban region is comprised of a set of practices hanging together in a geographically delineated region is consistent with that idea.

2.2 *Operationalizing the Levels*

In order to apply transition studies to mobility systems, it is necessary to discuss each of the levels of the MLP more operationally. The *landscape* is comprised of long-term exogenous trends (like Europeanization or the emergence of a network society), but may also include crises that may give rise to rapid change (e.g. the financial crisis). As Geels and Schot (2007) point out, it includes macro-political and macro-economic developments and deep cultural trends. Additionally, demographic and technological developments, as well as developments in the natural environment, are seen as part of the landscape. The quasi-autonomous nature of the landscape means that the developments here cannot be directly influenced, as such, by individual actors. However, the way in which they shape local practices and structures involves local agency. Furthermore, they are eventually the aggregate result of individual actions at multiple loci.

A *regime* can be considered to be the dominant configuration of the socio-technical system at a certain time and is composed of practices, rules and artefacts. Geels (2004) states that the practices of actors in a regime are supported by institutions or rules that, in some cases, can be internalized by these actors. These can be regulative (policy, laws, regulations and procedures), normative (roles and mechanisms that work through socialization, adaptation pressure, social authority and rewards and sanctions) and cognitive (belief systems, problem agendas and search heuristics which are deeply rooted and used to interpret problems). The material artefacts of a regime are intertwined with the practices and rules and have evolved in a co-evolutionary process (Smith *et al*., 2010). Due to the presence of established practices, rules and artefacts, the regime exhibits a certain obduracy and can be considered to be path dependent.

Socio-technical *novelties* are, by their nature, not dominant in the system, but can form an alternative for the regime. They have their own practices, rules and artefacts, which are not stable. In transition literature, the concept of the niche is often used to describe what we consider to be novelties. We suggest that (cf Grin, 2010, p. 265 ff) in a niche, novel practices, rules and artefacts can be developed while exposed to—or protected from—the influence of the regime. The niche offers protection from the influence of the regime where the practices, rules, and artefacts, which are not completely developed, can stabilize. In the early stages of the development of novelties, this instability means that it demands considerable effort from novelty actors to keep the practices, rules, and artefacts of the novelty stable (Geels & Schot, 2007). The distinction between a novelty and a regime is, however, according to Smith *et al*. (2010; cf Genus & Coles, 2008), not entirely clear. Nevertheless, the functional definitions described above are more important than the question of how much overlap there is between levels. Novelties may eventually develop into more full-fledged, stabilized structures or be incorporated in changes of the incumbent regime.

2.3 *Understanding Transition Dynamics*

Transitions occur due to prolonged co-evolution between and within various levels. The socio-technical perspective (by Geels & Schot, 2007, who base themselves on a sound review of different evolutionary approaches) and the complex systems view (by Rotmans & Loorbach, 2010, who combine the notion of co-evolution with complexity theory) have led to typologies of transition trajectories that represent how such reinforcement may develop over time. Abstracting from their differences, they both basically depict two main routes (Grin *et al.*, 2011): one starting with novel practices in the regime that either define, legitimate or bring about regime changes that enable further development of novel practices, etc. and one starting from instabilities at the regime level (that may arise from landscape pressure, as well as from internal tensions within the regime) that create a need and room for novel practices, which then further destabilize and change the regime, and so on.

From a governance perspective, a crucial addition is that actors engaged in changes at these various levels actively and reflexively 'reach out' to changes at other levels (Grin, 2006, 2010, pp. 274–275), 'translating' developments at one level into the need for changes at another level (Smith, 2007). This focus on agency has been partly inspired by critics (e.g. Meadowcroft, 2007; Shove &

Walker, 2007; Smith *et al.*, 2005) who have stated that in the MLP there is not enough attention on how actors may influence practices, rules and artefacts that form the regime and the landscape. To some extent, as far as novelties are concerned, it is already clear from transition studies that actors play a central role in establishing the practices, rules and artefacts of novelties and keeping them stable. The question as to how change can take place from within a regime, however, is much less trivial, as is the question of how novel practices may contribute to regime change rather than reproduce the incumbent regime.

Grin (2006, 2008, 2012) and Geels and Schot (2010) state that Giddens' (1984) structuration theory helps understand the dialectic relationships between innovative agency and structure. Practices have a strongly structured and normalizing character. Through his actions, the actor creates a social life, but his freedom is limited by unintended consequences and known limitations (Jacobs, 1993). Through the reproduction of structure during the process of acting, the structure can change as a result of these limitations to the freedom of individuals. An example is the change in some social structures in the last decades as a result of the realization that our travel behaviour has negatively impacted the climate. The result is that some people have gradually attempted to make their travel behaviour more sustainable to limit these negative impacts. In other instances, however, the actions of individual actors are rather responsible for the continuation of the incumbent regime.

3. Transition Studies and Change in the Mobility System

In this section, we will depict the mobility system in urban regions in a way that we may relate it to transition studies. First, the main elements of the socio-technical system will be discussed. Next, the conceptual framework presented in the previous section will be applied to the mobility system to develop a new conceptual model for change in the mobility system. Finally, the model will be illustrated using examples of the various elements.

A number of authors (Batty, 2005; Bertolini, 2010; Healey, 2007; Karadimitriou, 2010) have described planning in urban areas as complex and open to social processes with evolutionary characteristics. This seems to support the conceptualization of an urban region as a complex system in the sense implied in the MLP. The mobility system in such a region, given the relationship between this system and the rest of an urban region, can likely be considered through this same perspective (Shove & Walker, 2010).

One of the main theories about how the mobility system changes is the transport land-use feedback cycle as for instance conceptualized by Wegener and Fürst (1999) (see Figure 2). According to this model, travel between the places where different activities take place generates demand for mobility, which needs to be accommodated by changes in the transport network. These changes lead to changes in accessibility at certain locations, which in turn, influence which land is developed and the characteristics (density, functions and design) of the development. In turn, land-use change influences which activities are undertaken and where this occurs, as well as the choice of transport mode.

Bertolini (2012) builds on the work of Wegener and Fürst (1999) by adding internal complexities and external influences to the model (see Figure 3). According to Bertolini (2012) land-use is influenced by not only accessibility, but also the availability of land, characteristics of the surroundings, spatial policy and the

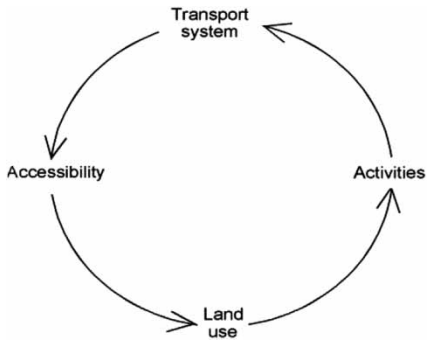

Figure 2. Transport land-use feedback cycle (Wegener & Fürst, 1999).

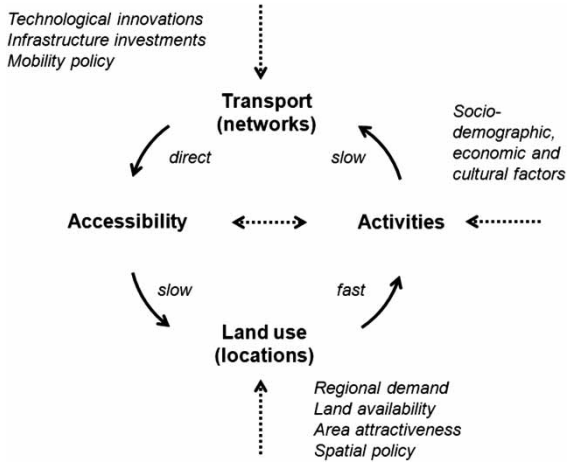

Figure 3. The TLU-feedback cycle with adaptations by Bertolini (2012).

economic dynamics of the region. Activity patterns are also influenced by individual characteristics of households, businesses and the broader socio-economic context (and to a larger extent than spatial factors). The development of the transport system is influenced by not only mobility demand, but also by relatively autonomous supply developments (policy and technology). The reaction times also vary within the cycle. Activity patterns change rapidly, but changes in land-use and the transport network require much more time. This results in short-circuits and contradictory actions. For instance, a decrease in accessibility as the result of congestion can lead to changes in activity patterns without changes in land-use.

3.1 *The Conceptual Model of the Socio-Technical System Applied to the Mobility System*

The transport land-use feedback cycle shows how the development of artefacts that make up the mobility system influence each other. Bertolini (2012) has already made a first attempt to incorporate several nuances into the model, but still the role of actors is not explicit, nor is the role of exogenous developments.

The insights from transition studies discussed above can help articulate this further. In the mobility system, the land-use and the transport network (two main material regime elements) change relatively slowly (as regime elements usually do) and (as structuration theory tells us) rarely spontaneously. Individual competent actors' reflexive agency is important. Actors can be public policy-makers, property developers, public transport companies, interest groups (including companies, scientists and activists) and firms and citizens who make choices about where to live and work, how they spend their free time and the mode of transport they choose. The actions of these actors are influenced by the rules in the regime, as well as expectations about the future, and are a reaction to developments in the landscape, other systems or the actions of other actors.

Figure 4 shows how the mobility system can be re-conceptualized in a transition perspective. The scheme is primarily intended as a heuristic framework, explicitly based on the recognition that governance and the socio-technical shape each other, and designed to inform what Smith and Stirling (2007, p. 364) have called reflexively acknowledging multiple framings of socio-technical practices. More specifically, by using the term 'heuristic', we mean that the scheme is primarily intended to structure the debate among different stakeholders, help them see interdependencies and dynamics in the urban mobility system (thus better understanding if and how change can be influenced) and both their and others' possible roles therein. Furthermore, heuristic means that the scheme is a starting point and one that can and must be improved through the understanding brought by the stakeholders in a specific situation. In this, parallels can be drawn with emerging insights in the literature on the role of decision support tools, ana-

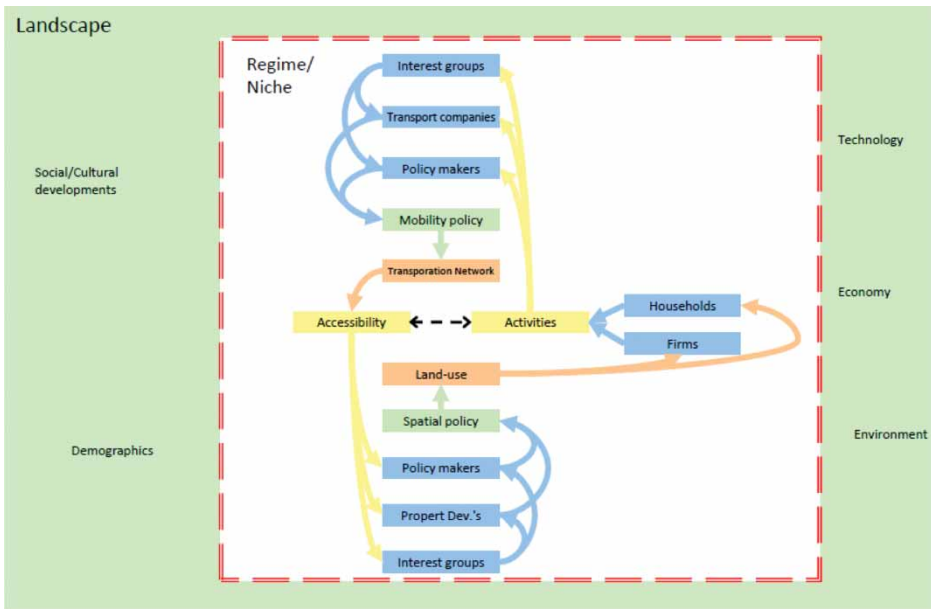

Figure 4. Conceptual model of the mobility system: transportation network and land-use are two crucial material elements of the regime; other regime elements are not being mentioned. The green boxes refer to policy practices, the green ones to societal practices. The figure does not distinguish between incumbent and novel practices and associated structural elements.

lytic models in general and policy-making, including in the field of transport and land-use planning (see e.g. Te Brömmelstroet & Bertolini, 2010, 2011).

Moving to the content of the scheme, in terms of land-use what we consider 'spatial policy' is determined by policy-makers from government, but also by property developers who place priority on developing certain locations. Furthermore, interest groups can also play a role in determining what land is made available for development and for which functions. It should be noted that the use of the word 'policy' in this context is quite broad and is an aggregation of government policy, but also the actions of businesses that are involved with the development of land or—as we will see later on—transport networks. Citizens and firms react to the availability of land and make choices about where to live, work and spend free time or to set up operations. Included here are decisions that citizens make regarding the mode of transport to be used. This and the decisions about activities generate demand for transport. This demand results in patterns in road or public transport network use which send a message to mobility policy-makers. In a process similar to that which determines land-use, policy-makers from government, transport companies and interest groups react to, anticipate and may even try to shape these developments on the demand side. Changes in accessibility as a result of these decisions are interpreted as opportunities and threats by the actors, mentioned above, that determine spatial policy. However, the choices of firms and households can affect accessibility conditions even without any mobility policy intervention (e.g. the impact of increased congestion). Conversely, changes in accessibility could lead to new activity and mobility choices even without the mediation of spatial policy (e.g. new location or transport choices following a decrease or increase in accessibility). In other words, the system can change in the absence of policy intervention, as well. This is indicated by the arrow linking accessibility and activities.

The landscape is composed of demographics, deep cultural trends, technology, macro-economic developments and macro-political developments. It is continually in flux and exerts pressure on actors in the mobility system with different intensities and at different speeds. In terms of the spatial components of the system, the growing preference for urban living can, for example, be explained based on these developments. Policy-makers, property developers and interest groups react to (or anticipate and try to shape) these developments and the actions of others when developing spatial policy. Their practices are influenced by other regime elements, namely rules (not shown in the figure). Concerning mobility practices, the preferences of citizens in terms of modes of transport are influenced by economic, social and cultural trends. The choice of transport mode is one of the best-studied examples of how the structuring influence of regime and landscape can influence the choices of actors (Dennis & Urry, 2009; Dupuy, 1995, 2005; Sachs, 1990; Urry, 2004). Landscape developments may support the existing regime, but also create windows of opportunity for the emergence of novelties. The current rise of the bicycle in certain cities could be seen as an example of how change in the landscape is helping the emergence of a novelty. The increasing costs of car use (resulting from economic and environmental developments) and shifts in cultural preferences as a result of the changing image of the bicycle could be responsible for the increasing popularity of this mode of transport in some areas.

The impacts of landscape developments are, because of the presence of the stabilizing social elements of the regime (rules), delayed (Geels & Schot, 2007;

Grin *et al*., 2004; Smith *et al*., 2010). Regulative rules prevent certain actions and normative rules make certain actions preferable to others. Finally, cognitive rules determine, at a higher level of abstraction, how problems are defined and how solutions are sought. Under new conditions, these rules can lead to 'tunnel vision' because of their obdurate nature.

3.2 *Comments on the Model*

At first sight, it can be argued that an unlimited number of arrows could be added to the model shown in Figure 4. This especially goes for the interest groups because the category is so broadly defined and they could use a broad range of actions, including marketing campaigns, information campaigns and power (resources or social capital) to influence the decisions of other actors. Concrete examples could be businesses that appeal to emotions of individuals, scientists that attempt to diffuse knowledge and governments that attempt to influence the behaviour of citizens. All of these actors have their own interests whereby their actions cannot be considered neutral. It is also possible that one actor could represent several actors in the model. The government can function as policy-maker, firm and interest group. The same is true for businesses, which can act as an interest group, but also make decisions about the location of the business.

In the mobility system structure can be considered to take form in three different ways. First, this is determined by developments that occur on a national or global scale—cultural, economic, social, demographic, environmental or technological developments are the most prominent types. Second, the aggregated preferences and needs of citizens form a part of the structure in which actors involved in planning the mobility system at the regional level are active. Third, the artefacts (existing built environment) and rules in the regime have a determining role. Structure and agency (the actions of individuals) must be seen together. However, the extent and speed with which this occurs varies. It can also not be ignored that feedback between actors and structure is present. The rules in the regime have been created and are maintained through this process. Shocks or gradual developments in the landscape and signals from other actors can lead to developments in these structures. An example is the influence that scientists can have on the rules of policy-makers. For instance, by sharing information about the functioning of the mobility system through learning-oriented workshops, cognitive or normative rules could be changed (Straatemeier *et al*., 2010). The aggregation of the decisions of all individual actors can influence the cultural, social and political landscapes. In terms of economic, environmental and demographic landscapes, the possible influence will be smaller. To keep the model simple, not all feedback lines are shown. However, the components and relationships depicted in Figure 4 can be considered as the primary ones.

Another observation that can be made is that the concept of the novelties offers insights into how innovations in the regional mobility system can be realized. Novelty actors are, to preserve simplicity, not separately shown in the model. As has been stated above, the novelty resembles the regime, but is characterized by less internal co-ordination. This means that similar social elements, as described above, are present, but less stable. It is expected that a novelty can be created as a consequence of the actions of one or more actors and subsequently stimulate other actors, leading to change in the system. According to Smith

et al. (2010), the value of the novelty is the fact that lessons can be learned through experiments. Also, the supporting conditions can be created and institutions can be developed that stabilize the novel development. Examples in the present Dutch context are (at a lower level of structuration) the OV-Fiets (rental bikes that are available at many train stations at a low price), car sharing, TomTom navigation systems with multi-modal travel advice and (at a higher level of structuration) examples of transit-oriented development (TOD). Some examples, such as the OV-Fiets, are novelties in the transport system and have little to do with spatial developments. This is not to say that further development of this novelty could not influence spatial development patterns. TOD is an example of a novelty that has both a transport and a spatial component. None of these novelties have been able to overcome the mobility system regime, so far. However, they could hold the seeds of change. All regimes were once a novelty, including the current car-dependent regime (Geels & Schot, 2007).

4. Testing the Heuristic Value of the Conceptual Model in Practice

In May 2011, a focus-group session was carried out with stakeholders involved in transport and land-use planning in the Amsterdam region. The actors represented the NS (Dutch Railways), the City Region of Amsterdam, the Province of Noord-Holland and the Municipality of Amsterdam. The objective of the session was to assess the usability of the conceptual model as a heuristic instrument (in the terms clarified in Section 3 above). Subsequently, the results of the session were presented to participants for verification.

The session consisted of two parts. First, the research programme and the model were presented. Those present were told how the model was developed and were shown what were considered to be the desired transition based on policy documents, often produced by the same participating stakeholders (see Figure 5). Participants were given the opportunity to ask informative questions or criticize the interpretation.

In the second part of the session, participants had to fill in the model (as depicted in Figure 4) based on their day-to-day experiences in attempting to achieve a transition. Initially, the model received little criticism. The discussion started immediately and dealt primarily with barriers that hinder the realization

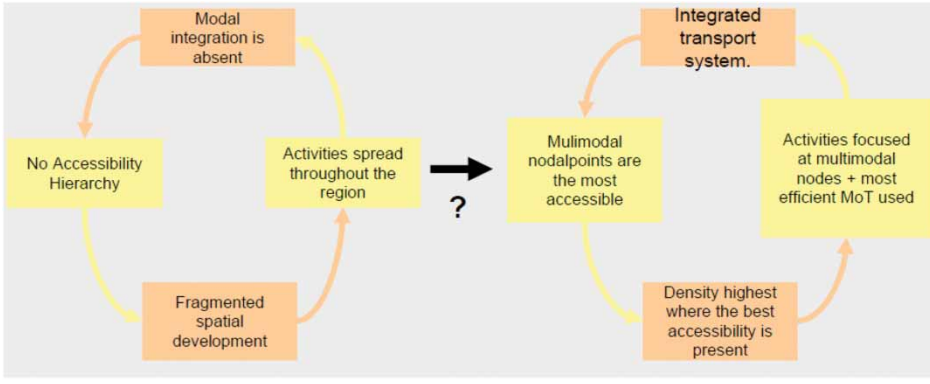

Figure 5. The desired transition in the mobility system.

of the desired transition. However, during the session, several suggestions were made to improve the model. It was suggested that the term 'transport companies' be replaced with 'transport implementation agencies' to reflect the fact that other actors, including Rijkswaterstaat (responsible for road construction) and the WGR+ regions (responsible for the development of public transport routes and tendering), among others, would also be covered by this term. Furthermore, as witnessed during earlier discussions of the model, it needed to be clarified that the boxes with different functions were about roles and not specific actors. For instance, an actor such as the NS can function as a property developer, a transport company (implementation agency) or a firm that makes choices about where to locate its offices. As far as mechanisms supporting or impeding the transition are concerned, the themes covered can be divided into two categories: barriers for the desired transition and system developments that are taking place. These are systematically handled below and are shown in their original form in Figure 6. It is important to note that the purpose of the discussion below is not to be exhaustive or consistent about the factors relevant for a transition of the mobility system in the Amsterdam region, but rather to document the sort of issues raised by the discussion of the model and, hence, be evidence of its heuristic value. A more comprehensive and coherent picture will be pursued in later phases of the research.

4.1 *Barriers*

Most time was devoted to discussing barriers in one form or another, as barriers for the desired transition in the region that underlie the persistence of mobility

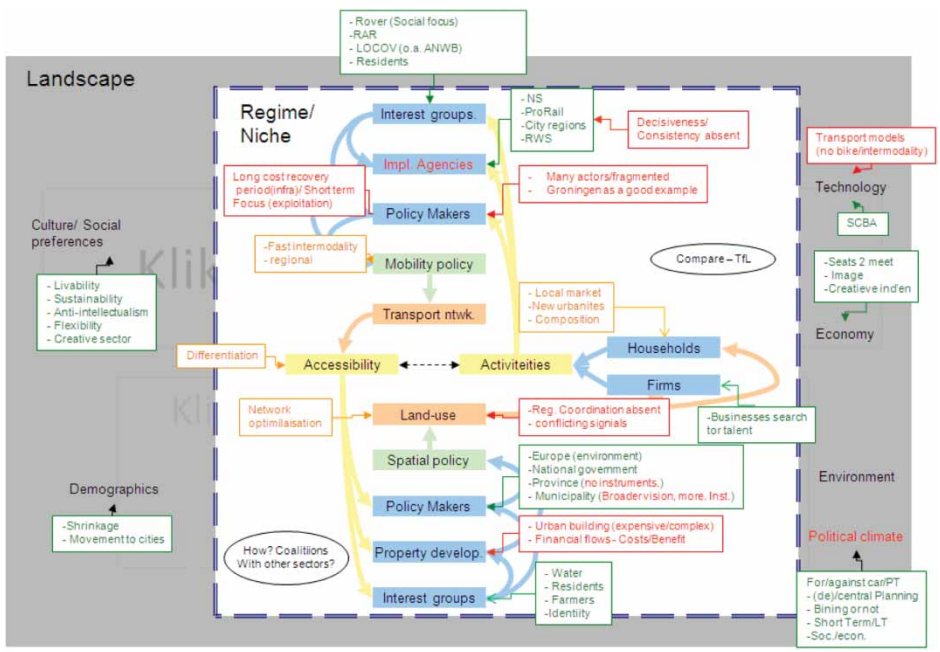

Figure 6. (Colour online) Model filled in after session. Green (new developments/suggestions); orange (solutions); red (barriers); black (suggestions for research).

problems are the motivation for this research. One major problem mentioned by participants of the focus group was a lack of continuity in political commitment and shifting priorities (e.g. liveability, sustainability, economic competitiveness, devolution), as well as a focus on short-term results. From a transition perspective, underlying this lack of political persistence is the difficulty of reflexively scrutinizing relevant elements of the incumbent regime. Using the heuristic scheme (Figure 5), the following barriers were identified:

- Transportation models (technology), used as a basis for policy-making, often do not include the bicycle and inter-modality. Investment assessment models (such as cost–benefit analysis) pose similar problems as they do not seem to adequately account for non-travel-related, longer-term implications.
- The institutional configuration of the administration of public transport is considered by some to be a barrier, while others see the lack of decisiveness and coordination between different administrative levels to be the real problem for TOD.
- Rules and laws in the form of concessions for public transport and the lack of legal instruments to support TOD were seen as a problem.
- Along the same lines, regulations dealing with nuisances, the separation of the parties that carry the costs and benefits from development and the separation of transport and land-use planning in government were seen as barriers.
- The way EU laws affect Dutch law was also seen to hinder various attempts at urban densification or TOD.

These barriers may serve as indicators of problematic regime elements that should be included in the transition (Grin, 2010; Grin *et al.*, 2004). Unhelpful in this transition were two other factors mentioned by participants in the discussion. First, an active public transport lobby that could promote public transport enhancement is lacking in the Netherlands (interest groups deal primarily with the equity aspects of public transport or local impacts of large infrastructure projects and not with improving performance). Second, the financial crisis has created a climate of risk aversion. Thus, strategies that focus on promoting sustainable mobility practices and rely on politicization of the environmental effects of the existing regime seem hardly promising as they require involvement of green-policy entrepreneurs, as well as risk-taking elected politicians (cf Hysing, 2009). Yet, our heuristic framework could also help find developments in the mobility system that may be pivotal in raising sufficient social support for overcoming the barriers identified by reflexively scrutinizing incumbent practices and identifying alternatives, recognizing that doing so may constructively interact with changing the power differentials implied in the incumbent regime (cf Grin, 2012; Meadowcroft, 2007). These are discussed below.

4.2 *Developments in the Mobility System*

During the focus-group session, Figure 4 also inspired some discussion about the direction in which the mobility system is developing, which novelties could be emerging and what landscape trends might have relevant impacts, both facilitating and hampering a transition. This took us beyond mobility practices, rules and artefacts. On the transition-hampering side, and among other things, this was related to the future of public transport that in its present form is only suitable for certain groups at certain times in the day (students; rush hour) and cannot

cope with the changing life patterns of many individuals (see Harms, 2003). At the same time, the opportunities for alternatives to the car seem to be changing more favourably due to another landscape trend—a growing preference for urban living has led to unprecedented growth in Amsterdam since the Second World War. Furthermore, businesses increasingly choose to locate where the right employees live as a result of a shrinking workforce (demographic change). Cultural preferences are also seen to be changing with an influence on the regime whereby people must justify why they choose to buy a car.

One of the novelties mentioned was the emergence of novel working practices. Specifically mentioned was seats2meet—a concept where workplaces and meeting facilities are available at major train stations—and was seen as something that could influence the preferences of business people to use public transport. According to some of those present, public transport can also benefit from the growing need for flexibility as it offers people the opportunity to be productive while travelling. Also, the status of the bicycle was seen to be changing as a result of individualization as it is increasingly being seen as a part of the identity of the owner (something that also occurred with the car in the past).

A suggestion was made that additional transition dynamics be created through building alliances with other sectors (systems), such as water management, that aim to achieve similar goals (in this case, limiting building to urbanized areas) even if the reasons are different. Finally, the participants see the need for promoting changes in cultural preferences. Inspiration could come from different contexts. For instance in Asia, living near a public transportation node is seen as living in an accessible location, while in the Netherlands having access to a car is seen as having accessibility. This is partly due to different transport and land-use conditions, but is also a matter of perception.

4.3 *Evaluation*

During the session, the model, with minor modifications, was largely accepted and appreciated by participants. Furthermore, considerable new information was collected and shared about the development of the mobility system, barriers that inhibit its transition along the desired lines and, perhaps, emerging windows of opportunity. In conclusion, we think the exercise has demonstrated that the model has heuristic value for developing strategies, based on novel visions of regional mobility systems. Of course, it is also important to note that the session only just touched up on the ultimate goal of the research—supporting the development of full-fledged transition strategies. In order to develop strategies with sufficient support to be implemented, a considerably more extensive exercise would be needed involving a more plural set of stakeholders in a longer time frame. Given the contested nature of visions and strategies, this would require appropriate iteration between 'opening up and closing down' (Voß *et al.*, 2006), as well as specialized methods and techniques (e.g. Elzen *et al.*, 2004; Störmer *et al.*, 2009; Truffer *et al.*, 2010). In addition, it would require the development of a set of transition pathways tailored to the mobility domain. To this and other points we turn in our conclusions.

5. Conclusions

To tackle the persistent problems that plague attempts to bring about transitions in regional mobility systems, it is first necessary to understand how the system func-

tions and changes. Consequently, this article considers transition studies—an area of research devoted to understanding transitions in complex socio-technical systems. In this largely theoretical article, we have depicted the mobility system, composed of material artefacts (shown in the original transport land-use feedback cycle) and social practices (both shaped by and shaping social structures—rules), as being socio-technical in nature. Our combination of the transport land-use feedback cycle with the MLP has allowed for the development of a model of how the urban-regional mobility system develops and changes.

This system is characterized by co-evolution, which means that the social practices are developed together with the social structures and material artefacts and support each other. Competent agents determine the developments of the artefacts (technical components), but these actions are influenced by social structures such as regulative, normative and cognitive rules, as well as, of course, expectations about the future. Both actors in novelties and the regime react to the actions of others, as well as to external developments in the landscape such as political, cultural, demographic and political developments. In this fashion, change takes place in the mobility system.

The testing and refining of the model during a focus group session suggested that it can be a useful heuristic tool for analysing barriers and opportunities for transitions in mobility systems and for identifying some clues for transition strategies. In the next stages of the research, the developed model will be used as a framework, as is customary in transition studies, to study transitions that have already taken place so that the mechanisms of change can be better understood. Ultimately, it is hoped that the insights generated will be useful in supporting processes attempting to bring about transitions in the urban-regional mobility system.

Clearly, additional work is needed in the form of trans-disciplinary exercises between ourselves as researchers and a wider set of stakeholders than those that could be involved in this first workshop. Yet, the above analysis has already provided some interesting insights on which these strategies could draw. Major developments at the landscape level exert pressures on the incumbent mobility regime. These developments may also guide the definition and elaboration of novel practices and associate regime elements. Some clues for designing these are suggested by novel practices. There seem to be possibilities for both strategies that promote pathways that depart from regime changes and for routes starting from developments at the level of the novelty. How to strategically connect the two kinds of pathways is another issue for further study.

While more work is thus clearly needed, we can already formulate the expectation that the transition studies lens points to, at the very least, the need of changes in the ways in which transport planning is taught and practiced. First, it shows how a transport plan aiming to facilitate the transition to sustainable urban mobility would have to cope with the systemic, multi-actor and multi-sector nature of urban mobility issues. This would require understanding of inter-relationships that go well beyond the transport sector and the ability to engage with actors and institutions that go well beyond the expert domain. Second, it shows how transformative change in the mobility system does not seem to be able to be predicted by models or prescribed by policies (still a dominant view in current transport planning). It seems, instead, to be a matter of cultivating promising socio-technical novelties while profiting from opportunities of regime change generated by landscape pressure. Old skills might still be useful, but new skills are also required.

A final thought concerns the broader relevance of the approach beyond the highly context-specific characteristics of the application, which resulted in the model specifications documented in Figures 5 and 6. In other contexts, spatial and institutional conditions will be different, just as specific policy goals and strategies. For examples of other contexts, one only needs to think of North American cities, cities in emerging countries, or other Euoropean cities. However, we also expect a general value of the approach for two basic reasons. First, all cities are faced with the dilemmas of urban mobility: they depend on mobility, but present mobility patterns are not sustainable. Mobility problems are persistent problems and thus there is a need for transformative change or a transition. The MLP is a conceptual tool that helps articulate this challenge. Second, in all contexts, mobility has a systemic nature with complex inter-relationships between transport and land-use components, and related actors and structures. The transport land-use feedback cycle helps to articulate these. Of course, further specifications beyond the notions, represented in Figure 4, need to be done in a local situation and in interaction with stakeholders as we have started to do in our focus group. This brings us back to the heuristic, rather than predictive or normative, character of the proposed framework.

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Notes

1. Institutions are understood here as relatively coherent sets of rules and resources.
2. We define an actor as an acting individual, group or organization; the actor may exhibit more or less agency.

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