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B.J.M. Petzer

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Technische Universiteit Eindhoven,
op gezag van de rector magnificus prof.dr.ir. F.P.T. Baaijens,

voor een commissie aangewezen door het College voor Promoties, in het openbaar
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Eindhoven University of Technology
School of Innovation Sciences

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Preface

Having come to the field of sustainability transitions as an outsider, I must salute my supervisors, Geert and Anna, for their patience (and persistence!) in guiding me from my first encounter with the MLP to the completion of this thesis. Learning to apply transitions thinking to stubborn and slow-moving problems has been an exercise in translation between disciplines with very different points of departure. I think that I appreciate most of all the many iterations of the ongoing discussions between us in which I presented what I viewed as points of consensus in urban planning and cycling activism, and tried to reconcile these imperatives with transitions frameworks and methods. This long, multi-year back-and-forth eventually evolved into the scarcity perspective and the legal street, which I see as a promising perspective and instrument, respectively, for a transitions approach to questions of urban space.

Writing this as we approach the first full year of the Covid-19 pandemic, I am heartened to see space reallocation efforts gathering in pace and scope as cities across the world eliminate car parking minimums, implement barriers to create cycling and walking space from what was car space, and call into question the ubiquity of car infrastructure and access in human settlements. It is my hope and expectation that sustainability transitions research will make a distinct contribution to space reallocation efforts as a driver of more equitable and sustainable urban mobility systems. I look forward to the insights that such research may bring to the 'street fights' of cycling and walking activists, whose aims are simple to articulate but very hard to achieve in practice. That very simplicity may be usefully revisited in light of the transitions literature's conceptualisations of power, obduracy and inertia, but also cracks, disruption and radical novelty, and all the accompanying methods and strategies for intervention.

Acknowledgements

Firstly, I would like to thank my mother, Isabel, and my sister, Alessandré, for lifelong support and encouragement through the rather numerous stages of my academic and professional career. My top comrades Jai Clifford-Holmes, Rashiq Fataar, Liam Kruger, Tyron Louw and Jonathan Smart, Scott and Rachel Gallagher, and Matt Rocha have been a constant support for the past decade-and-a-half, and especially in the course of this PhD. The Rhodes friends - Adrian and Penny Lynne Nel, Emma de Wet, Luke Reid, Alice Ruth Morrison and others – are by now simply part of the structure of the world.

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Of course, the reason I was in Amsterdam in 2015 in the first place was Marco te Brömmelstroet, véloprovocateur and Fietsprofessor, whose inaugural Planning the Cycling City summer school introduced me to Meredith Glaser, the PCCAMS alumni and speakers (Zsolt Schuller, Cosmin Popan, Mark Ames, Marius Gantert, Nadine Galle, Julie Schack, Carlton Reid – we're in it for the long haul). Marco also introduce me, and us, to the simple idea that any city can be an Amsterdam, or a Bogotá, if and when it stops subsiding automobility and starts investing in velomobility and walkability. Marco, you have reliably disrupted how I see cycling roughly twice a year in the half-decade I've known you – long may it continue.

I thank my research partners and interviewees from the Dutch Cycling-as-a-Service world, from the Fietsersbond and CROW, from Antwerp, Birmingham, Brussels, the Hague, Helsinki and Rotterdam, and particularly from the Gemeente and Vervoerregio Amsterdam. All gave generously, and many repeatedly, of their time; and shared with me insights and perspectives drawn from decades of experience. I thank them sincerely for contributing the material that is the foundation of this PhD thesis. For support during the PhD and in making the leap from academia back to practice, I especially thank Angela van der Kloof.

Lastly, I thank the funders of Bicycle Challenges, who have invested in our research and in our development as researchers and our upskilling as cycling advocates: NWO, Pon Holding, Rijkswaterstaat, the Dutch Ministry of Infrastructure & the Environment; Eindhoven University of Technology (University Board; Technology, Innovation, and Society Group; Philosophy Group; Urbanism Built Environment Group).

Glossary and Acronyms

bike (bicycle)	Bike or bicycle refer to bicycles and variations thereof, including cargobikes and e-bikes/pedal-assisted bikes. In the Netherlands and elsewhere, this is a regulatory category and a concept in flux; in the following chapters, it is therefore used in a non-restrictive sense.
BMC	Business Model Canvas (Osterwalder 2004)
CBM	Collaborative Business Model
CBMS (cycling-based mobility service/s), **CaaS** (Cycling-as-a-Service)	*CBMS* is the more neutral term used in this thesis to refer to services that offer users access to a bicycle, or variations thereon, without transfer of ownership. *CaaS* is a more specific term defined in Chapter 2; this definition may not apply to all CBMSs in all contexts, although the terms are practically synonymous in the Dutch context. In the following chapters, *CBMS* is sometimes used to refer to global contexts, while *CaaS* is more often used to refer to Dutch cases or cases comparable to the Netherlands.
cycling (utility cycling, transport cycling)	In this thesis, cycling is understood to refer to cycling for the purposes of transport, as opposed to cycling as sport or recreation.
Deelfiets	Bikeshare, shared cycling (Dutch)
ECF	European Cycling Federation
Gemeente Amsterdam	The local government of the City of Amsterdam
MaaS	Mobility-as-a-Service
MDDI	Multi-Dimensional Discursive Interactions (Rosenbloom 2018)
MfM	Marketplace for Mobility (Antwerp)
MLP	Multi-Level Perspective (Geels 2002)
MSP	Mobility Service Provider
OV-Fiets	Literally *public transport bike* – the bike-hire scheme operated by the Dutch National Railways (NS), and available at the majority of rail stations and stops in the Netherlands.
pedestrian	In this thesis, the terms *pedestrian* or *walking* is understood to include low-speed mobility modes that commonly share space with people walking, including wheelchair users and mobility scooters.
private cycling	This term is used to refer to the Dutch cycling regime, with an emphasis on its basis in the norm of riders owning their own bicycles; it is also used in opposition to the term *shared cycling*.
shared cycling (shared mobility)	This term refers to cycling by users who do not own their bicycles (for example, bikeshare, bike hire or bike leasing).
(sustainable) (urban) mobility transitions	In this thesis, the interdisciplinary field of transitions research (Köhler et al. 2019) is referred to with varying degrees of specificity. Sustainability transitions and socio-technical transitions are generally used to emphasise earlier and later scholarship in this area, respectively. Sustainable (urban) mobility transitions is sometimes specified, and sometimes implied, for reasons of concision, readability and emphasis.
TSA	Act on Transport Services of 2017 (Finland)

1 Introduction

1.1 Shared mobility, shared space? Cycling-based mobility services and urban space lock-in in the Netherlands

Urban mobility systems across the world are faced with an urgent need for transformation towards greater sustainability, in the face of the transport sector's stubbornly high carbon emissions and resource use (EU DG Mobility & Transport 2017). Cycling-based mobility services (CBMS), referring to services like bikeshare or bike leasing that offer users temporary access to a bicycle, offer one promising solution to this challenge. As a low-carbon, resource-efficient alternative mobility mode, CBMS has attracted a great deal of policy attention and public-sector support in low-cycling contexts, where services such as public bikeshare have become extensions of the public transport systems of major cities like London, Paris and New York City (Cohen and Kietzmann 2014). To date, however, emblematic CBMS technologies such as bikeshare have only found limited success in the Netherlands, despite its exceptional status as a high-income, mass-motorised country in which cycling has developed into an additional mass transport mode (Harms et al. 2014). Yet CBMS have the potential to contribute to the transformation of Dutch urban mobility too, by integrating with and extending travel by sustainable modes, especially cycling, and substituting travel by less sustainable modes. The seeming paradox of CBMS's limited uptake in a country regarded as a cycling paradise points to the significance of factors beyond the strictly technological in determining the course of mobility transformations. Scholars of transformation in major socio-technical systems, such as urban mobility, argue that realising the potential of innovations like CBMS requires a long-term, complex and uncertain process of fundamental change (Geels 2012). This change requires the co-evolution of technological and social elements, such as actors and institutions, and is itself shaped by the context of the Netherlands.

Urban mobility in the Netherlands is characterised by the dominance of the system of automobility (Urry 2004), as seen in measures such as passenger-kilometres travelled and national modal share, as well as a well-developed public transport system and cycling system (Turnheim et al. 2015). Amsterdam is an example of how, compared with the European norm, Dutch cities have developed into "socio-spatial niches" (Geels 2012) for cycling, as reflected in cycling's large and growing modal share, its cohesive and extensive supporting infrastructure, and its stable and significant position in governance structures and budgets (Pucher and Buehler 2008). As global interest in sustainable urban mobility has grown, the cities of the Netherlands have become a focus for mobility scholars and policymakers interested in observing one of a limited set of examples of a successful (ongoing) transition away from car dominance (Pojani and Stead 2015; Pucher and Buehler 2017).

Cycling innovations – both social and technological - have played a key role in the development of Dutch cycling, from successful framing struggles by radical activists of the 1970s (Ploeger and Oldenziel 2020) to the eventual breakthrough of the rail-integrated *OV-fiets* bike-hire scheme in the 2010s (Villwock-Witte and van Grol 2015). More recently, Dutch manufacturers have been at the forefront of e-bike development, while entrepreneurs have also found rapid success by offering conventional bicycles in a commercially novel way with *Swapfiets*, a budget lease bike. Some innovations have proven controversial, as in the case of dockless bikeshare services that entered Dutch cities rapidly in the summers of 2016 and 2017. These services faced commercial barriers, a struggle for public acceptance, and an eventual regulatory backlash in Amsterdam and other cities (Petzer et al. 2019). While dockless bikeshare services have been associated with controversy in multiple cities, dock-based bikeshare has also largely failed to develop in the Netherlands outside of the OV-fiets bike-hire system, which has evolved to serve a partly overlapping use case. This failure by dockless and dock-based bikeshare to achieve success in a highly supportive cycling context makes for an interesting contrast with the opposition they face in low-cycling contexts, which often takes the form of resistance to cycling in general (Fishman 2016; Hirsch et al. 2019). Indeed, where bikeshare has been subsidised or sanctioned by city governments, such as in London or Paris, this has typically been justified as an investment in the normalisation or mainstreaming of cycling (Goodman et al. 2014).

The question of why particular cycling-based mobility services have largely failed to scale up or sustain themselves in the Netherlands is interesting in a number of dimensions. In practical terms, the means by which CBMS could deliver on its hitherto unrealised potential may be of interest to policymakers locally and internationally. The Netherlands, where mobility expertise is a growing export industry, offers a unique testbed for the assessment of CBMS in a diversity of roles: as a substitute for the private bicycle, as an extension of the public transport or automobility regime (Park & Bike or last mile transport), and as a stand-alone mode for short urban trips. These diverse roles appear to account for the heterogeneity within Dutch CBMS, in terms of variations on the bicycle itself, as well as supporting technologies (geolocation, remote locking), service offerings to users, institutional arrangements, relationships with other mobility providers, and longevity in operation. This proliferation of social and technical variants in Dutch CBMS thus makes for an instructive empirical comparison with the forms taken by CBMS elsewhere.

In theoretical terms, the differences between individual CBMS may reveal tensions internal to the Dutch cycling regime. For example, the storage of commercially-owned shared bikes on public land, in a manner similar to the established practice for privately-owned bikes, has proven controversial.

City regulations on public space outlaw it, technically excluding dockless bikeshare providers (Petzer et al. 2019). This difference between shared bicycles and those owned by individuals reveals a systemic advantage that 'locks in' access to a key resource for a particular group of bicycle users. This lock-in mechanism has become highly institutionalised through decades of contestation by the Dutch automobility and cycling regimes, among many other stakeholders (Turnheim et al. 2015; Albert de la Bruhèze and Oldenziel 2016). The strength of this institutionalisation is reflected in the lengths to which dockless bikeshare providers have gone to circumvent it by modifying their business practices and the technical and operational aspects of their services.

The mixed performance of these deliberate variations among CBMS providers may in turn reveal dynamics at work between the cycling regime and other mobility regimes, such as automobility, but also between urban stakeholders from outside the mobility system. For example, the barrier faced by dockless bikeshare providers in accessing public land does not exist for car share providers, who have access to the existing market for paid (automobile) parking (Shaheen et al. 2019). In cities like Amsterdam, where public space is perceived as scarce, disparities in the allocation of space to various urban uses may produce uneven competition for this resource, suggesting that multiple 'lock in' mechanisms are at work. The differences between these mechanisms may be particularly revealing given the uniqueness of Dutch cycling as a national mass transport regime with no close comparators. This dynamic could, in turn, open up new approaches to the governance of sustainability transformations that take resource allocations as an organising framework.

This thesis addresses these problems by answering the research question, *Which dynamics have most influenced the form, performance and prospects of CaaS in the cities of the Netherlands?*

1.2 Research Design - Theoretical Concepts

This thesis uses sustainability transitions studies as a primary analytical framework for understanding CBMS in the Netherlands as a set of promising mobility innovations that have not realised their potential despite an ostensibly supportive context. As a transdisciplinary field that draws on science and technology studies, evolutionary economics, and sociology (Kemp et al. 1998; Geels 2002), transitions research is well suited to the analysis of the interrelated social and technological dimensions of CBMS within the exceptional mobility context of Dutch cities. Yet there are certain empirical aspects of CBMS that appear to limit the applicability of existing transitions concepts. Many of these are connected to the dynamics of urban open space as a finite physical resource contested by many claimants, and the form of lock-in constituted by the ways in which this finite resource is institutionalised in favour of particular socio-technical configurations over others.

Lock-in has been defined as increasing returns to the adoption of a technology that advantages incumbent technologies at the expense of novel technologies and typically favours incremental over radical innovation (Unruh 2000). Lock-in is effected through mechanisms, such as scale economies, learning effects, adaptive expectations and network effects, that reinforce technological or institutional dependencies on established pathways (Unruh 2000). Studies of lock-in have mostly attended to lock-in of a particular (set of) technologies (Unruh 2000; Maassen 2012), although this 'technological lock-in' is sometimes coupled with 'institutional lock-in' (Corvellec et al. 2013; Driscoll 2014; Bauwens 2015; Wesseling and Van der Vooren 2017). However, these terms are commonly used to emphasise two dimensions of a single phenomenon, and are sometimes used interchangeably with "techno-institutional lock-in" (Unruh 2002; Könnölä et al. 2006; Corvellec et al. 2013). Outside of the mainstream focus on techno-institutional lock-in in transitions research, physical, spatial and material factors have sometimes been identified as lock-in mechanisms. For example, Driscoll (2014) finds that in long-term transport planning for city regions, decisions about where to locate development can lock-in certain types of transport demand that favour particular mobility modes, producing path dependency in a literal sense. Turnheim et al (2015) identify the sunk costs of infrastructure, and urban planning patterns that favour car commuting, as locking-in automobility in the Netherlands; they also find that cycling is locked in by its own comprehensive infrastructure network. Schippl and Truffer (2020) examine how spatial variations in physical settlement patterns create different selection environments, which lead to distinct technological trajectories that produce characteristically 'urban' or 'rural' mobility regimes.

In addition to factors explicitly characterised as causes of lock-in, scholars have identified a broader set of factors relating to space, scale, place and geography that shape transitions, and which contribute to path dependencies or serve to stabilise regimes (for example, by generating certain kinds of mobility demand that are best suited to particular modes - see Geels 2018). This growing literature has contributed concepts such as *location* and *spatial differentiation* (Bridge et al. 2013), (relative) *distance* and *proximity* (Raven et al. 2012), *relational proximity* and *place* (Murphy 2015), and *place-bound institutions*.

However, these accounts of spatial and physical aspects of lock-in show common limitations when applied to lock-in on urban space. Many of these correspond with limitations in the broader transitions literature in its attempts to conceptualise cities (and urban form, urban space, urban morphology, etc.) in relation to transitions.

Spatial and physical accounts of lock-in tend to focus on comparisons *between* cities, usually on a regional or national scale, paying relatively little attention to the space *within* the city (Nielsen and

Farrelly 2019). In the broader literature, this focus is grounded in an emphasis on the sites and scales of transitions (Raven et al. 2012), in which cities (but also resources, industries, infrastructures and institutions) are primarily analysed in terms of their relative location (such as their relative proximity or distance, their relative clustering or dispersal, or relative concentrations or scarcities). This relational approach to space, which draws on economic geography, characterises much of the scholarship on space and scale in transitions, and aligns well with the interpretivist assumption that reality (or space) becomes real as it is perceived and interpreted by actors (Coenen and Truffer 2012; Murphy 2015; Truffer et al. 2015). However, these relational accounts of space have less purchase inside the spaces of the city, where urban open space is entirely contained by private property boundaries, and liable to monopolisation by powerful interests. This relational emphasis further contributes to a tendency to treat the urban fabric or the built environment as a whole, without distinction between public and private space. While the built environment is generally characterised by obduracy, which creates inertia and path dependency (Hommels 2005), there is a significant difference between private property and public open space (including sidewalks, streets, roads and squares). Unlike private property, open space is subject to constant intervention through processes such as maintenance, upgrading, redesign and repurposing. This difference is epitomised by emergency measures undertaken in European cities during the Covid-19 pandemic, where streets were closed to car traffic almost overnight to make room for social distancing.

The significance of the particular spatial aspects of lock-in described here – that is, lock-in of the finite urban open space inside the city – is demonstrated by the empirical efforts and strategies that actors have deployed to counter (or impose) lock-in. Dockless bikeshare providers in Amsterdam reformulated their businesses and network designs in order to circumvent their dependence on public space for parking their fleets (Petzer et al. 2019). An Amsterdam dockless bikeshare provider released anonymised user statistics in a bid to 'prove' that these users were local residents and business visitors, not tourists (whose claims on open space had become contested) (Petzer et al. 2020). City governments in the Netherlands' five largest cities combined to restrict access to the sum of their urban open space to dockless bikeshare providers, unless and until the latter developed a self-funded mobility service platform that would enable interoperability between service providers (Petzer et al. in press). These forms of lock-in, and the strategies adopted to counter them, cannot be adequately articulated through existing accounts of lock-in within transitions research, and can only be described indirectly through existing conceptualisations of space within transitions. This limitation in existing conceptualisations of lock-in leaves four specific theoretical gaps between sustainability transitions research and the empirical challenges faced by CBMS in the Netherlands.

These gaps, and their corresponding empirical challenges, also point the way towards more detailed research sub-questions that will be explored in this thesis, and related research literatures.

Firstly, the material or physical dynamics of urban space appear to exert an influence across several empirical dimensions of CBMS, from the business models developed by CBMS providers to the kinds of advocacy and lobbying performed by CBMS proponents. Examples of these spatial dynamics include the contingent distribution of space into areas where some uses of space may be practiced to the exclusion of others, resulting in constructed abundances and scarcities, or what Nikolaeva (2017) has called 'mobility austerity' for certain modes and uses. These spatial dynamics affect multiple aspects of CBMS simultaneously, rather than constituting stand-alone lock-in mechanisms, as they have been conceptualised to date. This may explain the frequency with which scholars of mobility transitions relegate these dynamics to the landscape level, an exogeneous source of influences that affect systems holistically but lie beyond the control of niche and regime actors (Geels 2012). However, many aspects of urban space show an intense dynamism that reflects successful institutional and political work by actors (Rosenbloom 2018).

The empirical efforts of CBMS proponents to counter the many facets of a lock-in on space that they encounter in Dutch cities are suggestive of the scope of this lock-in. CBMS proponents have reconfigured their organisations around the lock-in on space by creating alternative commercial models, network designs, and product-service configurations. This innovation reflects an empirical regulatory distinction, in cities like Amsterdam, in which the legitimacy of a bicycle in public space depends on whether it is owned by an individual, or by certain kinds of commercial entity (such as dockless bikeshare providers). Business model research (Osterwalder 2004) can contribute valuable precision and detail to existing accounts of lock-in in a mid-range theoretical literature such as that of transitions research. It is therefore incorporated into SQ1, *How can the conceptual integration of business models and sustainability transitions research help to explain the case of CaaS in the Netherlands in 2016-2018?*

Secondly, the political and institutional work done by a subset of CBMS proponents to legitimise their presence in public space points to overarching narratives about the public realm, the commons, and society as an under-explored source of lock-in (Hermwille 2016). Rosenbloom (2018) has used narrative analysis to refine and operationalise the concept of framing struggles as an expression of contestation and competition between niche and regime actors in transitions terms. Because urban mobility, by definition, operates in public space, the symbolic aspects of the public realm and the commons are an inevitable and central component of urban sustainability transitions. The struggles of CBMS proponents to counter particular delegitimating narratives in mass media

through concerted effort reflects a strategy to counter lock-in that draws heavily on normative and ethical frameworks, such as Mobility Justice (Sheller 2018). This framework presents, inter alia, strategies for countering lock-in that mobilise the symbolic aspects of urban open space as representations of a social ideal or compact to 'lock out' less sustainable uses and mobility modes. In order to integrate this well-developed ethical framework into the less variegated accounts of lock-in within transitions research, SQ2 asks, *How can the conceptual integration of mobility justice tenets and socio-technical transitions research contribute novel perspectives on the legitimation efforts of niche actors?*

Thirdly, while the spatial dynamics of urban space can be discussed at the level of individual streets in a particular city, the regulatory mechanisms that govern the design of roads are premised on the creation of cohesive networks with routine profiles. This means that it is also possible to speak of road space in general and in the aggregate, and of allocations of space, or hierarchies of access to space, that are typical of entire cities and sub-national, national and supra-national territories. These mechanisms have been acknowledged as a source of lock-in by Mäkinen et al (2015), although within a model that associates single dominant mobility modes with urban form (that is, the entirety of the built environment, including land use). The resulting analysis obscures the competition that can exist between various combinations of mobility modes, and other actors, for urban open space within the same urban form (von Schönfeld and Bertolini 2017). Geels (2018) partly addresses this in his argument for a focus on the reconfiguration of whole systems within sustainable transitions research. Using transport as an example, Geels argues that, because transport is essentially a derived demand, non-transport regimes, such as modes of working or spatial planning patterns, have a differential influence on niches and regimes within the mobility system (2018). What these efforts lack is an account of not only the mechanisms that produce lock-in, but the influence of practices that counter lock-in through appropriation and occupation of space, which have been extremely influential in Dutch urban mobility transitions in particular (Emanuel 2016; Ploeger and Oldenziel 2020). To incorporate and enrich existing accounts of lock-in effected through regulation with these practices, SQ3 asks, *By what criteria are claims on urban space by the automobility and cycling modes judged, and how does this affect urban transitions towards sustainable mobility?*

Fourthly, empirical challenges faced by CBMS actors suggest that the overarching logic by which mobility actors' claims on public space are governed, is that of vehicle type. In other words, the allocation of urban open space (for mobility) is governed on the basis of a typology of artefacts: paying for a car parking space in Amsterdam does not provide a user with exclusive access to that space for any purpose *other than the storage of an automobile*. This suggests that access to urban

open space is institutionally 'locked in' as a function of specific technology classifications, illustrating Unruh's observation that public institutions can become locked-in to *techno-institutional complexes* (2000). While Unruh's conceptualisation captures an important aspect of the challenge faced by CBMS, it does not recognise that this lock-in equates to a lock-out in two ways once space is understood as physical and finite. Namely, vehicles that belong to subaltern mobility modes face a higher level of competition for relatively scarcer allocation of space, and new, hybrid vehicles that do not unambiguously belong to established categories face a higher regulatory burden. This form of lock-in is illustrated empirically by the challenges of integrating CBMS into mobility service platforms alongside other modes. The resulting disparity in how modes access space is a key aspect of urban transitions that receives little attention within transitions literature, but connects to an established stream of business model research into the tensions between the commons and the market (Cohen and Kietzmann 2014; Bocken et al. 2014). Of particular theoretical interest is the institutional entrepreneurship that governments have shown in supporting, driving and in some cases imposing forms of collaboration on mobility actors that bring into being platforms which can potentially counter important forms of lock-in (Sarasini and Linder 2017; Hirschhorn et al. 2019). This leads to sub-question 4, *What are the existing challenges in creating MaaS platforms that integrate multiple bikeshare providers, and how could CBMs contribute to overcoming these?*

Taken together, these factors amount to a complex and prominent empirical role for the institutionalisation of urban open space as a kind of lock-in that creates differential access to a finite resource for different types of vehicle, and also transcends individual socio-technical systems by imposing a zero-sum allocation on all claimants to urban space. While the physical dynamics of urban space remain a marginal concern within transitions research, they appear to be a key empirical determinant of the success or failure of CBMS in the Netherlands. Consequently, transitions research may benefit from a more precise conceptualisation of the role that these dynamics can play in certain kinds of transition. More broadly, such a conceptualisation could be applied to a growing number of shared mobility and micromobility modes that have appeared in urban open space within the past decade. These modes include stable artefacts, such as the traditional skateboard or push scooter, and novel (usually motorised) versions thereof; they also include a plethora of hybrids, putting pressure on a traditional governance system defined by an established typology of vehicles. A proliferation of schemes that provide these modes on a shared or usership basis necessitates their storage, usually unattended, in publicly accessible places, placing increasing pressure on a governance system that has long legitimised storage of goods on public land as long as they are owned by private persons. The research questions and sub-questions set out above are presented in Table 1.

Table 1: Research question and sub-questions (SQs)

RQ	*Which dynamics have most influenced the form, performance and prospects of CaaS in the cities of the Netherlands?*
SQ1	How can the conceptual integration of business models and sustainability transitions research help to explain the case of CBMS in the Netherlands in 2016-2018?
SQ2	How can the conceptual integration of mobility justice tenets and socio-technical transitions research contribute novel perspectives on the legitimation efforts of niche actors?
SQ3	By what criteria are claims on urban space by the automobility and cycling modes judged, and how does this affect urban transitions towards sustainable mobility?
SQ4	What are the existing challenges in creating MaaS platforms that integrate multiple bikeshare providers, and how could CBMs contribute to overcoming these?

1.3 Research Design - Methods

Ontology

This thesis is embedded within, and seeks to contribute to, the theoretical literature known as sustainability transitions research, or socio-technical transitions research (hereafter 'transitions research')[1]. As such, it partly subscribes to the ontological position(s) that underpin(s) transitions research, but also includes perspectives from critical realism (Svensson and Nikoleris 2018; Sorrell 2018) and the structuralist ontology prominent in critical urbanism (Nielsen and Farrelly 2019).

Transitions research has its origins in efforts to better understand socio-technical transformations by incorporating evolutionary economics (especially notions of variation, selection and retention) and social-scientific approaches to technology, primarily sociology of technology and STS (Kemp et al. 1998). In ontological terms, the positivist orientation of evolutionary economics (as reflected in phenomena such as behavioural learning) has been partially integrated with the interpretivist-constructivist ontology of STS (as reflected in phenomena such as social enactment, sense-making, and cognitive learning) in what Geels calls an 'ontological crossover' (2010b). As the term 'crossover' implies, it is difficult to speak of a single ontology underpinning transitions research, even within its flagship theoretical framework, the Multi-Level Perspective (MLP). However, the degree of

[1] The question of what distinguishes sustainability transitions research from socio-technical transitions research is beyond the scope of this thesis, but this distinction is also very fluid in practice (Wieczorek and Berkhout 2009); as such, the two terms are used interchangeably here.

alignment between ontologies enables a critique of the field, and the MLP, in terms of its limitations in two related areas – namely, conceptualising the city and space in transitions research.

A key aspect of the constructivist-interpretivist ontology as it has developed in transitions research is its assumption that reality is reducible to the intersubjective interpretations of actors. For example, while technological artefacts have been central to regimes, transitions theorists hold that these regimes are constituted by a semi-coherent set of intersubjective, intangible rules that guide the behaviour of different actors. These ontological positions have been implicated directly and indirectly in criticism of transitions research and the MLP.

Directly, scholars from the critical realist tradition (Bhaskar 2013) have argued that transitions research's emphasis on human actors significantly limits its ability to give due weight to the causal powers of non-human entities, including long-lived human-made entities, such as the built environment. As a result, the physical constraints imposed on transitions by these entities, which may constitute a powerful source of inertia or lock-in, have not been incorporated on an equal basis into debates on agency, power and structure. This problem is likely to be acute in any study of cycling, where the contrast between its social construction (sustainable, legally permitted on almost all roads) and material obstruction (due to a car-dominated urban open space) is pronounced.

This thesis therefore productively contrasts some assumptions embedded within transitions research, such as the notion that structure is intersubjective and internal to (human) actors, with notions drawn from critical realist ontology, in which structure is objective and external to actors (Sorrell 2018). As these notions have already begun to be integrated into transitions scholarship, this thesis takes them as a point of departure (Svensson and Nikoleris 2018). The latter ontology corresponds closely with the pragmatic orientation to physical constraints that characterises urban disciplines, where the materiality and obduracy of the built environment are both a practical reality and a shared philosophical point of departure (Amin 2008; Gehl 2011).

The use of a critical realist account of structure to illustrate potential sources of lock-in in material and spatial aspects of urban transitions offers a partial remedy to the indirect or implicit critique of transitions ontologies by scholars of space, scale, place and the geography of transitions (Coenen and Truffer 2012; Raven et al. 2012; Murphy 2015; Truffer et al. 2015). These scholars share with critical realists a call for engagement with spatial aspects of transitions, although until recently, their interpretation of 'spatial' has arguably been relational, that is, understood as a social construct produced by human actors. Contrasting mainstream accounts of structure in transitions research with those derived from critical realism may also serve to better integrate urban transitions research with the more empirically-focused urban planning literature, which is characterised by a great

theoretical, ontological and epistemological diversity (Walker 2015). However, this theoretical heterogeneity has not impeded urban planning in articulating the oppositional, conflictual nature of urban space. The notion that providing space for some urban uses inherently constitutes an exclusion of others is arguably foundational to urban planning as a discipline (von Schönfeld and Bertolini 2017), independent of internal ontological differences.

Approach

Building on the ontological position discussed above, this thesis adopts the case study approach, a method that is closely aligned with constructivism-interpretivism in epistemological terms. Case studies emphasise the deep understanding of particularity as a data source. They are widely used in transitions research as a means of studying complex phenomena involving many actors, groups and artefacts over time (Yin 2014), especially with regard to the analysis of interpretive processes internal to actors or to groups, such as (collective) sense-making.

In this thesis, the primary case of CBMS in the Netherlands was chosen for the unique characteristics of the high-cycling Dutch mobility system in comparison with almost all other high-income, mass-motorised societies (Harms et al. 2014). Due to the success of cycling-based mobility services such as bikeshare outside the Netherlands, additional, secondary cases were analysed as what Bryman (2012, p. 70) terms *exemplifying* cases (which typify the global norm) in comparison with the Netherlands as a *critical* (or unique) case. Comparative case studies are increasingly used in sustainable mobility research due to their capacity for contextualising the typically tangled and cross-sectoral issues relevant to mobilities research (Klímová and Pinho 2020). The task of better understanding CaaS in the Netherlands in the late 2010s lent itself to these two approaches for a number of reasons. Firstly, the start of research coincided with a natural experiment in at least three areas: the influential, incumbent *OV-fiets* system entered a period of rapid growth after subscription fees were cut to zero; a dockless bikeshare 'boom' began as many providers entered Dutch cities rapidly and at scale; and a new model of lease bike (Swapfiets™) emerged and quickly reached exponential levels of growth. The large scale of cycling in the Netherlands and the rapid pace of change in these areas justified a case study of CaaS in one country, with specific focus on Amsterdam, a large cycling market within the country, and an emblematic and highly symbolic cycling market internationally (Feddes and de Lange 2019). The choice of exemplifying cases was deliberately limited to cities comparable to those of the Netherlands in income, climate, population density and (at least up to the Second World War) a robust history of cycling. Within this set, empirical developments guided the choice of case. Birmingham and Brussels were chosen for comparison with Amsterdam in Chapter 4 due to their ambitious, recent, explicit commitment to a

reallocation of space between mobility modes and urban space uses. Antwerp and Helsinki were chosen for comparison with a pan-Netherlands mobility service platform due to these cities' marked emphasis on developing public sector-led mobility service platforms.

Data Collection

In terms of data collection, this thesis draws on a wide variety of sources, such as policy documents issued by local government, websites of CBMS providers, current and archived press articles, and interviews. Across the thesis, data collection focused on two key sets of actors, namely CaaS providers and local governments, primarily in the Netherlands but including cases in the UK, Belgium and Finland. For CBMS providers, the objective of business model mapping was achieved by extracting relevant information from corporate grey literature on websites, public presentations and expert meetings (such as those hosted by the CROW), as well as press sources, interviews, and informal action research (all available Dutch services were tested by the author). For local governments, published policies were important as a record of public commitments and stated aims, supplemented by interviews with officials responsible for regulating CaaS, public space allocation, or mobility services platforms. Further, limited use was made of publicly-available GIS data, mostly for illustrative purposes. In order to situate framing struggles undertaken by dockless bikeshare providers within Dutch discourse surrounding shared bicycles (deelfiets*), 421 Dutch-language press articles were retrieved from the Nexis Uni® Krantenbank, a digital archive of the past 30 years of Dutch-language print and online media. Across all phases of the thesis, semi-structured interviews were used to gather comparable data on known issues while creating an opportunity for respondents to introduce new ones (Creswell and Poth 2018). Lastly, the author participated in the Dutch and Belgian CBMS community through regular attendance at meetings, conferences, workshops, symposia and activist manifestations in person and (in 2020) online (see Addenda); this process yielded informal contacts and exposure to this community's internal discourse(s).

Data Analysis

In terms of data analysis methods, this thesis relies primarily on descriptive qualitative content analysis, including narrative analysis and policy content analysis, as well as business model mapping. In qualitative content analysis, the content of a textual source is closely reviewed to identify relevant or emergent patterns by means of (usually iterative) coding of text segments. In this thesis, coding was conducted iteratively using NVivo™, and initial codes were subjected to thematic analysis in order to construct code hierarchies (Bryman 2012). As thematic analysis remains vulnerable to critique on grounds of methodological consistency and transparency, tables have been provided in the Addenda presenting code frequency across data sources, informed by the Framework matrix for

thematic analysis (Ritchie et al. 2013). Narrative analysis has been used in transitions research to examine "the immediate effects of the use of language in political debate", with an emphasis on what narratives or stories do or achieve as public speech acts, rather than what they mean or presuppose (Hermwille 2016). It is therefore well suited to the analysis of framing struggles undertaken in mass media or other public fora, and is increasingly used in sustainability research (Westerhoff and Robinson 2013; Moezzi et al. 2017; Mc Nally 2018). Business model mapping was used to organise data collected through content analysis of grey (especially) corporate literature, press articles and interviews in terms of Osterwalder's Business Model Canvas (2004).

In the following section, Tables 2, 3, 4 and 5 provide an overview of methods of data collection and analysis, and a summary of data sources for chapters 2, 3, 4 and 5, respectively.

1.4 Thesis Outline

The outline of this thesis consists of four chapters, each corresponding with a thesis sub-question and a related academic text, either published, submitted or in press.

Chapter 2 addresses sub-question 1 and surveys the many providers that form part of the Cycling-as-a-Service offering in the Netherlands, and maps their business models. Business models and socio-technical transitions perspectives are brought to bear on these providers to produce a 2x2 matrix that contrasts the strategies they use to enter the CaaS market. A key question that emerges from this research is the regulatory barriers surrounding the public realm, and how they affect different CaaS providers differently, depending on their business model and choice of technology.

Chapter 3 addresses sub-question 2, and focuses on the legitimacy of one set of CaaS providers in public discourse. This chapter applies narrative analysis to a multi-year sample of Dutch-language print and online media to distil dominant narratives and counter-narratives relating to dockless bikeshare providers in the Netherlands. These findings are combined with a narrative analysis framework developed within transitions research that attends to how groups of actors use (de)legitimating storylines to success in framing struggles around novel technologies. This framework is in turn analysed from the perspective of Mobility Justice scholarship.

Chapter 4 focuses explicitly on the question of how open urban space is allocated over time, not only between mobility modes, but between mobility and other urban uses. It contrasts how space is allocated in the city of Amsterdam, which is presented as a socio-spatial niche, with Brussels and Birmingham, concentrating on space for bicycles and automobiles. The paper introduces and develops the 'legal street' framework, which is a conceptualisation of physical urban open space designed to foreground its finitude in urban planning, and connect these binding physical constraints

with the insights on niche-regime struggles provided by transitions research. This chapter seeks to combine consensus positions in modern urban planning, such as that surrounding the necessity of space reallocation *away* from automobility, with transitions perspectives in which place and space have only emerged as key considerations relatively recently.

Chapter 5 returns to the theme of business models to analyse recent attempts in the Netherlands, Helsinki and Antwerp to create MaaS platforms that include bikeshare, with varying degrees of public-sector support or coercive pressure. This support or pressure, and its consequences for the design of business models and MaaS platforms, is contrasted with an inductive, exploratory review of the concept of 'collaborative business models' as it appears in peer-reviewed scientific texts. In so doing, the chapter revisits the theme of a regulatory divide between automobility and cycling, and how the resources they require are institutionalised and governed.

Table 5 below provides a general outline of the chapters of this thesis derived from published research. Each table provides an overview of a corresponding chapter's research sub-question, key theoretical concepts[2], and data sources, as well as of methods of data collection and analysis. Table 6 provides an overview of the publication status of each chapter, and Table 7 provides an overview of author contributions to the phases of each chapter.

[2] Abbreviations for broad theoretical areas, citing key works: BM – Business Model research (Osterwalder 2004); ST/MLP – Socio-Technical Transitions Research/Multi-Level Perspective (Geels 2002); NM – New Mobilities studies (Sheller and Urry 2016); UP – urban planning and urban planning history (Prytherch 2018); CS – cycling studies, referring to qualitative or social science approaches to the study of utility cycling/cycling for transport (Oldenziel et al. 2016).

Table 2: Overview of SQs, theoretical concepts, data collection and analysis – Chapter 2

Chapter and Theme	Sub-question		Theoretical Concepts
Chapter **2**: Cycling-as-a-Service in theory and practice	**SQ1:** How can the conceptual integration of business models and sustainability transitions research help to explain the case of CBMS in the Netherlands in 2016-2018?		• Cycling-as-a-Service (CS) • Interplay between technology strategies and business models within niches (ST)
	Data Collection	**Data Sources**	**Data Analysis**
	Literature review	Scopus and LexisNexis search for 'deelfiets' articles in Dutch	Informal literature review
	Interviews with CaaS providers	**12** total interviews	Business model mapping
	Web search for grey literature	Websites of CBMS actors	Descriptive content analysis

Table 3: Overview of SQs, theoretical concepts, data collection and analysis – Chapter 3

Chapter and Theme	Sub-question		Theoretical Concepts
Chapter **3**: dockless bikeshare discourse in Amsterdam	**SQ2:** How can the conceptual integration of mobility justice tenets and socio-technical transitions research contribute novel perspectives on the legitimation efforts of niche actors?		• Mobility Justice (Sheller 2018) (NM) • Framing struggles within MLP niches (ST) • Mobility Commons (NM)
	Data Collection	**Data Sources**	**Data Analysis**
	Literature review	Primarily Mobility Justice (Sheller 2018) and related literatures, as well as Rosenbloom et al (2016; 2018) on MDDI	Descriptive content analysis
	Dutch news articles via Nexis Uni® Krantenbank	421 initial results for 'deelfiets', refined to 97 results for coding	Narrative analysis and coding using NVivo™
	Coding and literature review results		Multi-Dimensional Discursive Interactions analysis

Table 4: Overview of SQs, theoretical concepts, data collection and analysis – Chapter 4

Chapter and Theme	Sub-question		Theoretical Concepts
Chapter **4**: The 'legal street' as a framework for urban space reallocation	**SQ3:** By what criteria are claims on urban space by the automobility and cycling modes judged, and how does this affect urban transitions towards sustainable mobility?		• Mobility Commons (NM) • Physical resources, space and place within socio-technical transitions (ST) • Space reallocation struggles within urban planning (UP/CS)
	Data Collection	**Data Sources**	**Data Analysis**
	Literature review	Snowball sample of urban space literature from multiple urban disciplines and from transitions literature	Descriptive policy content analysis Deductive coding Comparative case study
	Interviews with city officials responsible for space allocation	Transcripts of interviews	
	Framework verification by experts	Interviews and verbal feedback	
	Web search for grey literature	See Table *16*	

Table 5: Overview of SQs, theoretical concepts, data collection and analysis – Chapter 5

Chapter and Theme	Sub-question		Theoretical Concepts
Chapter **5**: Collaborative business models, bikeshare, and MaaS platforms	**SQ4:** What are the existing challenges in creating MaaS platforms that integrate multiple bikeshare providers, and how could CBMs contribute to overcoming these?		• Collaborative Business Models (BM) • Mobility Service Platforms (ST) • Public resources and platform mobility (NM/UP)
	Data Collection	**Data Sources**	**Data Analysis**
	Literature review	Systematic review of literature from multiple disciplines on 'collaborative business models' retrieved via Scopus	Inductive coding Business model mapping
	Interviews with mobility platform designers	Transcripts	Business model mapping Descriptive policy content analysis Comparative case study
	Web search for grey literature	City policies and reports – see Section 5.6.2.	

Table 6: Overview of chapter publication status

Chapter 2	published as	Petzer BJM, Wieczorek AJ, Verbong GPJ. 2020. Cycling as a service assessed from a combined business-model and transitions perspective. *Environmental Innovation and Societal Transitions* 36: 255-269. https://doi.org/10.1016/j.eist.2019.09.001.
Chapter 3	published as	Petzer, BJM, Wieczorek AJ, and Verbong GPJ. 2020. Dockless bikeshare in Amsterdam: a mobility justice perspective on niche framing struggles. *Applied Mobilities*: 1-19. https://doi.org/10.1080/23800127.2020.1794305.
Chapter 4	in press (01/2021)	Petzer, BJM, Wieczorek AJ, and Verbong GPJ. The legal street: a scarcity approach to urban open space in mobility transitions. *Urban Transformations*.
Chapter 5	in press (01/2021)	Petzer, BJM, Wieczorek AJ, and Verbong GPJ. "Collaborative business models and platforms in shared mobility transitions: the case of bikeshare integration" *in* Aagard A, Lüdeke-Freund F, Wells P (eds). 2021. Business Models for Sustainability Transformation. Palgrave MacMillan: London.

Table 7: Overview of author contributions, according to Contributor Roles Taxonomy (CRediT)[3]

	Conceptualisation	Investigation and Data Collection	Formal Analysis	Writing – Original Draft	Writing – Review & Editing
Chapter 1	BP, AW, GV, HJ	-	-	BP	BP, AW, GV
Chapter 2	BP, AW, GV, HJ	BP	BP	BP	BP, AW, GV
Chapter 3	BP, AW, GV	BP	BP	BP	BP, AW, GV
Chapter 4	BP, AW, GV, RO, MtB	BP	BP	BP	BP, AW, GV
Chapter 5	BP, AW, GV	BP	BP	BP	BP, AW, GV
Chapter 6+7	BP, AW, GV	-	-	BP	BP, AW, GV

[3] Author names are in order of relative contribution. Brett Petzer = BP, Anna Wieczorek = AW, Geert Verbong = GV, Hans Jeekel = HJ, Ruth Oldenziel = RO, Marco te Brömmelstroet = MtB

2 Cycling-as-a-Service assessed from a combined business-model and transitions perspective

Abstract: Cycling-based mobility services or 'Cycling as a Service' (CaaS) have recently expanded in number and scale in the Netherlands. In contrast to the contexts of most other CaaS studies to date, cycling has a high modal share and strong institutions in the Dutch context. However, these supportive features have not translated into straightforward success for CaaS providers. Instead, responses to CaaS providers have varied widely, from tolerance to opposition. In this study we employ a combined business model and transition perspective to investigate this variation and its implications for CaaS in Dutch urban mobility systems. We present value propositions derived from business models, and integrate these into Hoogma's fit-and-stretch strategy framework for emerging niches. This enables a comparison between technology design and value propositions, and an analysis of the CaaS niche's transitions potential. Our findings clarify the strategies used by niche actors to enter and operate within established cycling regimes.

2.1 Introduction

Cycling as a Service (CaaS), referring to services such as bikeshare that provide users with temporary access to a bicycle, has been promoted around the world as a low-carbon form of urban mobility that is cost, energy and space-efficient. Considering that transport's share of global carbon emissions is at 23% and rising, CaaS's potential to combat climate change on an urbanising planet is significant (World Bank 2017). However, despite the Netherlands' strengths as a leading cycling nation with a long history of cycling innovation, Dutch cities have lagged behind their developed-world counterparts in their adoption of city-wide public bikeshare systems, which have long been the face of CaaS elsewhere (van Goeverden and Godefrooij 2010; Alpkokin 2012; KiM 2016a). In many cities, the promotion of these systems, often with public subsidy or incentives, has been intended to pioneer a mainstream, everyday cycling culture (Goodman et al. 2014). In Dutch cities, in contrast, a mainstream cycling culture already exists, along with a supportive legal environment and physical infrastructure (KiM 2016b; Fishman 2016). However, despite these favourable conditions, CaaS in the Netherlands has until recently been largely limited to the rail station-based *OV-Fiets*[4] bike hire system.

[4] OV-Fiets is an example of a back-to-one (B21) system, meaning that rides should terminate at the same docking station at which they started. Back-to-many (B2M) systems allow the user to terminate a ride somewhere other than the starting point. Although OV-Fiets does technically permit B2M usage, a penalty equivalent to more than 2 times the cost of a ride is levied for this.

It was only in the period 2015-2017 that CaaS operators began to enter the Dutch urban mobility market *en masse* (van Waes et al. 2018). This period provides an instructive case of an innovation that has largely developed and matured in historically low-cycling contexts, interacting with a mature and socially embedded cycling context. The Dutch case also makes for a compelling study of CaaS operators' strategic responses to this environment. Understanding why CaaS lagged in its introduction to the Netherlands, and why individual CaaS operators met with varying levels of opposition from other actors, may yield a more nuanced understanding of its prospects in the future of Dutch urban mobility. These prospects are particularly important in light of the country's stated aim to further raise cycling levels and improve the integration of cycling with other mobility modes, in pursuit of a sustainable mobility transition (Bertolini et al. 2015; KiM 2018). These observations may also contribute to theoretical conceptions of how firms bring shared mobility innovations to specific markets (Manders et al. 2018) by creating and capturing value for various stakeholders. Business models are one unit of analysis that can help analyse and compare CaaS firms, as well as how they interact with other, more established incumbent actors, and shape outcomes that affect other firms.

The variations among CaaS business models in the context of ongoing urban mobility transitions are only beginning to be conceptually unpacked. Van Waes et al. (2018) address the case of CaaS in the Netherlands, using a co-evolutionary approach to industry emergence to determine the upscaling potential of various CaaS business models. Other, more general studies of CaaS in the Netherlands include Van Zessen (2017), who analysed the spatial effects of bikeshare and its potential for integration into urban public transport systems in order to project various pathways for CaaS development in the Netherlands. Outside of the Netherlands, the business models of CaaS providers, as well as other shared mobility services, have been investigated by Cohen and Kietzmann (2014) who focus on the relationship between mobility service providers and local government.

Scholars have also considered CaaS in terms of the role it might play in a wide-ranging and deep-seated transition towards more sustainable, lower-carbon forms of urban mobility. CaaS, mostly in the form of bikeshare, has been analysed from a sustainability governance perspective in London (Akyelken et al., 2018) while Spinney and Lin (2018) offer a critique of the transformational potential of dockless bikeshare systems in Shanghai.

From a theoretical perspective, the nexus between business models and transitions research has been explored in generic terms (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013; Evans et al., 2017; Schaltegger et al., 2016) and, more specifically, in connection with sustainable mobility (Hildermeier and Villareal, 2014; Abdelkafi et al., 2013; Wells, 2013) and shared mobility (Castillo-

Manzano et al., 2016; Cohen and Kietzmann, 2014; Lan et al., 2017; Sarasini and Linder, 2017). Such a conceptual integration can help transitions scholars with a more detailed understanding of the mechanisms by which firms can influence innovation processes (Boons and Lüdeke-Freund 2013). For business model researchers, transition approaches allow for a more robust account of the macro context in which organisations operate, including the potential of internal business model decisions to influence this macro context and, in turn, affect the firm internally (Wirtz et al. 2016).

However, despite sustained calls for further conceptual integration between the two fields, this literature is at an early stage, and is largely characterised by single case studies (Schaltegger et al. 2016; Wainstein and Bumpus 2016; Huijben et al. 2016; Bolton and Hannon 2016; Sarasini and Linder 2017). With few exceptions (see the work of Bidmon and Knab 2018, 2014, 2017), it does not yet provide an integrated lens that can elucidate key questions arising from cases such as CaaS in the mature cycling context of the Netherlands. These include the actual strategies and means used by organisations to bring such an innovation to market, and how these strategies can be accounted for in transitions terms; or the potential effects of an organisation's business model on its environment. While the empirical field of energy offers some work in this area[5], it has not yet been shown to what extent these insights are applicable to mobility services, given their distinct relationship with finite, enabling resources such as public space, and with the conventional bicycle's unique status as a 'new-old' technology[6] (Bijker 1997; Vivanco 2013). In this article, we attempt to address this gap by means of the following research question: *How can the conceptual integration of business models and sustainability transitions research help to explain the case of CaaS in the Netherlands in 2016-2018?*

In this paper, we combine insights from transitions and business models to create an analytical framework that will help to address this question and contribute to the discussion underway in this journal (e.g. Sarasini and Linder 2017).The paper is composed of seven sections. Following this introduction, section 2.2 presents our theoretical framework. In section 2.3 we set out our methods, while our case is described in section 2.4. Sections 2.5 and 2.6 respectively present and discuss the results obtained. In section 2.7 we conclude and offer recommendations for further research.

[5] For example, Bolton & Hannon (2016) contrasted the transitions research approach with two other systems views in analysing energy industry business models in the UK. Huijben et al. (2016) focused on fit-and-conform and stretch-and-transform strategies used by energy firms to contend with regulatory regimes. Wainstein & Bumpus (2016) investigated lock-in in the decarbonising of electrical power systems, concluding that business models can be drivers of transitions irrespective of technology.

[6] This refers to the safety bicycle's fundamental technological stability between the late 19th century and the present, which Bijker (1997) presented as a key example of technology stabilisation and closure.

2.2 Analytical Framework

In the context of mobility, Geels (2012) defined a socio-technical transition as a major shift in the configuration of elements that make up the mobility system, including technology, policy, markets, consumer practices, and infrastructure. Socio-technical transitions approaches offers a powerful lens to study the emergence and development of radical and incremental innovations within stable socially-embedded technical systems, and how they produce or prevent fundamental change (Geels 2002; Wieczorek and Berkhout 2009), including in the field of urban mobility (Geels 2012; Berger et al. 2014). Transitions research draws on evolutionary theory and constructivism from the field of science and technology studies, inter alia, to describe the variation, selection and retention of innovations, and the role played by creative and heterogeneous actors in interpreting and applying rules, albeit within constraints (Giddens 1984; Geels 2010b). The Multi-Level Perspective (MLP) (Geels 2012) has been developed within this approach to represent three analytical levels of increasing structuration (Giddens 1984). These are the niche, a protected space within which radical innovation occurs; the regime, a dynamically stable alignment of established practices and rules; and the landscape, an exogenous source of influences outside the short-term control of actors in the system (Geels 2012). Within these structuration levels, innovation trajectories result from social interactions subject to semi-coherent rule structures; between these levels, radical innovations at niche level ultimately interact with selection environments at the regime and landscape levels (Geels 2010b). However, the creation of 'fit' between niche variations, such as CaaS, and selection environments, such as urban mobility in the Netherlands, is an enacted and multi-dimensional process that depends on social and other dimensions as well as markets and regulations. Hoogma (2002), referring to initial stages of niche development, considers this 'fit' to be the outcome of a form of strategy that emerges from the interaction between the deliberate strategies of individual niche actors to promote their innovations, and the emergent strategies resulting from the mediating and constraining dynamics of the selection environment, as well as the unrealised strategies (Mintzberg et al. 1998) which are discarded before implementation.

The strategies used by individual organisations for initial entry into selection environments, or markets, are also a key concern in business model research (Casadesus-Masanell and Ricart 2010; Teece 2010). In the CaaS field much innovation is provided by private firms, meaning that business models, which address focal firms and their networks, are an essential analytical frame for understanding the transitions potential of CaaS in the Dutch context. While 'strategies' are defined in a number of different ways in both transitions and business model research, we argue that the commonalities in the interpretation of 'strategy' in Hoogma's framework and in aspects of business models are significant enough to enable direct comparison.

2.2.1 Socio-technical transitions and strategy

In socio-technical transitions approaches, actors in general "think strategically and try to further their interests" (Grin et al. 2010, p. 50); however, as meso-level theories, these approaches do not focus on the micro-dynamics of individual actors, and the determinants of their actions. Yet in recent years, scholars have called for closer attention to the critical role played by individual organisations in societal transitions, in pursuit of what Wells (2013) terms "more detailed causal mechanisms" for transitions theories (Boons and Lüdeke-Freund 2013; Bidmon and Knab 2018). In his development of structuration theory, a key influence on transitions research, Giddens (1984) had earlier recognised this need to integrate macro- and micro-phenomena to better account for the dynamics of structural change, and identified the concept of 'unintended consequences' as a bridge between the intentional actions of actors, and the unintended results of these actions within their context.

Mintzberg and Waters (1985, cited by Hoogma [2002]) use the concept of strategy, which they define as a "pattern in a stream of decisions", to differentiate between patterns of decisions mediated by context. According to Mintzberg et al (1998, p. 12), realised strategy equals deliberate strategy, minus unrealised strategy, plus emergent strategy. Realised strategy is thus the outcome of deliberate strategy, mediated and shaped by emergent strategy, minus unrealised strategies that are discarded or shelved before implementation.

The nature of the strategies used by niche actors to introduce novel technologies is described by Hoogma (2002, p. 15) in his heuristic model of initial niche development in the electrical vehicle industry. As such, Hoogma offers an analysis not of the deliberate strategies developed by actors before launching a product into the market, but of the realised strategies that result when an initial deliberate strategy combines with emergent strategies that respond to the dynamics of the niche, regime and landscape, and some strategies are blocked or discarded. Hoogma develops the concept of the fit between these strategies and the constraints of the existing regime, and differentiates between different dimensions on which innovations can be a better or worse fit with the regime. In this framework (Table 8), Hoogma concentrates on two strategically important articulation processes that occur in niche development. The first of these is the *technology choice and design* process, by which a technology is given form and articulated (including such factors as its optimal design and production method). The second is the process that establishes the innovation's targeted *use environment*, or the intended application domain for the technology (including such factors as how the innovation will be used and by whom, what infrastructures it will depend on and require, and how it will relate to the existing regulatory context). The use environment therefore approximates the innovation's projected value to users.

To these dimensions, Hoogma applies a typology of product strategies developed by firms, drawn from management literature and developed within the Strategic Niche Management literature, namely *fit-and-conform* and *stretch-and-transform* strategies (hereafter 'fit' and 'stretch' respectively) (since developed further by Raven et al. 2016). 'Fit' strategies seek to fit into and conform to existing mainstream practices within an unchanged selection environment. 'Stretch' strategies aim at the transformation of incumbent regimes through the development of new practices and institutions, thus changing the selection environment.

Table 8: Typology of introduction strategies for electric vehicles (Hoogma 2002)

Technology choice and design / **Use Environment**	**Fit & Conform**	**Stretch & Transform**
Fit & Conform	Selective Substitution	Leapfrog design for substitution
Stretch & Transform	Market differentiation	Exploration of a new regime

The comparison of two niche development processes (the two dimensions) and two strategies ('fit' and 'stretch') produces a 2x2 matrix in which the following four composite strategies appear:

Selective substitution: both the technology and use environment conform to the existing regime

Market differentiation: the technology remains close to the regime, while promoters target a use environment that differs significantly from the regime

Leapfrog design for substitution: the use environment remains close to the regime, while the technology develops into a substantially different form

Exploration of possible new regime: both technology and use environment depart significantly from the regime

This framework offers a nuanced perspective on niches at an early stage of development, such as CaaS in the Netherlands, where most firms have been operating for less than 3 years, and where the fundamental innovation offered by CaaS is not necessarily a technological novelty, but rather a novel form of access to an established technology.

2.2.2 Business models and strategy

The concept of the business model has been developed in fields such as strategic management and innovation management as a distinct unit of analysis that describes how organisations 'do business', centring on a focal organisation's activities but extending beyond them, to explain how they both create, deliver and capture value (Zott and Amit 2013). These functions can be conceptualised as the

value proposition, describing the value of the firm's offering to customers; value creation, detailing how value is actually produced and delivered; and value capture, or the means by which the firm transforms value into financial or other resources (Chesbrough and Rosenbloom 2002; Osterwalder 2004; Wainstein and Bumpus 2016). Business models are therefore also understood in both material and cognitive terms (Bidmon and Knab 2018). Materially, they are a set of objective relationships and interdependent activities involving contracts, routines and resource configurations (Chesbrough 2010; Teece 2010; Zott et al. 2011). Cognitively, they are a representation of how the causal links between exchange mechanisms of organisations and their environment are understood (Baden-Fuller and Mangematin 2013), often via abstractions that can serve as a reference language and aid in collective sense-making (Doganova and Eyquem-Renault 2009). There are many interpretations of business models, serving different analytical purposes (Massa et al. 2017). We here adopt a definition of the business model provided by Teece (2010, p. 179) that stresses that it is simultaneously a value proposition presented to the customer(s) or user(s), as well as a description of what organisations do to deliver that value:

> A business model articulates the logic, the data and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value.

Teece's description of business models as a value proposition, plus the means to deliver on that proposition, emphasise the potential of the value proposition to serve as a means of differentiation between firms (Payne and Frow 2014), especially from the perspective of customers or users. This differentiation is strategic in nature; for example, Chesbrough and Rosenbloom (2002) find that initial business models, before firms enter markets, serve as a kind of proto-strategy, while Kaplan and Norton (2001) define the business model as "the essence of strategy". Casadesus-Masanell & Ricart define the business model of a firm already in operation as "an expression of the firm's realised strategy" (2010, p. 195). This reference to 'realised' strategy draws on the conception of strategy used in both strategic management literature (Mintzberg et al. 1998) and the Strategic Niche Management field (Hoogma 2002, citing Mintzberg, 1984) to explain how an organisation's initial strategy, informed by expectations, visions and beliefs, is mediated by context, such as market or regime dynamics.

2.2.3 An integrated business models-transitions analytical perspective

In this paper we argue that selected aspects of business models and transitions research can be usefully combined based on this common strategic element. In Hoogma's framework (2002), the strategies that are realised from the interplay of deliberate, unrealised and emergent strategies of

individual niche actors are analysed along the dimensions of technology choice and design, and targeted use environment. The 'use environment' element of Hoogma's approach, which envisages the innovation's projected use in various contexts and therefore its value to users, has significant similarities with the value proposition element of business models, which projects how a firm can create value for its customers. However, it is more limited in scope, lacking an established and systematic method by which it can be analysed and collated, and lacking the competitive orientation of value propositions, which hinders comparison within a set of firms. By analysing the value propositions of CaaS firms in the place of use environments in an adaptation of Hoogma's framework in Table 8, the element of the business model that most directly addresses users, the value proposition[7], can be incorporated into a fit/stretch matrix of niche actor introduction strategies. While the value proposition is not a microcosm of the business model as a whole, we use it as a *pars pro toto* that best captures the essence of a firm's intended offering to users (Baldassarre et al. 2017).

Table 9: Introduction strategies for firms in the CaaS niche, adapted from Hoogma (2002)

Technology choice and design / **Value Proposition**	**Fit & Conform**	**Stretch & Transform**
Fit & Conform	**FIT/FIT:** Selective substitution	**FIT/STRETCH:** Leapfrog design for substitution
Stretch & Transform	**STRETCH/FIT:** Market differentiation	**STRETCH/STRETCH:** Exploration of a new regime

The resulting integrated framework in Table 9 creates a typology of four combinations of 'fit' and 'stretch' niche actor introduction strategies along the axes of technology choice and design, and the value propositions of the firms that bring these technologies to market. In this framework, firms in the category *Fit-Fit* have chosen a value proposition that closely conforms to existing user expectations, combined with a substantially familiar technology, meaning that these firms can be considered closely aligned with the regime. Firms in the *Fit-Stretch* group combine a technological 'stretch' with a 'fit' value proposition. An example of these might be firms using a familiar value proposition, such as commercial advertising on vehicles, to bring a technologically novel innovation to market. *Stretch-Fit* refers to firms that are offering a service that is familiar and established in technological terms, through the vehicle of a novel value proposition. Lastly, *Stretch-Stretch* includes

[7] In comparison, and despite their great heterogeneity, the remaining categories used in the business model literature, such as Osterwalder's Business Model Canvas (2004), tend to be more restrictive in scope, such as the *supply chain*, which involves suppliers, or the *customer interface*, which concerns only customers (Boons and Lüdeke-Freund 2013).

firms that aim to reconfigure the cycling regime around their offering, using novel value propositions and novel technology.

2.3 Methods

Our methodological approach has been shaped by the limited literature on CaaS in the Dutch context. This motivated the use of the case study method (Yin 2014), consisting of a desk study, followed by interviews with the sample of CaaS providers. The desk study aimed to delimit and define the concept of CaaS in the context of large Dutch cities, in light of the heterogeneity of the services they offer. It further aimed to establish a list of all the providers of CaaS operating within the Netherlands, along with preliminary data on their business models and value propositions, and on the technological choices that had been made in the development of their service(s).

We employed three data collection approaches in an iterative manner appropriate for heterogeneous and emerging fields, in which delimitations are in constant flux (Greenhalgh and Peacock 2005). Firstly, the scientific literature on CaaS was reviewed for relevant articles by means of a Scopus search[8]. Secondly, a LexisNexis search was conducted for articles in the Dutch-language press related to CaaS issues using the term 'deelfiets' (*shared bicycle, bikeshare*)[9]. Lastly, a Google Search was conducted for bikeshare firms mentioned in the scientific literature and Dutch-language press review, as well as using the search terms above in both English and Dutch. This search continued until saturation had been reached in terms of new information.

The interview phase aimed to verify and expand on this data. Questions were developed iteratively using Castillo-Montoya's Interview Protocol Refinement Process (2016) and Osterwalder's Business Model Canvas (2004), due to the latter's level of detail and emphasis on value propositions. Supplementary questions addressed the design of the service (such as the specifications of bicycles and digital and physical supporting infrastructure). Emphasising strategy as a link between these categories as set out in our theoretical framework, we then classified the value propositions and technology choices of each provider in terms of their fit with the existing cycling regime. We draw on the value proposition analysis criteria developed by Anderson et al. (2006, cited in Bohnsack and Pinkse 2017) to establish the extent to which these propositions differ from those already on offer within the regime. Interviews were requested with the full sample of CaaS firms listed during the desk study, in order to obtain a comprehensive view of the field; of these, 15 took place, lasting

[8] Using the terms 'bike OR bicycle AND share OR sharing AND netherlands OR dutch', 32 journal articles were obtained and reviewed.
[9] The 310 exact matches were refined to 40 sources from newspapers, magazines, and specialist mobility blogs and websites, such as that of the Fietsersbond, covering the period 2015-2018.

approximately 60-75 minutes each. The answers were transcribed and then used to tabulate each provider's value proposition and technology choices.

2.4 Case Description

In their regime analysis of the Dutch mobility system, Turnheim et al. (2015) make use of transitions insights to describe a dominant automobility regime and two subordinate regimes, that of public transport and cycling, and note that cycling's status as a regime is almost unique to the Netherlands, it being a niche almost everywhere else. The cycling regime is structured by several strong stabilising forces, such as: a high-density dedicated infrastructure market; well-developed civil society organisations such as the *Fietsersbond*; an established cycling retail, manufacturing and repair industry; a socially embedded cycling culture; high modal share for cycling; and cycling expertise in the public sector, especially in local government. In contrast, Turnheim et al. note only a few cracks, tensions or problems acting to destabilise the regime, which were characterised as of limited influence (such as bicycle theft in cities). While Turnheim et al. (2015) do not include pressure on urban public bicycle parking capacity in this list, they note that the creation of such capacity has been an important achievement and a source of synergy between cycling and public transport. Van Zessen (2017) however, identifies pressure on public bicycle parking capacity, whether in dedicated facilities or on open public space, as a central concern in the Dutch urban mobility system. This pressure continues to grow despite decades of public investment in such capacity, mostly provided cost-free or under heavy subsidy. Van der Spek and Scheltema (2015) ascribe this to its lack of management as a scarce resource, leading to a Dutch phenomenon whereby much formal parking capacity is taken up by abandoned or little-used second bicycles[10], necessitating costly and constant monitoring, while the obstruction of public open space by informally parked bicycles has been a longstanding challenge in Dutch cities (van Goeverden and Godefrooij 2010). Along with the assumption of a right to cost-free and convenient bicycle parking space, private bicycle ownership is a deeply socially embedded practice within this regime, and in turn helps to define Dutch national identity and culture (Kuipers 2013). In contrast, CaaS constitutes a socio-technical niche because it provides access to bicycles that are owned by service providers, using a business model that Wittmann (2017) terms 'usership', rather than the private ownership that is the norm within the regime.

[10] 'Second' bicycles here refers to the tendency of regular train commuters in the Netherlands to maintain one or more inexpensive bicycles in cities they commute to regularly, since bicycle parking is usually cost-free and conveniently located. However, this can result in underutilisation of well-located bicycle parking capacity.

2.4.1 The CaaS niche

The common emphasis on usership of bicycles across CaaS providers distinguishes them from the cycling regime in a number of ways. These include the many regulatory ambiguities common to shared mobility services, such as pre-existing local bylaws that render dockless bikeshare technically illegal (Cohen and Kietzmann 2014; Frenken 2017). Another example is the tendency among CaaS providers, of both bike share and bike leasing, to use a business model that 'bundles' support services, such as bike repair, into their offerings, in ways that reshape or replace users' relationships with powerful actors in the cycling regime, such as bicycle retailers and local repair shops. At the same time, the potential of CaaS to facilitate intermodal mobility may, in some instances, support other regimes in ways that run counter to the interests of private cycling (Gebhardt et al, 2016; Jonuschat et al, 2015), leaving it "caught between regimes" in the words of Parkhurst et al. (2012, p. 308). An example of this might be bikeshare schemes connected to car parking garages, that enable the ongoing use of the car to reach city centres (Villwock-Witte and van Grol 2015), in competition with (for example) a door-to-door trip via the bike-train combined mode (Kager and Harms 2017; Rottier 2018).

CaaS thus constitutes a niche distinct from, and in some ways competitive with, the Dutch private cycling regime. Present CaaS technologies in the Netherlands are also mostly imports from other, low-cycling contexts. A major exception to this is the OV-Fiets system, which developed by incorporating legacy bike hire firms with the backing of the national railway operator (Ploeger and Oldenziel, 2020; Oldenziel et al. 2016), and had long been the only sizeable CaaS operator in the country.

No. of Firms	1	1	1	1	1	1	1	1	1	1	2	2	8	13
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
All Other Bikeshare Fleets											150		1895	16755
OV-Fiets Fleet	800	1300	2500	3000	3000	4500	5000	6000	8500	8500	8500	8500	8500	15000

Figure 1: Evolution of bicycle fleet size and number of firms in the bikeshare market of the Netherlands, 2004-2017

By 2016, however, other new forms of bikeshare started to enter key urban markets in the Netherlands at scale, largely concentrated in the country's two largest cities, Amsterdam and Rotterdam. Figure 1 shows the non-OV-Fiets fleet (in orange) rising above a negligible level for the first time in 2016, and by the next year, surpassing the OV-Fiets fleet; the number of firms in the CaaS market also increases abruptly from 2 to 13 over 3 years. The rapid growth achieved by these systems in a mature cycling market suggests that, despite the success and unique features of the Dutch cycling system, its existing offering left some needs unmet (van Zessen 2017); however, these needs were difficult to ascertain using transitions approaches. Examples of these might include last-mile trips from public transport other than rail, since very few bus or tram stops have OV-Fiets docks; or short intra-urban journeys, particularly in peripheral areas where the existing public transport offering may be limited, or where maintaining a private bicycle may be challenging (for example, due to a lack of safe parking). The period following 2016 also saw an increase in public opposition to CaaS, largely directed at the dockless systems and expressed through many press editorials, public statements by local government leaders, and articles in the print and online press (Tour de Force 2020 2017; Koops 2017; Adrianne 2017; Trouw Editorial 2017; Verkade 2017; Echt Amsterdams Nieuws 2017a). In Amsterdam, a temporary ban was enacted on dockless bikeshare in August 2017, pending the development of a new policy (Gemeente Amsterdam 2017a), while in Rotterdam, these systems were allowed to continue under revised conditions (Gemeente Rotterdam 2018). One of the most frequent justifications for this policy response, particularly in Amsterdam, is CaaS's impact on urban public bicycle parking capacity, which has long been under great pressure in urban centres (van der Spek and Scheltema 2015). This suggests that safeguarding the interests of (private) cyclists, such as access to parking capacity, has been an important driver of official responses to (dockless) CaaS, and that the relationship between CaaS and stakeholders of private cycling is a key determinant of CaaS's future, although further research is needed to investigate this correlation.

2.5 Results

Given the developments and the limitations of both the transitions and business models approaches to clarify the controversy on their own, we applied our fit-stretch framework to CaaS providers' technology choices and value propositions. Here we discuss our empirical results and establish a contextual definition of CaaS in the Netherlands, present our sample of CaaS providers, and apply our framework to their technology choices and value propositions.

In the scientific literature, bikeshare is a well-studied concept (Fishman 2016) and generally refers to systems that grant access to a bicycle in increments ranging from 10 minutes to a one or more days.

In contrast, bike leasing, another form of bicycle usership, is little studied (exceptions include Flüchter 2014; and Park and Yoon 2015). Moreover, bike leasing mimics the freedom and responsibility of private cycling use, while bikeshare requires the user to locate a bicycle but releases the user from responsibility for their bicycle as soon as a ride ends. However, we found that bike leasing and bike share were most often discussed as part of the same set of potentially disruptive innovations in the Dutch national press, especially given the similar ways in which they bundle repair services, changing users' relationship to local bicycle repair and retail industries (Duursma 2017a; Homan 2017). We therefore define the CaaS niche in the Dutch context as *the set of services that provide access to a bicycle on a usership basis in time increments of between 10 minutes and 30 days*.

Drawing on academic literature, press coverage and web search content, including new bikeshare policy documents (Gemeente Amsterdam 2017a; Gemeente Rotterdam 2018) we compiled a list of organisations which had provided some form of CaaS service in the Netherlands in 2015-2017. These were: Cykl, BimBimBike, Donkey Republic, Dropbyke, E-bikeToGo, Flickbike, Gobike, Haagsche Stadsfiets, Hello-Bike, HopperPoint, Keobike, Mobike, Nextbike, Obike, OV-Fiets, Spinlister, Studentbike, Swapfiets, Urbee, and USP Campusbike. For these organisations, we used interview responses to tabulate a list of value propositions and technology design choices qualified and contextualised by the specific circumstances of each provider.

Our interview round verified this business model data, from which we derived each organisation's value proposition. Technology choice data emerged from specific questions relating to fleet and system design. The value propositions in our sample can be analysed along a number of dimensions, using distinctions such as conventional versus motorised bicycles, systems which store their bicycles on public versus private land when not in use, systems that support trips that do not terminate at their starting point, and systems that are formally integrated with other mobility modes versus those that stand apart. In addition, fleet size data emerged as an important proxy for the overall performance of each service, as it was available from public sources for all firms, whereas data such as ridership figures, turnover or profit, were very seldom disclosed. Table 10 presents 18 different CaaS firms classified by the 'fit' or 'stretch' strategy evident in their value propositions and technology choices, as measured against the cycling regime in the Netherlands prior to the advent of CaaS providers. When the same firms are sorted by fit/stretch quadrant, the variation in fleet size among the CaaS firms becomes apparent, as shown in *Figure 2*.

Table 10: Fit (F) or Stretch (S) strategies in Value Propositions and Technology Choice and Design, for selected CaaS providers in the Netherlands

CaaS Providers ***(Fleet Size)***	**Value Proposition**	**F/S**	**Technology Choice and Design**	**F/S**
OV-Fiets ***(14500)***	Back-to-one (B21) bike share of up to 24h for rail users (with option of 2 extra bikes) at all NS railway stations and some other locations with common smartcard	F	Rail station- hosted, dock-based system with simple bikes.	F
Keobike ***(340)***	Dock-based bikeshare for users of local public transport provider via app	F	Dock-based system with smart bikes unlocked via app.	F
Next-bike ***(75+80)***	B2M dock-based bikeshare for users of local public transport provider via app or by phone and card	F	Dock-based system with smart bikes unlocked via app.	F
USP Campus-bike ***(5)***	B2M dock-based bike share for up to 72 hours via app, but only within a campus area.	F	Dock-based, dockless-enabled smart bikes unlocked via app.	F
Uwdeelfiets ***(24)***	Bikeshare allowing one-way trips within each of several operating areas around Amsterdam, located and unlocked via an app.	S	Dock-based bike share with smart bike, unlocked via an app.	F
Haagsche Stadsfiets (180)	B2M bike share based at manned rental points via internet, phone or Whatsapp	F	Dock-based rental with tourism focus	F
Hopper-point (50)	B2M GPS-equipped bikeshare within Brabant city centres, via app.	F	Dock-Based Bikeshare on Public Land	F
Cykl (24)	B2M bike share within a campus via app run on a modified open-source platform.	F	Dock-Based Bikeshare on Public Land	F
E-Bike To Go (8)	B21 e-bike share across the Randstad offering higher-speed bike rides with geofencing via app and corporate reporting of rides	F	Dock-Based E-bike Share on Private Land	F
Gobike (50)	B21 e-bike share	F	Dock-Based E-bike Share on Private Land	F
Obike (2000+3000)	B2M dockless, last-mile bike share with blanket coverage of city centres, with deposit	S	Dockless Bike Share on Public Land	S
Flick-bike (1000)	B2M dockless bike share in Amsterdam via app	S	Dockless Bike Share on Public Land	S
Mobike (150)	B21 dockless bike share in Amsterdam via app.	S	Dockless Bike Share on Public Land	S
Hello-bike (250)	B2M bike share based within an urban business district using geofencing via an app	F	Dockless Bike Share with Geo-fencing	S
DonkeyBike (450)	B21 e-bike share outside AMS city centre via an app	F	Dockless E-Bike Share on Private Land	S
Urbee (300)	B21 e-bike share across AMS based at places of business via an app	F	Dockless E-Bike Share on Private Land	S
Swapfiets (17400)	A 'Netflix model' for cycling: maintenance and replacement of one bicycle on monthly rolling lease for flat fee.	S	Bike Leasing on (User's) Private Land	F
Student-bike (1000)	Cost-free cycling as a service monthly rolling lease in exchange for exposure.	S	Bike Leasing on (User's) Private Land	F

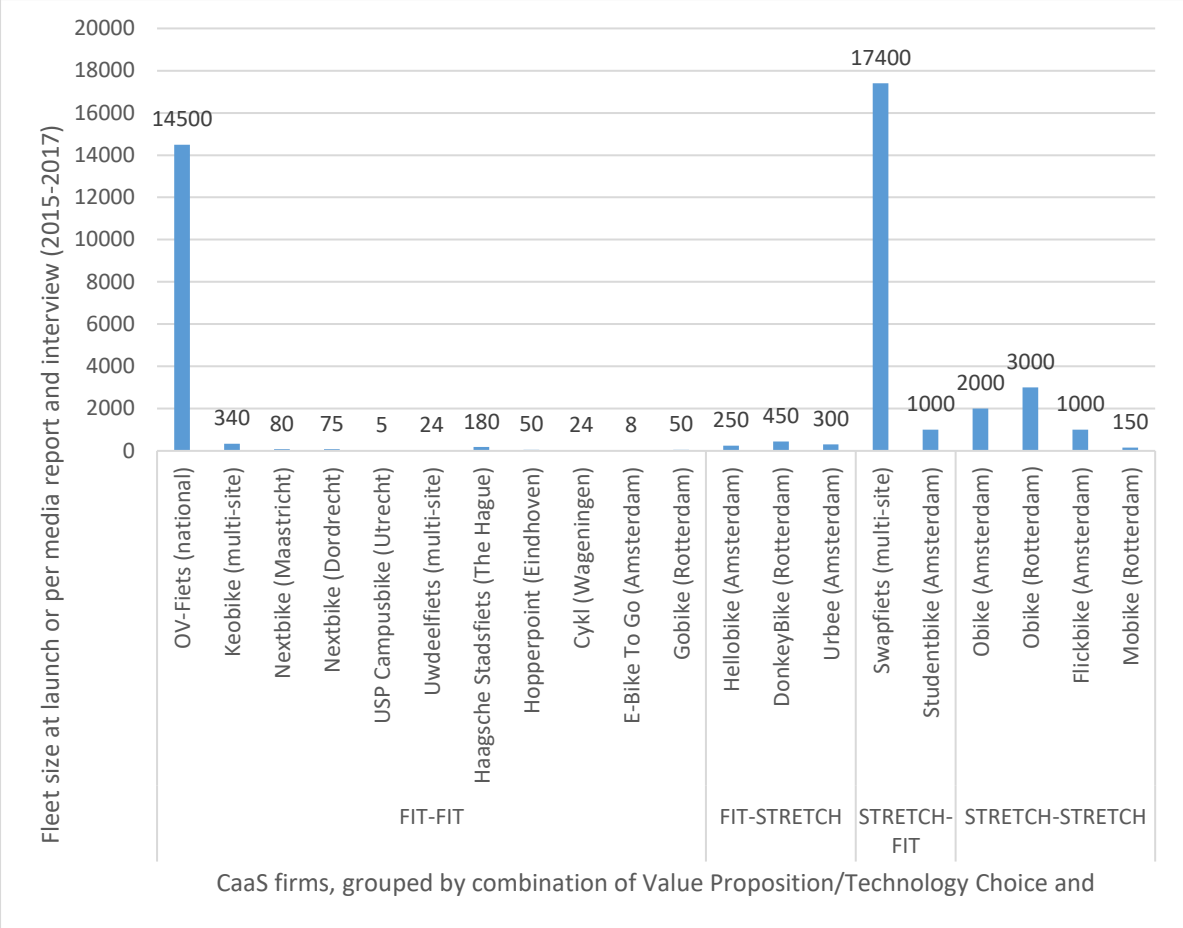

Figure 2: CaaS fleet size by Value Proposition/Technology Choice Strategy

The overall image of the CaaS niche at an early phase in its development consists of two elements. The first is a long tail of small to very small, geographically dispersed service providers in the Fit-Fit group, mostly operating without competition, except from the OV-Fiets system. The second are three clusters of larger fleets: the established OV-Fiets system, highly aligned to the public transport regime; Swapfiets and Studentbike, the leasing firms that mimic the regime norm of private bicycle ownership; and the cluster of Stretch-Stretch firms. The latter group, although severely affected by the Amsterdam temporary ban on dockless bicycles, succeeded in putting relatively large bicycle fleets into circulation in a short timeframe. These will be discussed in turn.

2.5.1 Fit-Fit

The OV-Fiets offers a good example of a provider that has consciously pursued a fit-and-conform pattern in both its value proposition and choice of technology. This strategy, which Hoogma (2002) terms *selective substitution*, can be seen in the OV-Fiets system's initial design, its subsequent incremental evolution, and in its steady growth. Ploeger and Oldenziel (2020) describe how the OV Fiets system brought 3rd-generation back-to-one bikeshare to the market in 2003, approximately 12

years before the advent of 4th-generation CaaS. The system was a combination of technologies that were more than a century old (standard Dutch bicycles), recently established (the railway operator's passenger smartcard), and novel (web-based communication of fleet data). The OV-Fiets value proposition was shaped by its parent company's decision to absorb existing bike hire firms already present at Dutch stations, and persuade them to accept lower fees in exchange for a greatly expanded user base; its minimum 24-hour ride increment is also an inheritance from these legacy business models (OV-Fiets interview, 26/04/2018). In technological terms, the OV-Fiets was defined by its durability and simplicity rather than its novelty, although innovations such as e-bikes have been trialled. The OV-Fiets' selective substitution strategy was also shaped by its parent company's scepticism as to its ability to break even, which was only achieved recently, after 15 years of operation (OV-Fiets interview, 26/04/2018)[11].

Firms with a similar strategy of closely integrating bikeshare offerings with existing public transport concessions and the full agreement of local government are Keobike and Nextbike. Also included in this group are the many small operators who either provide a comparable value proposition and a technology choice that closely resembles the regime, or who are so small and geographically limited (to a single town or campus) that they reach a very limited audience. For these firms, mostly limited to physical docks and the regulatory processes required to secure them, the OV-Fiets presents close competition and has a great scale advantage, with its 400 station-based docks and annual ridership of more than 3 million. In consequence, their fleet sizes are in many cases limited (by apprehensive local governments) to well below what many firms would otherwise operate (Nextbike interview 08/12/2017, Gobike interview 12/04/2018).

2.5.2 Fit-Stretch

This group consists of firms that have pursued a fit-and-conform value proposition combined with a novel technology, such as geofencing[12] (Hellobike) or e-bikes (Donkeybike, Urbee). In this case, our framework has been particularly useful in capturing within this group firms that initially adopted a 'stretch' value proposition and subsequently reorganised themselves in pursuit of a 'fit' in response to regime challenges. This is particularly true of Donkeybike, a dockless operator initially using open public land in Amsterdam to store its fleet between rides. When the city imposed a ban on the storage of dockless bikeshare fleets in the public realm in August 2017, Donkeybike responded by withdrawing from public land and securing permission to store its fleet on a series of public premises sited around Amsterdam. Donkeybike thus ensured its continued operation, but, due to the cost and

[11] When capital investments are taken into account.
[12] Geofencing refers to the designation of virtual docks visible through an app.

scarcity of private land in central Amsterdam, this came at the cost of greatly curtailing its availability across the city, and therefore its value proposition (Donkeybike interview, 07/02/2018).

A second example in this group is the geofencing model of Hellobike, which 'fits' into local governments' existing legal framework by conforming to existing legislation governing public open space, but deploys novel technology to avoid the investment costs associated with the placement of physical docks. Hellobike also enjoys a degree of local government support that is rare in the CaaS niche, with a direct mandate from a local authority in charge of Amsterdam's high-rise business district.

2.5.3 Stretch-Fit

This group consists of bike leasing providers who combine technologically familiar bicycles with highly innovative value propositions. In the case of Studentbike, students receive a bicycle (covered in advertisements) cost-free, provided that they cycle a minimum average number of kilometres per day. While Studentbike includes considerable innovation in value proposition terms through a gamification element that rewards users for completing tasks that result in greater exposure for the advertisements on their bikes, its size and therefore impact has been consciously limited by its operators (Hellobike interview, 08/11/2017). In contrast, Swapfiets has achieved spectacular growth in fleet size, surpassing the OV-Fiets fleet within 2 years of its founding. It has done so by combining a novel value proposition, which has been termed 'Netflix for bikes' (Meijers 2018) in reference to its flat-fee subscription model, with an ostensibly traditional product, the classic Dutch city bicycle.

While Swapfiets bikes in fact contain a degree of discreet innovation, mainly to improve service life, the system does not fundamentally depend on smartphone access, and its value proposition to its target group, students, is distinguished by services such as rapid maintenance, repair, and replacement of lease bicycles. Swapfiets' offer of a bicycle that users store at home and use like a private bicycle on a rolling month-to-month lease sets it apart from other CaaS offerings in the sample, most of which offer bikeshare and provide short-term mobility options for urban travel. However, Swapfiets is priced so competitively, with a monthly subscription equal to around 4 OV-Fiets trips or one day's use of a Donkeybike, that some users may find it economical to take out more than one subscription even in a city they visit occasionally, since bicycle parking is free, and any wear and tear to the bicycle (from storage in free bicycle parking, which is usually open-air) is not for their own account. It is this immense upscaling potential, and the addition of services that reposition cycling as a 'service' separated from responsibility for the bicycle as an object, that justify the inclusion of Swapfiets in the CaaS sample.

2.5.4 Stretch-Stretch

This group includes the dockless bikeshare operators that store their fleets on public land between trips, such as Obike, Flickbike and Mobike. These systems depend on novel technologies such as remote locking and geo-location on bicycles, as well as smartphone-based platforms, and their rapid advent in 2015-6 is associated with advances in performance and a fall in price for these technologies (Lan et al., 2017; Spinney and Lin, 2018). These technologies, in turn, underpin a value proposition that could not have existed before geo-location, smartphones and remote locking: that of the free-floating, one-way bikeshare system, in which users themselves decide where and how to park the bicycles they have used. This value proposition, far more than any other in the CaaS sample, positions all of public open space as bicycle parking capacity, to be monetised by private CaaS providers.

The firms in this group have also been most closely associated with the negative externalities of bikeshare, such as the perceived saturation of public bike parking capacity in Dutch cities (Adrianne 2017; Verkade 2017; Duursma 2017b) and highly publicised outcomes in their home markets in Asian cities and elsewhere (Lan et al., 2017; Spinney and Lin, 2018; Vlaskamp, 2017). These firms' approach to public space may be intrinsically associated with their value proposition; Obike representatives have stated in the press that launching at scale is essential to their system, which "only works with a bike every 200m", according to a company spokesperson (Voermans 2017).

In addition to their innovative technological offering, these firms tend to operate a service that is technically illegal under most Dutch cities' bylaws[13], meaning that early attempts to secure a regularised status with local government led instead to a tolerance policy on the part of the city (which continues in Rotterdam, but was abruptly withdrawn in Amsterdam). This willingness to enter a market in spite of regulatory ambiguity and associated risk exemplifies a stretch-and-transform value proposition.

2.6 Implications of CaaS providers' fit-and-stretch strategies for the niche

Analysis of a sample of CaaS providers in the Netherlands in terms of technology choice and business model 'fit' or 'stretch' strategies has yielded a definition of CaaS in context, and established the kinds of strategies that niche actors have realised in this early phase of niche development. However, the question remains of whether CaaS providers' strategies have had discernible effects on the niche as a whole, and whether a value proposition (or broader business model) perspective

[13] Known as the APV or *Algemeen Plaatselijke Verordening*.

can provide a conceptual link between the micro-level dynamics that may have determined these strategies, and dynamics within the CaaS niche and cycling regime that may affect individual firms.

Our finding is that CaaS in the Netherlands presents a correlation between two elements: value propositions and their approach towards the commons resource of public open space and bicycle parking capacity; and CaaS technologies that obviate physical docking infrastructure. Firms that have pursued 'fit' strategies in their use of public space, by limiting themselves to physical docking infrastructure depending on formal permission from local government, have generally failed to achieve significant scale in Dutch cities. This has resulted in high resident-to-bicycle ratios and system coverage that seldom extends beyond city centres to the peripheries, where transport choice is most limited. OV-Fiets is no exception to this rule, since it is based on private land owned by the railways, and is in almost every case accessible (for pick-up and drop-off of a bicycle) only in the centre of a given urban area (or, in larger Dutch cities, the centres of fairly large urban districts)[14], where the railway station is.

Some CaaS providers have robustly pursued a 'stretch and transform' strategy, and proceeded to launch in the face of regulatory ambiguity and a degree of public backlash against perceived saturation of bicycle parking capacity. These providers have also found their operations limited by greater scrutiny in Rotterdam (Gemeente Rotterdam 2018) and a temporary ban in Amsterdam (Gemeente Amsterdam 2017a), one of the country's largest markets with considerable symbolic power (Nextbike interview, 08/12/2017). Some of this backlash has been attributed by CaaS operators (Flickbike interview, 03/11/2017) to a projection of negative outcomes from other CaaS markets, such as the 'bicycle graveyards' of Asian cities (Tates 2017; Lanting 2018), onto the Dutch context, highlighting a communicative function of the business model which is absent from Hoogma's concept of use environment (2002). While these firms' operations continue to expand in Rotterdam and other centres, the losses associated with Amsterdam's temporary ban may be considerable (Teuling 2017a; Echt Amsterdams Nieuws 2017a) and their reach into regional cities, towns and rural areas is at present minimal, meaning that their contribution to mobility choice clusters around dense urban centres, where mobility choice, parking pressure and OV-Fiets availability are already high.

[14] One distinct feature of the synergy between cycling and public transport in the Netherlands is reflected in the distance between railway stations, which is on average higher than in the European norm. This is because the catchment area of a rail station tends to be measured by cycling distance, rather than walking distance, as in most other countries. As a result, distances between stations are longer, which has positive consequences for rail service, which can be more frequent due to the smaller number of stops (Kager et al. 2016)

In contrast with the restrictions and oppositions experienced by these two groups of CaaS providers, non-bikeshare firms such as Swapfiets have achieved rapid upscaling and avoided controversy by closely mimicking the dynamics of the Dutch private cycling regime. As such, the legitimacy of Swapfiets users' access to public bicycle parking capacity has not been significantly challenged in public discourse, even when these (individually) anonymous but (collectively) visually distinct bicycles saturate public spaces and public parking capacity, such as in student neighbourhoods or at railway stations. However, while Swapfiets' bicycle fleet conforms closely to the traditional image of urban Dutch bicycles, its business model has the potential to disrupt the Dutch cycling regime. For example, acquiring a Swapfiets may remove a growing number of users from frequent contact with neighbourhood bicycle retailers and repair services, since these needs are met centrally[15]. Since Swapfiets also faces no significant regulatory barriers, and since institutional tools for governing mobility services are largely limited to the lens of public space, its continued growth could also produce a situation in which a sizeable portion of a socially influential group, students, are habituated to 'usership' rather than ownership of bicycles. These attitudes may diffuse through society, further normalizing shared mobility (Parkes et al., 2013). When compared to the many small operators who reach a very limited number of users, and the limitation of even the large OV-Fiets system to a simple and consistent value proposition, this influence may be very significant.

The correlation between public space impact and CaaS business models has historical roots that may also account for certain second-order effects. For example, the Dutch state (with renewed focus since 1975) has undertaken to provide well-located capacity for parking private bicycles in Dutch cities, usually at great expense but almost always cost-free to users (Ministerie van Verkeer en Waterstaat (Netherlands) 2009; Turnheim et al. 2015, p. 37). The precedent of free bicycle parking meant that CaaS business models could not engage with an established method for determining fair financial compensation for use of a city's public space. The OV-Fiets system and its parent company conformed to and thereby reinforced this aspect of the private cycling regime in a way that poses a significant barrier to the upscaling of later CaaS business models, especially dockless systems.

For example, dockless operators are excluded from a wide area around Amsterdam's central station in the city's new draft bikeshare policy (Gemeente Amsterdam 2017a), while other providers already find it prohibitively expensive to find private land in central Amsterdam from which to operate (Donkeybike interview, 07/02/2018). By occupying the most profitable urban locations (at railway stations) while other providers are subject to limited access, the *OV-Fiets* system may thus

[15] Even when Swapfiets contracts local bicycle shops to perform local maintenance, this new relationship creates a powerful bargaining position for Swapfiets versus local bicycle shops.

constitute more of a barrier to other providers than its ostensibly non-overlapping use case at first suggests. This is especially likely given the slim profit margins in bikesharing (OV-Fiets interview, 26/04/2018).

As of 2019, no Dutch CaaS provider has yet emerged that offers a city-wide bikeshare service of the kind long established as an integrated mode of public transport in Paris and London, or the ubiquitous free-floating systems of Singapore and Shanghai. Users who seek usership of a shared bicycle for last-mile connections from a bus stop, or to make a spontaneous trip between two peripheral points in a Dutch city, either face the absence of any CaaS service, or the need to register with many different CaaS providers, as all remain limited to single locations or a handful of smaller locations.

The transition potential of the CaaS niche as a whole has therefore not yet been realised, despite calls by experts for the state-led creation of common digital infrastructure platforms for shared mobility services (Panozzo, 2017; Stratta et al., 2017) and a recent memorandum of understanding between various operators resolved to work towards interoperability for users between these systems (Puylaert 2018). Several interviewees party to this memorandum noted in interviews that they would only participate in such a platform, given the sensitive data exchange involved, if required to by local or national government. This is most true for firms in the Stretch-Stretch group, such as Obike and Mobike, which have already emerged in academic studies of their home markets as highly resistant to data sharing with local government, despite local user bases numbering many millions (Shen et al., 2018; Spinney and Lin, 2018).

2.7 Conclusion

The Value Proposition/Technology Choice framework adapted from Hoogma (2002) suggests that growth of CaaS has been strongest where service providers have most closely conformed to aspects of the existing cycling regime, such as OV-Fiets and Swapfiets. However, the firms that departed furthest from the regime, the Stretch-Stretch dockless firms that launched at significant scale all at once, are the next most successful group, barring heavy losses for those present in Amsterdam. Considering that, with the exception of Flickbike, the other two Stretch-Stretch firms belong to parent companies with vast financial reserves and user bases, it is interesting to note that these firms did not significantly alter either their bicycle fleet (in size and specifications) or their value proposition to prepare for the shift from a low-cycling context to one in which (private) cycling itself constitutes a regime.

The four distinct patterns of change shown in the Value Proposition/Technological Choice framework better facilitate application to our empirical case than Bidmon & Knab's (2018) model for the integration of business models and transitions perspectives, because all four patterns are directly comparable to each other, being defined in terms of both value propositions (and therefore business models), and socio-technical transitions research. In contrast, Bidmon & Knab's three-part model conflates both novel and existing business models into one category in relation to the commercialisation of technological innovation; we find that the differences between novel (or 'stretch') and existing (or 'fit') business models, as expressed through value propositions, are both distinct and a significant influence on outcomes for niche actors.

Combined with a case study, this framework explains a degree of opposition to certain CaaS providers that exceeds that those providers seem to have anticipated themselves, to the extent that they did not alter either their value proposition or technology choice in moving from their home markets to the Dutch context. The dynamics of this opposition, and the prevalence within press reports on CaaS of images of negative outcomes from other CaaS markets, like the bicycle graveyards of Asian cities, also suggest that the business model's communicative function has also served to shape public and media responses to CaaS to a significant extent.

More research is required into the exact means by which the cycling regime and local government have interacted, if at all, in order to bring about varying responses to the rapid arrival of CaaS firms in the Netherlands. Yet our findings suggest that the means by which common resources crucial to cycling are governed – most particularly public bicycle parking capacity, but also data infrastructure, common service standards, and other issues – are seldom articulated in a way that enables experimentation and innovation, especially at scale, and by private sector actors.

Our framework addresses the question of how using a strategy framework to compare value propositions and technology design choices developed by niche actors can contribute to both business models and transitions research.

A value propositions perspective reveals the very different commercial constraints facing actors that have made similar technology design choices, such as the firms that must position a bicycle every 200m in order to deliver on a strategy first developed for Asian cities, versus another dockless operator's geofencing agreement with local government that limits scale and profitability but provides regulatory cover. The more detailed business model aspects revealed in interviews on the subject of interoperability also clarify why firms have been slow to develop a common user platform, which is puzzling if seen from a transitions perspective alone. In turn, a transitions lens succeeds in explaining why firms with ostensibly similar value propositions, producing similar results in cities in

terms of parking congestion and visual impact, have faced widely different outcomes, some succeeding in legitimising themselves as adjacent to the existing regime, and others branded as an alien presence.

The adapted fit-and-stretch framework used here could be extended through the substitution of many other dimensions, such as government policy and regulatory frameworks, to map the development of strategies within the niche. While this paper makes a contribution to the field of qualitative studies of business models from a transitions perspective, more research is needed in the burgeoning and fast-changing empirical field of shared mobility, particularly where the technologies deployed interact with incumbent mobility cultures, and particularly where those technologies are 'new-old', for which part of their promise lies precisely in their simplicity and technological stability.

3 Dockless bikeshare in Amsterdam: a mobility justice perspective on niche framing struggles

Abstract: This paper conceptually integrates socio-technical transitions with a mobility justice framework through the method of discourse analysis. A sample of media articles and secondary sources relating to the contested introduction of dockless bikeshare in the mature cycling city of Amsterdam was analysed using a multi-dimensional discursive interactions framework, which emphasises actors' ability to succeed in framing struggles by persuasively combining content-related claims with relevant aspects of their context. Mobility justice tenets were then applied to this framework, yielding a number of novel framings that correspond to a prescriptive logic rather than the descriptive, strategic focus of discursive transitions. These novel framings represent not only a new rhetorical resource for actors seeking to legitimate their innovations, but also enable transitions researchers to pay more explicit attention to groups and sets of interests who are affected by but excluded from innovation debates. This degree of attention may also bring to light inequalities, barriers and immobilities that, as yet, lie outside of the frames through which transitions research seeks to analyse innovation journeys. Mobility justice in its turn stands to benefit from closer engagement with the micro-dynamics of innovation journeys, which may yield more detailed insights into how normative frameworks can be embedded into specific contests.

Keywords: mobility justice, sustainable transitions, framing struggles, narrative analysis, bikeshare, Amsterdam

3.1 Introduction

The imperative for contemporary urban mobility systems to become more sustainable necessitates a timeframe and scale of transformation that implies a wholesale transition of socio-technical systems. For cities in the Netherlands, which have particular strengths in active transport modes such as walking and cycling, as well as a relatively well-integrated public transport system and highly developed automobility system, this transition is no less urgent (Alpkokin 2012; Pojani and Stead 2015). Yet dockless bikeshare technology, a recent innovation with considerable potential as a low-carbon, low-cost mobility mode (Cohen and Kietzmann 2014; Fishman 2016), has faced a regulatory backlash in Amsterdam following a period of rapid market expansion. This backlash takes the form of a ban pending new city policy that is still in force 22 months later (at the time of writing). It is an interesting case of a promising cycling-based innovation that has been temporarily rebuffed by policymakers at an early stage in its development in one of the world's cycling capitals. This temporary rejection was also accompanied by a condensed but intensive period of struggle over the

narrative framing of dockless bikeshare, in which environmental and social conceptions of sustainability were sometimes leveraged against each other by vying sides of the debate.

Socio-technical transitions approaches take the mutual embeddedness of technology and its social, cultural, political and institutional context as a starting point for an account for how radical technological transformations have been, and could be, achieved (Kemp et al. 1998; Geels 2002; Wieczorek and Berkhout 2009). The intended outcome of such transformations have, always implicitly but in recent years, more often explicitly, been greater sustainability (Elzen and Wieczorek 2005; Nykvist and Whitmarsh 2008; Ernst et al. 2016). Despite its significance for socio-technical transitions, the meanings of 'sustainability', however, have not yet been sufficiently unpacked within this literature (Raven et al. 2017; Köhler et al. 2019). In particular, scholars have critiqued an emphasis on economic and environmental sustainability and on the micro (often urban) and meso (often national) scale, as opposed to social sustainability, and other spatial scales (Zijlstra and Avelino 2012; Rauschmayer et al. 2015; Avelino et al. 2016; Cherp et al. 2018).

A growing literature in mobilities research has specifically questioned whether the concept of sustainability can be appropriately conceptualised outside of an explicit ethical framework (Bergmann and Sager 2008; Sheller and Urry 2016; Cook and Butz 2018). Referring to transitions research in the energy field, Jenkins et al (2016, 2018) mobilise the term 'energy justice' to argue that an explicit engagement with the dynamics by which the outcomes of transitions are distributed among users is required to give meaning to the term 'sustainability'. In the mobilities field, scholars have attended to these critiques in the development of frameworks that emphasise notions of social and spatial equity in mobility transitions, ranging from the modally specific 'bicycle justice' (Golub 2016) to 'transport justice' (Martens 2017) and the more capacious 'mobility justice' (Mullen and Marsden 2016; Sheller 2018).

While the use of the term 'justice' in this sense is fairly recent, it is situated at one end of a long continuum of terms used to conceptualise the fairness of transport systems, such as transport equity (Pereira et al. 2017), transport poverty (Martens 2013; Geile 2017), transport-related social exclusion (Lucas 2004), or the social sustainability of transport (Jeekel 2017). What these approaches have in common is a concern with the social distribution of the benefits and harms of transport systems. In its latest iterations, justice frameworks specifically promise that more explicit attention to notions of fairness are an essential, but overlooked, component of efforts to build public support for the fundamental technological and social transformation required to combat catastrophic climate change.

The conceptual integration of justice concepts and transitions research may therefore contribute to the development of both fields. A mobility justice perspective on socio-technical transitions could provide better articulated concepts with which to assess and analyse the fairness of a given transition, and the innovations that are supposed to drive it. In turn, mobility justice, which has only recently given rise to its first book-length studies (Cook and Butz 2018; Sheller 2018), stands to benefit from the confrontation of its explicitly prescriptive principles with the actual trade-offs, compromises and mediation recorded by empirical transitions studies, in order to further refine and situate the concept of mobility justice in various contexts and at various scales.

This paper applies the normative ethical and distributional frameworks developed by Martens (2017), Sheller (2018) and others to Rosenbloom's (2018) multi-dimensional discursive model of the framing struggles undertaken by actors in the dockless bikeshare niche in Amsterdam. It does so by applying principles of mobility justice to an established framework for discursive analysis of the outward-oriented narratives and storylines propounded and framing struggles (collectively, the 'narrative work') engaged in by actors in the dockless bikeshare niche. These findings may assist in clarifying a key research problem arising from the case over the period 2016-2018, namely, *How can the conceptual integration of mobility justice tenets and socio-technical transitions research contribute novel perspectives on the legitimation efforts of niche actors?*

This paper consists of five parts. Section 3.2 presents our theoretical framework, which integrates mobility justice precepts with a transitions studies approach to discursive interactions. In Section 3.2.3 we present the method of narrative textual analysis we apply to various framing struggles. In Sections 3.3 and 3.4, we present our results and discuss the two most prominent framing struggles, while Section 3.5 presents our conclusions on the role that mobility justice can play in transitions research and our recommendations for future research.

3.2 Theoretical Framework

3.2.1 Transitions research

The field of sustainability transitions seeks to account for the coexistence of sites of radical innovation, or 'niches', with dynamically stable 'regimes', or constellations of artefacts and practices that make up systems, such as the Dutch urban mobility system (Kemp et al. 1998; Geels 2002). These concepts reflect a scale of increasing structuration, with the niche representing the least stable structuration of activities, and the 'landscape', or the set of influences that act on the regime, as an exogenous repository of socio-technical pressures.

Within this rapidly developing field, there is a wide-ranging agenda for further development in ethical aspects of transitions, including notions of distribution, justice and poverty (Köhler et al. 2019). The lack of emphasis on the antecedents of social dynamics within transitions, and a resulting lack of precision in articulating ethical aspects of transitions, has contributed to what has been termed a "moral vacuum" within transitions research (Newell and Mulvaney 2013; Sovacool et al. 2016). Current responses to this critique within the literature have included the 'just transitions' approach (Swilling and Annecke 2012; Newell and Mulvaney 2013).

These and other existing approaches, however, tend to focus on the 'justice' of transitions within specific contexts, especially in the developing world or in capacity-constrained state contexts, potentially eliding the ways in which justice and injustice can mutually and simultaneously constitute each other across North/South divides. Further areas for development in transitions research are noted in a review by Köhler et al (2019). These include moving beyond a highly contextual approach that focuses on particular spatial scales to the exclusion of other relevant scales (Bridge et al. 2013); addressing a tendency to consider regimes in such a way that insufficient attention is paid to non-users of a technology (Kahma and Matschoss 2017), and the development of an overarching normative orientation that is articulated in terms that enable robust comparison between spatial and temporal scales, and regimes (Raven et al. 2017). The development of such an overarching framework would be particularly useful in contrasting two regimes (or a niche and regime) that are already 'sustainable' in their own ways.

3.2.2 Mobility justice

The concept of mobility justice is distinguished from earlier approaches to assessing the fairness of mobility or transport systems by a conceptual and empirical extension beyond questions of the equitable distribution of benefits (such as accessibility) and harms (such as barriers to accessibility). Extension beyond concerns with distributional justice allows Sheller's framework for mobility justice to expand beyond an emphasis on 'who gets what' and ask how the composition and aims of mobility systems are constituted, who makes these decisions, and whose knowledge informs these processes. Combined with these more demanding conceptions of justice are other characteristics that distinguish mobility justice from earlier conceptions of fairness. The first of these is its insistence on simultaneous analysis of environmental and social aspects of mobility systems. Mullen & Marsden (2016) discuss this ecological-social nexus in their argument that earlier transport justice work has tended to treat various elements of the debate, such as accessibility or environmental justice, separately, thereby implicitly obscuring winners and losers.

In response to these concerns, Sheller's recent work (2018) argues for a conception of mobility justice that addresses multiple scales of mobility, and multiple approaches to justice in all mobility-related inequities. Sheller grounds this agenda in a multi-scalar mobile ontology informed by the limitations she finds in existing theoretical approaches to justice within the transport justice literature. A key aspect of this emphasis on scalar fluency is a concern with the justice ramifications of how debates are framed, and whose interests are foregrounded or elided through the effects of both temporal and spatial scale. The second aspect of Sheller's conception of mobility justice further distinguishes it from earlier approaches through the concept of mobile ontology. Mobile ontology draws on the work of Urry (2004) and the New Mobilities paradigm (Grieco and Urry 2011; Sheller and Urry 2016) and argues that space is constructed relationally, and is experienced by different subjects in ways that are mediated by their position, rather than being a stable Euclidean property that is prior to and merely contains actions. As mobility justice is a relatively recent framework, a major direction for future research is closer engagement with the situated and compromised nature of socio-technical transformation on the ground. Sheller (2018, p. 35) is asking an empirical question when, concerning the normative aspect of mobility justice, she writes:

> How do local, regional, urban, national, and global systems for control over space, territory, communication, and speed produce differently disciplined mobilities, differentiated by race, gender, class, nationality, sexuality, etc.?

The micro-dynamics invoked in this question are precisely those that are the focus of transitions approaches, in their contextual specificity. Integrating these micro-dynamics into mobility justice approaches can therefore enrich them empirically and conceptually, by complicating the prescriptions of mobility justice Sheller calls for, while retaining the normative orientation and scalar fluency needed in transitions research. Accordingly, we will apply to our transitions framework the areas of focus developed by Sheller (see Figure 3) as a minimum conceptual threshold for mobility justice approaches.

Sheller here presents a model of the kinds of justice that conceptually underpin the concept of mobility justice. *Distributive justice*, for Sheller, largely coincides with the requirements propounded by Martens (2017) and claimed by a long history of bicycle justice activism (Golub et al. 2016); namely, that priority in the planning and funding of mobility systems should go to ensuring a critical minimum of accessibility for all people, rather than a traditional cost-benefit analysis tied to the projected effects of a given transport infrastructure intervention. *Deliberative justice* describes the access previously excluded actors have to processes of deliberation through which substantive values are arrived at.

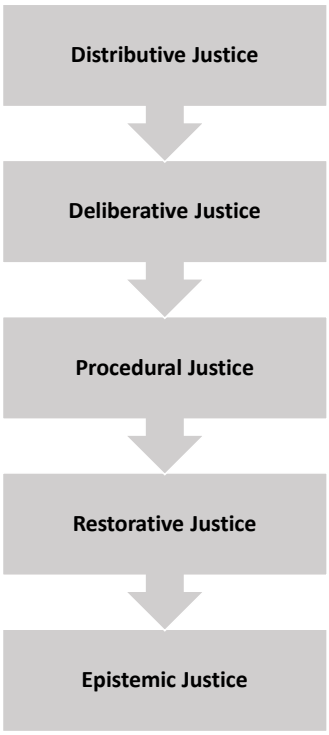

Figure 3: Sheller's nested approaches to mobility justice

Such a process is grounded in pro-active recognition of persons, especially those hitherto excluded from deliberation, and their active participation in it. *Procedural justice,* referring to the fairness of processes by which mobility systems are governed, depends on the affirmative provision of relevant and accessible information which can be understood by affected persons, thereby enabling their (ongoing) informed consent[16]. *Restorative justice* refers to the admission and acknowledgement of those immobilised or coerced into mobilities and a pro-active undertaking to effect redress, thereby enabling their inclusion and participation. Where such recognition allows for meaningful participation, such that all affected actors are able to participate in a substantively informed way, the scope or frame of mobility discourse must itself form part of the parameters for debate. This renegotiation of what is 'out of the frame' of mobility debates entails a concern for *epistemic justice*, grounded in the proactive production of knowledge and its ongoing adaptation. This model of justice concepts provides a framework for understanding how traditional distributive concerns, which are well established in fairness approaches such as transport equity (Pereira et al. 2017) and transport disadvantage (Hine and Mitchell 2017), are a necessary but not sufficient component of mobility justice. The model demonstrates that mobility justice in its fullest sense extends well beyond physical movements in space and makes particular normative demands of decision-making processes relating to mobility systems. Crucially, the inclusion of restorative and epistemic justice requires the consideration of immobilities created by particular forms of mobility, such as when an urban freeway serving suburban car commuters negatively affects an inner-city community through which it passes. Sheller's (2018) nested approaches to mobility justice are not a checklist for evaluating mobility

[16] The role of data is particularly important in this regard, given the well-established data gap that persists around cycling and walking, compared to motorised modes and, especially, automobility (Forsyth 2010). The selective capture and analysis of data is itself a reflection of the institutional power of mobility modes – see for example Section 4.2.2 on page 78 and Section 4.5 on page 91.

justice (such a list is provided elsewhere in the same volume). Rather, the types of justice elaborated here have an analytical function, serving as a prompt for the consideration of mobility issues in their fullest complexity, with particular attention to the groups whose interests have traditionally been marginalised in the mass automobility era (Golub 2016; Pereira et al. 2017; Lugo 2018).

3.2.3 Introducing framing struggles as method

An interesting and fruitful conceptual link between transitions and justice approaches can be provided by framing struggles (Healy and Barry 2017; Sol et al. 2018). Framing struggles are attempts to adjust the parameters of societal debate, recast the implicit consensus around a given subject, and (re)politicise actors, technologies and institutions to the benefit of participants in the struggle. Whether these participants constitute a more or less coordinated group, their efforts are a form of what Sovacool et al. (2017) term 'deliberative resistance'. Healy and Barry (2017) argue that adopting a justice approach can provide the conceptual basis for reframing debate within transitions from, as one example, a focus on future, potentially just and sustainable mobilities, to a focus on the present mobility injustice and lack of sustainability.

The intersection between narratives, storylines and discourse analysis, and socio-technical transitions approaches, has been investigated by scholars primarily in the empirical field of energy (Rosenbloom et al. 2016; Hermwille 2016). These analyses, reflecting their Foucauldian grounding, focus on questions of the relative power of actors to shape discourse, and thus the context in which energy innovations operate. The key findings of both Hermwille (2016) and Rosenbloom (2016) centre on the question of how strategy, timing, and the relative size and makeup of coalitions of actors, can affect the 'success' of storylines. Success, in these terms, may be defined as the normalisation of a storyline, granting it the power of the obvious, which is usually accompanied by changes (such as regulatory or financial changes) that are favourable to the innovation backed by a given narrative coalition. In the transitions field, discourse analysis has been used to study the narrative work done by actors engaged in framing struggles, and the conditions under which they succeed in legitimating their innovations (Geels and Verhees 2011; Hermwille 2016; Marletto and Ortolani 2017; Rosenbloom 2018).

In this paper, we draw on and make an adaptation to the Multi-Dimensional Discursive Interactions (MDDI) approach developed by Rosenbloom et al (2018) in order to understand the framing struggles surrounding the advent of dockless bikeshare in Amsterdam. The key argument of this approach is that, in framing struggles, actors succeed in legitimating their niche innovations when they are able to combine claims related to the content of their innovations with the context in which they are operating, in a way that is more convincing to a relevant audience (such as the public

and/or decision-makers) than an opposing storyline. According to Hajer et al. (2006), storylines imply a common understanding of an issue, even if they depend for their coherency on differing components in different contexts (Hajer et al. 2006); they are thus a strategy for making meaning and for guiding concerted action among disparate groups of users who share goals that are sufficiently aligned. Other units of analysis in Rosenbloom's (2018) framework are: actors or groups of actors who pursue their interests, such as dockless bikeshare operators seeking to legitimize their innovation; the content of the claims made by actors, such as the socio-technical features of an innovation; the context in which framing struggles are conducted, including the landscape level but also developments within the regime; and the implications suggested by storylines for transitions pathways (see Figure 4). This refers to the projected mediating effects that current storylines are likely to have on likely future states. Implications therefore implicitly connect the framing struggles of the present with the socio-technical systems of the future, incorporating a new temporal scale to the integration of discursive approaches and transitions research.

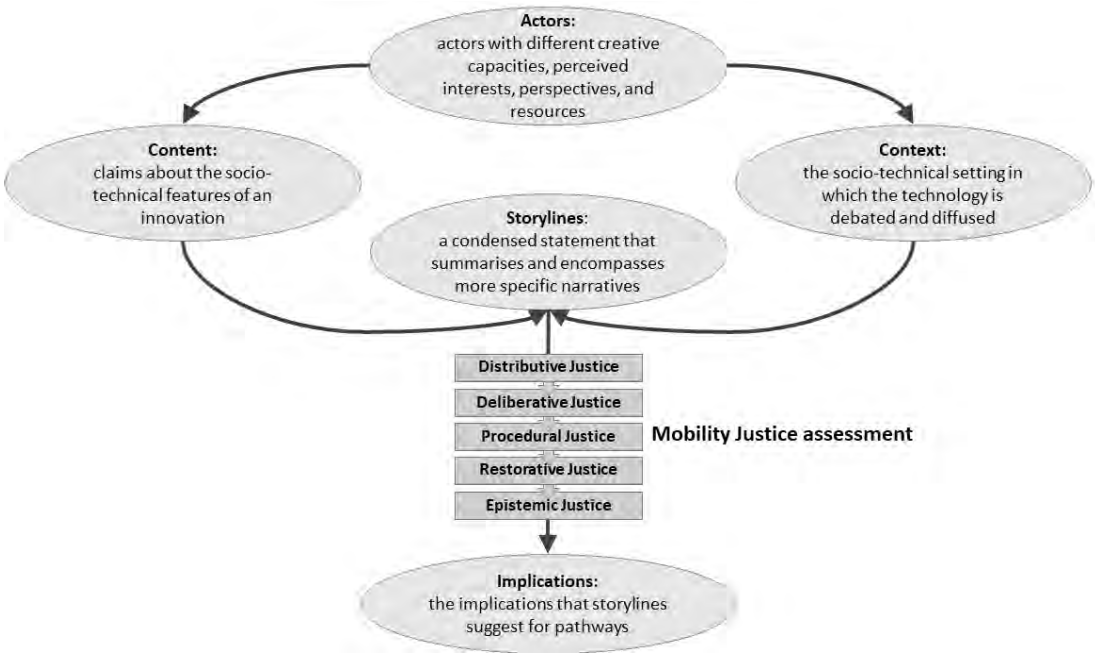

Figure 4: Adapting Rosenbloom's MDDI framework with nested justice concepts

To the elements constituting Rosenbloom's (2018) framework (Actors, Content, Context, Storylines and Implications), we add Sheller's five-part model of nested approaches to justice, situated between Storylines and Implications. Conceptually, we have placed these concepts between storylines (i.e., the strategic mobilisation of a narrative by actors) and implications (i.e., the projection of how these storylines may mediate future events and framings) in order to emphasise the analytical possibilities of these concepts at the boundary between the descriptive present and a projected future.

In order to analyse the framing struggles underway between actors in the Amsterdam dockless bikeshare niche, the LexisNexis database 'Krantenbank', an archive of Dutch-language national and regional newspaper, newsmagazines and professional publications, was searched using the term 'deelfiets' (shared bike), yielding 421 initial results. These were reduced to 97 unique results that applied to Amsterdam and referred to dockless bikeshare in sufficient depth. A time criterion was applied in order to focus on a period of intense controversy starting in early 2016 and leading up to the city of Amsterdam's imposition of a temporary ban on dockless bikeshare on 1 August 2017. We further extended our sample to the end of October of that year, by which time the two largest operators affected (Flickbike and Obike) had left the market (Niewold 2017), and other operators (DonkeyBike) had temporarily left the market in order to redesign their system to operate on private land (Feitsma 2017). This period captures the advent of dockless bikeshare systems in Amsterdam as well as the narratives relating to their departure by the deadline of 20 October 2017, under a temporary ban which is still in force at the time of writing (January 2019), pending the approval of a new dockless bikeshare policy in Amsterdam. These media articles were reviewed and supplemented by web searches for sources referred to in them, in order to gain a fuller picture of the "outward-oriented narrative work" (Rosenbloom et al. 2016) undertaken by these actors. These sources (see Dataset) include the draft bikeshare policy and press releases issued by the City of Amsterdam, and the websites and corporate literature of the dockless bikeshare providers then operating in the city.

The sources were analysed using a qualitative discourse analysis method (Hajer et al. 2006) consisting of an initial coding for emergent arguments relating to dockless bikeshare. In subsequent coding, following an iterative and inductive process (Dixon-Woods et al. 2005), major legitimating and delegitimating storylines were identified. While this text sample excludes unofficial and private communications and social media, it does offer a valuable public representation and site of contestation of technology and policy (Rosenbloom 2018).

3.3 Results

The actors identified in our analysis are presented in Table 11. We have retained Rosenbloom's (2018) distinction between prominent actors, who are substantially interested in the (de)legitimation of dockless bikeshare in Amsterdam, and aligned actors, whose key interests lie elsewhere but overlap with those of prominent actors to some extent (for example, advocates of the sharing economy in general). The most prominent niche actors within the dockless bikeshare niche in Amsterdam include Flickbike and Obike, both launched in June 2017, with initial free-floating fleets of approximately 1000 bicycles each (Petzer et al. 2019). Donkeybike, launched in April 2017,

launched with a fleet of 450 bicycles; other providers (Dropbyke, Hellobike and Urbee) operated smaller fleets. Prominent actors in the cycling regime include local government actors in Amsterdam, particularly Pieter Litjens, the then alderman responsible for mobility, as well as officials from other cities. Traditional bike hire operators were sometimes quoted in reports as a group threatened by the new systems. Well-established cycling lobbies like the Fietsersbond, and technical knowledge institutions such as the CROW and its Tour de Force 2020 initiative were active in producing policy and providing expert opinion. Actors aligned with the niche were limited to a few academics, while those aligned with the regime included residents' associations and scholars critical of issues related to bikeshare, such as the sharing economy.

Table 11: Prominent and aligned actors relevant to dockless bikeshare and cycling in Amsterdam

Prominent actors within the Amsterdam dockless bikeshare niche	**Prominent actors within the cycling regime (including dock-based bikeshare operators)**
Flickbike Obike DonkeyBike Other providers (Dropbyke, Hellobike and Urbee)	Local government: Pieter Litjens, the alderman for mobility with the City of Amsterdam (Gemeente Amsterdam), other Dutch local governments and alderpersons Industry: Traditional bike hire operators NGOs and cycling/mobility lobbying groups: Fietsersbond, CROW, Tour de Force 2020.
Aligned actors	**Aligned actors**
Scholars and knowledge institutes supportive of the sharing economy (ShareNL)	Residents' organisations Scholars critical of the sharing economy

Our text analysis reveals a wealth of contention surrounding the concept and reality of dockless bikeshare in Amsterdam, as well as in wider frames, such as concerns relating to shared mobility and the sharing economy, and gentrification and the impact of tourism on the city. The key legitimating and delegitimating storylines resulting from our analysis, as well as the frequency with which excerpts were coded for each storyline, are presented in Table 2. Across the sample, references to the 'deelfiets' or bikeshare were primarily negative. Explicit mentions of the positive contributions bikeshare can make were limited in number, and were most often framed in potential terms (that is, the mode could potentially contribute if current challenges were addressed). However, most sources were framed as a critique of bikeshare, often in revealing and charged terms, such as *zwerffietsen* or 'stray bikes' (Westeneng 2017), or *strooifietsen* or 'scatter bikes' (Schravesande and Amghar 2017).

This discourse is necessarily grounded in the mobility context of the Netherlands, in which the appeal of bikeshare as a mobility mode tends to contrasted not with automobility, but with the mature existing cycling system (Harms et al. 2014), which has been characterised in transitions terms as a 'subordinate mobility regime' in its own right, rather than a niche, as is nearly universal across

the car-dependent developed world (Turnheim et al. 2015). In this context, bikeshare is not intended, as elsewhere, to pioneer or normalise utility cycling, but to serve as last-mile transport from rail journeys on the model of the OV-Fiets (Villwock-Witte and van Grol 2015) and relieve bicycle parking pressure (Gemeente Amsterdam 2017a). The latter concern has long been a major priority in Amsterdam, where the mostly cost-free public provision of bicycle parking capacity and a high degree of tolerance for bicycle parking on open public space are the norm (van der Spek and Scheltema 2015). The broader history of Dutch cycling in relation to dockless bikeshare is beyond the scope of this paper. In order to allow for a nuanced mobility justice analysis, we now focus on the first two of the four framing struggles to emerge from our textual analysis (see Table 12), due to the frequency with which they appear and their relative prominence in sources.

Table 12: Delegitimising (D) and legitimising (L) storylines

Delegitimising storylines	**Code Count**	**Legitimising storylines**	**Code Count**
D1: Dockless bikeshare is nothing more than an effort to privatise public space.	106	L1: Dockless bikeshare should have access to public space if it serves hitherto unmet public needs.	70
D2: Dockless bikeshare can only be tolerated if it increases cycling while decreasing bicycle numbers and/or bicycle parking pressure.	94	L2: As a sustainable urban mobility mode, dockless bikeshare can only be expected to prove itself at scale and in time	61
D3: Dockless bikeshare is a foreign import alien to Dutch cycling culture	54	L3: There is no valid reason dockless bikeshare cannot become an extension of Dutch cycling culture	48
D4: Dockless bikeshare is really about monetising data, not mobility	14	L4: Dockless bikeshare is a novel form of mobility that leverages data for superior sustainability	7
Total D1-D4	**268**	**Total L1-L4**	**186**

3.3.1 D1 and L1: Dockless bikeshare in the public realm

The most significant framing struggle surrounding bikeshare relates to whether it has a right to exist in public space at all. This legitimating storyline (L1) was framed by advocates as a natural extension of dockless technology itself, which operates from no fixed physical docking station, because this material property of the technology is the basis of its sustainability promise: that is, its ability to not only be deployed rapidly and at low cost, but also to respond rapidly to changes in a city's mobility needs or patterns. These actors made a mostly implicit, content-related claim that it was through use by the public that their systems would be legitimated. This strategy reflects a calculation that the public's right to access public bicycle parking capacity is relatively uncontested, especially in Amsterdam, and that this legitimacy would be transferred to new services that achieve reasonable rates of use. This legitimising storyline (L1) was countered by a delegitimising one (D1) advanced by

editorials in national newspapers, sustained reporting by certain prominent journalists, and widely-quoted statements by a city spokesperson.

These actors reiterated that bikeshare operating on public land could only be legitimated if it led to a reduction in the number of bicycles parked in public spaces[17], implying that its only path to acceptance was in supplanting the storage of private bicycles in public parking among a significant group of users. This content-related rhetorical relegation of bikeshare away from the public realm, in which privately-owned bicycles have a right to reside by virtue of belonging to a diffuse public, was supported by claims that bikeshare was nothing more than a private, for-profit industry[18] (D1) devoid of altruistic pretence. This equivalence between the public realm as a place to be protected from privatization, and dockless bikeshare as an attempt to partly privatize or enclose the urban commons, was repeated by a city council member in July 2017[19]. Frequently, dockless bikeshare is referred to in this way in proximity to increasingly charged context-related discourse surrounding gentrification and the spatial effects of unsustainable tourism (or 'Venice syndrome') in Amsterdam (Pinkster and Boterman 2017). In this increasingly charged 'Venice' narrative, tourism in Amsterdam is mainly problematized through its demands on public urban space and housing affordability, and the storyline (D1) which presents bikeshare as the commodification and commercialisation of public space reinforces this through proximity.

In a reflection of Rosenbloom's observation that framing struggles evolve over time, we observe a specific attempt by niche actors to counter this narrative. Vikenti Kumanikin, the director of Flickbike, released an anonymized register of the users of his system with the aim of establishing that they were not tourists, thereby advancing (L1). This context-related claim was reinforced by a more general strategy, among niche advocates, to demonstrate their willingness to conform to the city's regulations and contribute materially to the maintenance of public space, by citing their early and ongoing efforts to secure permission to operate and pay an honorarium (called a *precario*) to the city (Niewold 2017; Gemeente Rotterdam 2018).

However, these L1 claims, presented as a reaction to the initial controversy following the launch of Obike and Flickbike in July 2017, appeared less often in the sample than comparatively vivid

[17] "We are open to the concept of sharing, on condition that it leads to fewer bicycles in the city. But as the concept has been realised now, the number of bicycles is only increasing", citing a City of Amsterdam spokesperson quoted in NRC Handelsblad of 03.08.2017 (Schravesande 2017).
[18] "The term bikeshare is misleading, the city has become a giant warehouse…[commercial bikeshare operators] are simply storing their inventory outdoors", citing mobility consultant Pascal van den Noort (Echt Amsterdams Nieuws 2017b). See also Kruyswijk in *Het Parool* of 23.05.2017 (Kruyswijk 2017a).
[19] "Public space belongs to everyone. Whoever wants to earn money from it, must be subject to rules, and must make a financial contribution in return", quoting Amsterdam city council member Jan-Bert Vroege in Het Parool of 26.07.2017 (Koops 2017).

descriptions of how members of the public were interacting with these visually distinct bicycles. In these accounts, frustration at their placement, or their use of a public parking facility, was a common theme, but vandalism and the discarding of bikes were also mentioned and presented in images relatively frequently. By 1 August 2017, the City of Amsterdam released a statement announcing a temporary ban on dockless bikeshare, to be enforced by local councils, with a deadline of 20 October for their removal from public space (Gemeente Amsterdam 2017b).

3.3.2 D2 and L2: More bicycling with fewer bicycles – scale and utilisation

A D2 storyline held that dockless bikeshare would have to demonstrate that it had contributed to maintaining or increasing cycling rates while reducing bicycle numbers in the city. This demand was articulated in prominent national news sources quoting disapproving city officials in the month leading up to the temporary ban. Context-related claims were prominent in this storyline, drawing on the fact that Amsterdam's bicycle parking problems were notorious; a figure often quoted was that, of the 800,000 bicycles in the city, approximately 200,000 were abandoned at any one time (De Volkskrant 2017; Schravesande 2017). Emphasis in this storyline was directed away from the long-term potential of dockless bikeshare towards the short-term impact of more bicycles in the city, and away from the city as a whole towards its highly congested centre. In response, the L2 storyline emphasised the need for a longer-term perspective and an experimental approach. Hugo Knuttel, director of Obike, offers a good summary of this defence in an article where he is quoted alleging that dockless operators were the victims of a 'smear campaign' or *hetze*, that their negative impact had been largely exaggerated in the press, and that the city's ban was an unexpected response to what should be seen as a transition period or *overgangsfase* (Teuling 2017b). The L2 storyline also sought to defend the scale of their launch fleets, which reached a maximum of approximately 7000 prior to the ban (Gemeente Amsterdam 2017a), through a content-related claim that connected this scale to their business models. Knuttel, with the largest fleet, was again quoted: "Our system only really functions properly when there is a bike every 200m" (Voermans 2017). The D2 storyline shows an evolution in response to these claims, developing, later in 2017, the claim that dockless bikeshare fleets were limited to the centre, where mobility choice was highest, and absent at the city periphery, where mobility choice was lowest (De Volkskrant 2017). Niche actors responded in October, after the ban, to the effect that the ongoing uncertainty of their regulatory position made expansion to outlying districts too risky. L2 proponent Vikenti Kumanikin, director of Flickbike, connected this to context when he claimed that a city's response was being "dominated by a small, vocal group of city centre residents…deciding for the rest of the city's inhabitants" (Kruyswijk 2017b).

3.4 Discussion

Success, in framing struggles, is not easily determined. Rosenbloom defines it as discursive resonance, or "the extent to which a storyline gains traction among policymakers and the public" (2018, p. 131; Geels and Verhees 2011). While the concept of discursive resonance is inherently difficult to measure, in the context of Amsterdam, in which an elected official temporarily banned an entire mode of shared mobility to minimal public backlash (as measured in press responses), delegitimizing framings appear to have attained the greater discursive resonance. In Rosenbloom's model, this success is most often framed in strategic terms, as the outcome of purposeful actions that aim to align compelling content-related claims with convincing appeals to context, delivered by trustworthy messengers. Rosenbloom's multi-dimensional discursive framework, of which a condensed version is used here, provides a compelling account of how actors contend to establish the dominant framing of an innovation, and the material consequences that can accompany a failure to establish narrative resonance for a niche. However, a mobility justice approach can provide an outside, normative perspective on the mostly strategic and self-interested actions provided for in the multi-dimensional framework.

3.4.1 A mobility justice view on Framing Struggles D1-L1 and D2-L2

The first of these outside perspectives is a distributional justice critique. In Rosenbloom's model, the innovation of dockless bikeshare, which is novel in the Amsterdam context, is the common reference point between the niche and the regime, and the basis for discussion. However, a mobility justice approach enjoins policymakers, and therefore framers of discussion, to 'start with the people, not the system' (Martens 2017; Sheller 2018). In a mobility justice framing, the burden of proof for a new mobility service attempting to establish itself in a context such as Amsterdam might shift considerably through a reappraisal of the existing distribution of public goods. For example, while private motor cars account for approximately 20% of the daily modal share in Amsterdam, 48% of public space is allocated to car traffic and storage (van Liere et al. 2017), reflecting a legacy inequality tied to the dominance of automobility historically and at other spatial scales (Kansen et al. 2018)[20]. In a transitions framing such as the MDDI, which takes technological innovations as a unit of analysis, novelty plays a central role, rendering it rhetorically more difficult to foreground old inequalities (such as the space allocated to cars) as an urgent problem due for reconsideration.

[20] While efforts to more equitably allocate this space have long been underway in Amsterdam, those processes involve significant investment in and accommodation of current car-owners, and parking places remain heavily subsidised below their true cost.

The D1 storyline invokes an appeal to distributive justice in its positioning of dockless bikeshare as an attempt to deprive the public of a part of a public good, or what Nikolaeva (2017) has termed an enclosure of the urban commons, and again in D2 (with a degree of dissonance with the first claim) in its argument that bikeshare, as implemented, has only benefited wealthy residents of the centre, rather than outlying districts. The L1 storyline makes a direct counter appeal that presents the users of dockless bikeshare as members of the public, with a consequent entitlement to cost-free and anonymous use of the city's public bike parking capacity, while L2 argues that all residents could have benefitted in time. The prevalence of distributive justice concerns in both of these pairs of storylines suggests that distributive justice rhetoric is relatively persuasive (compared to other kinds of justice).

Secondly, a deliberative and procedural justice critique of the D1-L1 struggle may ask whether a decision that plays out in the press, with a limited amount of public participation in Amsterdam, can be deemed 'discursively resonant' if the discourse in question is too narrowly circumscribed. The perceptions of the broader public towards bikeshare were very rarely described by means of quotation, and were mostly inferred from newsworthy acts of vandalism (especially the dumping of shared bicycles, always of the dockless kind). Additionally, actors in both D1 and L1 groups in the Rosenbloom model frequently mobilise descriptions of 'the public' for strategic purposes, with varying degrees of precision.

Claims of this nature are strategically valid in Rosenbloom's framework, although they run counter to the tenets of deliberative justice, as the knowledge or attitudes of the public were at no point tested through direct consultation prior to the ban. Deliberative justice demands that decision-makers recognize those who are affected by a given mobility question and ensure that they are able to both participate in the debate and deliberate over its parameters. Procedural justice might, in turn, be characterized by the proactive disclosure and sharing of information relevant to the public, as well as securing the public's informed consent. Deliberative and procedural concerns may be less obviously applicable to the D1 and L1 framing struggle than more concrete distributional concerns, but they make for an illuminating contrast with the more strategy-focused analysis of the MDDI. Normative claims such as these provide a metric for 'success' that is an alternative to discursive resonance, and may run counter to it. If, as Jenkins (2018) argues, a lack of explicit attention to social inequalities in transitions may create new inequalities or reproduce existing ones, a mobility justice lens may be useful in contextualizing the 'success' of actors who benefit from a power differential. In particular, the L2 claim that a vocal, privileged group of city centre residents had, through their

disproportionate influence, succeeded in bringing about an unexpected and indefinite ban might have had more discursive resonance in a deliberative and procedural justice framing.

The concepts of restorative and epistemic justice are most often discussed in the context of great contrasts in power, such as groups living on islands threatened by climate change who seek reparations from industrialised countries. In the context of Amsterdam, where income and other forms of inequality are less marked, the discourse of what 'redress' is owed to whom, and how knowledge can be co-created with various actors, may take a different form. A restorative justice lens on the D1 storyline's high bar for the legitimacy of dockless bikeshare might, for example, question Amsterdam's hesitation to support experimentation with bicycle-based mobility while air-polluting internal combustion engines continue to be welcome in the city centre.

A conceptual integration between tenets of mobility justice and socio-technical transitions through the method of textual analysis shows that mobility justice has produced useful new framings. This is especially true in distributive terms, as the prescriptive nature of justice approaches enable fundamental questions to be asked about the existing distribution of resources, without the persuasive power, or credibility, or ability to align content and context that secure an actor's ability to succeed in framing struggles according to Rosenbloom. The addition of mobility justice tenets to the conceptual map of the MDDI framework does not, as with the other elements, represent a real actor or real narrative work, but rather a set of ethical enjoinders that are valuable precisely because they operate outside of the strategic logic of the model.

3.5 Conclusion

This paper contributes to the mobility justice literature through its consideration of a mobility mode, cycling, that is marginal and subaltern in most urban contexts of the developed world, which in this context constitutes a regime of its own, with a degree of institutional power. This conflict 'within' cycling, between the interests of private cyclists and those of a novel shared mode of cycling, presents a valuable contrast with the traditional alignments between motorisation and primacy in urban space on one hand, and human-powered transport and marginality on the other. The conflict within cycling also presents a more complicated contest between visions of 'sustainability' (between two low-carbon, human-powered, space-efficient mobility modes) than is the norm in mobility justice case studies.

Our study contributes to transitions research through the explicit inclusion of a set of mobility justice considerations in a discursive transitions framework. Our results complicate existing hypotheses in the field of normatively-driven transitions, such as the finding of Elzen et al (2011) that such

transitions are more likely when discursive pressures line up with other pressures on the incumbent regime. In this case, the longstanding discourse of parking capacity and space scarcity in the (incumbent but subordinate) cycling regime was successfully invoked in delegitimating storylines. However, niche advocates' claim that their technology would ultimately reduce these pressures was not contested by their opponents. Instead, de-legitimators successfully emphasised a particular timescale, insisting that these benefits be delivered upfront if the niche was to be allowed to continue operations. Furthermore, the success of delegitimating storylines that connected the niche to seemingly unrelated but charged issues such as overtourism and gentrification in Amsterdam (since tourists are among the users of the technology) and the spectre of rampant and uncontrolled urbanisation in China (through dramatic images of 'bikeshare graveyards') suggest a potential connection to forms of discursive destabilisation (Roberts 2017) that are not yet well defined theoretically. An example of these is Bigelow's concept of 'dormant' issues (Bigelow et al. 1993), which simmer outside of a particular discourse but can be invoked, often implicitly and abstractly, to delegitimise an innovation. A further contribution of this paper is its description of the tensions that may inhere between a subordinate regime, such as that of cycling in the Netherlands, and a niche, such as dockless bikeshare, where the regime is itself under pressure from and in competition with the dominant regime of automobility, for resources such as road space, public funds and priority in urban planning. These tensions are mediated through the framing of the bicycle itself as an 'old' technology in contrast with automobility as 'modern'; the political power that flows from this opposition is complicated by the technological novelty of dockless bikeshare (Schrag 2000; Turnheim and Geels 2012).

The particularities of dockless bikeshare in the Netherlands, and the competition within sustainable mobilities in a mature cycling context (Harms et al. 2014), are relevant to the growing number of jurisdictions in which a still undifferentiated 'cycling' is becoming an accepted part of the mobility mix and the streetscape. This relevance is likely to grow in as a result of the Covid-19 pandemic of 2020, and a corresponding intensification of competition for public space. In these cases, policymakers and cycling advocates may gain from a critical awareness of the potential strengths and limitations of mobility justice precepts within framing struggles. The limitations of this study include the uniqueness of Amsterdam's context, although further research could usefully contrast our approach with other mature cycling cities, such as Copenhagen. Further institutional and governance research into the process by which the city arrived at its decision would also greatly contribute to this study, and provide a valuable counterpoint to our emphasis on public discourse, as would a more longitudinal study that more fully exploits the longer-term perspective allowed for by Rosenbloom's model.

4 The legal street: a scarcity approach to urban open space in mobility transitions

Abstract: An urban mobility transition requires a transition in space allocation, since most mobility modes are dependent on urban open space for circulation and the storage of vehicles. Despite increasing attention to space and spatiality in transitions research, the finite, physical aspects of urban space, and the means by which it is allocated, have not been adequately acknowledged as an influence on mobility transitions. A conceptual framework is introduced to support comparison between cities in terms of the processes by which open space is (re-)distributed between car and bicycle circulatory and regulatory space. This framework distinguishes between regulatory allocation mechanisms and the appropriation practices of actors. Application to cases in Amsterdam, Brussels and Birmingham reveal unique relationships created by the zero-sum nature of urban open space between the dominant automobility mode and subordinate cycling mode. These relationships open up a new approach to forms of lock-in that work in favour of particular mobility modes within the relatively obdurate urban built environment. Empirically, allocation mechanisms that routinise the production of car space at the national scale within the EU are shown to be far more prevalent than those for bicycle space, highlighting the constraints faced by radical city-level policies aimed at space reallocation.

Keywords: Sustainable mobility, urban space, bicycle parking, space distribution, parking policy

4.1 Introduction

A number of cities worldwide have resolved to initiate a transition towards sustainability (UN Habitat 2013; Loorbach 2016). Such a transition implies radical changes in the way cities organise vital systems, such as urban mobility (Frantzeskaki et al. 2017). In this sector, a transition away from a present dominated by fossil-fuelled private automobility has proceeded unevenly and slowly, despite political commitments, scientific imperatives and many bottom-up initiatives (Banister 2005; Hebbert 2005; Castán Broto 2015; Cidell and Prytherch 2015; Hoffmann et al. 2017).

In this paper we argue that this process is difficult partly because an urban mobility transition implies an urban space transition, since automobility, in common with most mobility modes, is highly dependent on access to the open space required both to move and to store vehicles (Prytherch 2015). For this reason, we focus on spatial aspects of sustainable urban mobility, which have received relatively little attention in comparison with themes such as low-carbon propulsion systems, automated driving and shared mobility (Banister 2008).

Urban open space is subject to contestation between various mobility modes and other land uses, all of which make overlapping claims on it that must be reconciled within the finite envelope of open urban space (Cidell and Prytherch 2015). This process has yielded what Prytherch (2018, p. 19) terms a "legal geography" of the street, referring not only to legislation but to the full set of regulations, policies, practices and laws, across all levels of government from international law to neighbourhood zoning, that physically apportion and distribute physical space in a way that codifies urban open space into familiar categories like 'roadway' and 'sidewalk'. Here, we adopt and compress this term as the legal street to refer to the physical product of these regulations and practices, namely, the allocation of uses within urban space. By 'allocation', we refer essentially to the relative distribution of designated spaces within the envelope of urban open space, rather than the means by which that (regulatory) distribution is communicated or expressed (that is, through signage, visual markings, physical infrastructure, paving and surfacing, etc.).

The close relationship between space and mobility systems sets it apart from other socio-technical systems that have been analysed by transitions scholars, requiring a different approach from that developed in transitions research to date (Monstadt 2009, p. 1931). Transitions research offers sophisticated means of analysing these mode-specific factors and their linkages to contexts beyond the scale of the city, that complement the more descriptive and place-bound approach prevalent in urban disciplines (Norton 2011; Cidell and Prytherch 2015; Wells and Xenias 2015; Prytherch 2018). However, researchers have identified limitations within transitions research's current capacity to move beyond a focus on single systems towards multi-system interactions in areas such as land use, as well as its capacity to address "spatial-institutional challenges" concerned with the systemic configuration of urban areas (Wolfram et al, 2016, p.23). These factors are particularly significant for analysis of the inherent physical aspects of urban open space, which is typically governed in a highly fragmented way, with historical divisions between road building and maintenance, and traffic management; between public and private mobility; and between each mobility mode (Crozet et al. 2019). Transitions research would thus benefit from more detailed conceptualisations of the role that space allocation and contestation play in mobility transitions.

We therefore draw on literature that takes urban open space as a primary unit of analysis, from urban disciplines such as spatial planning, law, history and economics. We find that key works in this tradition share foundational assumptions about the nature of this space, namely that it is exhaustible, finite, and subject to overlapping space claims (Shoup 2011; Longhurst 2015; Nikolaeva 2017; Shill 2019). Empirically, case studies in this literature confirm that these factors, which we summarise as the 'scarcity' of space, are highly influential in shaping the political struggles that

attend cities' efforts to transform their mobility systems away from car domination, and towards a greater role for public and active transport (that is, cycling, walking and wheelchair use) (Henderson 2015; Longhurst 2015; von Schönfeld and Bertolini 2017). These literatures also share a broad agreement that claims on physical urban space are mediated by multiple forms of regulatory lock-in that are particular to each mobility mode and urban use, such as parking minimums, pedestrian design guidelines and traffic impact assessments (Barter 2015; Rohracher and Späth 2017a). Because open space plays a central role in cities, these urban disciplines have produced an extensive literature supporting the claim that the systemic reallocation of urban space towards automobility has been an essential, and often overlooked, factor in its dominance. These analyses range in physical scale from the urban (Emanuel 2016; Spinney 2016) to the national (Norton 2011), European (Schipper 2008; Oldenziel and de la Bruhèze 2011) and systemic or global level (Urry 2004).

Based on these insights we propose a framework that introduces a space 'scarcity perspective' to transitions research on urban mobility, and focusses on regulatory mechanisms that allocate space for the parking of automobiles and bicycles. We compare these mechanisms with cycling practices in our primary case study of Amsterdam, one of the world's only large cities with a very high cycling modal share (EC DG MOVE 2017), and the rest of the EU, illustrated by the cases of Birmingham and Brussels. The paper addresses the following research question: *By what criteria are claims on urban space by the automobility and cycling modes judged, and how does this affect urban transitions towards sustainable mobility?*

The argument in this paper is structured in the following way: In section 4.2, we review conceptualisations of urban open space in urban disciplines and transitions research. In section 3, we set out the method employed in this study. In section 0, we present our results, with discussion and conclusions in section 4.5.

4.2 Urban open space in transitions research

Urban space has been addressed in transitions research from early on, in influential studies of socio-technical transformation in land transport (Geels 2005). It has been acknowledged in the growing stream of work on sustainable transport (later, mobility) transitions (Geels 2012; Geels et al. 2012; Epprecht et al. 2014; Ghosh et al. 2016). Urban space has also been addressed in the growing literature on urban sustainability transitions (Geels 2010a; Bulkeley et al. 2010, 2014; Frantzeskaki et al. 2017). However, transitions scholars have treated urban space as one component of transitions among many others, obscuring the very particular and potentially unique constraints and forms of contestation that it is subject to. One example of this is found in Geels' mapping of the socio-

technical system for modern car-based transport (2005, p. 448), in which the question of the space needed for the car system to operate is subsumed into the category of 'road infrastructure'. The use of the term 'road' here implies that open space has already been allocated for a roadway. This assumption obscures the significant and always contingent allocation of a finite resource towards one set of uses, in this case, a roadway appropriate for car-based transportation, at the expense of others. This contingency, reflected in the constant adjustment and reallocation of urban open space over time[21], and the sustained public contestation that accompanies it, sets urban open space well apart from other components of socio-technical systems. Before reviewing this conceptualisation of urban space in greater detail, it is useful to contrast it with a broader current of transitions literature that addresses space in general.

Early studies in this stream (Zijlstra and Avelino 2012; Coenen and Truffer 2012; Raven et al. 2012) explicitly responded to claims that transitions research lacked spatial sophistication or precision (Whitmarsh 2012) by drawing on geographical (Hansen and Coenen 2015) and New Mobilities scholarship (Sheller and Urry 2016; Affolderbach and Schulz 2016). These studies seek to 'spatialise' transitions by incorporating space into transitions frameworks as both locus and focus of transitions. This means reconceptualising space as not only physical - a site or container within which transitions occur - but as a dimension of transitions in itself, one that has causative power and is relationally constructed by actors and institutions (Coenen and Truffer 2012; Wieczorek et al. 2015). This project is ongoing, and has yielded a rich account of space in dialogue with other spatial disciplines (Becker et al. 2016; Caprotti and Harmer 2017; Levin-Keitel et al. 2018). However, it is limited in its ability to articulate space as a physically finite resource that lies within and largely constitutes a city, especially given the cumulative, aggregated significance of physical urban open space (streets, sidewalks, square, parking) for transitions in cities, countries and regions.

Instead, conceptualisations of space within transitions research have hitherto been defined by their lack of reckoning with physical constraints, such as exhaustibility or finite carrying capacity. When space is conceptualised in physical terms in this literature, (for example, to explain the unevenness of transitions in Coenen and Truffer 2012) it is implicitly presented as a kind of infrastructure defined by notions of connectivity, reach and proximity (Hodson et al. 2012; Bulkeley et al. 2014), or as a set of scales within a multi-scalar framework (Raven et al. 2012).

[21] Examples of this include the addition or removal of car parking spaces, the creation of bus or bicycle lanes, the conversion of streets to one-way traffic, the widening of roadway or sidewalks, the pedestrianisation of streets, as well as network-level effects like selective permeability.

Despite this general observation, references to the significance of physical urban open space as a determinant of urban mobility transitions can be found across the literatures that focus on some combination of the themes cities, sustainability, and mobility. However, these empirical observations tend towards an indirect or incomplete analysis of this relationship, in which it is often treated as one component among many.

For example, to return to Geels (2005), he notes that the rise of mass automobility in the USA in the early 20th century entailed the systematic codification of urban open space into new categories such as 'roadway' and a residual 'sidewalk'. The codification of space for mass automobile storage enabled an additional step, that of commodification, or the development of a market for the sale and rental of car 'parking' spaces. Geels notes that congestion, or the saturation of roadway space, produced regulatory responses that would be widely exported and copied wholesale to other contexts with the global spread of automobility (Geels 2005, pp. 458–459). Later, Geels observes that globally subaltern mobility regimes, such as cycling and walking, compete for urban open space on terms that are less favourable than those that apply to the dominant automobility regime (Geels 2012, p. 475), and refers to the physical constraints of road space as a 'crack' in the (relatively space-hungry) automobility regime. Geels (2005, 2012) thus acknowledges that urban open space is finite, that it has been codified and commodified by historical processes, and that it is contested on unequal terms by different mobility regimes, resulting in an uneven, "constructed scarcity" (Nikolaeva 2017).

In contrast to case studies focused on a single socio-technical system, Rohracher and Späth (2017b) represent a stream of transitions research that takes the city as a unit of analysis, extending this 'scarcity perspective' on urban open space to acknowledge that it is contested by very heterogeneous sets of claims extending beyond a single socio-technical system. Their model of the city as an 'arena' for low-carbon transitions sees multiple levels of governance (metropolitan, global), multiple functional subsystems (mobility, tourism), and multiple actor constituencies intersecting in close proximity. Moreover, they view cities as subject to collective commitments that belong less to the 'landscape' level of particular socio-technical systems, than to the city's own emergent policies or strategies (2017b, p. 291), such as a transition towards carbon neutrality. Rohracher and Späth operationalise this approach through Jensen et al's concept of the 'junction' (2015). A junction is a place-specific catalyst or mediator of change processes that extend across different infrastructure systems, logics and visions through a conflictual process or 'trial of force' (Latour 1987).

In contrast with the more abstract treatments of space within transitions research as a whole, the two streams discussed above, which take socio-technical systems and cities respectively as their unit of analysis, succeed only partially in capturing a scarcity perspective on urban open space. The first stream treats urban space scarcity as just one aspect of transition among others, obscuring the fact that because this kind of space is measurable and finite, it is subject to zero-sum allocations, meaning that a lock-in for one use of space necessarily 'locks out' others. However, transitions literature does not provide an adequate means of conceptualising this lockout, which is distinct from the definition of technological lockout (Schilling 1998). While the second stream acknowledges that urban space is contested by a diversity of claimants, the conflict, competition and 'trials of force' that take place within a 'junction' are (1) inherently exceptional, since junctions arise from novel configurations and place-specific projects, and (2) not inherently zero-sum, since the contestation within the junction can arise from any source. We argue, however, that the contestation of urban open space is animated precisely by its routine nature (as in the case of parking minimums) and inherent zero-sum competition.

Sengers and Raven (2015) capture this zero-sum aspect in their spatial analysis of attempts to introduce the Bus Rapid Transit (BRT) niche in various cities. Unlike, perhaps, energy or water infrastructure, the logic of an intersection means that street-level mobility systems are 'rivalrous', meaning that they can only enable mobility for some by requiring the simultaneous immobility of others[22]. The works reviewed above reveal that, while 'space' has received growing attention within sustainability transitions research, this literature does not, as yet, offer a means of directly and fully conceptualising the most salient aspects of urban open space, namely that it is finite and exhaustible, and subject to contestation through the overlapping, often rivalrous space claims of rival mobility modes and a multitude of other urban uses. This means that a powerful source of lock-in remains unarticulated, namely the zero-sum nature of the distribution of urban open space, combined with the unequal dynamics by which it is contested. This spatial embedding (Bridge et al. 2013) of dominant modes over subaltern ones through both current allocation practices, and the legacy of historical allocation, is the focus of our empirical research.

The process of commodification of dormant space for automobiles, which has been an influential component of street design across the motorised world, has been studied and critiqued by Shoup (2017) and others (Barter 2015; Groote et al. 2016). Dormant cycling space, or the space used to

[22] We acknowledge that urban open space can be and is also shared between, or simultaneously occupied and used by, a diversity of mobility modes and urban activities. However, very different sets of compatibilities between various modes and activities obtain at different speeds and volumes of movement, meaning that modally-specific spaces remain a widespread feature of urban open space.

park bicycles, has also been studied, both as a formal component of the 'legal street' in countries where cycling enjoys institutional support (van der Spek and Scheltema 2015; Heinen and Buehler 2019), and as a more or less transgressive appropriation of space, in contexts in which the bicycle's status is uncertain (Aldred and Jungnickel 2013).

4.2.1 Introducing a scarcity perspective on urban open space

Movement in cities depends on space for circulation, and vehicle-based forms of transport, such as automobile driving and bicycling, further require 'dormant space' (Spurling 2019) for vehicle storage. Dormant and circulatory space are, in turn, subtracted from the open public space that is bounded by private property boundaries (Prytherch 2018).

Historically, these kinds of spaces were informally or fluidly defined until the advent of mass urbanisation and mass automobility in many countries through the late 19th and early 20th century. Mass automobilisation saw the gradual construction of a legal regime (Norton, 2011) or 'lawscape' (Philippopoulos-Mihalopoulos and FitzGerald 2008) to govern conflicts arising from intensifying competition for urban space (Hamedinger 2014). This process culminated in an internationally consistent regulatory regime governing and apportioning urban space for the use of automobiles, including global standards for parking spaces, turning geometry, and lane width (Schipper and Schot 2011; Attias 2017). The strong codification of automobile space has been accompanied by the commodification of dormant car space in the form of car parking (Foster and Iaione 2015; Borch 2015). New urban areas created after the advent of mass automobility have tended to reflect the constraints and opportunities of the prevailing automobility system (Newman and Kenworthy 1999), creating a worldwide set of urban forms characteristic of mass automobility (Mäkinen et al. 2015), accompanied by rapidly increasing global sprawl (Barrington-Leigh and Millard-Ball 2020). A significant component of this automobile urbanism has been the spatial embedding of parking requirements into routine processes for the approval of new buildings, in the form of'parking minimums. They have been adopted very widely, although with great variation in application and enforcement (Henderson 2009; Shoup 2017).

In contrast to the automobility regime, which is governed and stabilised by international treaty and cross-border travel, other kinds of space in the legal street tend to be far more fluidly defined, and most are bundled within the residual category of pedestrian space. In the large majority of countries in which cycling modal share is very low, bicycles, which lack any functional equivalent to the global, mutually reinforcing regulatory regime of automobile space, are "matter in or out of place" (Aldred and Jungnickel 2013). This means that bicycles are a regulatory category in flux, variously and contingently allocated to car space, pedestrian space and/or their own designed space, sometimes

along the length of a single street. Globally, designated circulatory and dormant space for bicycles is a rarity in all but a few countries and cities (EC DG MOVE 2017).

Similarly, pedestrian space tends towards the function of a residual category that collects all non-car mobility modes and uses (Prytherch 2018), retaining many features of the pre-existing commons, or common pool resource, of open urban space (Chatterton 2016). Accordingly, while urban space is 'open', it is far from empty, since it teems with regulatory structure governing the spatial and temporal dimensions of movement and activity (von Schönfeld and Bertolini 2017; Shill 2019). The codification of urban space into differentiated kinds of modally- and functionally-specific spaces is an important component of the 'legal street'. Table 13 summarises these ideas in the form of the 'legal street', which we represent as a conceptual cross-section of urban open space and the means by which it is divided into distinct types of modally-defined circulatory and dormant space. The dividing lines in the table represent regulatory demarcations that vary in kind and in relative strength, such as legislation, city by-laws, property lines, national design guidelines, zoning, and engineering formulae. Within pedestrian space, these lines are dotted to reflect the relatively fluid or informal demarcation of space between the many modes and activities that share 'pedestrian' space, while the double line represents the kerb, a very widespread physical delimitation of the 'roadway' from residual pedestrian space.

Table 13: Conceptual model of the legal street

Private Property	Urban Open Space					Private Property
	Vehicle space		Pedestrian space			
	Circulatory space for vehicles	Dormant space for vehicles	Dormant space for bicycles and other non-car vehicles, etc.	Pedestrian circulation	All other urban open space uses: seating, consumption, assembly, etc.	

4.2.2 Operationalising the legal street

In this study, we operationalize the institutional order represented by the legal street framework to analyse the means by which it is created and maintained. We acknowledge that this order is not permanent, but in constant flux, shaped by the success of claims that actors make on urban space (Henderson 2009). Drawing on the work of urban scholars who find that urban open space is uniquely well-regulated to meet the spatial requirements of automobility, while other modes are subject to regulation that is typically fragmentary, informal or fluid, we distinguish between two kinds of process: allocation mechanisms and appropriation practices.

In our model, space allocation mechanisms generate claims on public and private space to satisfy the space requirements of a given mobility mode or activity. We consider these mechanisms to be stronger where they create legal obligations; where they are applied routinely and consistently as part of basic city governance; and when they codify and allocate space explicitly. Conversely, mechanisms are weaker when they are non-binding; inconsistently enforced; include many loopholes; or only apply sporadically or exceptionally. Taking Western Europe as an example, car parking norms[23] have historically been strong, due in part of to their consistency between very divergent national contexts (ITDP 2011; Mingardo et al. 2015) and their embedding over decades in the production of new urban fabric. In contrast, some of the most pronounced differences in European spatial allocation mechanisms can be seen in bicycle parking norms, which are strong only in the Netherlands, Denmark and some German *Länder* (Pucher and Buehler 2008).

We define a second kind of process in practical terms, as a space appropriation practice, or the observed, actual taking (up) of urban open space by users. While space allocation mechanisms may be strong or weak, space appropriation practices are reflected in data such as mode share, or the occupancy rate of parking infrastructure. Space appropriation practices may be formal or informal, and legally sanctioned or otherwise, as in the case of bicycles that are locked to railings, poles and building elements where this is not allowed, or the widespread practice of motorists' parking automobiles on or partly on sidewalks, or that of deliverers who park freight vehicles in bicycle lanes.

Spatial allocation mechanisms and appropriation practices are necessarily extremely diverse in urban open space at every scale, from the neighbourhood to the supra-national. They are also an abstraction and simplification of the complexity of stasis and mobility in cities. However, by differentiating between the allocation and appropriation outcomes within the framework of the physically bounded and finite legal street, it is possible to compare different places to each other through the lens of space scarcity and zero-sum allocation.

This brings to transitions research a more explicit means of capturing the ways in which the finitude of urban space converts the advantages of one socio-technical regime into the disadvantages of every another regime and activity. In so doing, it renders measurable (through mobility and space allocation data) a significant form of lock-in and path dependency that has historically favoured both automobility, and the built environment conceived around automobility's spatial needs (Newman

[23] Car parking norms generally take the form of sets of formulae used to convert certain parameters relating to private and public space (for example, the number of beds in a hotel) into a mandatory minimum provision of dormant car space, on private (off-street) and public (on-street) land (Shoup 2017).

and Kenworthy 1999). This reflects the findings of Mäkinen et al that successive phases of urban mobility regimes have typical corresponding urban forms, such that "changing urban mobility patterns is difficult as we are not only dependent on cars due to established practices but also due to urban form built around car use" (2015, p. 500).

Our refined framework is set out in Table 14, illustrated with general observations applicable to the European Union as a whole (ECF 2018). Owing to constraints on space and data availability, we focus here in particular on dormant space for automobiles and bicycles, on the relative strength or weakness of their corresponding allocation mechanisms, and on whether mode share (circulatory space) and/or occupancy rates (dormant space) are high or low. Broken lines reflect the finding that the separation between pedestrian and (especially dormant) bicycle space is seldom clear (ECF 2018; Heinen and Buehler 2019, p. 21), and tends towards the condition of the urban commons that predated mass automobility.

Table 14: Space allocation mechanisms and appropriation practices for the EU as a whole

Type of Space / Type of claim	Automobile space		Bicycle space		Pedestrian and other space
	Circulatory space	**Dormant space**	**Circulatory space**	**Dormant space**	
Allocation Mechanism	Strong – car access is a legal pre-requisite of building regulations	Strong - Guaranteed by parking minimums and stabilized by international treaty; access free or through payment	Weak – No wide-spread guarantee of access	Weak – No widespread regulation of availability or dimensions; access often informal	Weak – No widespread regulation or set of minimum standards
Appropriation Practice	Strong – high overall mode share	Strong – high occupancy rate, well documented as revenue source	Weak – low overall mode share	Weak – lack of data on occupancy rate, little to no revenue	Mixed

The divide shown in this table between strong allocation mechanisms and appropriation practices for automobility only, suggests that the 'scarcity' of urban space does not constrain all claims on space equally, but is mediated by the power of socio-technical regimes. We hypothesise that in certain "socio-spatial niches" (Geels 2012, p. 475), claims on space are measured against a different, more consistent interpretation of scarcity - one that is less modally mediated; relatively decoupled from historical accumulations of allocated space; and relatively more integrated into the stated aims of current policy.

4.3 Methods

This study was prompted by the authors' observation that conceptualisations of space across several highly cited papers in transitions studies were of limited utility when applied to urban space as a measurable resource for vehicle movement and parking. In designing a more systematic review of this literature, we further observed that keywords related to physical urban open space were inconsistent across and within journals, and that a small minority of studies attended to space in this sense. These factors guided us towards a snowball citation sampling method (Lecy and Beatty 2012). We started with a thematic analysis of highly-cited papers addressing spatial themes in transitions (Coenen and Truffer 2012; Geels 2012; Raven et al. 2012; Bridge et al. 2013; Sengers and Raven 2015; Becker et al. 2016; Caprotti and Harmer 2017; Levin-Keitel et al. 2018). We continued to add to our sample citations that proved relevant to physical urban space, until saturation had been reached in terms of space conceptualisations within transitions.

Centuries of attention to urban space as a site of exchange and circulation have produced a large literature describing its evolution, codification and commodification in fields such as urban planning, economics, law and history. In consultation with leading mobilities scholars who have published extensively on questions of urban open space[24], we were guided towards key works outside of the transitions literature that address questions of urban open space allocation and contestation. Following a snowball process, we added to our sample until saturation was reached in terms of conceptualisations of urban open space as a physical resource, yielding a sample of 20 papers representing the fields of urban planning (8), urban politics (5), urban history (3), urban economics (3), urban law (3), and civil engineering (3) (see Table 15).

Table 15: Sources for thematic review of space concepts in non-transitions literature

Research Area	**Journal Articles**
Urban history	(Norton 2011; Oldenziel and de la Bruhèze 2011; Longhurst 2015)
Urban economics	(Fiorito and Kollintzas 2004; Gössling and Choi 2015; Groote et al. 2016)
Urban law	(Philippopoulos-Mihalopoulos and FitzGerald 2008; Prytherch 2018; Shill 2019)
Urban politics and sociology	(Henderson 2009, 2015; Becker et al. 2016; Avelino et al. 2016; Ward et al. 2018)
Urban planning	(Magalhães and Carmona 2006; Castán Broto 2015; Cidell and Prytherch 2015; Mäkinen et al. 2015; Brown 2016; von Schönfeld and Bertolini 2017; Adam et al. 2018; Nello-Deakin 2019)
Civil engineering	(Jones 2014, 2016; Gössling et al. 2016)

[24] Open-ended interviews were conducted with these scholars: Prof. Marco te Brömmelstroet, Professor of Urban Mobility Futures at the University of Amsterdam; Prof. Ruth Oldenziel, Full Professor in the History of Technology at the Eindhoven University of Technology.

A comparison of these two sets of space conceptualisations, from transitions research and urban disciplines respectively, resulted in initial conceptualisations of space allocation mechanisms and appropriation practices. A draft of our legal street framework was further submitted to an expert on cycling space contestation in Amsterdam, Prof Ruth Oldenziel, for review and triangulation of the overall framework and the concept of allocation mechanisms and appropriation practices in particular.

This developing distinction guided our choice of a comparative case study of cities within the European Union to analyse these concepts empirically (Yin 2014). Among the cases, Amsterdam belongs to one of few large European cities in which cycling modal share is high, cycling space is relatively abundant, and space re-allocation policies have matured over decades as a major focus. Amsterdam's status as a socio-spatial niche (Geels 2012) or 'extreme case' (ibid.) in which space reallocation policies have been implemented and developed for decades motivated a structure in which it serves as a primary case to be studied in greater depth. Birmingham and Brussels were selected as secondary cases more representative of European norms (ECF 2018), as two other historically car-dominated cities in which major space reallocation policies are comparatively recent and therefore largely prospective. Birmingham, historically known as the UK's "motorway city" (Gunn 2018), has adopted radical plans aligned with Belgian and Dutch precedents, which aim to rapidly reallocate urban land away from car parking towards housing, public transport and cycling (Birmingham City Council 2019; Reid 2020a, "MJ" interview 29/09/2020). Brussels, a city known for political fragmentation and the loss of major public spaces and landmarks in favour of motorway-building and institutional campuses (Bruxelles Mobilité 2016a), radical space-reallocation plans have been underway since the late 2000s, and are beginning to deliver visible change, as well as significant contestation ("AK" interview, 02/10/2020).

To study allocation mechanisms across all cases, we retrieved applicable regulations from EUR-Lex and reviewed grey literature obtained via web search of city websites, focusing on laws, design guidelines, and applicable city-issued policies, and including relevant academic sources cited in these texts (see Table 16). Appropriation practices for all cases were captured through publicly-available data relating to mobility modal share and parking use rates. Data on allocation mechanisms and appropriation practices was thematically coded in terms of the legal street categories operationalised in Table 14.

For all three cases, brief semi-structured interviews were conducted with city officials responsible for space reallocation and bicycle or automobile parking. Questions focused on corroborating the claims and descriptions presented in grey literature and capturing any significant data not included

in these texts. For our primary case, the greater maturity and scope of Amsterdam's space reallocation policies prompted supplementary interviews with officials as well as stakeholders from a major cycling charity and neighbourhood organisation engaged in a well-publicised contestation of these policies.

Table 16: Data sources for comparative case study

Data sources	**Primary case**	**Secondary cases**	
	Amsterdam	**Brussels**	**Birmingham**
Interviews	"HvS", Fietsersbond, 13/01/2020; "A-J O", urban planner, City of Amsterdam, 17/01/2020; "RA", urban designer, City of Amsterdam, 22/01/2020; "BvN", Vervoerregio Amsterdam, 29/11/2020	"FD", Head of Cycling Policy, Brussels Capital Region, 30/09/2020; "BD", Public Space Strategic Advisor, 02/10/2020.	29/09/2020, "MJ", Head of Transport Planning, City of Birmingham; "AK", Principal Transport Policy Officer, City of Birmingham, 02/10/2020
Grey literature	Gemeente Amsterdam [City of Amsterdam] (2016, 2017a, b, 2019a, b, c); Metropoolregio Amsterdam [Greater Amsterdam metropolitan transport authority] (Nieuwstraten 2019).	Bruxelles Mobilité (2016a, b, 2017, 2020); Bruxelles Environnement (2019); Pro Velo (2017); Région de Bruxelles-Capital; Van Zeebroeck and Charles (2014)	Birmingham Cycle Revolution, "Our Journey" (January 2020)[25]; Birmingham Parking: Supplementary Planning Document, Consultation Draft (2019)[26]; Birmingham City Council (Birmingham City Council 2020a, b)
Academic Sources	(Hirschhorn et al. 2019; Buiter 2008)	(Henry et al. 2020; Hubert et al. 2017; May 2017)	(Gunn 2018; Hirschhorn et al. 2019)
Journalism	(Verkade 2019)	(De Muelenaere 2020)	(Reid 2020a, b)
Legislation and Design Guidance	CROW (2012, 2016); Wet ruimtelijke ordening (BWBR0020449), revised 2018 (1965)[27].	Wegcode [Roads Act] of 1975.	Manual for Streets 1 and 2 (UK DfT 2007; CIHT 2010).

4.4 Results

4.4.1 Legislation and the 'legal street'

While trans-European road infrastructure is governed by international and European-level agreements, and trunk, primary or through-roads are typically subject to distinct national laws (such as the UK's Design Manual for Roads and Bridges, or Germany's Bundesfernstraßengesetz), urban

[25] https://www.birmingham.gov.uk/downloads/file/15003/birmingham_cycle_revolution_-_our_journey
[26] https://www.birminghambeheard.org.uk /economy/parkingspd/supporting_documents/Parking%20SPD%20consultation%20FINAL.pdf
[27] https://wetten.overheid.nl/BWBR0020449/2018-07-01, consulted 30/08/2020.

space, and the roads and streets that serve it, have historically been governed at the local level, resulting in sometimes highly heterogeneous regulatory environments. In most cases, these environments are in themselves a more or less haphazard accretion of rules and practices originating in disparate efforts to control fire, levy tax, prevent disease, etc. As such, it is challenging to cite a definitive set of laws that govern space allocation at local street level, especially as the laws that do exist, tend to define broad parameters and principles, primarily in relation to automobility only. The technical detail that gives effect to these laws usually resides in manuals and design guidelines that are often advisory (for example, Birmingham's advisory cycle lanes, "MJ" interview, 29/09/2020).

More recently, local and national governments and the EU have responded to this state of affairs with consolidating design guidelines and unifying regulatory frameworks that seek to impose greater consistency on street-level design and space allocation. This process began in the mid-1960s in the Netherlands, and has to date produced several generations of urban form shaped by a consolidated regulatory framework for local streets, while in Birmingham and Brussels, comparable efforts are very recent, with major regulatory changes limited to the past decade-and-a-half. The Netherlands' Wet ruimtelijke ordening (Wro) [Spatial Planning Act], adopted in 1965 and constantly revised since, has imposed a high degree of alignment and integration between street-level design and the urban, regional and national scales, expressed in the ASVV design guidelines (CROW 2012). Since 1997, it has been complemented by the programme Duurzaam Veilig [Sustainable Safety], which has guided a comprehensive redesign of Dutch roads and streets, with relatively strict and nationally consistent distinctions in speed regulation, physical design, and degree of modal separation between local access roads, mixed roads, and through roads[28]. In the UK, the fragmented nature of street design practices led in 2007 to a major shift in approach with the central government's Manual for Streets (UK DfT 2007), the first such revision in 30 years, with sharply reduced priority for automobility space. In Brussels, a city that only gained meaningful control over its transport planning as late as 1989, primary roads and freeways penetrate into the heart of the city, and a large measure of control over streets rests with 19 municipalities (Bruxelles Mobilité 2016a). Given this uneven legislative framework, and the significance of heterogeneous non-statutory elements in the makeup of the 'legal street', we interpret our results using the concepts described in the legal street framework (Table 14), namely automobile, bicycle and pedestrian space; circulatory and dormant space; and spatial allocation mechanisms and appropriation practices.

[28] In Dutch, local access streets are known as *erftoegangswegen*, mixed roads are *gebiedsontsluitingswegen*, and through roads are *stroomwegen*.

4.4.2 In the European Union

The European Union has traditionally regarded urban policy as a matter for member states to govern at the national or local level (EU Partnership on Urban Mobility 2017). In the absence of an EU-wide approach to urban space, a profusion of programmes promoting cooperation, pilot schemes and experimentation at the city and regional level has led to a substantial policy consensus on the importance of a collective urban agenda that can support a sustainable urban mobility transition (EU DG Mobility & Transport 2017). However, we find that this lack of uniform regulation affects bicycle and pedestrian space significantly more than automobile space: less than a third of member states have a national bicycle parking minimum, whereas 5 out of 10 member states continue to impose a strict minimum car parking requirement for new buildings (ECF 2018). A major review by the European Cyclists' Federation (2018) summarises these differences as a stable, relatively consistent system of automobile space allocation mechanisms, particularly due to international treaty agreements[29], compared to a mechanisms for bicycle and pedestrian space allocation that are fragmentary, highly localized, inconsistently applied and enforced, and often vague.

Automobile circulatory space

In the EU, automobile circulatory space is governed by national transport codes subject to significant constraints, such as the regulations governing the Trans-European Transport Network (TEN-T), which include directive 2008/96/EC. These spaces stabilize high-level international links, reinforcing uniformity between national regulations (Schipper 2008), and reflecting the EU average modal split for passenger cars of 81% (EC DG MOVE 2019).

Automobile dormant space

Across the EU, only one country, France, sets maximum limits on off-street parking at the national level (ECF 2018), while 9 countries, the Brussels region and several German states impose parking minimums that can be adjusted locally. The remaining majority of states and regions have no national guidelines, or impose strict parking minimums at the national level[30]. Despite these differences, the overall supply of car parking spaces in the EU is abundant, amounting to an estimate of 47 million regulated (paid) parking spaces, equal to approximately one third of the land area of the Netherlands (European Parking Association 2013, p. 4), at an estimated public subsidy of €300 per person per year (ECF 2018).

[29] At the highest level, these variations within the EU must firstly be understood within international constraints such as the Vienna Convention of 1968, which defines and separates international open public space into a circulatory space for vehicles (the "carriageway"), separate from pedestrian space ("footpaths, pavements or verges") and, where applicable, bicycle circulatory space ("cycle tracks/lanes") (UN 1968).
[30] Namely, Bulgaria, Cyprus, Czechia, Italy, Romania, Slovakia, and several Austrian and German states.

Bicycle circulatory space

Bicycle circulatory space, much like dormant space, is defined in highly variable terms across EU member states, reflecting the generally low cycling modal share across the vast majority of the EU. This is also attributable to a data gap – at present, the cycling mode share for the EU as a whole is unknown, although a 2014 Eurobarometer survey suggested a figure greater than 10% in only 7 out of 28 member states (ECF 2017, p. 25). This variation extends from the national network of urban, rural and long-distance cycling routes of the Netherlands and Denmark to a near absence of designated infrastructure in countries like Malta, Cyprus and Portugal, where estimated mode share approaches 0% (2017, p. 25).

Bicycle dormant space

There is no EU-wide standard for bicycle infrastructure of any kind (ECF 2018). Bicycle parking was mentioned for the first time in EU Directives as recently as 2018 (ECF 2018, p. 38). The Energy Performance of Buildings directive, EU 2018/844, recommends that member states consider the need for dedicated supporting infrastructure for sustainable transport modes in building regulations, and the interaction between these regulations and mobility; it is non-binding. Overall, bicycle parking space provision is fragmentary, and mechanisms for the allocation of bicycle space have little institutional power[31]. At the national level, more than 70% of EU member lack binding national regulations or guidelines for bicycle parking[32] (ECF 2018).

Pedestrian space

There are no national regulations governing the provision of open space for pedestrian access and other urban uses on the EU level, although the provision of open and green space is mentioned in various directives and policy documents.

4.4.3 Brussels

Brussels has long been subject to daily car traffic congestion, and continues to invest in subsidized parking; as recently as 2016, residential parking permits cost €10 per first car per year, or the price of 2 hours' on-street parking in the city centre. One of the city's largest public works ever, the large-scale pedestrianisation of a grid of city centre streets, is intended to signal a change of direction to

[31] Lobbying to promote these claims nationally and EU-wide is at an early stage and calls for the adoption of binding principles for cycling infrastructure that feed through to national and local design standards (ECF 2017, p. 49).

[32] Non-binding regulations exist in Czechia, Estonia, Iceland, Ireland, Latvia, Portugal, Sweden and Switzerland, as well as the regions of Wallonia (BE) and Rhineland-Palatinate (DE). There are no national regulations in Croatia, Finland, Greece, Luxembourg, Malta, Norway, Poland, Romania, Slovakia, Spain and the UK, as well as the regions of Burgenland (AT), Flanders (BE) and Bavaria (DE).

decades of car-centric planning that saw motorways penetrate into central Brussels to support elite flight to the suburbs (Hubert et al. 2017, "FD" interview, 30/09/2020). However, this pedestrian and cycling circulatory space remains disconnected from other similar infrastructure by the car-dominated urban fabric that remains.

The city of Brussels mandates a bicycle parking minimum only for new-build, multi-unit buildings (ECF 2018, p. 16), while retaining a strict minimum of car parking spaces (ECF 2018, p. 37), although this policy is about to be replaced by far stricter sets of maximums ("AK" interview, 02/10/2020). In Brussels, only 55% of households own a car, yet building regulations have hitherto required a minimum of one new parking space per new apartment. The city plans to increase cycling mode share from 7-8% in 2019 to 20%, and is investing heavily in new purpose-built secure parking facilities, but outside of the city centre[33], these investments are accompanied by the expansion of dormant and circulatory car space as well, and in 2016, only 1.5% of road space was reserved exclusively for bicycles (Bruxelles Mobilité 2016a, p. 73).

4.4.4 Birmingham

Birmingham's new set of spatial allocation mechanisms are intended to make a dramatic break with the car-dependent present. After decades of parking minimums resulting in highly abundant car parking, the city has moved to audit and review its allocated car circulatory space; set maximums for dormant car space; remove all city-centre on-street free parking; and charge an annual levy on workplace car parking, to encourage their removal and conversion to other uses (Birmingham City Council 2019). Scarcity concepts are cited in the city's new parking plan, which emphasizes that "valuable land in short supply [should be] used in the most productive way possible" (Birmingham City Council 2019; Reid 2020a).

However, bicycle parking remains scarce, with new cycling parking minimums applicable only to new buildings (Birmingham City Council 2019, p. 31). Spatial appropriation practices currently present a stark contrast with the city's new policy direction. The city's intention is to quintuple cycling mode share from the current level of less than 1% (2019) to 5% by 2023, while an historical overabundance of dormant car space allocation is reflected in the finding that 10,000 car spaces remain unoccupied through the workday in central Birmingham (Birmingham City Council 2019). However, car mode share shows a steady decline since 2013, matched by increasing use of public transport ("MJ" interview, 29/09/2020).

[33] This disjuncture can in part be attributed to the large measure of autonomy that Brussels' constituent municipalities retain in the application of the city government's plans (AK interview, 02/10/2020).

Table 17: The legal street across the EU, in Brussels and in Birmingham

Type of Space / Type of Claim	Automobile space		Bicycle space		Pedestrian and other space
	Circulatory space	Dormant space	Circulatory space	Dormant space	
European Union (28)					
Allocation Mechanism	Strong - Stabilised by EU Directive 2008/96/EC governing road safety, as well as international treaties.	Strong - Standardised by historically widespread parking minimums, which still exist in 18 EU states.	Weak - No legal definition or standard, fragmented national standards	Weak - No legal definition or standard, first mention in energy performance of buildings directive in 2018	Weak -No legal definition or standard
Appropria-tion Practice	Strong – high modal share	Strong – abundant parking supply, occupancy rate unknown	Weak – modal share unknown, estimated to be low	Weak – occupancy rates unknown, with exceptions in the Netherlands and Denmark, where very high occupancy is common in city centres	Weak – walking data is uneven
Brussels					
Allocation Mechanism	Strong: motorised road access is highly codified	Strong: strict parking minimums	Weak: infrastructure is still fragmentary (1.5%)	Weak: only multi-unit new buildings must provide bicycle parking	Weak: pedestrian space is not highly codified
Appropria-tion Practice	Strong – high modal share	Strong – high occupancy	Weak – low modal share (2%)	Weak: low occupancy	Weak – low modal share
Birmingham					
Allocation Mechanism	Strong but significantly weaker in new policy	Historically abundant but weak in new policy (30% of all land)	Weak: infrastructure is fragmentary (<1%)	Bicycle parking provision is mandatory, but supply remains small	Weak but stronger in new policy
Appropria-tion Practice	Strong – high modal share	Weak – low occupancy	Weak – modal share very low (1%)	Weak – occupancy unknown, with very limited capacity	Weak but strong in new policy

In summary, the lack of common EU-wide regulations to govern spatial allocation mechanisms for cycling, but not automobility, closely matches the space appropriation practices of Europeans, as evidenced by walking and cycling mode share. Much of the work of structuring automobility space is

determined by international regulations and interoperability requirements. In contrast, bicycle space lacks this international dimension, and is very largely governed at the local level, despite a long history of EU calls in favour of common standards as a means of increasing, or even consistently measuring, cycling modal share (EU 2004; ECF 2017).

The construction of the legal street for the European Union as a whole, Birmingham, and Brussels is summarised in Table 17, where dotted lines reflect the same fluid demarcations as above; private property is not shown here due to space.

4.4.5 Amsterdam

Amsterdam is one of only two large cities in Europe (with Copenhagen) in which cycling has a dominant modal share. Significantly, the Netherlands as a whole has a high national modal share for cycling, accompanied by a widespread willingness to limit automobile space and speed. For example, the Netherlands was arguably the first European state to introduce a national car parking policy in 1988, in the form of the ABC scheme, which classified the national territory according to its accessibility by various modes, and limited car parking requirements where accessibility by bicycle or public transport was high (ECF, 2018).

Automobile circulatory space

Automobile circulatory space in Amsterdam is governed by the city's new Agenda Amsterdam Autoluw (Gemeente Amsterdam 2020), which sets out a role for the car as a city-wide mobility mode within limits on through-traffic and speed, as well as an overall commitment to reducing absolute traffic volumes.

Automobile dormant space

In Amsterdam, following decades of lock-in through parking minimums, the city has converted parking minimums to parking maximums, capping the total number of parking spaces such that new off-street provision will entail the removal of on-street parking, and reducing parking provision in new-build neighbourhoods to very low levels (Gemeente Amsterdam 2019a). Instead of the routinized allocation of on-street dormant space for cars that produced a large amount of car space in the city up to the 1990s, the role of parking minimums as a constraint on the options available to public space decision-makers is now largely historical[34]. There is no single approach or rationale to justify the retention or removal of a car parking space, and no single framework that governs or

[34] Pointing to this history, the Agenda contrasts 1970s photographs of iconic Amsterdam squares and streets packed with parked cars with the relatively car-free present, and sets out a vision for an equivalent transition by 2040 (Gemeente Amsterdam, 2019a).

determines the allocation of open urban space (Gemeente Amsterdam 2020, p. 57). Instead, the city's Agenda sets out overall ambitions and decision-making frameworks that must be tested in and adapted to every street and case. Respondent B, an urban planner specialising in shared space at the City of Amsterdam, relates that the parking maximum for new-build neighbourhoods in the city, such as the Havenstad, is set at 1 (off-street) parking space per 5 dwellings[35]. This is lower even than the current average for central Amsterdam (0.4 per dwelling) (Gemeente Amsterdam 2020). The resulting development will be free of the presence of parked cars at street level. Even designated loading zones have been omitted, in favour of a physical design that permits loading vehicles to stop without completely obstructing traffic, but without the security of access provided by a demarcated loading area.

Bicycle circulatory space

Bicycle circulatory space has long been a backbone of mobility planning in Amsterdam, and its current policy builds on an already fine-grained network of segregated major cycleways and supporting bicycle lanes.

Bicycle dormant space

Amsterdam sets out a requirement that bicycle parking space within a given street should have a maximum occupation rate of 85%, based on observation. Exceeding this limit triggers a procedure to increase dormant bicycle space. This provision supports a national building regulation, the Bouwbesluit, that requires off-street bicycle parking space to be provided in new buildings (Netherlands Government 2012). However, unlike the Bouwbesluit, the space claims emanating from observation of bicycle parking demand do not automatically impose a regulatory burden on private property owners, nor do they automatically entail the provision of dormant bicycle space in the immediate environment. Instead, these space claims prompt the city to consider allocating space nearby: it is increasingly understood that this may involve a walk to a neighbourhood off-street parking facility (buurtstalling) or large bicycle parking facility (fietsenstalling), since "the days of parking your bike in front of the door of your destination are over" (Interview "AJ", 17/01/20).

Pedestrian space

A city-wide minimum width for pedestrian and wheelchair access on sidewalks is set at 1.8m. It is widely recognized that this minimum is insufficient in higher-traffic areas, particularly in the city's

[35] In comparison, parking minimums were set at 1.0 per dwelling, five times higher, as recently as 2011 (ITDP 2011)

historic centre. There is also a consensus that the pedestrian space is frequently obstructed by other space uses, including dormant bicycles, as well as automobiles loading or parked.

In summary, Amsterdam's approach to space claims reveal that its ambitious decoupling of automobility lock-in on public space claims fits within a national framework of limitations on on-street car parking (in city centres), and widespread and longstanding bicycle parking minimums (everywhere). In contrast, while the EU contains several examples of visionary approaches to space claims at city level, very few of these fit within supportive national policies.

Table 18: The legal street in Amsterdam

Type of Space / Type of Claim	Automobile space		Bicycle space		Pedestrian and other space
	Circulatory space	**Dormant space**	**Circulatory space**	**Dormant space**	
Allocation Mechanism	Strong but weakening – ending through-traffic in city centre is under consideration; emergency & disabled access now routinely separated from other vehicle access by technology	Actively being reduced, near zero for new developments; historical minimums changed to maximums	Strong – a comprehensive system under constant redevelopment	Strong – growing supply, but informal parking extends into pedestrian space	Strong but under pressure – walkability impacted by spillover bicycle parking and car parking
Appropriation Practice	Weak – modal share relatively low	Weak – low occupancy off-street, high on-street	Strong – modal share very high and rising	Strong – very high Occupancy with saturation at peak times	Strong – relatively low modal share by EU standards due to cycling rate

The legal street in Amsterdam is summarised in Table 18. In contrast to the diagrams for the EU as a whole, Brussels and Birmingham, it shows that bicycle space allocation mechanisms are strong; solid lines reflect a stable demarcation between bicycle and automobile space. As in the other cases, the boundaries between pedestrian and bicycle space are relatively fluid, but in the case of Amsterdam's high mode share for cycling, this results in significant incursion of parked bicycles into pedestrian space. In interviews, Amsterdam officials state that in the last five years, day-to-day decision-making has evolved away from a model that closely resembles the legal street – in which teams of personnel, organised by mode, articulated spatial claims through allocation mechanisms. This has meant an a priori weakening of these mechanisms as determinants of how space is distributed, in favour of a more contextual, case-by-case process in which officials haggle internally about space

requirements. Arguably, the new process reflects a scarcity-based approach organised around the recognition that "the space between private properties is fixed" (Interview "AJ", 17/01/20).

4.5 Discussion and Conclusions

The differences revealed in the legal streets for the cases above show that automobility space allocation mechanisms have been relatively strong all over the EU until the beginning of this century. Moreover, these mechanisms have been, and to a considerable extent remain, embedded in binding national policy in a majority of EU states. In contrast, bicycle space allocation mechanisms are largely absent at the international level, and at the national level, they are largely absent or, if they exist, largely advisory. Only at the level of towns, cities and city-regions are allocation mechanisms for bicycle space relatively widespread.

However, appropriation practices often tell a different story. The number of places in the EU in which cycling plays a significant role in everyday urban mobility[36] is smaller still than the number of places with some level of protection for bicycle space claims (ECF 2018). This discrepancy points to the limitations of considering spatial allocation mechanisms, and the distribution of urban space more generally, as a proxy for the strength or weakness of urban mobility regimes. However, by simplifying and generalising complex spatial arrangements through the legal street framework, some clear differences emerge between high-cycling (Amsterdam) and aspirational cycling contexts (Brussels and Birmingham).

The first of these relates to the lock-in that automobility has historically enjoyed in terms of the strength and stability of its claims on public space. Decades of production of parking spaces, driven by parking minimum formulae, have produced an abundant supply of car parking space in western European cities, including Amsterdam. Because car journeys must start and end in a parking space, and because the built environment changes relatively slowly, this legacy allocation of space locks cities into automobility in a particularly obdurate way (Mäkinen et al. 2015). The legal street framework shows that this 'stock' of space should be contrasted with the 'flow' of current allocation mechanisms, which, even when they aim at radical transformation, tend to affect only new building and renovation projects. In Amsterdam, the flow of car parking space production has been attenuated rather than bolstered by national policy. It has also been contested by strong and long-established bicycle space allocation mechanisms, including those requiring off-street bicycle parking in building regulations. In Brussels and Birmingham, car space allocation mechanisms have more

[36] Comparison of cycling and walking data across EU member states is very challenging (EC DG MOVE 2017), but national figures from a 2014 survey suggests that cycling mode share was then under 10% in 21 out of 28 member states (Eurobarometer 2014).

fully monopolised open space until recently. In these cities, present-day transitions policies must therefore simultaneously reclaim car space and create an arena of competition between the dominant automobility regime and a relatively much weaker cycling system.

A second salient aspect is an institutional connection between urban space commodification, data, city revenue, and space allocation mechanisms. Through historical processes, car dormant space has become highly codified and commodified, creating a substantial market for the hourly, daily or annual rental of urban open space that generates revenue and data for cities. At the same time, this market is heavily distorted, particularly in the form of subsidised residents' parking permits, which constitute a large ongoing entitlement to urban open space for car storage. In contrast, bicycle dormant space is mostly operated on a cost-free basis, especially in Amsterdam, where even off-street bicycle parking tends to be free (for the first 24 hours of every use); it costs rather than generates revenue.

In Amsterdam, despite decades of successful cycling governance, systematic data collection and monitoring of on-street bicycle parking is a recent phenomenon. In contrast to cars, interviewed officials agree that Amsterdam has "almost no regulatory tools to control bicycles" (Interview "AJ", 17/01/20), and it has only recently become possible to designate districts in the city where informal bicycle parking is banned (meaning that all bicycles must be parked in formal infrastructure, on pain of removal) (Interview "RA", 21/01/20; Interview "BvN", 29/11/2019). An institutional disparity therefore exists between licensed drivers in registered automobiles occupying geometrically codified parking spaces, and the usually anonymous cyclist riding an unregistered bicycle, who most often parks informally in a space shared with other uses (Petzer et al. 2019).

In tension with this difference is the fact that both car and bicycle parking make overlapping, identical claims on the finite square metres of urban open space, in Amsterdam as in Brussels and Birmingham. The legal street framework presents the allocation mechanisms that express these claims as strong and weak, reflecting the relative institutional power of the automobility and cycling regimes respectively. The framework also underlines that, in all three cities, these mechanisms convert the common stock of urban open space into a commodified rental market (for car parking) and a very weakly codified, mostly uncommodified 'commons' (for bicycle parking). In all three cases, however, the bicycle 'commons' forms part of the residual pedestrian commons, which accommodates an intense and growing mix of mobility modes and other space uses.

In transitions terms, the legal street framework enables comparison between mobility systems through the lens of an essential, rivalrous resource. This resource lens sheds light on hitherto underdeveloped constraints that the finitude and scarcity of urban open space impose on

sustainable mobility transitions. Some of these insights are applicable to any common-pool resource (Parker and Johansson 2011), but others are unique to the urban context. Thus, while transitions research has highlighted the obduracy of the built environment, we contribute a distinction between that environment based on its division into two kinds of space (commodified, and commons), with different kinds of obduracy. Transitions scholars have likewise extensively described the lock-in that benefits automobility. However, the scarcity approach to urban open space suggests that, in many cases, automobility lock-in on its own spatial requirements amounts to a lock-out of other, subordinate mobility modes as well as other urban activities. This relationship is emphasised by a common quantitative measure that can directly compare the space-efficiency of one car parking space with n bicycle parking spaces, and the prominence of 'space efficiency' arguments in policies for the EU (EC DG MOVE 2019), Amsterdam (Gemeente Amsterdam 2019a), Brussels (Bruxelles Mobilité 2017) and Birmingham (Birmingham City Council 2019). By the same token, the scarcity approach suggests that weakening the allocation mechanisms that produce car space, or weakening appropriation mechanisms (for example, banning sidewalk car parking), could in itself be a powerful (albeit institutionally and politically very challenging) means of countering car lock-in.

In addition, a mobility transitions framework that foregrounds space offers an important counterpoint to more technology-focused transitions research. Our findings suggest that efforts to innovate more sustainable and safe propulsion or driving systems for cars will not, in themselves, address the space allocation imperatives locked-in by cars, emphasising an important distinction among mobility modes that are widely labelled 'sustainable'. Our focus on streets in the aggregate offers a contrast to the more typical focus on specific project sites, or new-build city districts, in scholarship such as that reviewed by Nielsen and Farrelly in their study of conceptualisations of urban physicality from a transitions perspective (Nielsen and Farrelly 2019).

For transitions research as a whole, our framework provides a potentially useful means of highlighting space allocation within place-based, urban, and geographical transitions research, and more broadly, as an institutional aspect of urban mobility regimes that can be assessed at distinct analytical and spatial scales.

Our study is limited by the generalisations required to condense parking and land-use policies for the purposes of comparison in our legal street framework. The legal street, as a notional cross-section of a street, is useful as a representation of the cumulative effect that streets have in shaping mobility transitions (Henderson 2009, 2015). It does, however, ignore the heightened politics of intersections (Prytherch 2015), and relative differences within the city – for example, between centre and periphery. We also leave open the excellent question posed by Nello-Deakin (2019) and Mullen et al

(2014), as to how a fair distribution of road space between modes could be determined or identified; we focus only on the stated aims of our case study sites. Further research is needed to explore the question of how stubborn physical aspects of space interact with relational conceptualisations of space (Coenen et al. 2012), and more empirical work must be done to develop and test the concepts of space claims, allocation mechanisms and appropriation practices in other contexts.

5 Collaborative business models and platforms in shared mobility transitions: the case of bikeshare integration

Abstract: Collaboration between organisations plays an increasingly fundamental role in a growing number of sectors, including Mobility-as-a-Service (MaaS), and has given rise to the Collaborative Business Model (CBM). A review of literature on CBMs provides an overview of CBM interpretations, and finds that tensions between collaboration and competition, and those related to the commons, are major emerging tensions. A further review of MaaS business model literature, and a case study of 3 platforms attempting to deliver bikeshare-inclusive MaaS, focuses on these tensions. The means by which commons resources are made available to MaaS CBMs is found to be a significant determinant of how far these CBMs depart from conventional business model logic and morphology, in part because they determine the leverage that city governments can bring to bear on MaaS CBMs.

5.1 Introduction

Advances in smartphone penetration, geolocation and remote locking, online payment and battery performance have rapidly expanded the technological possibilities of shared access to vehicles in the past decade. These advances have also improved the commercial prospects for shared mobility, especially for smaller, lighter and cheaper vehicles, such as bicycles and micromobility modes (Cohen and Kietzmann 2014). Services that provide shared access to these modes offer cities a relatively rapid means of increasing their mobility offering to residents and combatting car dependency. Ultimately, their success could produce a shift from a global status quo dominated by mass private ownership of passenger vehicles towards an Internet-enabled, integrated system that meets residents' mobility needs without the need for private ownership, especially of motorised vehicles (Machado et al. 2018). Such a shift is considered essential to realising the vision of mobility-as-a-service (MaaS) (Hensher et al. 2020). However, this transition will entail a profound transformation of aspects such as the business models through which mobility services are provided (Heikkilä 2014; Li and Voege 2017; Hensher et al. 2020), and the platforms or interfaces through which these services reach users. Promising innovations such as web-based platforms have already come to play an essential role in connecting users to the multiplicity of (new) mobility service providers. In particular, platforms that accommodate multiple providers merit closer study as they continue to proliferate. These platforms may constitute a distinct kind of business model in themselves, based on a degree of internal collaboration coupled with outward competition between providers. Their potential has also generated interest from the public sector, as local governments seek to harness platforms of this kind to deliver everyday urban mobility services that were formerly provided by the state. This chapter offers an exploratory review of how business models based on collaboration have

been defined in various literatures, and applies the results to a case study of three mobility services platforms shaped by public sector actors.

Recently, the concept of the Collaborative Business Model (CBM) has emerged as a means of describing entities or practices that are characterised by very deep, sustained, and technologically-mediated integration between actors. In contrast to currently dominant frameworks in business model research, such as Osterwalder's Business Model Canvas (BMC) (2004), some proponents argue that CBMs are characterised (inter alia) by value propositions that cannot be satisfactorily analysed in terms of a focal firm and its partners, but depend intrinsically on collaboration between multiple actors (de Man and Luvison 2019).

CBMs are an emergent stream of business model research, although business and management scholars have long attended to the theme of collaboration between firms. In the field of transport/mobility studies alone, scholars have explored collaboration between actors through frameworks such as business ecosystems (Kamargianni and Matyas 2017), business alliances (de Man and Luvison 2019), and agency theory (Cohen and Kietzmann 2014). However, CBMs may offer a more powerful means of describing and analysing the advanced degree of integration and coordination between actors that will necessarily underpin the mature MaaS systems of the future. They may capture transformative features of collaborative entities and practices that are marginal in current business model research but which may occupy a central role in a future in which interoperability across entire sectors is the norm.

For this reason, CBMs may be particularly productive as an organising framework applied to contemporary urban mobility systems, in which progress towards MaaS has been slow and uneven (Mulley 2017). Some scholars have explicitly attributed this lag to unresolved regulatory and institutional barriers that remain long after purely technological ones have been resolved (Berger et al. 2014; Ambrosino et al. 2016). More specifically, research into current empirical attempts to achieve MaaS has often pointed to a conflict between the assumptions of mainstream business model research (for example, the assumption of competition between firms with similar offerings) and the requirements of an integrated mobility system, such as the non-duplication of services (Cohen and Kietzmann 2014). This difference is especially marked given the norm of significant public ownership of 'natural monopolies' in transport (especially rail, trams and buses) in Europe, which created stable conditions for their development and maturation through the 20th century[37]

[37] In 2001, the EU First Railway Package began the process of creating a single passenger rail market.

(Amaral 2008; EC DG MOVE 2019). Insofar as they potentially depart from these assumptions, CBMs may therefore offer novel insights into the limited progress that cities have made towards MaaS.

The analysis of MaaS also offers benefits to current understandings of CBMs, which differ very widely among scholars. The term 'collaborative', in particular, is used to refer to a broad set of meanings both within and beyond CBM literature, some of which are potentially contradictory. For example, Gyimóthy (2017) distinguishes between corporatized extractive models and altruistic communitarian or commons models of collaboration within the term *collaborative economy*. Botsman and Rogers (2011) introduce *collaborative consumption* to refer to Internet-enabled marketplaces as distinct from the more solidarity-minded and mutualist principles of peer-to-peer sharing platforms (especially in the early phase of platform development). In contrast, the term *collaborative* has a smaller range of meanings in the context of MaaS, because of the constraints imposed by the nature of the space required for storing and operating vehicles on public or semi-public[38] land. This space, which is fundamental to MaaS, is typically conceived of and governed as a commons, or common pool resource, and access to it is usually highly institutionalised. This institutionalisation has, in European cities, developed over centuries to produce distinct outcomes and mechanisms for domains such as outdoor restaurant seating, public markets, mass gatherings, and tourist flows (de Magalhães and Freire Trigo 2017; Brandajs and Russo 2019). Furthermore, the means of access to this resource within MaaS differs widely between different modes: the space required by automobiles is generally highly commoditised (as parking space), while that required for modes such as bicycles is usually governed more informally or non-commercially (Petzer et al. in press, 2019).

The study of MaaS platforms that incorporate bicycles (most often in the form of docked or dockless public bikeshare) thus highlights a potentially productive tension within the term *collaborative* (and related terms, such as *cooperative* and *coordinated*) into CBM research. Additionally, considering MaaS platforms that include bikeshare[39] through the lens of the CBM brings to this new field a long empirical record of collaboration around a limited resource (space). This resource constrains, and is constrained by, the incentive for firms to compete, as this has been a constant feature of urban mobility governance for centuries (Gössling et al. 2016; Akyelken et al. 2018). The effects of this constraint are most pronounced in the case of platforms that already include, or make provision for,

[38] 'Public land' here refers to land owned by the state and intended for public use, such as roadways, sidewalks and squares. Semi-public here refers to space that is generally perceived as public and operates much like public land, but is owned or operated by a private firm, such as parking space at railway stations or what Carmona (2015) terms 'pseudo-public' spaces, such as London's privatised public squares.
[39] Following Fishman (2016) we define 'bikeshare' as shared cycling-based mobility systems providing temporary access to any form of bicycle and variations thereof, that is available to the public.

multiple providers of services based on the bicycle. This difference constitutes an essential distinction between MaaS and other parts of the 'collaborative economy', where commons resources may well be significant, but are seldom fundamental to day-to-day operations[40] (Karppanen 2017; Nieuwland and van Melik 2018).

The meaning of *collaboration* in the empirical field of MaaS platforms that include bikeshare may therefore depart in significant ways from its meanings (which are themselves diffuse) in business model research[41]. By the same token, the forms of de facto collaboration, cooperation or coordination that can be empirically observed in these MaaS platforms could produce a more nuanced understanding of the nature of collaborative business models in general, and the diversity contained within this term. We thus propose to further develop and critically assess the concept of CBMs that offer consumers access to bikeshare as a service (both on its own and as part of wider MaaS platforms), to answer our research question: *What are the existing challenges in creating MaaS platforms that integrate multiple bikeshare providers, and how could CBMs contribute to overcoming these?*

In this paper we discuss how CBM can be defined in relation to MaaS, identify current efforts to integrate bikeshare into MaaS platforms, and assess the challenges in these efforts. We address these questions by conducting a systematic literature review into conceptualisations of CBMs across various subject areas in section 5.3.1. We supplement this with a thematic analysis of a systematic review of literature on the business models of MaaS platforms in section 5.3.2. To underpin our theoretical findings, we analyse three cases - the Netherlands, Antwerp (BE), and Helsinki (FI) - in light of these organising concepts by drawing on interviews and grey and academic sources in section 5.3.3. In particular, we will investigate, in greater detail than previous studies, the extent to which MaaS platform formation and bikeshare integration in these cases is the result of voluntary 'collaboration', or a response to conditions imposed by government, and the consequences of these distinctions for the balance of risk and alignment between organisations (Li et al. 2018). We discuss how the CBM concept could contribute to the success of bikeshare-inclusive MaaS platforms in section 5.4, and provide conclusions and recommendations for further study in section 5.5.

[40] For example, research has shown that Airbnb has significant impacts on the 'commons' of neighbourhood liveability and affordability in certain contexts, but these effects are not yet well quantified or legally defined (Nieuwland and van Melik 2018). In contrast, public space is explicitly governed by regulations around its permanent and temporary use.

[41] These definitions range from a mechanism requiring a dynamic of mutual trust between partners (Aagaard 2019, p. 215) to the coordination of outward-facing actions (such as resource acquisition) between organisations (Dreyer et al. 2017).

5.2 Methods

The systematic literature review method has been developed in the social sciences to synthesise findings from large bodies of information, especially where key concepts remain undefined or contested (Petticrew and Roberts 2006, p. 21). We employed a 7-part systematic (literature) review approach to establish how CBMs are currently conceptualised across academic literatures. To ensure consistent quality and peer reviewed status, we limited our search to Scopus, using the search term *TITLE-ABS-KEY ("collaborative business model*")* to retrieve 92 initial results, which were screened for relevance[42]. This process yielded 50 results which were coded using NVivo® software in an iterative process until saturation was reached. The rationale for coding was to establish the heterogeneity of interpretations or definitions of CBMs (see Addenda for sample lists and code tables).

The systematic review succeeded in providing an overview of heterogeneity in the meaning of CBMs, as well as a survey of related terms and their respective similarities and differences relative to CBMs. However, none of these sources addressed the field of MaaS, and only one addressed the question of commons or common pool resources to any extent (Cohen and Muñoz 2015). We therefore conducted a second literature review to establish how and which business model terms were used to describe existing MaaS platforms, with an emphasis on the role of dominant business model frameworks (like the BMC) versus novel or niche frameworks. This survey was informed by the findings of the first[43], resulting in the Scopus search term TITLE-ABS-KEY ("business model*" OR "business ecosystem*" OR "alliance formation") AND TITLE-ABS-KEY (bikeshar* OR "maas" OR "mobility as a service" OR "shared mobility"), which returned 45 initial results. This comprehensive sample was refined to 26 sources[44] for further thematic coding using NVivo® until saturation was reached.

We supplemented the generic and theoretical findings of two sets of surveys of peer-reviewed journal articles with the particular and embedded findings of multi-site case studies of MaaS platforms that included bikeshare. Multi-site case studies are effective means of testing theoretical assumptions against empirical data, revealing variations among ostensibly similar cases, and defining new areas for research by exposing unanticipated findings (Yin 2014). We selected three

[42] Exclusion criteria: sources that mentioned but did not discuss CBMs; that focused solely on operational technical aspects of CBMs (for example, business process engineering).
[43] For example, our inclusion of “business ecosystem” and “alliance formation” as alternatives to *business model* was prompted by highly relevant sources in the first survey that employed this term
[44] Exclusion criteria: sources that explicitly excluded bikeshare or any form of micromobility (due to the modally distinct nature of open space allocation discussed above), or that focused on developing-world contexts (as our study cases were limited to high-income European contexts).

Northwestern European MaaS platforms for further study by means of semi-structured interviews with MaaS platform designers or project initiators, supported by web searches for grey literature published by these same platforms, as well as selected academic sources mentioned in grey literature or in interviews. The choice of platform designer or initiator as research participant allowed us to focus on the MaaS platform itself as an example of a potential CBM, and the design choices and constraints that shaped these platforms. Our interview questions aimed to inform limited organisational case studies focussing on a parameter of interest (MaaS platform design and structure), rather than the business ecosystem of each MaaS case as a whole, or the business models of participants in the platform. Our interview questions therefore asked platform designers to describe their platforms in terms of BMC categories (namely, Key Partners; Key Activities; Key Resources; Value Propositions; Customer Relationships; Channels; Customer Segments; Cost Structure, and Revenue Streams) to aid comparison with the results of our literature surveys. These questions were supplemented by more open-ended questions regarding the aims and objectives of the platform, and the challenges encountered in operationalising it, to capture aspects of each case that may diverge from, or not be easily expressible within, the parameters of the BMC (see Section 5.6 for interview protocols, a list of interviews, and a list of grey literature sources).

Three cases were selected for contrast in scale, in degree of initial success in achieving bikeshare-inclusive MaaS integration, and for consistency as relatively wealthy Northern European urban contexts. The first case is the CROW Deelfietsdashboard, a Dutch multi-city proto-platform for interoperable bikeshare that is currently in its pilot phase, and which is intended to serve as the basis for a public-facing app. The second is the Antwerp Marketplace for Mobility, which already includes a public-facing app. In both the Dutch and Belgian cases, the platforms are limited to the provision of wayfinding and information services, and cycling modal share is very high by global standards. The third case, Helsinki's Whim app, is one of very few current examples of a MaaS platform that provides public-facing services beyond wayfinding and information; here, cycling modal share is much lower than in the Dutch and Belgian cases. The three cases vary widely in terms of platform design, in terms of regulatory context and their relationship with institutional gatekeepers of common resources, and in terms of the services they offer. By means of interviews and a review of grey and selected academic literature related to these cases, we contrast theoretical claims made in academic literature about CBMs and MaaS respectively, with the challenges arising from real-world attempts to operationalise bikeshare-inclusive MaaS.

5.3 Results

Our analysis of the CBM literature sampled reveals three distinct interpretations of the word 'collaborative', as well as two characteristic tensions within CBMs: namely, that between collaboration and competition, and that surrounding the role of place and the commons in CBMs. We find that only a small minority of sources (see group 3 in Table 19) explicitly describes CBMs as analytically distinct from other existing BM frameworks, especially Osterwalder's BMC (2004). In all other sources, CBMs serve either as a means of describing the practice of collaboration between organisations (group 1), or as a reference to sectors deemed to belong to the sharing (or 'collaborative') economy (group 2). These three sets of interpretations provide a valuable overview of the theoretical and empirical uses to which the term CBM has been put.

5.3.1 Systematic review of CBM literature

Table 19: Coding frequency and data for CBMs

Group of sources derived from coding	Coding: Files	Coding: References	Would exist without collaboration	Can be expressed in conventional BM terms	Focus
Group 1: CBMs as practice	29	34	Yes	Yes	B2B
Group 2: CBMs as activity or sector	13	14	No	Yes	B2B, B2C, for-profit P2P
Group 3: CBMs as analytically distinct	5	5	No	No	B2C, B2G, non-profit P2P

Group 1: Collaboration refers to practices that occur between organisations

In the great majority of sources, CBMs are deployed as a descriptor for collaborative practices that take place between organisations (B2B). These practices vary widely within the sample, from structured and contractual to informal and sporadic, but all are essentially activities undertaken by organisations that are or could be described in conventional BM terms. For this group, 29 out of 50 sources, the term 'CBM' is thus a descriptor of collaborative *practices*, not of a distinct type of BM. These practices vary widely in scale (some connect entire value chains, others only consist of regular coordination between two firms), and are found across many sectors (including manufacturing, the service sector, and product-service firms). In general, within this group, the impetus or rationale for undertaking collaborative practices is provided by anticipated competition from rivals due to technological advances, market forces, or established practices within a particular sector, but the decision to initiate collaborative practices is voluntary and strategic; further, the collaboration practiced here is most commonly business-to-business (B2B), although consumers feature in some collaborations as significant and influential actors.

Group 2: Collaboration refers to one organisation's key activity or sector

In a smaller group of sources, CBMs are used as a descriptor for single organisations whose business it is to facilitate collaboration, or who operate within a sector that the source considers to belong to the *collaborative* or *sharing economy*. As with group 1, these sources deploy the term CBM to refer to organisations with conventional BMs; in this case, these organisations profit financially from providing the means for others to collaborate, whether on a B2B, business-to-consumer (B2C), or for-profit peer-to-peer (P2P) basis. Group 2 includes many platform-based organisations, whose BM centres on the management of a platform as infrastructure for collaboration, as well as many project-based consortia. The 'collaboration' referenced in this use of CBM broadly serves as a synonym for activities that have traditionally been provided on a commercial basis (such as coordination activities, matching, and networking), for which the advent of new communications technologies such as the Internet and smartphones represent an opportunity in terms of lower transaction costs, expanded potential markets, or more efficient matching and coordination. Unlike group 1, organisations in this group depend on collaboration as a primary activity; within this group, a number of organisations have been set up explicitly as joint ventures or project-based consortia, while others have been founded in order to exploit perceived opportunities within the collaborative sector (such as Airbnb).

Group 3: Collaboration refers to a kind of BM that is analytically distinct from the BMC

The smallest and final group are presented in 5 sources as analytically distinct from conventional BMs on a number of grounds. Bleja et al (2018, 2019) present a CBM as a *collaborative system business model* (CSBM) that is identical to the BMC in structure, but exists above the level of the individual BMCs of partner organisations, coordinating and consolidating their activities. For Grossman et al (2017), the distinctiveness of a CBM from the BMC resides in its value proposition, which is irreducible to the value propositions of partner organisations, even if that value proposition is delivered or realised by the activities of individual partner organisations. As such, these sources argue that that the organisations concerned could not exist except on the basis of collaboration, and also cannot be adequately articulated in BMC terms. These organisations serve a range of markets including B2C, business to government (B2G), and not-for-profit P2P, as in the case below.

CBMs, commons, and the city

Three further sources within group 3 consider CBMs as analytically distinct due to their relationship with the commons in general (Gyimóthy 2017), and place, or the physical commons of the city (Cohen and Muñoz 2015; Muñoz and Cohen 2016), respectively. Gyimóthy (2017) introduces a

distinction between two types of BMs within the sector of the collaborative economy, arguing that the term CBM has been widely but erroneously attributed to a particular archetype of "corporatized extractive model" (such as Airbnb) that in fact represents a very conventional BM applied to the collaborative sector. Airbnb is an example of this model, in which individual private assets are exploited and the 'commons' of residential neighbourhoods monetised without an efficient mechanism by which the community can limit or demand compensation for the externalities of that monetisation (Nieuwland and van Melik 2018). In opposition to this type of BM, Gyimóthy (2017) discusses the "communitarian or commons" model of the collaborative economy, which differs intrinsically from the BMC in a number of ways. This Commons CBM is premised on solidarity, mutuality and co-ownership. Value is created through non-monetary exchange on a basis of reciprocity, mediated by a strong commitment to a physical or digital commons (such as a place, a natural resource, or a virtual community). The role played by the commons in Gyimóthy's commons CBM differs substantively from the assumptions of the BMC in areas such as key resources (which are shared in perpetuity between stakeholders) and revenue streams (which are non-financial).

Cohen and Muñoz (2015; 2016) argue that one kind of CBM is that created in practice through the work of purpose-driven urban entrepreneurs. This is a response to the limitations of conventional business models in the face of complex, interconnected urban challenges, which tend to be strongly mediated by various urban commons (such as urban space). Purpose-driven urban entrepreneurship, and the CBMs it gives rise to, have a number of characteristics that are unique in our sample. Firstly, Cohen & Muñoz situate CBMs explicitly in the city, for which CBMs are both locus and focus, using an approach to urban entrepreneurship that draws on the related concept of the *place-based enterprise* (PBE) (Shrivastava and Kennelly 2013). Secondly, while other sources have treated the impetus or incentive to collaborate as voluntary and strategic, the complexity and physical constraints of cities mean that collaboration is not optional for urban entrepreneurs, but a requirement imposed by place. Lastly, through their engagement with place, urban entrepreneurs are obliged to collaborate with the public sector actors tasked with the stewardship of public goods or the commons, or what Poderi (2019, p. 244) terms *gatekeepers*, making the articulation of the commons an essential component of CBMs for urban entrepreneurship. The urban entrepreneur is "embedded in place", and aims to resolve "unique, interconnected city challenges" (Cohen and Muñoz 2015, p. 2) in close collaboration with public and private-sector actors. This requires that the entrepreneur respond not only to a local 'market' but to the tangible, physical and geospatial circumstances of the city and its "place-specific anomalies", including deeply embedded social, cultural and political conditions (Shrivastava and Kennelly 2013; Cohen and Muñoz 2015, p. 2).

Balancing competition and collaboration: CBMs and platform competition

Within our sample, the term *collaboration* is used with much of the same variation as the term *CBM*: as a descriptor for both formal and informal interaction between organisations, as a sectoral designation for organisations in the *sharing* or *collaborative economy*, and additionally as a method for BM design. In this study, we therefore employ the term *collaboration* to refer to purposeful interaction between organisations in the broadest sense, without connotations of altruism or an assumption of common purpose or alignment of interests between collaborating partners. The most specific interpretation of collaboration in our sample is that of Salazar (2015), who presents it as the antithesis of classical competition. On this basis, Salazar argues that CBMs exhibit *platform competition*, a kind of behaviour that is distinct from the assumption of rational competition between organisations embedded in the BMC (Osterwalder 2004), because it imposes value co-creation and shared appropriation as a collective project for all platform participants. As such, it resembles the *keiretsu* phenomenon of interfirm co-specialisation in manufacturing (Dyer 1996), although service or product-service platforms are less often tied to a focal firm or dominant design. Platform capitalism therefore departs from elements of the BMC such as the assumed relationships between the firm and key partners, as competition *within* platforms is balanced by the mutual interest that platform participants have in competition *between* their platform and others, and positive network externalities are an essential factor for the success of the platform.

These three conceptions of CBMs differ substantially in their implicit or explicit definition of what CBMs are, but share a common emphasis on interdependence between the focal firm and other entities or actors that is not an inherent feature of the BMC. This interdependence, which serves as an impetus for collaboration, takes two forms in our analysis. Firstly, the majority of CBMs across our sample are subject to tensions between collaboration and competition, which in BMC terms can be expressed as a departure from the assumptions that underpin the category of Key Partners. Secondly, the CBMs presented as analytically distinct (group 3) are subject to significant tensions surrounding the commons. These themes of collaboration versus competition, and of engaging with the commons, are also prominent in MaaS and bikeshare literature, and will therefore be developed as common points of reference between these two literatures. They are discussed in the following sub-sections.

5.3.2 MaaS platforms: competition, collaboration and the commons

A discussion of business models across the scientific literature on MaaS is beyond the scope of this study. For our purposes, we limit ourselves to a discussion of key terms within the MaaS literature that describe elements of MaaS business models. We follow Smith and Hensher (2020) in

considering MaaS to be composed essentially of a single digital platform which grants users access to mobility services across multiple modes. This *mobility services* or *MaaS platform* (alternatively, a mobility *broker* or *aggregator*) integrates *mobility services* to connect *mobility service providers* (MSPs) – those who operate the physical means of transport, such as vehicles - with the users who demand mobility services. The data generated by the mobility system – such as route and timetable information for public transport, or trip data for bikeshare – constitutes a *data commons*, when it is (potentially) accessible as a common resource, and is often given form through *API*s. The data commons has a finite and tangible analogue in what Petzer, Wieczorek and Verbong (2019) term the *physical commons*, or the finite stock of urban open space that is available for the movement and storage of vehicles; Meurs et al (2020) refer to a similar concept when they describe *complementary network resources* as the supporting physical infrastructure that enables mobility services. Access to the physical commons is highly institutionalised and regulated, as well as modally distinct, and is governed by the *city government* acting as a commons gatekeeper or steward. This gatekeeper role can sometimes take the form of a *spatial monopoly* operated either by a government, or a public transport authority with exclusive right to operate certain mobility services within a geographic area.

These terms are drawn from sources that vary considerably in focus and in their approach to MaaS, from studies of private-sector MaaS business alliances (Smith et al. 2018; Meurs et al. 2020) to a focus on public-sector MaaS policies (Smith and Hensher 2020), and using methods ranging from MaaS business model prototyping (Polydoropoulou et al. 2020) to econometric modelling of business models (Wong and Hensher 2020).

The points of agreement across our sample touch on a set of interconnected problems.

Firstly, sources attribute the small number of full-service MaaS platforms operational today to the challenge of the complex and novel partnerships that MaaS requires between multiple private and public-sector actors in a rapidly-evolving sector (Mulley 2017).

Secondly, the degree of integration and interoperability that MaaS will demand at scale from platform participants remains a technical and organisational challenge within current regulations, even when this level of collaboration is entirely voluntary (Meurs et al. 2020).

Table 20: MaaS terms used in this study

Term used in this study ***with alternatives***	**Role or description**
MaaS platform *Mobility broker or aggregator* (Meurs et al. 2020; Wong and Hensher 2020; Pangbourne et al. 2020)*; aggregator* (Jittrapirom et al. 2017)*; MaaS operator* (Polydoropoulou et al. 2020)	Integrates mobility services to connect demanders and suppliers of mobility services using an internet-enabled platform
Mobility service provider (MSP) *MaaS partner* (Polydoropoulou et al. 2020)*; transport provider* (Meurs et al. 2020)	Operates the physical means of transport – vehicles, with and without drivers
Data commons (Pangbourne et al. 2020)	A description of a state in which public data useful in mobility service provision is commonly accessible
API (Audouin and Finger 2018, p. 5)	An application programming interface provides a feed of data about transport, such as route and time information for public transport
Physical commons (Petzer et al. 2019) *"physical resources"* (Polydoropoulou et al. 2020, p. 158)*, Complementary Network Resources* (Meurs et al. 2020)	The physical stock of open public space available for the storage and movement of vehicles, especially informal parking space
City government (Polydoropoulou et al. 2020)	Oversees and safeguards urban commons
Spatial monopoly (Meurs et al. 2020, p. 4)	An MSP provider holding a monopoly on transport within a geographic area

Thirdly, a number of sources acknowledge that the fixed-route, high-volume public transport modes (rail, buses) and active modes (bikeshare) which are viewed as the backbone of MaaS, and the core of its sustainability and accessibility promise, also offer very low profit margins, and have traditionally been supported by public subsidy as a result (Smith and Hensher 2020). In contrast, the private mobility services offered on MaaS platforms seek to maximise private profits for their owners. Further, the interests of private mobility services may align closely with those of the incumbent, ownership-based regime, such that the former could potentially stabilise (rather than disrupt) the latter, as Wells et al (2020) demonstrate with respect to 'automobility-as-a-service'. Combining these kinds of services within a single organisation is a key concern in the design and operation of MaaS platforms.

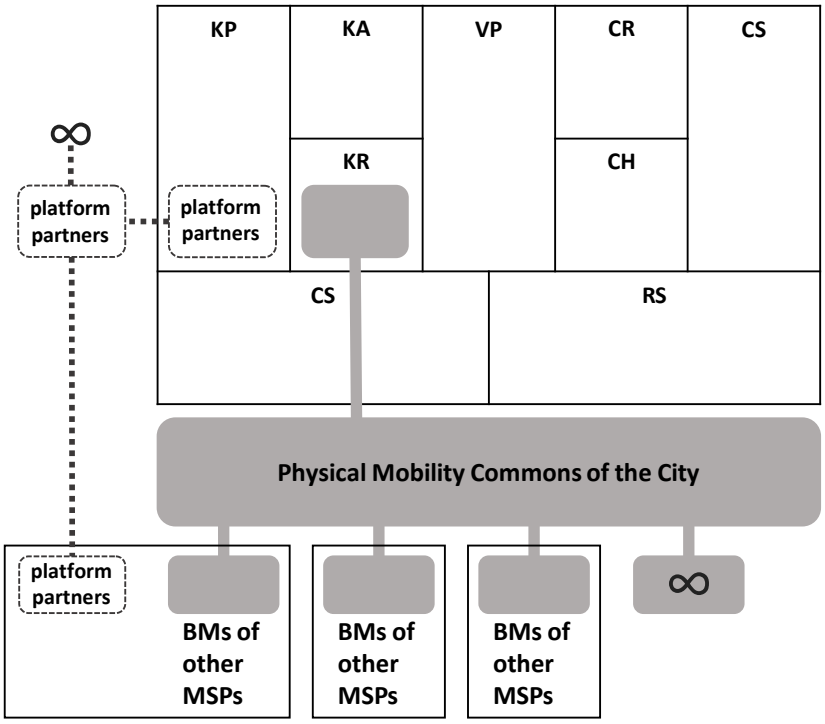

Figure 5: The physical mobility commons in relation to the BMs of a focal MSP and other MSP

The tensions identified in the CBM literature are also present in studies of MaaS. These factors are presented in *Figure 5*, in which the diagram at top right represents a MaaS firm's business model using the conventional elements of the BMC (Osterwalder 2004)[45], while the infinity symbols represent the open-endedness of the composition of the set of platform partners. The problem of a lack of control over platform partners, and that of deep dependence on reliable access to the contested key resource of the physical commons, is a key concern for MaaS firms. It is represented here by the extension of the physical mobility commons of the city (in grey) into the business model of the MaaS firm at top right (as a key resource, labelled KR), and also into the business models (labelled BMs) of other MSPs. The physical mobility commons is therefore outside of the focal firm's control, but also simultaneously in demand by an unlimited number of other claimants of space (represented by the infinity sign at bottom left), both within and beyond the mobility sector. Platform partners may also be added to or reduced against the wishes or the interests of the focal firm, especially in cases where local governments play a strong role in regulating platforms or require platforms to be created.

[45] Where KP = Key Partners, KA = Key Activities, KR = Key Resources, VP = Value Propositions, CR = Customer Relationships, CH = Channels, CS = Cost Structure and RS = Revenue Streams

5.3.3 Case studies

The Deelfietsdashboard/Openbike (Rotterdam and other cities, NL)

In the Netherlands, bikeshare has long been integrated into public transport through the highly successful OV-Fiets system, a 24-hr bike hire system operated across the country's railway stations by the national railways. Following the rapid arrival of dockless bikeshare providers in Dutch cities in 2017-2018 and ensuing regulatory backlash in major jurisdictions (Petzer et al. 2019), the Netherlands' five largest cities[46] signalled in 2018 that they would henceforth allow dockless bikeshare providers to operate only through a single, interoperable platform, after the model of the OV-fiets (Slütter 2018)[47]. This platform would support governance of the physical and data commons by cities (through data sharing) and, more significantly, allow any user access to the services of every bikeshare provider present on the platform (Fietsberaad 2018). This leveraging of access to some of the world's largest cycling markets against the achievement of a high degree of integration prompted the creation of the Openbike[48] initiative (de Haan 2018; Slütter 2018). Openbike brought together 12 bikeshare providers in a collective attempt to satisfy these requirements by developing a common technical standard in partnership with the 5 city governments. Funding for a pilot project to set up a test platform came from the Netherlands Ministry of Infrastructure & Water, which culminated in the *Deelfietsdashboard* ('bikeshare' dashboard). In this phase, the function of the Dashboard was to relay real-time operations and geolocation data from MSPs to city governments for monitoring and enforcement of the activity in the physical commons. This phase was explicitly intended to lay the groundwork for a public-facing full-service platform (Boor and Vincent 2019) by March 2019, structured around the GBFS+ data-sharing standard. At the time of writing (September 2020), progress towards this goal has stalled (Boor interview, 13/05/2020 and 16/07/2020), due to the challenges MSPs encounter in attempting to modify their business models to prepare for interoperability of services with other MSPs.

The first of these is the variation in value propositions and size between these individual MSPs, which range from multimillion-dollar multinationals to one-person startups (Petzer et al. 2019), as well as major differences in the duties and deposits they require users to perform and pay (Boor interview, 13/05/2020). A second fundamental challenge lies in the aggregation of users acquired by

[46] Amsterdam, Rotterdam, The Hague, Utrecht and Eindhoven

[47] "Evenals de gemeenten Amsterdam, Rotterdam, Utrecht, Den Haag en Eindhoven die interoperabiliteit als voorwaarde stellen voor het toelaten van deelfietsen in de stad" (Slütter 2018, p. 27).

[48] Participating providers are: BimBimBikes, Cykl, Donkey Republic, Du Nord/Haagsche Stadsfiets, Emotion sustainable mobility, FlickBike, Hello-bike, Mobike, Nextbike, Urbee, Luud Schimmelpennink and Gobike. The national giant, OV-Fiets, is noticeably absent.

each provider into a common pool accessible to all, especially in light of the cost to firms of acquiring a user. Thirdly, the access to their respective commons that cities have promised, and the specific performance, enforcement and rebalancing requirements that major jurisdictions such as Amsterdam and Rotterdam have already signalled in new, dedicated policies (Gemeente Amsterdam 2017a; Gemeente Rotterdam 2018), combine to impose high minimum operational costs on providers, against no guaranteed minimum in profits (Boor interview, 16/07/2020). Lastly, the public interface of any potential platform would have to resolve design issues rich in potential conflicts, such as the prominence given to each provider for a potential user request or query (Slütter 2018).

The Openbike initiative therefore develops out of what might be called coerced collaboration: dockless bikeshare MSPs initiated this collaboration in response to a decision by the Netherlands' largest cities to exclude dockless bikeshare from the physical commons (that is, to refuse these MSPs permission to operate on public land and use public bicycle parking) absent an interoperable platform. In BMC terms, this could be articulated as a loss of control over the Key Partners that individual MSPs, as well as the mobility platform itself, must collaborate with to deliver interoperable services. Indeed, the challenge of combining direct competitors on a single platform has, to date, proven overwhelming, and more recent developments in Amsterdam indicate that the city has abandoned its support for an interoperable platform in favour of local concessions in which 3 MSPs will be invited to operate a fixed fleet size for a fixed term (Gemeente Amsterdam 2019b).

The commons aspects of the Dashboard affect the Key Activities and Key Resources elements of the BMC. In its current pilot phase, a key activity of MSPs is to contribute to the data commons through APIs that allow participating local governments to see all authorised dockless bikeshare activity in real time. This contribution is an interim step to the original vision of the five cities, which is that access to their physical commons would be conditional on success in creating an interoperable platform for all (dockless) bikeshare MSPs. This case is conceptually illustrated in Figure 6, which represents users (in darker grey at top) connected by arrows to the MSPs whose services they consume. These public transport, bikeshare and automobility MSPs each make claims on the physical mobility commons of the city (in light grey at bottom); these claims overlap for different MSPs belonging to the same mode, creating a distinct public transport ("PT"), bicycle and car commons. City government (at left) is adjacent to the commons, and creates regulations (a dotted line) that restrict commercial access to the physical commons in Dutch cities. These regulations affect other MSPs but are suspended for bikeshare MSPs included in the "Bikeshare MaaS Platform" (medium grey, where the dotted line is suspended). This platform thus offers an enhanced service to users (represented by a thicker arrow) as a result of its wide range of MSPs.

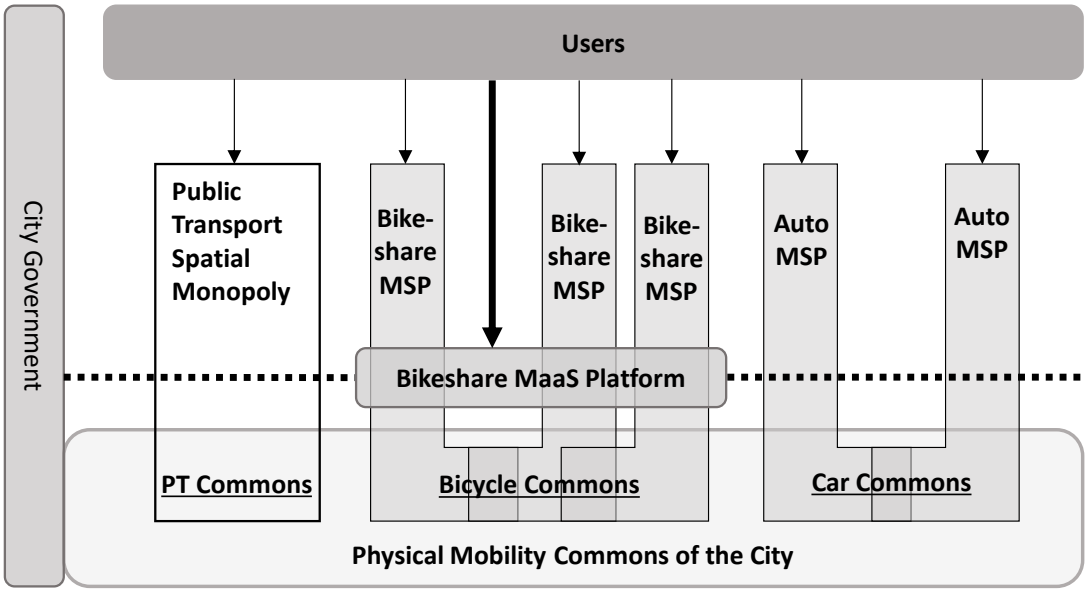

Figure 6: A conceptual model of the physical mobility commons of the city in relation to compulsory bikeshare MaaS platforms, users, government, and other MSPs

Antwerp Marketplace for Mobility (Antwerp, BE)

In Antwerp, a city of 520,000 and home to Europe's second-busiest port, imminent major roadworks required for freight movement required a concerted approach to the city's mobility as whole, in order to preserve accessibility for residents. In 2016 this broad agenda prompted the creation by the City of Antwerp and its partners[49] of the Marketplace for Mobility (MfM), which is described as a 'cooperation framework' including three forms of commercial partnership, rather than a market platform (Kishchenko et al. 2019a). The MfM could be described as a proto-platform, in that all formal relationships are between the city and individual service providers. The city retains full control of the physical commons of Antwerp by structuring MfM interactions on a clearly-defined project basis on "no fix, no pay" terms, meaning that no measurable impact means no financial support from the city (Kishchenko et al. 2019a; Vernaillen 2020).

Furthermore, in commons terms, the city makes it mandatory for all mobility service providers to limit their fleet size, to share data with the city, and to be integrated, at least on a data-sharing level, with at least 2 MaaS platforms. This leveraging of access to the city's physical commons against a requirement for contribution to the data commons has produced striking results: Antwerp is the only global market in which Bird, a last-mile electric scooter provider operated by the powerful rideshare giant Uber, shares data in this way (Vernaillen 2020). Antwerp also offers its own

[49] The Antwerp Port Authority, the Province of Antwerp, the Belgian federal railways (NMBS), the Flemish transport authority (De Lijn), the Antwerp mobility authority (beheersmaatschappij antwerpen mobiel) and a mobility consultancy (Traject).

wayfinding and information platform, which will soon offer full MaaS services: direct access to multiple service providers, payment, tax and payroll integration (Vernaillen 2020), all built around an open-data, open-source platform standard with no vendor lock-in (Kishchenko et al. 2019a; Maroey 2019).

As with the Deelfietsdashboard, the set of Key Partners with which any individual MSP must necessarily partner, is outside of its control, since collaboration in the city's official platform is a requirement for any MSP that seeks access to Antwerp's physical commons. Figure 7 represents the Antwerp case conceptually. In contrast to the previous case, it shows a multimodal MaaS platform that also incorporates all of the MSPs within each mode. The pair of horizontal dotted and solid lines interrupted by the platform represent the various modally-specific regulations that limit access to the physical commons; the city-backed platform ("MaaS Platform") partially shields participating MSPs from these.

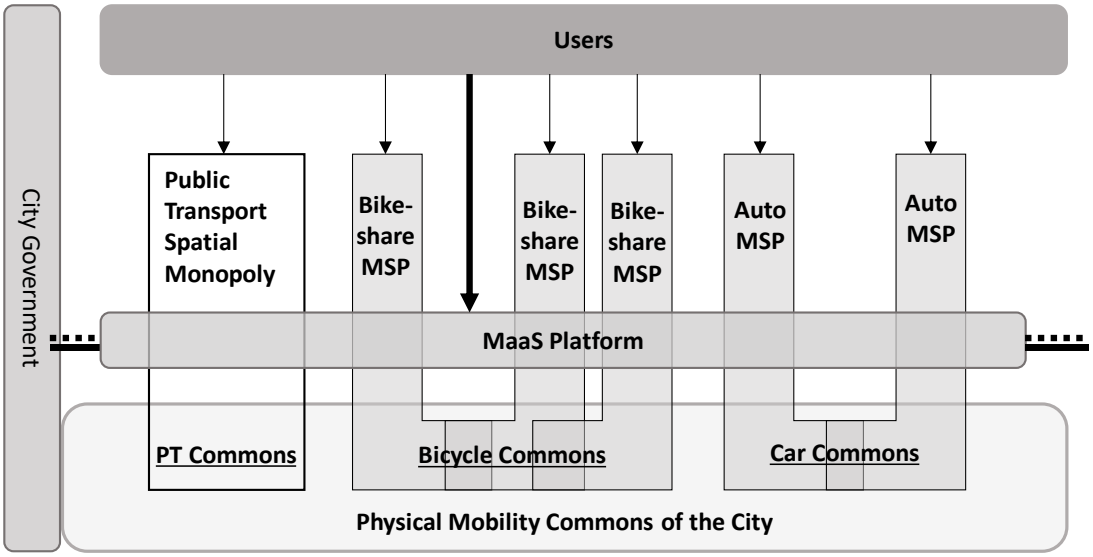

Figure 7: A conceptual model of the physical mobility commons of the city in relation to a compulsory multimodal platform, users, government, and other MSPs

Whim Helsinki (Helsinki, FI)

Helsinki is home to Whim, the world's first platform to provide full MaaS services (wayfinding, information, booking, un/locking, and payment). Whim, launched by the firm MaaS Global in 2016, is the outcome of more than a decade of purposeful state planning, starting with Finland's world-first Intelligent Transport Strategy in 2009, and culminating in the Transport Services Act (TSA) of 2017, the world's first comprehensive national legislation for the regulation of MaaS (Kivimaa interview, 30/06/2020). The TSA, for example, abolished quotas on mobility service fleet sizes; required all transport service providers to make essential data such as route, timetable and fare information

publicly available; and established a framework for full interoperability of ticketing by requiring mobility service providers to open their ticket APIs (Audouin and Finger 2018)[50]. The TSA therefore created a publicly accessible and legally defined and enforced data commons for the kinds of information that MaaS platforms depend on. These requirements were informed by close but informal cooperation between the City of Helsinki and the founder of MaaS dating from 2013, in which an agenda of regulatory changes required for a successful MaaS platform was established (Heikkilä 2014; Audouin and Finger 2018). This cooperation continued as the City of Helsinki positioned itself as an international champion of MaaS, leading in 2015 to an open call for the creation of a private-sector MaaS firm. Out of 200 interested parties, 23 went on to collaborate through a new organisation, MaaS.fi, which went on to release Whim (as MaaS Global) in 2016.

The Whim platform business model is therefore an example of voluntary collaboration between competing firms to create a new organisation. The resulting joint venture operates a MaaS platform that acts much like a profit-making private sector firm, as it integrates the mobility services of both public and private-sector MSPs into a platform that presents the public with full access to all modes, according to various subscription models (Ramboll and MaaS Global 2019; Hietanen interview, 13/12/2017). Figure 8 presents the case of MaaS in Finland in conceptual terms. In the Finnish case, the mandatory creation and maintenance of a data commons of basic information that can support MaaS platforms allows for the possibility of many MaaS platforms that offer different combinations of modes. Some, such as a rival platform pioneered by a public transport operator (white box), may attract a significant user base in their own right, and produce a different form of competition between service providers. The pair of dotted and thick solid lines emanating from "City Government" represent modally mediated regulations that limit or constrain access to the physical commons; these remain in operation and apply to the various MaaS platforms. However, unlike in Antwerp (29%) (Broer 2016) and in Dutch cities, the bicycle has a small modal share in Helsinki (6% in 2012) (Ramboll and MaaS Global 2019), meaning that the "Bicycle Commons" – referring to the sum of the infrastructure and space required for bicycle movement and storage on public land – is relatively less saturated and contested by users.

[50] Taxi, ride-hailing and ride-sharing services are largely excluded from these requirements (including the surge pricing mechanism pioneered by Uber), although in October 2020 the Finnish Government tabled specific amendments to the Act that require greater price transparency for this sector (Finnish Government 2020).

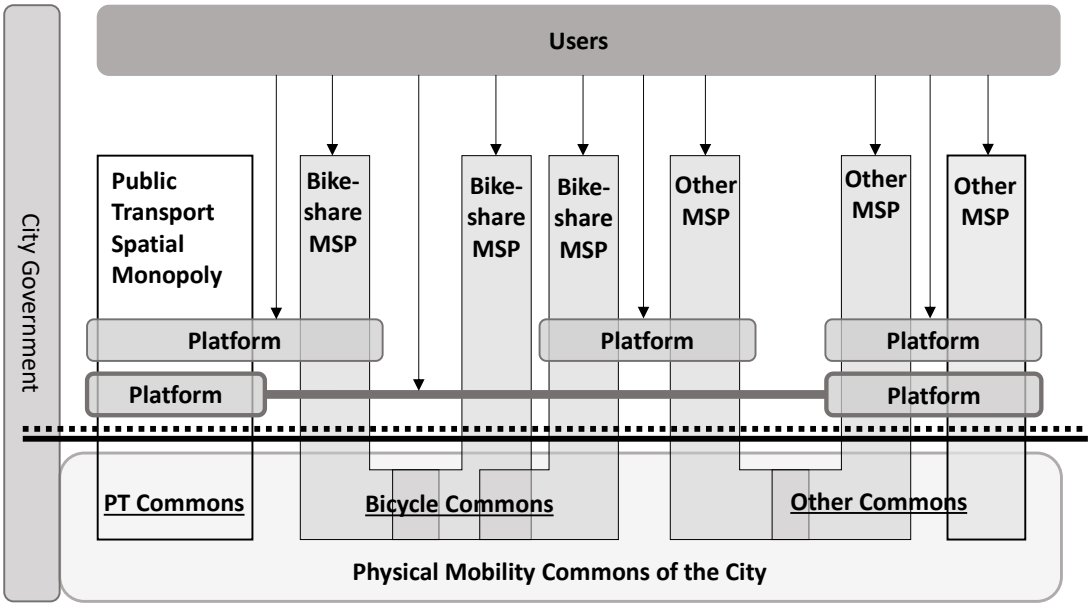

Figure 8: A conceptual model of the physical mobility commons of the city in relation to multiple platforms, users and government

5.4 Discussion

The cases of an interoperable bikeshare platform in the Netherlands, a multimodal proto-platform and 'cooperation framework' in Antwerp, and a true MaaS platform in Helsinki that originated as a collaborative business, present clear contrasts in the areas of competition versus collaboration, and that of coding and valuing the commons (see Table 22).

Table 21: Key characteristics of MaaS platforms per case

Case country	Conditions for MSP collaboration	Data commons conditions	Conditions for MSP access to physical commons	Services offered by platform
NL	Mandatory	MSPs must share with cities	(Initially) Strictly conditional on platform participation	Pilot: to city governments – trip and fleet information
BE	Mandatory	MSPs must share with city	Identical to those for private citizens	To public: information and wayfinding (further services planned)
FI	Optional	Both cities and MSPs must share data publicly by law	Identical to those for private citizens	To public: information, wayfinding, plus full services – booking, un/locking, payment

Figure 8 presents the case of MaaS in Finland in conceptual terms. In the Finnish case, the mandatory creation and maintenance of a data commons of basic information that can support MaaS platforms allows for the possibility of many MaaS platforms that offer different combinations of modes. Some, such as a rival platform pioneered by a public transport operator (white box), may

attract a significant user base in their own right, and produce a different form of competition between service providers. The pair of dotted and thick solid lines emanating from "City Government" represent modally mediated regulations that limit or constrain access to the physical commons; these remain in operation and apply to the various MaaS platforms. However, unlike in Antwerp (29%) (Broer 2016) and in Dutch cities, the bicycle has a small modal share in Helsinki (6% in 2012) (Ramboll and MaaS Global 2019), meaning that the "Bicycle Commons" – referring to the sum of the infrastructure and space required for bicycle movement and storage on public land – is relatively less saturated and contested by users.

In theoretical terms, the forms of collaboration that exist de facto between organisations and other stakeholders in our three cases have much in common with other MaaS platforms surveyed in our snowball literature review, but little in common with the CBM examples in our systematic review. This illustrates, in particular, the difference that mobility makes, in tying firms that have otherwise conventional business models to the very particular constraints of the public outdoor space required for moving and storing shared vehicles.

In contrast, governance actors' objective to achieve public goods by compelling firms with conventional business models to collaborate deeply through platforms serves to illustrate the potential of collaborative business models to deliver on these social agendas. This is especially marked in the case of purpose-driven urban entrepreneurship (Muñoz and Cohen 2016). In the Dutch case, these aims have not been met, and progress towards an interoperable national bikeshare platform is arguably moribund. The objectives that have justified five Dutch cities' demand for such a platform also appear difficult to achieve within the limitations of conventional business models and classical competition. However, these factors suggest that more support, more mitigation of risk, and more efforts to level the playing field are required from governance actors, especially at the national level, where Finland's interventions have proven so decisive.

However, the risk involved for individual participants in such a platform is high, and the requirement that service providers (rather than, for example, intermediaries operating in a deregulated market) expose customers to the offerings of direct competitors runs counter to classical notions of competition that underpin Osterwalder's Business Model Canvas (2004), and which remain implicit across groups 1 and 2 in our CBM sample. This risk has not been managed or mitigated, as in the Finnish case, by the creation of an overarching regulatory framework that imposes a level playing field for all mobility service providers across all modes, at least in terms of information and ticketing functions. This is striking, considering that the Netherlands was the first country in the world to require open-data sharing between all public transport operators in 2008 (Boor interview,

13/05/2020). The designer of the Deelfiets Dashboard proto-platform expressed regret that publicly-available open data sharing had not been built into this system from the outset to address this competition problem (Boor interview, 16/07/2020), due to opposition from pilot funders.

In Antwerp, a collaborative business model may be said to exist in a loose sense in the form of the Marketplace for Mobility and its public-facing wayfinding and information app. Taken together, these MaaS proto-platforms facilitate the simultaneous provision of (sometimes competing) services by multiple providers to the City of Antwerp and its MfM partners. Risk is limited by the creation of non-overlapping and explicit project parameters for firms, which have formal relationships with the MfM (as client or *opdrachtgever*) rather than with each other. Antwerp's unilateral imposition of the requirement that service providers share their data with the city, and integrate their services with a minimum of 2 MaaS apps, has been successful in leveraging access to the city's commons to attract firms, even where this requires fundamental changes to their business models, as in the case of Bird scooters.

However, the development of a MaaS app that goes beyond wayfinding and information services is likely to require the development of a distinctively collaborative business model (as per group 3 in our CBM sample) rather than modifications of service providers' own business models, which is likely to pose a significant challenge. For example, the City of Antwerp has set a precedent by manipulating wayfinding services in order to achieve certain public goods, such as minimising city-centre automobile traffic and reducing automobile congestion to facilitate the movement of passengers and port freight. Providers of services such as taxis and automobiles may find that they become less visible to users requesting trips along particular routes or at particular times. Secondly, the principle of *no fix, no pay* represents a high risk for current MfM participants, especially since the current logic of the MfM is focussed on the replacement of peak-hour automobile trips as the primary assessment criterion. Thirdly, the degree of integration between major mobility governance stakeholders at the federal, language community, provincial and urban levels is currently very minimal in comparison with the Netherlands (Vernaillen 2020).

This general fragmentation is reflected in the lack of a standard data sharing protocol between the national railways and local urban transport, or the fact that the federal Belgian mobility planning document expired in 2014-5 and has not been renewed. This lack of structured cooperation through official channels has, paradoxically, fostered an entrepreneurial culture of direct, informal contact

between stakeholders[51]. For Antwerp, this has produced a high degree of flexibility and autonomy in defining the parameters of the MfM. It may also have potentially reduced the arenas in which powerful mobility operators, such as Uber, are able to (cost-)effectively lobby for favourable regulations. By the same token, the city's own requirements and policies do not have the force of law, and may therefore run counter to the duties and imperatives that commercial law imposes on firms with conventional business models. Antwerp's experiment, while it thus benefits from a regulatory vacuum at some levels, may lock out organisations that would benefit from modifying their own business models to accommodate the demands of a MaaS platform, but are prevented from doing so on fiduciary grounds.

Regarding the success of Whim, however, closer examination of its first-in-the-world offering suggests that such prodigious success may have a price for Finland's urban commons, since the platform faces few demands from the city, such as for the limitation of shared vehicle fleets to prevent saturation of the physical commons. This factor may not yet be readily apparent as cycling mode share in Helsinki is low, but it is unclear that MaaS, in the particular instance of Whim, can be harnessed as an instrument to raise it, or to deliver on the City of Helsinki's current and future policy goals. Similarly, in Antwerp, automobile modal share is high, cycling rates are low compared to the Netherlands, and public transport use is falling (Vernaillen interview, 29/05/2020). The pressure on public open space, outside of car parking, is correspondingly lower than in Dutch cities, and the policy goals of the MfM are overwhelmingly framed in terms of managing automobile congestion and safeguarding the accessibility (by automobile) of the port and freeway system[52]. In the Netherlands, where the public urban space required for vehicle storage is highly contested due to the strength of cycling as a rival to automobility, the barriers against MaaS, and bikeshare, are higher. In the Dutch context, therefore, the achievement of MaaS (as in Helsinki) may be less beneficial than the achievement of a CBM for bikeshare (as per the objectives of Openbike), and the greater challenge of achieving MaaS via CBM (rather than MaaS at any cost) may be well worth the wait.

[51] For example, one of the initial challenges in setting up the Smart Ways to Antwerp project was simply gaining access to existing data streams regarding programmed and real-time route data from De Lijn, the Flemish public transport authority (Vernaillen 2020).

[52] The entire Smart Ways to Antwerp project is framed, in policy terms, as an anti-car congestion measure designed to maintain accessibility for freight and passenger movements on the city-region's roads, and all of the MfM's projects are evaluated, in project materials, in terms of one key metric: the number of peak-hour automobile trips avoided (*uitgespaarde autoverplaatsingen*).

5.5 Conclusions and recommendations for future research

The three cases of bikeshare integration into MaaS platforms reveal that MaaS platforms and the MSPs that partner with them still face significant challenges in achieving the integration, in commercial terms, that is already possible in strictly technological terms (that is, integration of booking, un/locking, and payments). The CBM sources we have analysed largely retain the assumptions of the BMC, such as that of classical competition between focal firms, a high degree of control over prospective key partners and key resources, and a value proposition that can be largely attributed to a single focal firm. In our cases, these conditions do not obtain. This chapter thus contributes a first attempt at a systematic review of the Collaborative Business Model across various literatures. It clarifies the meaning of collaboration and of the CBM within that sample according to three major interpretations. Of these, the most common is a 'narrow' interpretation of collaboration as a practice voluntarily undertaken by one or more organisations for an indefinite period, on a formal or informal basis. In the second-commonest interpretation, collaboration is a sectoral designation for organisations considered to form part of the sharing economy. Only a small minority of studies ascribe a 'broader' interpretation to collaboration and to CBMs as analytically distinct from the BMC, and of these, those relating to urban contexts all insist on the role of the commons as the basis of that distinction.

This three-part division of interpretations of the CBM may be relevant for sustainable urban mobility researchers seeking to better understand how collaboration can be mandated as a governance approach for new mobility modes. In the case of cycling, which is appealing to urban decision-makers precisely because of the uncaptured positive externalities it produces for society, the Dutch case shows how difficult it can be to sustain a CBM where private risks remain high but the capture of private rewards (for service providers) is limited. Further, the few CBM sources that explicitly address the commons, and particularly the urban commons, suggest that public and private stakeholders in urban mobility could benefit by moving beyond a transactional logic in structuring mobility services, particularly where bikeshare is concerned. For example, purpose-driven urban entrepreneurship and Gyimóthy's (2017) account of commons or communitarian business models share a dual role for the commons as both the host and the recipient of concerted action. In business model terms, this could take the form, in MaaS, of proactive efforts by city government to offer MSPs and MaaS platforms a more stable, 'ring-fenced' stake in the physical or data commons. This is the case with Finland's TSA, which has given legal stability to a very new sector and produced a relatively mature and pioneering framework for innovation in bundled mobility services.

What is also striking in our cases is the extent to which 'collaboration' is imposed on MaaS platforms and MSPs by fiat of a city or regional government, acting as a commons gatekeeper or steward, without supporting interventions at other levels of government (especially national legislation). This is an underexplored avenue for further research into CBMs, and ultimately, for a more specific definition of the term 'Collaborative' in CBMs in opposition to closely-related terms like coercion, coordination and cooperation. Public sector decision-makers in cities contemplating the creation of a mobility services platform may take note of the difficulties that collaboration entails when it is imposed on different mobility modes. Analysis of the individual MSP business models reveals that these difficulties differ according to mode, and are therefore amplified in the case of a single-mode MSP, as in the Dutch case.

Our study is limited by the limited number of interviews carried out, as well as by a lack of comprehensive mapping of the business models of MaaS platforms, as well as MSPs. Future research on the fast-moving empirical field of MaaS platforms could better develop the theme of business model morphology among different types of MaaS platform, for example, as a function of high-margin, motorised, heavyweight mobility services, as opposed to low-margin, non-motorised modes, such as cycling and walking. Lastly, future research is likely to benefit from the growing number of MaaS platforms that offer services beyond wayfinding and information, thereby allowing for a richer comparison.

5.6 Addendum: Interviews

5.6.1 Interview Protocols

Q1-Q3: Please describe your (Q1) value proposition, (Q2) value creation mechanisms (prompt: resources, supplier and distribution channels and partners) and (Q3) value capture mechanisms (prompt: costs structures and revenue models) mechanisms *[interviewer presents two BM canvases to respondent: one blank, and one filled in with interviewer's projection of BM derived from grey literature]*.

Q4-Q6: Does your organisation (Q4) distinguish between commercial/for-profit and non-commercial/social elements of your value proposition? If so, please describe these (Q5) commercial and (Q6) non-commercial elements.

Q7-Q9: How does your organisation (Q7) mediate or limit the incentive to compete between participating service providers, and (Q8) between your organisation and participating service providers? What role does your organisation play in (Q9) mitigating or managing risks between service providers?

Q10: How did your platform come to be? What factors influenced its current design?

Q11: What limitations or barriers would you like to see removed? What forms of support would you like to receive now or in the future, and from whom?

5.6.2 List of Interviews, presentations or meetings, and grey literature sources per case

	Case: Netherlands (Openbike /Deelfietsdashboard)	**Case: Antwerp (Marketplace for Mobility)**	**Case: Helsinki (Whim app)**
Interviews	Video interview with Sven Boor, 13/05/2020 and 16/07/2020, recorded and transcribed	Video interview with Stijn Vernaillen, 29/05/2020, recorded and transcribed	Video interview with Sampi Hietanen, 13/12/2017, recorded and transcribed Video interview with Paula Kivimaa, researcher on MaaS in Finland, 30/06/2020, recorded and transcribed
(Virtual) Presentations	Boor, Sven, and Hink Vincent. 'Deelfiets Dashboard voor gemeentes: Hoe krijgt een gemeente inzicht in (real-time) deelfietsgebruik?' Presented at the Lancering gemeentelijk Deelfiets dashboard, CROW-Fietsberaad, Utrecht, 25/04/2019.	Maroey, Chris Van. 2019. 'Antwerp's Marketplace for Mobility'. Presented at the Polis Network, 27-28/11/2019, Brussels. https://www.polisnetwork.eu/wp-content/uploads /2019/11/4F-Chris-Van-Maroey.pdf. City of Antwerp. 'Smart Ways to Antwerp/Slim naar Antwerpen – Webinar NXTMobility'. 29/04/202053.	Tuli, Apaar and Oxley, Brylie (MaaS Global/Whim). 'Designing the Future of Urban Mobility'. Presented at Data-Driven Design Day, 19/09/201854.

[53] https://www.youtube.com/watch?v=lgacUjyRlSs
[54] https://www.youtube.com/watch?v=8W5ljbKgjLQ

	Haan, Dirk Jan de. 2018. 'Het Deelfietsconvenant Openbike Brengt MaaS Voor Deelfietsen Dichtbij'. Presented at meeting 'Aan de slag met deelfietsen', CROW-Fietsberaad, Utrecht, 13/11/2018		
Apps	-	Slim naar Antwerpen iOS app55	Whim iOS app56
Websites	Websites: CROW (crow.nl), Deelfietsdashboard (deelfietsdashboard.nl), Openbike (openbike.nl)	Smart Ways to Antwerp (slimnaarantwerpen.be)	Whim (whimapp.com), Helsinki Smart Region (helsinkismart.fi)
Grey literature (reports and corporate literature)	Mingardo, G., M. Streng, and J.J. Witte. 2017. 'Een deelfiets voor de Hele stad: Een onderzoek naar de kansen en uitdagingen voor Een Stadsbreed deelfietssysteem in Rotterdam'. RHV Erasmus Urban, Port and Transport Economics.	Broer, Karin. 2016. 'Fietsdeelsystemen in Antwerpen: Het success van de Velo'. CROW-Fietsberaad57.	Kanger, Laur, and Paula Kivimaa. 2017. 'Transformative Innovation Learning History: Finland - The Emergence and Consolidation of Mobility-as-a-Service in Finland'. Transformative Innovation Policy Consortium58. Ramboll, and MaaS Global. 2019. 'WHIMPACT: Insights from the World's First Mobility-as-a-Service (MaaS) System'. Helsinki: Ramboll59.
Academic sources	(Petzer, Wieczorek, and Verbong 2020; van Zessen 2017)	(Kishchenko et al. 2019b)	Ache 2011; Audouin and Finger 2018; Heikkilä 2014; Kivimaa and Rogge 2020; Surakka et al. 2018

[55] https://apps.apple.com/be/app/slim-naar-antwerpen/id1343247830?l=nl
[56] https://apps.apple.com/fi/app/whim-all-your-journeys/id1110962965
[57] https://www.fietsberaad.nl /CROWFietsberaad/media/Kennis /Bestanden/CROW-Fietsberaad_notitie_excursie_huurfietsen_antwerpen_mei-2016.pdf?ext=.pdf.
[58] http://www.tipconsortium.net /wp-content/uploads /2019/04/finland-TLHC-v5.pdf
[59] https://ramboll.com /-/media/files/rfi/publications /Ramboll_whimpact-2019.pdf

6 Conclusions

6.1 Introduction

Chapters 2-5 present research that takes four distinct approaches to answering the research question identified in Section 1.1 – namely, *which dynamics have most influenced the form, performance and prospects of CaaS in the cities of the Netherlands?* For all four chapters, the dynamic that has most influenced CaaS in the Netherlands has been the institutionalisation of urban open space. In a specific sense, this dynamic applies to the empirical focus of this thesis on the city of Amsterdam, on recent entrants into the Dutch dockless bikeshare market, and on the institutionalisation of public space. More broadly, the spatial controversies engendered by the advent of dockless bikeshare in Amsterdam point to a cross-cutting challenge that shared mobility services face in securing access to the public space they require in order to operate. This challenge applies to the Northern European cases studied in this thesis, but also to mass-automobility cities everywhere, as shown by the perennial parking controversies that attend CaaS internationally (Akyelken et al. 2018; Shaheen et al. 2019). This challenge also applies not only to bikeshare or CaaS, but to the present and near-future (micro)mobility modes which are likely to be added to the commons of pedestrian space, or the fluid boundaries between the road, the kerb, and the sidewalk (Loukaitou-Sideris and Ehrenfeucht 2009). For this reason, this thesis has used CaaS as a means to understanding the relationship between urban open space and shared mobility modes that belong to subordinate socio-technical regimes, rather than pursue research that could directly examine CaaS in its entirety across the Netherlands over the period 2017-2020.

As discussed in Section 1.1, shared mobility services have the potential to support a profound transformation of urban mobility systems by decoupling ownership of a mobility mode from access to it. However, the impact of this transformation, and the means by which cities seek to bring it about, necessarily varies by mode. Cycling is regarded as a sustainable mobility mode, and cities view cycling-based shared mobility services as a means of increasing its modal share by offering users access to bicycles in situations where this was previously lacking (Gössling 2016). Automobility is regarded as a less sustainable mode, and mobility services that give users access to a car or a car ride are viewed as a means of reducing car modal share, or at minimum, as a means of combatting car dependency and the norm of single-occupant car use. These observations, at least, apply to the European national norm, in which car modal share is dominant, and cycling modal share is low to negligible (ECF 2018). However, the period covered by this thesis (2017-2020) has shown that, at least in Amsterdam, some CaaS services are not necessarily viewed as a complement to the

established practice of private cycling[60] by influential actors such as city decision-makers, cyclists' organisations, journalists, and neighbourhood activists. Indeed, as the empirical events analysed in Chapters 2-5 show, one form of CaaS in particular, dockless bikeshare, has faced great opposition from these actors, with its providers largely barred from operating in major Dutch cities. As the analyses in these chapters show, this opposition has primarily been expressed through the restriction of access to public space (see Chapter 2).

Accordingly, the efforts of dockless bikeshare providers to operate their services has focused on circumventing these spatial constraints through framing struggles (Chapter 3) and adaptations to their business models (Chapters 2 and 5). The fact that established cycling institutions are a prominent source of opposition to dockless bikeshare sets the Netherlands (a high-cycling context) apart from the (low-cycling) European norm, where CaaS of every kind is generally viewed as a complement or precursor to private cycling. However, the finding in Chapter 4 that different mobility modes compete for access to public space on different terms, and through different processes, is true of both the Netherlands and other European contexts. More specifically, the chapter shows that the means by which automobility and cycling modes make claims on public space have developed patterns that are comparable across both high and low-cycling contexts. For automobility, these spaces – exemplified by the on-street standard parking space and parking minimums embedded in land use regulations – tend to be commodified and formalised, and are seldom shared with other modes or uses. Reducing the space allocated to them has proven exceptionally controversial and politically challenging, as demonstrated in Brussels and Birmingham (see Section 5.3.3). In contrast, the space required to store and move a bicycle tends, in regulatory and institutional terms, towards the condition of a commons that also accommodates many other modes, uses, and users.

This thesis shows that this difference in *space allocation mechanisms* (see Section 4.2.2) between the automobility and cycling modes in particular has very wide-ranging consequences for mobility transitions. Across the cases studied, a shift towards car-sharing and ride-sharing is operationally straightforward: providers of car-based mobility services are generally able to access existing parking spaces and use existing roadways as private drivers do. However, this has not been the case for providers of dockless bikeshare in Amsterdam, who have been explicitly banned from accessing the same public bicycle parking facilities used by private cyclists. This difference between the modes relates to a fundamental divide between the commodified nature of car spaces, and the nature of the commons to which cycling space belongs. The cases analysed in this thesis do not suggest that

[60] Private cycling refers to a user who cycles on a bicycle that they own, and is used here in contrast to shared cycling.

either a commodified or commons approach to space allocation is ultimately desirable to bring about mobility transitions. However, they do show that dominant mobility modes tend to have advantageous spatial allocation mechanisms, while subordinate modes are subject to disadvantageous mechanisms. They also show that this difference must be taken into account (for example, in the design of policies and regulations) by stakeholders seeking to bring about sustainable mobility transitions, as demonstrated by the relative success of Finland's policies in this regard, and the stalled progress of the Openbike initiative (see 5.3.3). Further, they demonstrate the persistence of the knowledge gap between *spatial allocation practices* for different modes. These are relatively well documented for the automobility regime, whereas for cycling, records and data on practices tend to be fragmentary and sporadic (especially outside of the Netherlands).

In terms of urban sustainability transitions, these empirical accounts are of theoretical interest because they demonstrate that collective dependence on an essential resource (urban open space) imposes distinct relationships on niche and regime actors. The relationships between these actors and the resource partly reflect the relative power of these actors, but are also shaped by the inherent physical limitations of the resource. This empirical observation has two theoretical implications for sustainability transitions research.

Firstly, the zero-sum allocation that the finitude of urban open space imposes on niche and regime actors in the mobility system also imposes particular kinds of competition (and, alternatively, collaboration) on these actors. This competition is shaped more by differences in the institutionalisation of space than by other factors, and changes to this institutionalisation can produce sudden and profound changes for relationships between niches and regimes. For example, all of the mobility modes legally allocated to the same shared space are, by that same token, in competition with each other, whatever their other socio-technical similarities and differences. Further, dominant mobility regimes (such as automobility) have historically secured space allocation mechanisms that are separate and exclusive to them, creating a 'compartmentalisation' of this shared resource that expresses niche-regime and regime-regime power differences in a measurable way.

Secondly, these cases also demonstrate the significance of a single resource, space, to the socio-technical system of mobility, since the mobility system not only exists in space but also 'deals' in space. Unlike many other socio-technical systems studied by transitions researchers, the demand for mobility is mostly a "derived demand" (Geels 2018, p. 88) that stems from the distance between a user's destination and origin point. Spatial dynamics therefore influence every aspect of mobility systems in a way that is not matched by other socio-technical systems and resources, and is

therefore not highly developed within transitions scholarship. For shared cycling, this link is doubly emphasised. Cycling has historically developed a relatively informal and unstable claim on urban space across the mass-motorised world. Shared cycling, or CaaS, renders this claim more tenuous still, because a parked bicycle's legitimacy in urban open space has historically been justified through its status as the property of an individual user. The instability of shared cycling's claim on space facilitates theoretical development by making visible a fundamental link (between mobility systems and space) that may be less readily discernible in most contexts[61].

The following section revisits the four chapters that take particular approaches to identifying (Chapter 2) and describing (Chapter 4) space allocation as the dynamic with most influence on CaaS, and analysing this dynamic from a business model (Chapters 2 and 5) and narrative and ethical (Chapter 3) perspective.

6.2 Chapter 2: Identifying space dynamics' influence on CaaS form and performance

Chapter 2 examines the cycling-based mobility services active in the Netherlands in 2017-8. A transitions approach was mobilised to place these services in the context of the existing cycling regime and other parts of the Dutch urban mobility system, leading to their identification as a socio-technical niche termed Cycling-as-a-Service (CaaS). The heterogeneity within the group of CaaS providers prompted the use of business model analysis to gain a micro-level perspective on the variations among CaaS actors in terms of the services they provide and the regulatory implications thereof. These variations proved especially consequential for a subset of CaaS actors, the dockless bikeshare providers, whose service and business model produced a kind of demand for bicycle parking space that was a poor fit with existing regulations. However, other subsets of CaaS actors, such as advertising-driven gamified bicycle leasing for students, also presented distinct relationships with space, along with a more or less deliberate exploitation of ambiguities in the regulations governing bicycles in public space. Further, some CaaS operators altered their business models and the design of the service they offer in the course of 2017-2018 in response to new regulatory barriers, while other operators grew rapidly with minimal regulatory oversight. The sets of strategies implicit in the business models and service designs of CaaS providers, especially as they changed in response to events, prompted the mobilisation of Hoogma's (2002) fit/stretch framework for niche actors' market entry strategies.

[61] That is, other than the 'socio-spatial niche' of Dutch cities, where automobility faces less powerful challengers for road space.

This framework was adapted to incorporate value propositions as a *pars pro toto* for CaaS operators' business models, yielding a method of contrasting fit/stretch strategies in technological and commercial (Business Model) terms. This method exploits the common strategic emphasis of value propositions, which are interpreted as the essence of a business model's strategic differentiation from competitors, and the technology or technologies chosen, configured and refined by niche actors. Using this method, this chapter shows that CaaS providers that conform closely to established Dutch private cycling regime have succeeded commercially, measured by fleet size. Providers that adopt a 'stretch-stretch' strategy in terms of both technology and value propositions initially achieved the largest fleet sizes (excluding the OV-fiets system), but have also been most affected by the imposition of new regulatory barriers. In contrast, the large number of 'fit-fit' providers who closely adhere to both the letter and the spirit of existing public space regulations remain, as a result of local government restrictions on fleet size, too small to make any sizeable contribution to the local mobility offer in their cities. Lastly, the success of the OV-fiets, which enjoys an unmatched advantage over other CaaS provides in terms of access to centrally located land in Dutch cities, demonstrates the importance of a secure claim on space in contrast to the stretch-stretch providers who have had to cease or drastically curtail operations due to loss of access to space.

This chapter demonstrates that, for cycling-based shared mobility services, lack of secure access to public space for bicycle parking can be overcome by some providers. However, this process is not straightforward or simple, especially in comparison to the process used by car-based services. The means used to justify Amsterdam's temporary ban (see Section 2.5.4) suggest that this decision was partly based on factors beyond the direct control of CaaS actors, such as public reaction to the example of CaaS in other contexts. Those CaaS providers who were able to adapt to the ban did so at the cost of comprehensive changes to most elements of the provider's business model, extending to the users it targets, its physical distribution of service points in the city of Amsterdam, its long-term growth prospects, and its profitability. These findings reinforce the importance of space as a component of transitions that is connected to all other components, and lack of access to space as a barrier that can only be overcome by changes to (almost) all other components of the business model. This chapter also shows that business model analysis can reveal significant differences between mobility modes that are not easily identified using transitions approaches. This micro-scale perspective provides a more detailed insight into the spatial dynamics of shared mobility transitions for subordinate modes, and their preponderance over other dynamics in determining whether CaaS providers are able to start or continue operations at all.

6.3 Chapter 3: Analysing narratives and normativity in space allocation contests

Chapter 3 builds on the preceding chapters' finding that the means by which cycling-based mobility actors attempt to claim public space are complex and uncertain, and involve a significant element of contestation in the public sphere. The chapter therefore considers the narratives and counter-narratives used by sets of (cycling) regime and (dockless bikeshare) niche actors to contest the legitimacy of dockless bikeshare CaaS services seeking to use public land for parking in Dutch cities. The nature of this contestation, which draws on descriptive and prescriptive narratives and focuses on very concrete outcomes, is thus well suited to analysis by means of a combination of socio-technical transitions and ethical frameworks. The chapter therefore seeks to integrate a transitions method for analysing narrative framing struggles by niche actors developed by Rosenbloom et al (2016; 2018) with the prescriptive Mobility Justice framework developed by Sheller (2018). In empirical terms, the pairs of legitimating and delegitimating storylines surrounding dockless bikeshare in Amsterdam confirm that concerns about consumption of public space are very dominant in the framing struggle conducted through press articles. These storylines accounted for a large majority of the codes, while concerns related to the mode itself, such as the sharing technology or the bicycle artefact itself, were relatively minor. Accordingly, niche actors' strategies to counter delegitimation have focused on public space in both its physical dimension (contesting the scarcity of urban open space) and symbolic dimension (contesting the extent to which dockless bikeshare is 'foreign' to Dutch cycling culture in its user group and norms). The chapter demonstrates that the application of Sheller's (2018) Mobility Justice conceptual tenets to a transitions framework with a descriptive and strategic focus can itself 'reframe' framing struggles by connecting analytical levels (the niche, regime and landscape) to each other through both controversies and the interests of users.

6.4 Chapter 4: Synthesising spatial dynamics at street level

Chapter 4 consolidates the preceding chapters' findings that spatial dynamics are highly influential in determining the performance and prospects of CaaS, as revealed by actors' attempts to respond to them through adaptations to their business models, or contest them through framing struggles. This chapter introduces a framework, the 'legal street', that presents a visual schema of urban open space and its allocation to mobility uses. This framework collates the means and mechanisms by which space is allocated, and classifies them as either hard (where they are formal, entrenched, have legal force, or are widely embedded in regulations and codes) or soft (where they are less formal, relatively new, advisory, or weakly integrated into regulations and codes). This legal street

framework is applied to the cases of Amsterdam, Birmingham and Brussels, as well as the EU as a whole (for EU-wide regulations).

Theoretically, the legal street is an attempt to describe a foundational observation in urban planning (namely that urban space is scarce and oversubscribed) with the treatment of urban space in transitions research, in which this scarcity is acknowledged very indirectly at best. The chapter reviews transitions accounts of space (and similar concepts such as scale and place). It finds that they largely do not address space within the city at all, focussing instead on the space in the abstract (i.e., with references to innovation or natural resources as concentrated or dispersed). They also do not attend to the finite nature of urban space produced by the relative obduracy of buildings and private property lines that surround the urban open space, where changes in space allocation can occur very rapidly (as they did, for example, in the Covid-19 pandemic). Lastly, transitions scholars do consider the differences between mobility modes in terms of the scope, embeddedness, or strength of the regulations that secure these modes (such as emissions regulations for cars, or bicycle light requirements). However, they have largely not connected these relative differences to an essential shared resource, such as the open space required for parking, which is essential to support both car and bicycle use. The legal street presents a theoretical response to these gaps in transitions as an exploratory method for analysing and generalising space allocation processes in a city to reflect the relative strength of the claims made by various mobility modes to a resource, space, that is subject to a zero-sum allocation. The legal street thus contributes a means of translating the relative power of regimes and niches in the mobility system into physical stocks of space. The dynamics inherent in these physical stocks are thereby translated into transitions – for example, the fact that removing the entitlement of car owners to on-street parking spaces can in itself 'create' cycling infrastructure, without any positive investment in cycling *per se*.

The legal street is thus presented as a method for bringing a *scarcity perspective* on urban space into transitions research. This method may be empirically useful in transitions management, as it emphasises access to an enabling resource over the evolution of a technology itself. This emphasis applies with particular force to the conventional bicycle, which is striking for its simplicity and stability as a technology (Bijker 1997; Cox and Van de Walle 2007), whereas technological novelty plays a central role in transitions research.

The rise, fall and (potential) rise of cycling in European cities, including the cases of Birmingham and Brussels, are reflected in the legal street, which shows clear differences between these cases and Amsterdam. The weakness of the protections on bicycle space in the former cases also emphasise cycling's status in post-war Europe as a subordinate mobility mode and a "dormant" practice (Shove

2012). The chapter briefly reflects on the significance of a contrasting legacy of radical activism and disruptive practices in Amsterdam (and other Dutch cities), which contributed to a different legal street. These practices, which may run counter to regulations, are reflected in the legal street through a distinction between allocation mechanisms and appropriation practices. The former refers to regulations, building codes, parking minimums, policies, and rules of thumb. The latter refers to what users of a mode actually do, including modal share but also informal or illegal practices, like parking a car or bicycle where it should not be parked. As for technological novelty above, the inclusion of appropriation practices in the legal street framework reflects the significance of ad-hoc, informal and pragmatic (or even somewhat anarchistic) practices as a visible and significant aspect of everyday cycling. Although transitions scholars attend closely to practices as part of the social, the practices incorporated in the legal street may contribute to an improved understanding or capturing of artificial oversupply or suppressed demand for space allocations. An example of oversupply is the disparity between the car parking supply mandated by Birmingham's parking minimum formulae and the low percentage of this supply that is actually used. The case of Birmingham car parking can be read as an empirical indicator for a shift in policy-making (as is in fact underway) but also as a theoretical indicator of the power of the city's automobility regime, compared to the severe undersupply of bicycle parking noted in the city's policy documents.

6.5 Chapter 5: Assessing 'collaboration' as a precondition for accessing urban space

Chapter 2 examined how some CaaS actors adapt their business models as a response to spatial constraints imposed on them by a local government actor (the City of Amsterdam). This chapter revisits the connection between business models and transitions research to assess three cases in which public sector actors have attempted to impose a particular business model (or form of interaction between individual business models) as a condition for gaining access to urban open space. In the case of a bikeshare-only mobility services platform in the Netherlands, and bikeshare-inclusive platforms in Antwerp and Helsinki, the resulting entities have required that the actors involved diverge, to varying degrees, from the assumptions of Osterwalder's Business Model Canvas (2004). We argue that this divergence, especially in the area of competition, should be understood as a collaborative business model (CBM).

The chapter supports this argument through a systematic review of interpretations of CBMs across several literatures. It finds that in most studies that refer to CBMs, the term is interpreted in one of two narrow senses that describe features of conventional business models. Firstly, 'collaborative' is used to refer to collaborative practices (of varying degrees of formality, scope and intensity) undertaken by firms. These practices are not new in kind, but may be novel in scale, as technological

advances and commercial incentives have led firms to collaborate across longer value chains and at greater scale than before. Secondly, 'collaborative' is used as a sectoral designation, to refer to firms operating in fields that are considered to form part of the sharing economy or collaborative consumption. The firms in this group can also be described and analysed in terms of the BMC with relative completeness, and for the most part represent an Internet-enabled iteration of familiar product-service systems. However, a third and much smaller group represents a business model that differs analytically from the BMC and is irreducible to BMC terms. A subset of this group argues that CBMs can be differentiated from the BMC through their relationship with the commons, which serves as an essential resource for these organisations while also being a beneficiary of the added value that they create. The survey argues that, by this definition, Cohen and Muñoz' notion of a *place-based enterprise* should be considered an example of such a CBM in which the city serves as a commons. Further, for all three groups, the review finds that there is a tension between the assumption of classical competition in the BMC and varying degrees of collaboration. The latter range from informal coordination between firms that are not direct competitors, to platform competition, which Salazar (2015) terms the antithesis of classical competition. The notions developed in this review are complemented by a conceptual vocabulary gathered from a second review of MaaS platform business models, which results in a refinement of the commons as used in the third CBM group into the notion of a *data commons* and *physical mobility commons of the city*, to better reflect the implicit resources described in the MaaS business model literature.

This theoretical framework is applied to the three case studies, yielding both theoretical and empirical contributions. In theoretical terms, the physical mobility commons of the city proves useful in clarifying the competition problems that emerge in the Dutch case of the Openbike/Deelfietsdashboard initiative[62]. From a MaaS perspective, these problems can be summarised as an inability of service providers to capture the value that their services add to the physical mobility commons of the city, combined with an unlimited liability for the maintenance of the commons (that is, through rebalancing obligations for their fleet parked on public land). In CBM terms, the Deelfietsdashboard structure imposed by public-sector actors requires direct competitors to engage in platform competition with each other. Added to this, however, is a problematic obligation to develop this platform with direct competitors in order to meet the entry requirements that the public-sector actors have erected around the physical mobility commons of the cities (of the

[62] At the time of writing (mid-January 2021) a new iteration of this Dashboard has just been announced. The difference between it and the preceding vision suggest that the avoidance of competition problems has been the main impetus for a redesign.

Netherlands). These contributions elucidate two sources of failure for an empirical effort that had, at the time of writing, stalled, despite high initial expectations of success.

These concepts also yield a number of clarifications when applied to the cases of Antwerp and Helsinki. In Helsinki, the national government's pro-active efforts to make mandatory the creation of a data commons resolved an important barrier that had hitherto prevented cooperation between direct competitors, as in the Dutch case. As the chapter shows, the demands on various modally-specific subsets of the broader mobility commons are not equal, just as the commons differs in importance between modes[63]. Although the bicycle commons is essential for the cycling mode, due to the globally dominant practice of informal bicycle parking (see section 4.2.2), in Helsinki the bicycle commons is not strongly contested by rival service providers, due to the low modal share of cycling. In Antwerp, a condition imposed on all firms was their sharing of data with the city's own navigation app, for which they received access to the physical mobility commons for storage of their vehicles. Unlike in Helsinki, the resulting data commons was not available to service providers and the public, but controlled by the city, and openly manipulated to achieve policy goals. Also unlike Helsinki and the Dutch case, participating providers in Antwerp were part of an open-ended platform that could, in future, grow to include any number of direct or indirect competitors.

6.6 Summary of Conclusions

This thesis finds that it is spatial dynamics that have most influenced the forms taken by CaaS in the Netherlands. This is demonstrated by the fact that it is the conditions under which CaaS actors access space that determine (in the decision-making of public-sector actors) whether or not they can operate at all, rather than the financial viability of their services, or their contribution to the city's mobility offering. Further, this thesis finds that the performance of CaaS has been primarily influenced by spatial dynamics. This is shown by the correlation between CaaS actors' fleet sizes and the nature of their claim to urban open space, as well as the rapid and relatively unhindered success of CaaS providers, such as Swapfiets, that most closely mimic the (private) cycling regime's means of accessing space. The prospects of CaaS are also found to be narrowly related to spatial dynamics. CaaS providers who are able to adapt their offering to respond to spatial regulatory barriers have been able to continue operations; others have left the Dutch market. In the case of mobility service platforms, CaaS providers find themselves confronted a mandate to 'collaborate' with competitors as a condition for access to the physical (but also digital) commons of urban open space.

[63] Because, as established in the *legal street*, the claims that mobility modes make on urban open space are strengthened or weakened according to the power of the associated socio-technical regimes.

These conclusions are, to varying degrees, particular to the cases studied, to cycling-based shared mobility services, and to subordinate mobility regimes, such as cycling. However, a broader finding is applicable to urban mobility regimes in general – namely, that the means by which urban open space is allocated to mobility modes reflects the relative strengths of the socio-technical regimes associated with those modes. These 'means' are conceptualised as spatial allocation mechanisms, which are primarily regulatory, and spatial appropriation practices, which are based on the empirical behaviour of users, and may differ from what is approved or legal. The mechanisms by which space is allocated, and the appropriation practices that endorse or contest that allocation, are themselves a reflection that claims on space are subject to constructed scarcity and abundance. Where the disparity between modes is especially sharp, such as the relative strength of the mechanisms that allocate space to automobility versus those of all other modes, it is possible to speak of a 'lock-in' on space. This lock-in reflects the relative power of regimes, but also demonstrates that urban open space is ultimately finite and oversubscribed, and therefore scarce. These dynamics, and their relative power, are represented in the legal street diagram, which enables comparison between sites and over time, and can represent relative or absolute allocations.

The scarcity perspective on urban open space represents a departure from the conceptualisations of space that have developed to date in the sustainability transitions literature. The former is grounded in a recognition of space as subject to a zero-sum allocation due to the relative obduracy of the buildings that surround open space, contrasted with the relative fluidity and frequency with which open space is re-configured and re-allocated. It contrasts with the account of space in transitions literature, which has not taken the absolute finitude and relative allocation of mobility space in the city as a unit of analysis, although many transitions scholars have acknowledged the influence of the built environment and of physical infrastructure on mobility transitions as a whole.

7 Discussion and Contributions

7.1 Introduction

The initial research question for this thesis sought to identify the forms taken by cycling-based mobility services in the Netherlands, the dynamics that influence the performance of these services, and their prospects within the Dutch urban mobility system in the near future. The paper which appears as Chapter 2 surveyed these cycling-based mobility services and adopted the Business Model Canvas as the most appropriate method for describing the salient features and differences between these forms. The resulting analysis pointed to the existence of a niche, which I named 'Cycling-as-a-Service' (CaaS), and to a number of dynamics. Of these, the problem of space for shared cycling-based mobility has formed the basis of the subsequent chapters and of this thesis as a whole. This focus on space has prompted a broader exploration of how urban space is conceptualised within transitions research, which may be relevant for urban mobility transitions in general, and specifically for research into automobility, micro-mobility, public transport and other modes. This focus has come at the expense of a sustained exploration of the various futures of particular CaaS actors and services in Dutch urban mobility, which I leave to the Netherlands' highly specialised and productive mobility research community.

This thesis thus identifies the dynamics of urban space as one major influence on CaaS, and offers a conceptualisation of those dynamics that could serve to clarify the prospects of CaaS (as well as other modes) in the future. Some of the other issues pertaining to CaaS that have proven controversial or substantive are the problem of data privacy, monetisation and sharing; the role of advertising and private-sector sponsorship in CaaS as opposed to the precedent of public ownership of public transport; and the major question of whether (and under what conditions) CaaS is sustainable and equitable. These issues have been addressed in this thesis insofar as they find expression in the medium of space. For example, CaaS generates sensitive and highly personal data that enables geo-location and tracking across spatial coordinates; CaaS fleets represent private-sector assets that cannot create value except through the use of public goods; and early research suggests that there are conditions under which CaaS serves to stabilise and reproduce exploitative aspects of the existing mobility system, rather than challenge them (Duarte 2016; Spinney and Lin 2018).

Indeed, the emphasis in this thesis on space and CaaS is empirically supported by the aforementioned factors as well as the many processes and efforts from various actors in which access to or competition for space is revealed to play a defining role. One clear example hereof is the restrictions on private goods storage on public land, which have strongly shaped dockless CaaS

business models, local government responses, contractual barriers, and public acceptance. These differences also show a clear difference between modes: whether they are privately owned or commercially 'shared', cars access and compete for public space on fundamentally different terms from other modes. These factors point towards the major theoretical preoccupation of the four chapters of this thesis, which is to identify and describe limitations in the literature on socio-technical transitions research that leaves these spatial issues under-theorised and imprecisely described. The scarcity perspective on urban open space, given form as the legal street framework and discussed in the following section, is an attempt to provide the basis for scholars to incorporate urban open space and its constraints into urban mobility transitions research. Thereafter, two additional theoretical contributions made by this thesis are discussed, relating to the integration of (collaborative) business models and transitions, and the integration of mobility justice into transitions.

7.2 The legal street as a visualisation of the scarcity perspective on urban space

The major contribution of this thesis is a scarcity perspective on urban open space in sustainability transitions research. This perspective differs from existing conceptualisations of space in transitions in a number of ways, which are collated and consolidated below. The legal street diagram represents a first attempt to give form to this perspective, and thus contributes a new instrument to transitions. This instrument can explicitly describe the allocation of urban open space between different uses, the relative strength of these allocations, their susceptibility to be compressed and/or merged, how they differ between locations or cities, and how they change over time. The legal street is limited in that it can be used to represent either a specific street classification, a notional street, or a particular street, rather than the city's streets as a whole. However, a limited number of legal street diagrams can provide a meaningful overview of a city's space allocation by including types of streets that are very common in the aggregate (such as a residential street) or important in the city's network (such as a main thoroughfare). This is due to the profound influence that road design standards, geometric formulae, engineering guidelines and tolerances, and uniform speed limits have on urban roadways (Schröter and Dean; Schipper 2008).

Legal street diagrams of this kind will clearly show the absence or presence of space allocations that are produced formulaically, like on-street parking minimums, and indicate the mandatory dimensions set out in regulations and policy, like minimum sidewalk widths. Where the legal street departs from a simple cross-section of a street as found in normal city policy is its articulation of differences in the strength of various space allocations, where 'strength' refers generally to the relative characteristics or properties of allocations. The characteristics of strong and weak space

allocations developed in the legal street thus far are exploratory; a working set of characteristics derived from the case studies in Chapter 4 are presented in Table 22 to provide an indication of the norm across the EU (ECF 2018).

Table 22: Characteristics of strong and weak space allocation mechanisms

No.	Strong	Weak
1	Common, present on a wide variety of streets, considered a default, abundant	Rare or sporadic, present only on special or selected streets, not taken for granted, scarce
2	Is seldom compressed when the overall space envelope is too narrow	Is often or routinely compressed or merged with other space allocations when the overall space envelope is too narrow
3	Is less likely to be merged with other space allocations	More likely to be merged with other space allocations, including less compatible ones
4	Mandatory	Advisory, recommended, identified as a best practice
5	Required by (national) law	Required by (local) policy
6	Requirement is usually not dependent on proof of need or data collection	Usually provided only when a positive case is made or when justified by data collection
7	Often over-allocated in anticipation of future conditions	Usually scaled to meet current needs only
8	Seldom provided on a pilot, experimental, or temporary basis	Often provided on a pilot, experimental, or temporary basis

7.2.1 Strong and weak space allocation mechanisms as reflections of regime power

These characteristics are a summary of recurring tendencies and patterns observed in city policy, national law and European law, local by-laws, building regulations, and spatial planning. They are provided as an example of the kinds of oppositions that may be observed between space allocation mechanisms. The theoretical argument implied by the legal street is that these characteristics tend to express the relative power of mobility regimes: mechanisms that allocate space to cars tend to be relatively strong, while those for bicycles are relatively weak. Using Table 22 by way of example, car space tends to be provided (1) in abundance and by default, and when overall space is limited, car space is seldom compressed to a width that requires extreme caution. In contrast, bicycle space is relatively (1) rare, and tends to be fragmented into 'archipelagos' of cyclable streets and bicycle infrastructure; (2) cycle space frequently falls away when overall space is insufficient. Following a typical urban bicycle route in most EU countries requires users to navigate many different conditions in succession, as bicycle infrastructure tends to (3) shift quickly and repeatedly from space shared with cars to dedicated space to space shared with pedestrians. Car space tends to be (4) mandatory, and has the force of law, whereas bicycle space tends to be supported only by policy, and to be advisory. Further, the re-allocation of space to bicycles tends to require (6) concerted efforts by stakeholders, supported by data collection and advocacy, is often provided at a (7) minimum level or width, and (8) tends to be provided on a pilot, experimental or temporary basis, often preceded by

studies and rounds of consultation. This is less often the case with existing car space in cities, which tends to be provided (6) as a matter of course, to be (7) proportioned in anticipation of future growth, and (8) to be provided on a permanent basis.

7.2.2 Strong mechanisms as a form of lock-in on a finite resource required by multiple regimes

This highly simplified summary of differences between car and bicycle space in the case studies in Chapter 4 illustrates the differences between strong and weak space allocation mechanisms, and demonstrates that strong mobility regimes are empirically correlated with strong space allocation mechanisms. This finding also recurs in each of the chapters of this thesis. With reference to cars, this relationship can be described as a lock-in on urban space relative to other modes, but especially modes such as walking and wheelchair use, and cycling. In Figure 9, the basic diagram of the legal street reflects these differences through line differences: solid lines reflect strong mechanisms, while weak ones are indicated by the zig-zag lines internal to dormant space for bicycles, pedestrians, and all other urban space uses.

<table>
<tr><td rowspan="3">Private Property</td><td colspan="5">Urban Open Space</td><td rowspan="3">Private Property</td></tr>
<tr><td colspan="2">Vehicle space
(“road, carriageway”)</td><td colspan="3">Pedestrian space
(“sidewalk, pavement”)</td></tr>
<tr><td>Circulatory space for vehicles</td><td>Dormant space for vehicles</td><td>Dormant space for bicycles and other non-car vehicles, etc.</td><td>Pedestrian circulation</td><td>All other urban open space uses: seating, consumption, assembly, etc.</td></tr>
</table>

Figure 9: Conceptual model of the legal street

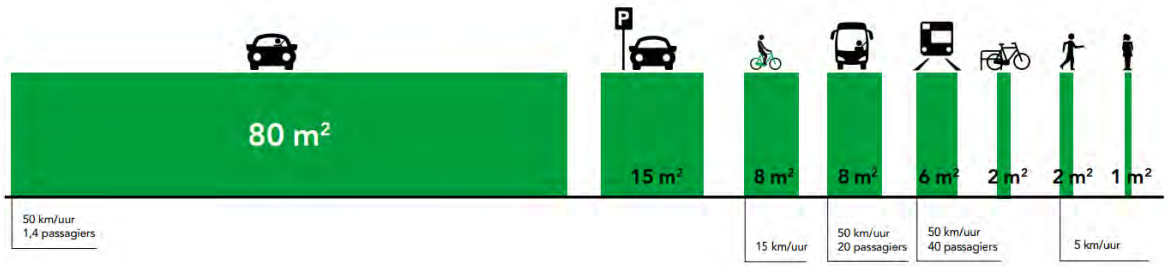

Figure 10: Space required per mode in square metres in the Netherlands[64]

[64] Source: (Gemeente Amsterdam 2020, p. 18). In this image, *km/uur* refers to km/h, and *passagiers* refers to passengers. The modes, from left to right, are: private car, moving; private car, parked; bicycle, moving/being ridden; bus, moving; tram, moving; bicycle, parked; pedestrian, moving/walking; pedestrian, stationary. Original Dutch caption: “Het ruimtebeslag per vervoerwijze verschilt. Onderstaand figuur laat de actuele berekening zien o.b.v. de gemiddelde lengte, oppervlakte en snelheid van het voertuig, gedeeld door het gemiddeld aantal inzittenden (en/of door het aantal voertuigen dat naast elkaar kan rijden).” In English (author’s translation): “The space required per mobility mode differs. This image shows the current figures for the average surface area [required by] each vehicle, divided by the average number of persons seated in it and/or by the number of vehicles that can ride next to each other”.

Briggs et al (2015) draw on diffusion, lock-in and path dependency concepts to describe automobility as a 'large socio-economic regime' (LSER) that locks in its own dominance in the mobility system of the USA. For Briggs et al, the term LSER is useful in that it emphasises the primarily non-technological elements – such as government and market stakeholders – whose influence has secured the enduring dominance of automobility. Similarly, Unruh (2007, p. 817) argues that large-system lock-in occurs when a 'techno-institutional complex' (TIC) is subject to path dependency. Briggs et al (2015) draw on the LSER and TIC to argue that the achievement of 'Automotive Modal Lock-In' in the USA proceeded in three phases associated with the (1) saturation of existing road infrastructure, followed by (2) coordinated efforts to lobby for a massive expansion of publicly-funded road infrastructure. This new infrastructure, which was optimised only for automobility, to the exclusion of other modes, in turn became congested by the 1970s, by which time "the recast urban infrastructure now left consumers with few [alternative] transport options" (2015, p. 62). The work of Briggs et al is described here to differentiate the prior acknowledgement, by scholars, that 'infrastructure' is an important component of lock-in where urban mobility is concerned. However, what is missing from Briggs et al and similar accounts is the recognition that this form of lock-in amounts to a lock-out *if* the overall envelope of open urban space is finite. Scholars may hitherto have overlooked this aspect due to an emphasis on competition between modes for funding streams and hidden subsidy rather than for space, and on competition *between* motorised modes. This thesis has maintained its focus on the bicycle in order to emphasise precisely this lock-out, and thus also to direct attention towards the possibility for rapid space reallocation that is inherent in city streets, rather than the obduracy of dedicated automobility infrastructure (freeways, freeway interchanges, onramps, offramps, elevated freeways) that exists beyond the urban core.

Within the finitude of urban open space, the lock-out of modes other than automobility in the default legal street in the Netherlands and across mass-motorised societies is reflected in the de facto space requirements of various modes shown in Figure 10. On average, the automobility regime requires 80m^2 of urban space to move a car (transporting an average of 1.4 persons) through the city, compared with 8m^2 for a bicycle and its rider. Parked cars require 15m^2, against 2m^2 for parked bicycles. This requirement is a total area across the length of the street, while the legal street (in this thesis) takes the form of a transverse cross-section. Nonetheless, the zero-sum aspect of the scarcity perspective draws attention to the disparity in space efficiency between modes – for example, the removal of a parking space liberates space sufficient for 7 parked bicycles, or 8 standing pedestrians. In the face of this disparity, the slow and contested process of re-allocating a minimum of space away from cars and to cycling is one example of automobility's lock-in on urban open space.

7.2.3 Shared mobility as a new perspective on existing space allocation mechanisms

The allocations discussed above have long been at the heart of contestation of urban mobility, and have taken on new urgency with shared mobility, which has introduced a new relationship between users, vehicle storage, vehicle use and ownership, and urban open space. Transitions research will benefit from a framework that directly articulated space contestations between mobility regimes as a process that can bestow the right to operate in the city on an entire mobility mode, or withdraw it, as shown in Amsterdam's temporary ban on dockless bikeshare (see Chapter 2). Further, access to space in the law tends to be regulated as a function of vehicle type as well the basic set of conditions surrounding the vehicle's use (Prytherch 2018). The first of these can be directly compared to the *technological artefact* in transitions terms, such that bicycles are clearly understood to be distinct from cars as technological artefacts, and new variations or innovations in both areas (for example, ever smaller electric cars versus larger electric cargo bikes) can be classified in terms of their resemblance to the dominant design or key technological artefact in each regime. The second condition relates to use, and is less clearly defined in transitions terms. In this thesis, CaaS has been treated as part of the Dutch cycling regime, but with the qualification that many CaaS providers cannot be assumed to share the interests of the cycling regime, and do not benefit from some of its most significant arrangements. This is because many CaaS providers operate as intermodal connectors, who gain more from extending and stabilising automobility than defending the gains of the cycling regime. This may also be true of intermodal mobility services as a whole, which Parkhurst (2012, p. 308) referred to as "a niche caught between two regimes". Parker's title describes the disparity between a socio-technical regime based around a vehicle type, and the way in which particular regimes have, in practice, sought to pursue their interests through intermodal mobility based on modes outside the regime. There are many examples of this in Dutch CaaS, where the largest providers are owned or backed by automobility and rail interests.

7.2.4 The status of space claims as an operational distinction between mobility actors

The legal street provides for a distinction between space claims based on operational differences (for example, between private bicycle owners and dockless bikeshare providers). It also expresses differences in the basic conditions that apply to groups of space allocations, such as the distinction between car space and the commons of pedestrian space, which are notionally separated by the kerb. The legal street could, in principle, articulate a difference within the cycling regime between the space entitlement of private cyclists, and those of users of dock-based or dockless bikeshare services. In cases where on-street car parking is directly converted into bike parking, such as the

Rotterdam *fietsvlonder* (Rottier 2020), dormant car space can be regarded as having entered into direct competition with space claims from other regimes. Its space allocation mechanisms can then be regarded as weaker. In the same way, the removal of dockless bikeshare (when not in use on a ride) from the space allocated to private cyclists for parking, removes dockless bikeshare from direct competition with private cycling. By articulating these analytical differences with regards to space, the legal street thus captures important and relatively fast-changing differences within and between mobility regimes that materially affect mobility transitions but are only indirectly articulated in current frameworks.

7.2.5 The scarcity perspective and the legal street as integrated concepts in urban mobility transitions research

Because transitions researchers have long noted the importance of physical infrastructure and supporting facilities like parking to mobility transitions, their inattention to the distinctions in space noted above requires explanation. The literature on space in transitions reviewed in this thesis suggests that one reason for this outcome may be a difference in conceptual starting points between mobility transitions researchers and mainstream positions in urban disciplines regarding the urban open space. This foundational difference must be addressed before the treatment of urban space in transitions scholarship can be assessed in more depth.

The legal street diagram presents an abstraction of the theoretical unit of analysis of this thesis, namely the open, public space between private property lines within cities, which has been described in historical terms with reference to the USA (Norton 2011; Longhurst 2015), Europe (Oldenziel and de la Bruhèze 2011; Spinney 2016) and elsewhere (Clarsen 2015). This space can be conceived as a ground plane of unallocated space, that is, space which is not physically developed, configured or improved to express a specific and enduring allocation of space. Barring modes such as trams, which require fixed physical infrastructure[65], any urban function is theoretically possible and permissible in this space, which is simultaneously a conduit or through-route for movement, and a place of stasis where people gather, sit, trade, and assemble. This idea is a reasonable description of the actual materiality of public space across the world before mass motorisation, which precipitated the long and contested process described by urban historians in which city space was divided, or 'allocated' (Oldenziel and de la Bruhèze 2011; Halpern et al. 2018). This process involved the division of urban open space into enduring categories of space for defined sets of activities and purposes. This division required that the ancient concept of a 'right of way' – essentially, the right to proceed

[65] In practice, of course, other mobility modes, especially public transport and cycling, are commonly permitted to the street space also occupied by tram lines.

onwards through a space – develop into an institutionally defined allocation of space with fixed and measurable physical dimensions. Historians of the road note that these allocations were in flux during a period of rapid socio-technical innovation in the late 19th and early 20th centuries (see Geels 2005 on the USA; Feddes and de Lange 2019 provide an account of Amsterdam). In the age of mass motorisation, a subset of these allocations gained in stability and priority relative to the others: 'roads' for automobiles became the dominant networked mobility infrastructure[66]. In the same process, the 'sidewalk[67]' developed into a residual category of space for all purposes other than moving and storing vehicles. At this stage, 'vehicles' in turn came to refer essentially to privately-owned, fossil-fuelled automobiles[68] (Geels 2005).

7.2.6 From space-as-infrastructure to space as a resource in transitions research

The legal street takes unallocated 'urban open space' as its conceptual starting point, as the uppermost level in Figure 9 (see page 135). In contrast, transitions scholars have to date taken the defined-use spaces that result from allocation ('road', 'sidewalk') as a pragmatic starting point for their analyses. In consequence, the highly politicised process by which these allocations are (re)produced have been de-emphasised, even as transitions researchers problematise the disparities and outcomes that these allocations underpin. Taking space as a starting point in turn requires a distinction between the space taken up by mobility, and the infrastructure required for mobility. This distinction has, to date, not been made in transitions research, where the infrastructure required for a mobility regime is treated as synonymous with its space requirements (Bulkeley et al. 2010). This elision obscures the potential for existing urban roads and streets to support a changed mobility system with little or no change to physical infrastructure. This potential is demonstrated by a long tradition of car-free days (Cervero et al. 2009), by event-related street closures, and more recently

[66] As historians underline, this process was gradual, with automobiles first establishing themselves in particular niches as urban, then suburban, then rural and eventually inter-urban and international transport (Schipper 2008; Norton 2011).

[67] In this thesis, the unambiguous US English term *sidewalk* is preferred to the Commonwealth term *pavement.*

[68] As many historians have observed, this process was not an equal one, at least in the mass-motorised West: the development of roads into a networked infrastructure was commonly achieved at the expense of creating a 'network' of sidewalks, leaving a fragmentary sidewalk system cut off by major roads and, eventually, motorways (Oldenziel and de la Bruhèze 2011). Of course, the distinction between 'road' and 'sidewalk' is highly simplistic, and even within Northwestern Europe, the history of public space differs widely between and within countries. Despite these differences, the road (and therefore automobility) spaces of Northwestern Europe form a contiguous network that starts at the neighbourhood scale and extends across the world. There is no equivalent global infrastructure for modes such as walking and cycling, and only a few regional examples. Some north-western German Länder, Denmark and especially the Netherlands can be said to have comprehensive networks of walking and cycling space that serve the entire territory, with a capillary system extending down to the neighbourhood level (Pucher and Buehler 2008). The ancestral 'right to roam' that survives, and is now often encoded in law in some European states , can be interpreted as a vestigial sidewalk network, although it seldom guarantees the physical possibility of traversing entire regions on foot (Mullen et al. 2014).

by emergency space reallocation measures in the Covid-19 pandemic (Mladenović and Stead 2021)[69]. The distinction between infrastructure and space is most significant for modes that require only a paved surface, such as walking, wheelchairs, bicycles, scooters, skateboards, and the many new micro-mobility vehicles that have entered the market in the past decade. These modes can and do appropriate the paved roadway commonly allocated to cars, when circumstances permit. In Dutch traffic planning, they are intended to mix fully with cars wherever car traffic volumes and speeds are low enough, under the maxim "Mix where possible, separate where necessary" (CROW 2016).

Transitions scholars' conflation of infrastructure and space in urban mobility has yielded an assessment that reducing the dominance of automobility will require the *provision* of more and better infrastructure to serve subordinate regimes (such as walking and wheelchair use, cycling, and to a lesser extent, public transport). With regard to walking and cycling, this analysis often leads transitions scholars to advocate for the provision of more signalised pedestrian and cyclist crossings; physically protected cycling routes and sidewalks, and raised pedestrian crossings, footbridges and tunnels. While this assessment and advocacy message are well supported by data ('build it and they will come'), if propounded in isolation, they risk perpetuating several assumptions

7.2.7 Re-politicising cycling infrastructure and the 'vulnerable' road user

More recently, mobilities scholars have questioned whether these defensive structures can be regarded as 'pedestrian' or 'cycling' infrastructure at all. This challenge forms part of a broader effort to re-politicise car dominance in mobility systems (Tironi 2015) and re-evaluate the framing of people walking and cycling, who are commonly referred to as 'vulnerable road users' in policy in the EU (EU DG Mobility & Transport 2011), including the Netherlands (SWOV 2018). Instead, they draw on the balance of risk and convenience that these infrastructures create between motorists and others to argue that their purpose is to facilitate the flow or throughput of motorists while disciplining other users (Böhm 2006; Norton 2011). This argument is in keeping with a century of regulatory and physical changes that voided the incipient 'roadway' of almost all users and activities except for automobile driving and storage (see e.g. Geels 2005, p. 455). Examples of these changes, which were essential components of the roadway/sidewalk allocation, include the creation of

[69] A spontaneous response by the author to the space allocation processes initiated in the early months of the Covid-19 pandemic appears in Section 10.1 of the Addenda.

"jaywalking"[70] as a crime in the USA, and in many countries, the official encouragement of helmet use among cyclists.

In both these cases, the danger that motorists pose to other road users imposes new imperatives, safety precautions and burdens on those users, which in turn requires more defensive infrastructure, as well as skills and equipment from users. The provision of this infrastructure, in its turn, is a slow and highly politicised process precisely due to automobility's strong space allocation mechanisms[71]. This thesis therefore adopts 'urban open space' as its unit of analysis, as distinct from the infrastructure that fills that space, in order to problematise the presence of cars in that space as a contingent cause of the need for 'protective' infrastructure. This thesis therefore also conceptualises space as a *resource* and not as *infrastructure,* or as a metonym for the infrastructure that occupies it (a rich discussion of infrastructure from a transitions perspective is provided in Rutherford 2020, p. 9).

7.2.8 Existing conceptualisations of (urban) space in transitions literature

This section has introduced the empirical justification for a scarcity perspective on urban space, and presented the legal street as an instrument that gives form to it. This perspective has been developed in the course of the research described in Chapters 2-5, and most fully set out in Chapter 4. As it purports to make a specific contribution to transitions studies, it is necessary to compare this perspective to the conceptualisations of space (and related notions such as scale, place, proximity and distance) mobilised in a selection of key works in the transitions literature. This comparison will mobilise this thesis' primary theoretical contribution: the concept of an automobile lock-in on space and a scarcity perspective on urban open space characterised by zero-sum allocation made on the basis of mobility mode. This contribution will be compared to the conceptualisations of spatial notions that have been advanced in influential transitions studies. The aim of this section is to demonstrate that, while it is possible to describe urban space reallocation in terms of conceptualisations of space and lock-in in transitions, they do not reflect its empirical importance and do not describe the features that set a lock-in on space apart from other forms of lock-in.

[70] Jaywalking refers, in the USA, to the practice by which pedestrians cross the street in disregard of formal indications, signals or infrastructure (Norton 2011, pp. 71–78). For Norton, the process by which jaywalking became a fineable offence in the USA in the 1920s is an important marker of the closure of interpretive flexibility in the social construction of the street, and the advent of the 'roadway' as primarily car space.
[71] In addition, the acquisition of skills and equipment raises the barrier to cycling, and partially explains the preponderance of less risk-averse demographics (especially working-age men) among the cycling population outside of the Netherlands and Denmark.

The first and broadest claim that can be made about transitions literature and urban space is that very few scholars have taken the space inside cities as a unit of analysis in itself. A large proportion of the substantial literature on spatial aspects of transitions treats space in one of two ways. Firstly, in physical terms, as a context in which transitions occur, with an emphasis on explaining spatial variations in regimes and systems, and how notions such as dispersal and aggregation, or proximity and distance, can explain these variations (Coenen and Truffer 2012; Coenen et al. 2012). The second group has developed a relational account of space, treating it as a socially constructed phenomenon, and thereby seeking to spatialise transitions frameworks like the MLP to articulate linkages and dynamics across structuration levels and physical scale (such as the nation, regions, and cities) (Raven et al. 2012). While these literatures have been highly productive, they engage only indirectly and partially with the empirical observations listed in Table 22; implicitly limit themselves to spatial scales larger than that of the street within the city; and thus do not treat space as a finite or exhaustible resource (Hansen and Coenen 2015).

As a result, as Nielsen and Farrelly (2019, p. 232) note with reference to urban transitions, "the physical object (the city), is often considered to be an exogeneous factor that is outside the realm of direct influence". An example of this is found in Geels (2005, p. 451) who describes the landscape level for the road transport socio-technical system as "the material aspect of society, e.g. the material and spatial arrangements of cities, highways and electricity infrastructures". However, Geels also names stabilising forces at the regime level that include road infrastructure and material networks as "sunk costs" that "acquire a logic of their own" once in place (2005, p. 450), suggesting that road infrastructure and the configurations of local streets (perhaps in opposition to 'highways') are subject to the influence of actors. Further, Geels (2005, pp. 455–460) describes in some detail how the mixed-function public space that predated the automobile was gradually transformed in material and administrative terms into the modern street, consisting of the roadway as a conduit for moving (automobile) traffic, with other uses relegated to the margins. Geels thus implies that there is a divide between some material and physical elements of the city which belong to the landscape, and some that belong to the regime, but does not clarify or explain it.

This divide is all the more important insofar as it reflects what Soja (1980, cited in 2019) terms the "socio-spatial dialectic", namely the tension between the built environment understood as the product of the agency of actors, and as a relatively fixed constraint on the agency of actors. Geels (2005) acknowledges the former in his account of the making of the modern street, but pays little attention to the ongoing re-making of streets (through the re-allocation and contestation of space). As a result, it is the second part of the dialectic that is far more prominent in Geels' work. This

emphasis on the undifferentiated "obduracy" of the urban built environment as a cause of socio-technical inertia and path dependency is widespread (Hommels 2005; Maassen 2012; Bulkeley et al. 2014) and persistent (Hölscher and Frantzeskaki 2020). As with Geels (2005), Hommels (2005) emphasises the obduracy part of Soja's dialectic, and pays little attention to the ongoing work of remaking open urban space (for example, maintenance, resurfacing and re-paving). Hommels (2005) does not distinguish between buildings, which have lifespans measured in decades, and the layout and configuration of streets, sidewalks and squares (that is, urban open space), which can and do change constantly through changes in parking, public transport, adjacent land uses, traffic flows, and logistics needs (von Schönfeld and Bertolini 2017). The scarcity perspective advanced in this thesis seeks to direct attention back to the first part of the socio-spatial dialectic by emphasising actors' agency in remaking and reallocating urban open space. The legal street, in turn, articulates the variable obduracy of the built environment by making a distinction between the property boundaries of buildings and the publicly accessible open space in between.

A second contribution that the scarcity perspective can make to transitions is a more nuanced understanding of mechanisms that lock-in urban open space allocations on the basis of mobility modes. Automobility currently benefits from a historical accumulation of space allocated through mechanisms such as parking space minimums, which were adopted in all Western European (capitalist) societies to varying extents in the 20th century (Shoup 2017). This artificial abundance of space for car movement and storage has produced a 'constructed scarcity' of space for other uses that Nikolaeva (Nikolaeva 2017) terms a kind of 'mobility austerity'. This austerity is reflected not only in the current space allocation that stabilises automobility as an urban mobility mode, but in the mechanisms that maintain a distinction between a competition for space *between* subordinate modes and competition between the dominant mode (automobility) and all other modes. This thesis argues that these factors constitute a lock-in on urban open space by automobility which can be seen across the developed world, with exceptions currently limited to 'socio-spatial niches' (Geels 2012) where car entitlements have been weak(er), or other entitlements (such as the Dutch requirement for bicycle parking minimums) have been stronger (Netherlands Government 2012).

7.2.9 Space reallocation as system reconfiguration

More recent prospective transitions work supports the contention that space reallocation (accompanied by demand management) can be the primary driver of a mobility transition, and is thus more significant in practice than it is prominent in the literature. Köhler et al (2020, p. 11) refer to this approach as a 'reconfiguration pathway', referring to investment "in the conversion of roads for innovative cycling infrastructure" and the "partial re-appropriation of roads for 'cycling

superhighways'". Similarly, Schippl and Truffer (2020) have recently argued for the physical structure of settlements (in their case, a rural/urban dichotomy) to be addressed as a source of difference in selection environments, because space is generally scarcer and more oversubscribed in urban contexts. This framework allows these authors to explore the various regimes' (inherently shared) dependency on the 'interface' of urban open space, such as roadways, and conclude that "Cycling is strengthened and better aligned internally because a shrinking car regime needs less space and creates fewer conflicts with cyclists and pedestrians" (Schippl and Truffer 2020, p. 351). These recent studies, with a strong empirical focus, support the claim that the lock-in on space is set apart from other forms of lock-in by the zero-sum character of urban open space: its scarcity is what converts a lock-in into a lock-out.

7.3 (Collaborative) business models, the commons, and mobility transitions

In this thesis, business models have been mobilised instrumentally to better understand the dynamics of mobility systems in Amsterdam and the Netherlands, and in Antwerp, Birmingham, Brussels and Helsinki. Although business models feature prominently in this thesis, it does not focus on resolving empirical problems faced by firms, or recommend specific changes to their business models. Instead, business model analysis has served as a micro-level extension of and complement to meso-level transitions concepts applied to both cities (Geels 2010a) and mobility (Geels 2012), such as the niche, regime and landscape. The two contributions this thesis offers to the literature on the integration of business model and transitions research relate essentially to how niche actors' business models are affected by regulatory barriers maintained or imposed by regime actors, and how niche actors respond.

7.3.1 The value proposition/technology choice fit-stretch framework

In empirical terms, the first of these contributions is the adaptation of Hoogma's (2002) fit/stretch framework to actors in the CaaS niche in the Netherlands. The framework developed in Table 10 exploits a common strategic element implicit in both business models and transitions, using each actors' value proposition as a distillation of its strategy for market entry, and contrasting this in fit/stretch terms with that actor's technology choice and design. This framework resolves an empirical problem by explaining why regime actors' response to the rapid expansion of CaaS providers has differed so significantly between (for example) Swapfiets and Flickbike. Both are Dutch firms whose users mostly reside in the Netherlands, and whose bicycle fleets were observed to cluster in areas where bicycle parking pressure is already high. Yet Swapfiets much more closely matches the existing Dutch private cycling regime, even if it contributes to existing problems in that

regime[72], while Flickbike departs from it, because regime actors do not deem a Flickbike's presence on public land to be legitimate between rides.

Theoretically, the value proposition-technology choice fit/stretch framework has proven successful at enabling the level of simplification and comparison required to isolate the salient distinctions between a set (n=18) of business models of niche actors. It has also demonstrated which distinctions are salient and why (namely, because they infringe on institutions [concerning space allocation] that have been developed by the regime). The use of a relatively simplified form of business model analysis both provides a micro-level perspective to complement transitions research, and allows for a level of aggregation of actors that provides, as in Chapter 2, an overview of an entire niche at the national level. A limitation of this framework is the degree of simplification involved, which may lose precision and rigour when applied to larger niches which contain more variation than the relative homogeneity of Dutch cities.

7.3.2 Collaborative Business Models, the digital and physical commons, and platform mobility

This thesis' second contribution in terms of business models takes the form of a systematic literature review of so-called Collaborative Business Models (CBMs), and the application of the results thereof to three cases of what could be called *imposed* or *coerced collaboration* in urban mobility platforms.

In theoretical terms, the systematic review finds that three interpretations of CBM occur in the literature, depending on the meaning attributed to the word *collaborative*. In the first and largest group, *collaborative* is used as loose descriptor for processes or activities (ranging from informal, opportunistic and occasional to formal, structured and continuous) undertaken by actors with conventional business models. In the second-largest group of sources, *collaborative* is a sectoral description that is similarly applied to organisations with conventional business models that are considered to form part of the *sharing* or *collaborative economy*. The third and smallest group is unlike the first two, in that the word *collaborative* describes business models that are analytically distinct from the Business Model Canvas (BMC) (Osterwalder 2004), and cannot be adequately described in BMC terms. While this review is exploratory and offers an early overview of a term that is ever more widely (and variously) applied in the literature, it is a subset of this third group that is of interest for mobility transitions. This subset considers CBMs to be set apart from those described by the BMC due to the significance of the commons, which operates as both the beneficiary of the

[72] That is, the problem of second bicycles stored at high-demand public transport and city centre bicycle parking facilities; Swapfiets' model makes it well suited (and well used) for this use case.

surplus generated by the organisation, and its key client and resource. An example of this is the place-based, purpose-driven *urban entrepreneur* (Cohen and Muñoz 2015; Muñoz and Cohen 2016).

Urban entrepreneurship and its relationship to public goods has already been analysed by Cohen and Kietzmann (2014), who apply the Business Models for Sustainability framework (Boons and Lüdeke-Freund 2013) to shared mobility business models, including bikeshare. Chapter 5 goes further than the notion of public goods discussed in these studies by expanding and refining the notion of public and merit goods (Cohen and Kietzmann 2014) and the common good (Muñoz and Cohen 2016) into the concept of the physical mobility commons of the city. This physical mobility commons is presented diagrammatically and theoretically as a resource on which all mobility service providers depend on, and compete for to varying extents (for example, among providers who belong to the same mobility mode, producing concepts such as the *bicycle commons, car commons*, etc. The notion of a physical mobility commons, describing the finite stock of space available for movement and the storage of vehicles in relation to business models, is one of this paper's contributions; it can in part be considered an application of the far more expansive notion of the mobility commons/mobility *as* commons introduced by Nikolaeva et al (2019)[73]. In theoretical terms, the physical mobility commons of the city contributes a new means of differentiating the access that mobility service providers have to space, and how the access is enabled, denied and shaped by public-sector actors (which this thesis treats as regime actors). As with the legal street, this contribution is essentially a means of representation, but with theoretical content and a strong empirical justification. As the Openbike/*Deelfietsdashboard* case (page 108) makes clear, access to the physical mobility commons served as the rationale for regime actors' imposition of a particular form of 'collaboration' on dockless bikeshare niche actors, but also as the organising principle for the form that this collaboration was to take. This coerced collaboration is found to varying extents in all three cases in Chapter 5, and its coercive aspect departs from the implicit assumption of *voluntary* collaboration found in the systematic literature review, including the third group focused on the commons (such as Muñoz and Cohen 2016 and; Gyimóthy 2017). The three cases of mobility services platforms analysed in Chapter 5 appear to exemplify some features of collaboration as a novel departure from the logic of the focal firm as reflected in the BMC. These characteristics prompted an investigation into whether they could be considered CBMs. However, closer analysis shows that they do not fit any of the three interpretations of CBMs derived from the existing

[73] While Nikolaeva et al include the common pool resource of the physical mobility commons in their discussion, and also discuss the logic of scarcity as it applies to mobility, their argument focuses on commoning/enclosure as process and practice, and on mobility in a broader sense than the narrower, functional meaning used in this chapter.

literature. This is due to the nature of the 'collaboration' (which is not voluntary but imposed by regime actors acting as gatekeepers), but also because bikeshare operators, especially in the *Openbike* case, do not capture the benefits that accrue to the commons through their operations. As with the legal street framework, bikeshare operators in the cases studied here rely heavily on a commons for storage of their vehicles, unlike providers of car-based services in the same contexts. This underlines once again the explanatory power of the different regimes' space entitlements in clarifying why (collaborative) business models affect different actors differently according to mode, and why a modally-differentiated understanding of the physical mobility commons is essential for understanding mobility transitions.

7.4 Mobility Justice, framing struggles and mobility transitions

7.4.1 Integrating a prescriptive ethical perspective into mobility transitions

Sustainability transitions research has always had a more or less explicit normative orientation, as the meanings of the term *sustainability* are by their nature highly contested, and vary considerably within and between contexts (Köhler et al. 2019, p. 30). The conceptual tenets of Mobility Justice (Sheller 2018) that are operationalised in Chapter 3 are therefore not the first attempt to formally integrate an ethical system into transitions research. However, this chapter does represent one of a very limited number of analyses of the distributional consequences of sustainability transitions in urban mobility[74] (Mullen and Marsden 2016). Unlike Mullen and Marsden (2016), it also extends its analysis beyond a focus on distributional issues towards deliberative, procedural, restorative and epistemic justice. At the same time, the application of Sheller's (2018) expansive conception of Mobility Justice to situated actors engaged in a framing struggle is a novel attempt to assess the degree of *discursive resonance* (see page 66) that actors have achieved through invocations of Mobility Justice tenets. Further, the use of Mobility Justice tenets as part of Roosenbloom's MDDI (2018) makes two specific contributions. For transitions researchers, these tenets highlight outcomes and processes that are relevant to the framing struggle in question, but which have not been formulated or deployed rhetorically by the actors involved. While the orientation of the MDDI is primarily towards analysis rather than intervention, this contribution can inform the actions of researchers and, potentially, actors, thereby making it possible to anticipate and mitigate injustices ex ante (Köhler et al. 2019, p. 33). In particular, the wide net that Mobility Justice tenets cast into the case study of dockless bikeshare in Amsterdam raises issues that are unlikely to enter the frame precisely because they tend to pose a challenge to the regime, such as the immobilities (Kanger and

[74] In contrast, the literature on energy justice and transitions is far more developed (Newell and Mulvaney 2013; Sovacool et al. 2016; Jenkins et al. 2018).

Schot 2016) created by the status quo, or its outcomes for non-users (Kahma and Matschoss 2017) or marginalised actors (Jenkins et al. 2018). The mapping of ethical harms and risks that the Mobility Justice tenets enable contribute a more detailed understanding of what *just* or *sustainable* mobility means in a particular context, which remains a priority for the development of "normative directionality" (Köhler et al. 2019, p. 5) in transitions research. Crucially, because this mapping is not directly dependent on the (in)action(s) of actors in the MDDI, it permits an analysis of how the relative power and stability of these niche and regime actors correlates with their responses to harms and risks (Avelino 2017).

8 Recommendations

8.1 Recommendations for future research

In this thesis, a focus on space institutionalisation connects a niche and two regimes within the Dutch urban mobility system. Although this thesis does not extend its analysis to space contestation that connects space claims from mobility actors to space claims from outside the mobility system (e.g., retail, hospitality, urban design), this kind of contestation is an intrinsic and permanent feature of space allocation processes in cities, as discussed in Section 4.2. However, the challenge of analysing dynamics that may operate across multiple systems, and which are central to transitions across multiple systems, has not been resolved in transitions research (Köhler et al. 2019, p. 39). Holtz (2012) responds to this challenge with the complementary PSM approach, premised on three steps: identifying a phenomenon of interest (P), such as a specific interaction between that connects regimes to each other; developing specifications and measurable indicators (S) to operationalise this phenomenon; and identifying mechanisms (M) by which interactions between multiple entities lead to an observable fact. The scarcity perspective on urban open space may be compatible with this framework as a phenomenon of interest, operationalised and made measurable by the legal street framework. Space allocation mechanisms and appropriation practices also correspond partly to Holtz's mechanisms. By providing a description of the phenomenon of space (re-)allocation in cities, this thesis may contribute to the application of the PSM approach to this aspect of urban mobility transitions, and in particular to the development of policy measures defined at the micro-level but producing a macro-level effect in the aggregate[75]. Further research in this direction could integrate the scarcity perspective and the legal street more directly with established transitions approaches.

More generally, this thesis seeks to contribute to the productive scholarship on the geography of transitions and spatial aspects of transitions (Köhler et al. 2019). It is to be hoped that the spatial shock of the Covid-19 pandemic may draw more attention, in this field, to the existing inequity in space allocation between modes at the micro scale of individual streets. Further, it is to be hoped that researchers will increasingly connect this micro-scale to the vast aggregate surface area of the urban open space that is planned, designed and maintained according to the limited set of notional profiles and proportions that make up the *legal street*. Much as the addition of business model analysis contributed a firm-level perspective to the transitions approach used in Chapter 2, this micro-level analysis of streets could be used to build generalisable concepts and claims regarding

[75] That is, because the allocation of urban open space is highly routinised, changes to the formulae or routines by which space is allocated to classifications or types of streets can have a large effect when replicated across a large number of streets.

space allocation struggles, as well as a strong empirical base of measurable change in the space allocated to various urban mobility modes and uses. Given the urgency of climate change, and the stubbornly high carbon intensity of passenger land transport, more research in this direction could also extend towards a study of the disparity in efforts required to advance claims for different categories of space within the legal street. Ethnographic and sociological accounts of cycling activism and radical re-allocation efforts such as that of Hoffmann (2013), Longhurst (2015), Golub et al. (2016), Lugo (2018), Cox (2019) and many others all emphasise the vast investment of time and organisational capacity that is still required across mass-motorised societies to produce incremental gains in cycling space at the expense of automobility space. Frequently, as happened in London at late as December 2020, these allocations are reversed[76]. In contrast, there are few community fundraisers for new freeways, and newly-built automobility infrastructure is seldom demolished owing to complaints from a number of local residents. These examples highlight the great institutional differences that offer markedly different levels of resistance to space claims, depending on mobility mode, and on the particular challenges that attend efforts to unmake or exnovate (Arne Heyen et al. 2017; David 2018) car-dependency and the dominance of automobility. This points towards a potentially productive area for new research at the confluence of the ethnography and sociology of mobilities (Elliot et al. 2017; Cox 2019), social practice theory (Shove 2012), and socio-technical and sustainable transitions research.

8.2 Recommendations for practice

Lastly, in the final stages of writing the conclusions to this thesis, the actors involved in the Openbike initiative discussed in Chapter 5 have announced a renewed effort to agree on and jointly develop an interoperable platform for dockless bikeshare providers across the Netherlands (Jacobs 2020). The new, publicly-available memorandum of understanding signed between multiple providers and the Netherlands' five largest cities, known as Openbike II, suggests a continuing evolution among all parties from the stalemate analysed in Section 5.3.3. In empirical terms, it is hoped that a scarcity perspective on urban space, potentially combined with persuasive claims that draw on Mobility Justice tenets, could become part of mainstream public and policy-making discourse. The diffusion and circulation of a scarcity perspective informed by Mobility Justice could prove beneficial to initiatives such as Openbike II (and to CaaS overall) by bringing space allocation to all mobility modes into the arena of contestation.

In a similar vein, the legal street could be used by policymakers, researchers and advocacy organisations in support of more recent demands for radical reform to the way city space is paid for.

[76] Walker, P. 'Removed london bike lane blocked by parked cars most of the time', *The Guardian*, 01/01/2021.

One example is Robin Chase's proposal that every person present in a city receive one notional square metre of moving and dormant space for free, with every square metre after that charged at an equal rate that is fixed to the average rental price for nearby private space (e.g., commercial rentals per square metre). By this model, parking a bicycle and taking up a seat in public transport would be cost-free to the user, while parking a car would cost the equivalent of renting roughly $9m^2$ of commercial space for the same duration (Kloppenberg and ten Hage).

In more immediate terms, it is hoped that the legal street would be used as both a template for the representation of typical and notional street profiles and space allocations, and as a representation of desired profiles and allocations. In combination with Nel·lo-Deakin's (2019) approach to mapping space allocation per mode, the legal street could serve to not only render varying proportions of mode-specific space across and between cities, but also to map the processes and institutions that must be engaged with by those hoping to bring about a reallocation of space.

9 References

Aagaard A (ed) (2019) Sustainable Business Models: Innovation, Implementation and Success. Springer International Publishing, Cham

Abdelkafi N, Makhotin S, Posselt T (2013) Business Model Innovations for Electric Mobility - What Can Be Learned from Existing Business Model Patterns? Int J Innov Manag 17:1340003. https://doi.org/10.1142/S1363919613400033

Ache P (2011) 'Creating futures that would otherwise not be'–Reflections on the Greater Helsinki Vision process and the making of metropolitan regions. Prog Plan 75:155–192. https://doi.org/10.1016/j.progress.2011.05.002

Adam L, Jones T, te Brömmelstroet M (2018) Planning for cycling in the dispersed city: establishing a hierarchy of effectiveness of municipal cycling policies. Transportation. https://doi.org/10.1007/s11116-018-9878-3

Adrianne DK (2017) Rotterdamse politiek voor deelfiets, maar klaar met overlast. In: Alg. Dagbl. https://www.ad.nl/rotterdam/rotterdamse-politiek-voor-deelfiets-maar-klaar-met-overlast~a8f48dd0/. Accessed 1 Oct 2017

Affolderbach J, Schulz C (2016) Mobile transitions: Exploring synergies for urban sustainability research. Urban Stud 53:1942–1957. https://doi.org/10.1177/0042098015583784

Akyelken N, Banister D, Givoni M (2018) The Sustainability of Shared Mobility in London: The Dilemma for Governance. Sustainability 10:420. https://doi.org/10.3390/su10020420

Albert de la Bruhèze A, Oldenziel R (2016) Who Pays, Who Benefits? Bicycle Taxes as Policy Tool, 1890-2012. In: Oldenziel R, Trischler, Helmuth (eds) Cycling and Recycling. Berghahn Books, New York, pp 73–100

Aldred R, Jungnickel K (2013) Matter in or out of place? Bicycle parking strategies and their effects on people, practices and places. Soc Cult Geogr 14:604–624. https://doi.org/10.1080/14649365.2013.790993

Alpkokin P (2012) Historical and critical review of spatial and transport planning in the Netherlands. Land Use Policy 29:536–547. https://doi.org/10.1016/j.landusepol.2011.09.007

Amaral M (2008) Public vs private management of public utilities–The case of urban public transport in Europe. Res Transp Econ 22:85–90. https://doi.org/10.1016/j.retrec.2008.05.021

Ambrosino G, Nelson JD, Boero M, Ramazzotti D (2016) From the Concept of Flexible Mobility Services to the 'Shared Mobility Services Agency.' In: Mulley C, Nelson JD (eds) Transport and Sustainability. Emerald Group Publishing Limited, pp 203–215

Amin A (2008) Collective culture and urban public space. City 12:5–24. https://doi.org/10.1080/13604810801933495

Arne Heyen D, Hermwille L, Wehnert T (2017) Out of the Comfort Zone! Governing the Exnovation of Unsustainable Technologies and Practices. GAIA - Ecol Perspect Sci Soc 26:326–331. https://doi.org/10.14512/gaia.26.4.9

Attias D (ed) (2017) The Automobile Revolution. Springer International Publishing, Cham

Audouin M, Finger M (2018) The development of Mobility-as-a-Service in the Helsinki metropolitan area: A multi-level governance analysis. Res Transp Bus Manag 27:24–35. https://doi.org/10.1016/j.rtbm.2018.09.001

Avelino F (2017) Power in Sustainability Transitions: Analysing power and (dis)empowerment in transformative change towards sustainability: Power in Sustainability Transitions. Environ Policy Gov 27:505–520. https://doi.org/10.1002/eet.1777

Avelino F, Grin J, Pel B, Jhagroe S (2016) The politics of sustainability transitions. J Environ Policy Plan 18:557–567. https://doi.org/10.1080/1523908X.2016.1216782

Baden-Fuller C, Mangematin V (2013) Business models: A challenging agenda. Strateg Organ 11:418–427

Baldassarre B, Calabretta G, Bocken NMP, Jaskiewicz T (2017) Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design. J Clean Prod 147:175–186. https://doi.org/10.1016/j.jclepro.2017.01.081
Banister D (2005) Unsustainable Transport: City Transport in the New Century. Routledge, London
Banister D (2008) The sustainable mobility paradigm. Transp Policy 15:73–80. https://doi.org/10.1016/j.tranpol.2007.10.005
Barrington-Leigh C, Millard-Ball A (2020) Global trends toward urban street-network sprawl. Proc Natl Acad Sci 117:1941–1950. https://doi.org/10.1073/pnas.1905232116
Barter PA (2015) A parking policy typology for clearer thinking on parking reform. Int J Urban Sci 19:136–156. https://doi.org/10.1080/12265934.2014.927740
Bauwens T (2015) Socio-Technical Lock-in and the Alignment Framework: The Case of Distributed Generation Technologies. Compet Regul Netw Ind 16:155–181. https://doi.org/10.1177/178359171501600205
Becker S, Moss T, Naumann M (2016) The Importance of Space: Towards a Socio-Material and Political Geography of Energy Transitions. In: Gailing L, Moss T (eds) Conceptualizing Germany's Energy Transition. Palgrave Macmillan UK, London, pp 93–108
Berger G, Feindt PH, Holden E, Rubik F (2014) Sustainable Mobility—Challenges for a Complex Transition. J Environ Policy Plan 16:303–320. https://doi.org/10.1080/1523908X.2014.954077
Bergmann S, Sager T (eds) (2008) The ethics of mobilities: rethinking place, exclusion, freedom and environment. Ashgate, Aldershot, England ; Burlington, VT
Bertolini L, Pelzer P, te Brommelstroet MCG (2015) Is het debat over toekomstige mobiliteit te beperkt? Een voorstel voor een multidimensionaal perspectief. https://hdl.handle.net/11245/1.494959
Bhaskar R (2013) A realist theory of science. Routledge, Abingdon.
Bidmon C, Knab SF (2017) Exploring the Roles of Business Models in Societal Transitions. Academy of Management, p 12604
Bidmon CM, Knab S (2014) The three roles of business models for socio-technical transitions. In: Huizingh K, Conn S, Torkkeli M, Bitran I (eds): The Proceedings of XXV ISPIM Conference – Innovation for Sustainable Economy and Society, 8-11 June 2014, Dublin, Ireland.
Bidmon CM, Knab SF (2018) The three roles of business models in societal transitions: New linkages between business model and transition research. J Clean Prod 178:903–916. https://doi.org/10.1016/j.jclepro.2017.12.198
Bigelow B, Fahey L, Mahon J (1993) A typology of issue evolution. Bus Soc 32:18–29
Bijker WE (1997) Of bicycles, bakelites, and bulbs: Toward a theory of sociotechnical change. MIT Press; Cambridge, Mass.
Birmingham City Council (2019) Birmingham Parking: Supplementary Planning Document, Consultation Draft. Birmingham City Council Transport Policy
Birmingham City Council (2020a) Birmingham Transport Plan (Draft)
Birmingham City Council (2020b) Emergency Birmingham Transport Plan: A low carbon, clean air recovery after COVID-19. Birmingham, UK
Bleja J, Grossmann U, Langer H (2018) A collaborative system business model for ambient assisted living systems. pp 78–81
Bleja J, Langer H, Grossmann U (2019) Business models for wireless AAL systems-financing strategies. pp 130–133
Bocken NMP, Short SW, Rana P, Evans S (2014) A literature and practice review to develop sustainable business model archetypes. J Clean Prod 65:42–56. https://doi.org/10.1016/j.jclepro.2013.11.039
Böhm S (ed) (2006) Against automobility. Blackwell, Malden, MA
Bohnsack R, Pinkse J (2017) Reconfiguration Tactics in the Case of Electric Vehicles. Calif Manage Rev 59:18. https://doi.org//doi.org/10.1177/0008125617717

Bolton R, Hannon M (2016) Governing sustainability transitions through business model innovation: Towards a systems understanding. Res Policy 45:1731–1742. https://doi.org/10.1016/j.respol.2016.05.003
Boons F, Lüdeke-Freund F (2013) Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J Clean Prod 45:9–19. https://doi.org/10.1016/j.jclepro.2012.07.007
Boor S (2020) Sven Boor interview 16072020
Boor S, Vincent H (2019) Deelfiets Dashboard voor gemeentes: Hoe krijgt een gemeente inzicht in (real-time) deelfietsgebruik?
Borch C (2015) Urban Commons: Rethinking the City, 1st edn. Routledge, Abingdon, Oxon ; New York
Botsman R, Rogers R (2011) What's mine is yours: how collaborative consumption is changing the way we live
Brandajs F, Russo AP (2019) Whose is that square? Cruise tourists' mobilities and negotiation for public space in Barcelona. Appl Mobilities 1–25. https://doi.org/10.1080/23800127.2019.1576257
Bridge G, Bouzarovski S, Bradshaw M, Eyre N (2013) Geographies of energy transition: Space, place and the low-carbon economy. Energy Policy 53:331–340. https://doi.org/10.1016/j.enpol.2012.10.066
Briggs M, Webb J, Wilson C (2015) Automotive Modal Lock-in: The role of path dependence and large socio-economic regimes in market failure. Econ Anal Policy 45:58–68. https://doi.org/10.1016/j.eap.2015.01.005
Broer K (2016) Fietsdeelsystemen in Antwerpen: Het success van de Velo. CROW-Fietsberaad
Brown MG (2016) Access, Property and American Urban Space. Routledge
Bruxelles Environnement (2019) Mieux se déplacer à Bruxelles: Des idées simples qui donnent envie de bouger
Bruxelles Mobilité (2016a) Le partage de l'espace public en Région de Bruxelles-Capitale
Bruxelles Mobilité (2016b) Espace pour le transport public
Bruxelles Mobilité (2017) Diagnostic de mobilité en Région bruxelloise. Service public régional de Bruxelles, Brussels
Bruxelles Mobilité (2020) Plan régional de mobilité 2020-2030: Plan stratégique et opérationnel. Bruxelles Mobilité, Brussels
Bryman A (2012) Social Research Methods, 4th ed. Oxford University Press, Oxford ; New York
Buiter H (2008) Constructing Dutch Streets. In: Urban Machinery: Inside Modern European Cities. MIT Press, Cambridge, MA.
Bulkeley H, Broto VC, Hodson M, Marvin S (2010) Cities and low carbon transitions. Routledge
Bulkeley H, Castán Broto V, Maassen A (2014) Low-carbon Transitions and the Reconfiguration of Urban Infrastructure. Urban Stud 51:1471–1486. https://doi.org/10.1177/0042098013500089
Caprotti F, Harmer N (2017) Spatialising Urban Sustainability Transitions: Eco-cities, Multilevel Perspectives and the Political Ecology of Scale in the Bohai Rim, China. In: Urban Sustainability Transitions. Taylor & Francis, Abingdon, UK
Carmona M (2015) Re-theorising contemporary public space: a new narrative and a new normative. J Urban Int Res Placemaking Urban Sustain 8:373–405. https://doi.org/10.1080/17549175.2014.909518
Casadesus-Masanell R, Ricart JE (2010) From strategy to business models and onto tactics. Long Range Plann 43:195–215
Castán Broto V (2015) Contradiction, intervention, and urban low carbon transitions. Environ Plan Soc Space 0:0–0. https://doi.org/10.1068/d13050p
Castillo-Manzano JI, López-Valpuesta L, Sánchez-Braza A (2016) Going a long way? On your bike! Comparing the distances for which public bicycle sharing system and private bicycles are used. Appl Geogr 71:95–105. https://doi.org/10.1016/j.apgeog.2016.04.003

Castillo-Montoya M (2016) Preparing for interview research: The interview protocol refinement framework. Qual Rep 21:811–831
Cervero R, Sarmiento OL, Jacoby E, et al (2009) Influences of built environments on walking and cycling: lessons from Bogotá. Int J Sustain Transp 3:203–226. https://doi.org/10.1080/15568310802178314
Chatterton P (2016) Building transitions to post-capitalist urban commons. Trans Inst Br Geogr 41:403–415. https://doi.org/10.1111/tran.12139
Cherp A, Vinichenko V, Jewell J, et al (2018) Integrating techno-economic, socio-technical and political perspectives on national energy transitions: A meta-theoretical framework. Energy Res Soc Sci 37:175–190. https://doi.org/10.1016/j.erss.2017.09.015
Chesbrough H (2010) Business model innovation: opportunities and barriers. Long Range Plann 43:354–363
Chesbrough H, Rosenbloom RS (2002) The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Ind Corp Change 11:529–555
Cidell J, Prytherch D (eds) (2015) Transport, mobility, and the production of urban space. Routledge, New York ; London
CIHT (2010) Manual for Streets 2. Chartered Institute of Highways & Transportation, London
Clarsen G (2015) Pedaling Power: Bicycles, Subjectivities and Landscapes in a Settler Colonial Society. Mobilities 10:706–725. https://doi.org/10.1080/17450101.2014.927201
Coenen L, Benneworth P, Truffer B (2012) Toward a spatial perspective on sustainability transitions. Res Policy 41:968–979. https://doi.org/10.1016/j.respol.2012.02.014
Coenen L, Truffer B (2012) Places and Spaces of Sustainability Transitions: Geographical Contributions to an Emerging Research and Policy Field. Eur Plan Stud 20:367–374. https://doi.org/10.1080/09654313.2012.651802
Cohen B, Kietzmann J (2014) Ride on! Mobility business models for the sharing economy. Organ Environ 27:279–296. https://doi.org/10.1177/1086026614546199
Cohen B, Muñoz P (2015) Toward a Theory of Purpose-Driven Urban Entrepreneurship. Organ Environ 28:264–285. https://doi.org/10/f75mb4
Cook N, Butz D (2018) Mobilities, Mobility Justice and Social Justice. Routledge, London
Corvellec H, Zapata Campos MJ, Zapata P (2013) Infrastructures, lock-in, and sustainable urban development: the case of waste incineration in the Göteborg Metropolitan Area. J Clean Prod 50:32–39. https://doi.org/10.1016/j.jclepro.2012.12.009
Cox P (2019) Cycling: a sociology of vélomobility. Routledge, Abingdon, Oxon ; New York, NY
Cox P, Van de Walle F (2007) Bicycles Don't Evolve: Velomobiles and the Modelling of Transport Technologies. In: Cycling and society. Ashgate, Aldershot, England ; Burlington, VT
Creswell JW, Poth CN (2018) Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 4th edn. SAGE Publications, Thousand Oaks, CA
CROW (2012) Aanbevelingen voor verkeersvoorzieningen binnen de bebouwde kom. CROW, Ede (NL)
CROW (2016) Design Manual for Bicycle Traffic. CROW, Utrecht
Crozet Y, Santos G, Coledfy J (2019) Shared Mobility, MaaS and the Regulatory Challenges of Urban Mobility. Cerre | Centre on Regulation in Europe, Brussels
David M (2018) The role of organized publics in articulating the exnovation of fossil-fuel technologies for intra- and intergenerational energy justice in energy transitions. Appl Energy 228:339–350. https://doi.org/10.1016/j.apenergy.2018.06.080
de Haan DJ (2018) Het Deelfietsconvenant Openbike brengt MaaS voor deelfietsen dichtbij
de Magalhães C, Freire Trigo S (2017) 'Clubification' of urban public spaces? The withdrawal or the re-definition of the role of local government in the management of public spaces. J Urban Des 22:738–756. https://doi.org/10.1080/13574809.2017.1336059

de Man A-P, Luvison D (2019) Collaborative business models: Aligning and operationalizing alliances. Bus Horiz 62:473–482. https://doi.org/10/ggs45v
De Muelenaere M (2020) «Bruxelles a besoin de plus d'espace public». Le Soir
De Volkskrant (2017) Amsterdam gaat deelfietsen verwijderen die "schaarse parkeerplekken" bezetten. Volkskrant
Dixon-Woods M, Agarwal S, Jones D, et al (2005) Synthesising qualitative and quantitative evidence: a review of possible methods. J Health Serv Res Policy 10:45–53
Doganova L, Eyquem-Renault M (2009) What do business models do?: Innovation devices in technology entrepreneurship. Res Policy 38:1559–1570
Dreyer B, Lüdeke-Freund F, Hamann R, Faccer K (2017) Upsides and downsides of the sharing economy: Collaborative consumption business models' stakeholder value impacts and their relationship to context. Technol Forecast Soc Change 125:87–104. https://doi.org/10.1016/j.techfore.2017.03.036
Driscoll PA (2014) Breaking Carbon Lock-In: Path Dependencies in Large-Scale Transportation Infrastructure Projects. Plan Pract Res 29:317–330. https://doi.org/10.1080/02697459.2014.929847
Duarte F (2016) Disassembling Bike-Sharing Systems: Surveillance, Advertising, and the Social Inequalities of a Global Technological Assemblage. J Urban Technol 23:103–115. https://doi.org/10.1080/10630732.2015.1102421
Duursma M (2017a) Gaan deelfietsen de weerstand overwinnen? NRC Handelsbl.
Duursma M (2017b) Amsterdam pakt overlast door deelfietsen aan. In: NRC Handelsbl. https://www.nrc.nl/nieuws/2017/09/29/amsterdam-pakt-overlast-door-deelfietsen-aan-13256552-a1575433?utm_source=NRC&utm_medium=related&utm_campaign=related2. Accessed 5 Oct 2017
Dyer JH (1996) Does governance matter? Keiretsu alliances and asset specificity as sources of Japanese competitive advantage. Organ Sci 7:649–666. https://doi.org/10.1287/orsc.7.6.649
EC DG MOVE (2017) Support study on data collection and analysis of active modes use and infrastructure in Europe: Active Modes Summary Table. European Commission Directorate-General for Mobility and Transport, Brussels
EC DG MOVE (2019) Transport in the European Union: Current Trends and Issues. European Commission Directorate-General for Mobility and Transport, Brussels
ECF (2018) Making Buildings Fit for Sustainable Mobility: Comparing Regulations for Off-Street Bicycle and Car Parking in Europe. European Cyclists' Federation, Brussels
ECF (2017) EU Cycling Strategy: Recommendations for Delivering Green Growth and an Effective Mobility System in 2030. European Cyclists' Federation, Brussels
Echt Amsterdams Nieuws (2017a) Deelfietsbedrijven moeten fietsen weghalen uit de stad. In: Echt Amst. Nieuws. http://www.at5.nl/artikelen/172615/deelfietsbedrijven-hebben-nog-een-week-om-fietsen-weg-te-halen-uit-de-stad. Accessed 5 Oct 2017
Echt Amsterdams Nieuws (2017b) "Term deelfiets is misleidend, stad is grote winkelstalling." Echt Amst. Nieuws
Elliot A, Norum R, Salazar NB (eds) (2017) Methodologies of mobility: ethnography and experiment. Berghahn Books, New York
Elzen B, Geels FW, Leeuwis C, van Mierlo B (2011) Normative contestation in transitions 'in the making': Animal welfare concerns and system innovation in pig husbandry. Res Policy 40:263–275. https://doi.org/10.1016/j.respol.2010.09.018
Elzen B, Wieczorek A (2005) Transitions towards sustainability through system innovation. Technol Forecast Soc Change 72:651–661
Emanuel M (2016) Monuments of Unsustainability: Planning, Path Dependence, and Cycling in Stockholm. In: Oldenziel R, Trischler, Helmuth (eds) Cycling and Recycling. Berghahn Books, New York, pp 101–124

Epprecht N, von Wirth T, Stünzi C, Blumer YB (2014) Anticipating transitions beyond the current mobility regimes: How acceptability matters. Futures 60:30–40. https://doi.org/10.1016/j.futures.2014.04.001
Ernst L, de Graaf-Van Dinther RE, Peek GJ, Loorbach DA (2016) Sustainable urban transformation and sustainability transitions; conceptual framework and case study. J Clean Prod 112:2988–2999. https://doi.org/10.1016/j.jclepro.2015.10.136
EU (2004) Urban Design for Sustainability: Final Report of the Working Group on Urban Design for Sustainability to the European Union Expert Group on the Urban Environment. EU Working Group on Urban Design for Sustainability, Vienna, Austria
EU DG Mobility & Transport (2017) European Urban Mobility: Policy Context. EU Directorate-General for Mobility and Transport: Directorate - Investment, Innovative & Sustainable Transport: Unit B4 - Sustainable & Intelligent Transport, Brussels
EU DG Mobility & Transport (2011) ITS ACTION PLAN - D4–Final Report Action 3.4 – Safety and comfort of the Vulnerable Road User. EU Directorate-General for Mobility and Transport: Directorate - Investment, Innovative & Sustainable Transport: Unit B4 - Sustainable & Intelligent Transport, Brussels
EU Partnership on Urban Mobility (2017) Urban Agenda for the European Union: Orientation Paper
Eurobarometer (2014) Quality of Transport. European Commission Directorate-General for Mobility and Transport, Brussels
European Parking Association (2013) The Scope of Parking in Europe: Data Collection by the European Parking Association. European Parking Association, Cologne, Germany
Evans S, Vladimirova D, Holgado M, et al (2017) Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. Bus Strategy Environ 26:597–608. https://doi.org/10.1002/bse.1939
Feddes F, de Lange M (2019) Bike City Amsterdam. Uitgeverij Bas Lubberhuizen, Amsterdam
Feitsma H (2017) Deelfietsbedrijven ontvluchten Amsterdam na actie gemeente. In: Autobahn.eu. https://www.autobahn.eu/5814/deelfietsbedrijven-ontvluchten-amsterdam-na-actie-gemeente/
Fietsberaad (2018) Overal een deelfiets met één account. In: Nieuws. http://www.fietsberaad.nl/?section=nieuws&mode=newsArticle&newsYear=2018&repository=Overal+een+deelfiets+met+%C3%A9%C3%A9n+account
Finnish Government (2020) Numerous amendments proposed to taxi legislation. In: Valtioneuvosto. https://valtioneuvosto.fi/en/-/numerous-amendments-proposed-to-taxi-legislation. Accessed 5 Jan 2021
Fiorito R, Kollintzas T (2004) Public goods, merit goods, and the relation between private and government consumption. Eur Econ Rev 48:1367–1398
Fishman E (2016) Bikeshare: A Review of Recent Literature. Transp Rev 36:92–113. https://doi.org/10.1080/01441647.2015.1033036
Flüchter KA (2014) The Impact of the Internet of Things on Business Model Innovation: Insights from the Electric Bicycle Industry
Forsyth A (2010) Measuring Walking and Cycling Using the PABS (Pedestrian and Bicycling Survey) Approach: A Low-Cost Survey Method for Local Communities. Mineta Transportation Institute Publications. https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1078&context=mti_publications
Foster S, Iaione C (2015) The city as a commons. Yale Law Policy Rev 34:
Frantzeskaki N, Broto VC, Coenen L (eds) (2017) Urban Sustainability Transitions, First Edition. Routledge, Taylor & Francis Group, New York
Frenken K (2017) Political economies and environmental futures for the sharing economy. Philos Trans R Soc Math Phys Eng Sci 375:20160367. https://doi.org/10.1098/rsta.2016.0367
Gebhardt L, Krajzewicz D, Oostendorp R, et al (2016) Intermodal Urban Mobility: Users, Uses, and Use Cases. Transp Res Procedia 14:1183–1192. https://doi.org/10.1016/j.trpro.2016.05.189

Geels F (2010a) The role of cities in technological transitions: analytical clarifications and historical examples. In: Bulkeley H, Castán Broto V, Hodson M, Marvin S (eds) Cities and Low Carbon Transitions. Routledge, London ; New York, pp 29–44
Geels FW (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Res Policy 31:1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8
Geels FW (2012) A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. J Transp Geogr 24:471–482. https://doi.org/10.1016/j.jtrangeo.2012.01.021
Geels FW (2018) Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). Energy Res Soc Sci 46:86–102. https://doi.org/10.1016/j.erss.2018.07.008
Geels FW (2010b) Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Res Policy 39:495–510. https://doi.org/10.1016/j.respol.2010.01.022
Geels FW (2005) The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). Technol Anal Strateg Manag 17:445–476. https://doi.org/10.1080/09537320500357319
Geels FW, Dudley G, Kemp R (2012) Findings, Conclusions and Assessments of Sustainability Transitions in Automobility. In: Geels FW (ed) Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York; London, pp 335–373
Geels FW, Verhees B (2011) Cultural legitimacy and framing struggles in innovation journeys: A cultural-performative perspective and a case study of Dutch nuclear energy (1945–1986). Technol Forecast Soc Change 78:910–930. https://doi.org/10.1016/j.techfore.2010.12.004
Gehl J (2011) Life between buildings: using public space. Island Press, Washington, DC
Geile M (2017) Cycling as a viable response to transport poverty. MSc., University of Freiburg
Gemeente Amsterdam (2017a) Gemeente Amsterdam Nota Deelfiets (concept). Amsterdam
Gemeente Amsterdam (2017b) Amsterdam gaat deelfietsen verwijderen. In: Press Release. https://www.amsterdam.nl/bestuur-organisatie/college/individuele-paginas/pieter-litjens/persberichten/amsterdam-gaat/
Gemeente Amsterdam (2016) Handboek Handhaving Fietsparkeren
Gemeente Amsterdam (2017c) Meerjarenplan Fiets 2017-2022. Gemeente Amsterdam
Gemeente Amsterdam (2020) Agenda Amsterdam Autoluw: Amsterdam maakt ruimte. Gemeente Amsterdam, Amsterdam
Gemeente Amsterdam (2019a) Inrichtingsprincipes voor een autoluwe stad (Bijlage: Agenda Amsterdam Autoluw). Verkeer & Openbare Ruimte
Gemeente Amsterdam (2019b) Deelmobiliteit, kansen voor de stad: Beleid voor het delen van schone vervoermiddelen anders dan de auto. Verkeer & Openbare Ruimte
Gemeente Rotterdam (2018) Beleidsnotitie deelfietsen Rotterdam. Rotterdam
Ghosh D, Sengers F, Wieczorek AJ, et al (2016) Urban mobility experiments in India and Thailand. In: The Experimental City. Routledge, London, pp 122–136
Giddens A (1984) The constitution of society: Outline of the theory of structuration. Univ of California Press
Golub A (ed) (2016) Bicycle justice and urban transformation: biking for all? Routledge Taylor & Francis Group, London ; New York
Golub A, Hoffmann ML, Lugo AE, Sandoval GF (2016) Bicycle Justice and Urban Transformation: Biking for All? Routledge, London; New York.
Goodman A, Green J, Woodcock J (2014) The role of bicycle sharing systems in normalising the image of cycling: An observational study of London cyclists. J Transp Health 1:5–8. https://doi.org/10.1016/j.jth.2013.07.001
Gössling S (2016) Urban transport justice. J Transp Geogr 54:1–9. https://doi.org/10.1016/j.jtrangeo.2016.05.002

Gössling S, Choi AS (2015) Transport transitions in Copenhagen: Comparing the cost of cars and bicycles. Ecol Econ 113:106–113. https://doi.org/10.1016/j.ecolecon.2015.03.006
Gössling S, Schröder M, Späth P, Freytag T (2016) Urban Space Distribution and Sustainable Transport. Transp Rev 36:659–679. https://doi.org/10.1080/01441647.2016.1147101
Greenhalgh T, Peacock R (2005) Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources. Br Med J 331:1064–1065. https://doi.org/10.1136/bmj.38636.593461.68
Grieco M, Urry J (eds) (2011) Mobilities: new perspectives on transport and society. Ashgate, Farnham, Surrey ; Burlington, VT
Grin J, Rotmans J, Schot J (2010) Transitions to Sustainable Development: New directions in the Study of Long Term Transformative Change. Routledge, Abingdon, Oxon ; New York
Groote JD, Ommeren JV, Koster HRA (2016) Car ownership and residential parking subsidies: Evidence from Amsterdam. Econ Transp 6:25–37. https://doi.org/10.1016/j.ecotra.2016.07.001
Grossmann U, Horster B, Khess I (2017) Collaborative business models for AAL-services based on M2M-communication. pp 436–440
Gunn S (2018) Ring road: Birmingham and the collapse of the motor city ideal in 1970s Britain. Hist J 61:227–248
Gyimóthy S (2017) Business models of the collaborative economy. In: Collaborative Economy and Tourism. Springer, Cham; pp 31–39. https://doi.org/10.1007/978-3-319-51799-5_3
Hajer MA, van den Brink M, Metze T (2006) Doing discourse analysis: coalitions, practices, meaning. Neth Geogr Stud ISSN 0169-4839
Halpern C, Sarti F, McArthur J (2018) Road space re-allocation: Streets as contested spaces (v2). MORE Multimodal Optimisation of Roadspace in Europe
Hamedinger A (2014) The Mobility and/or Fixity of Urban and Planning Policies – The Role of Divergent Urban Planning Cultures. Eur Spat Res Policy 21:23–37. https://doi.org/10.2478/esrp-2014-0003
Hansen T, Coenen L (2015) The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. Environ Innov Soc Transit 17:92–109. https://doi.org/10.1016/j.eist.2014.11.001
Harms L, Bertolini L, te Brömmelstroet M (2014) Spatial and social variations in cycling patterns in a mature cycling country exploring differences and trends. J Transp Health 1:232–242. https://doi.org/10.1016/j.jth.2014.09.012
Healy N, Barry J (2017) Politicizing energy justice and energy system transitions: Fossil fuel divestment and a “just transition.” Energy Policy 108:451–459. https://doi.org/10.1016/j.enpol.2017.06.014
Hebbert M (2005) Engineering, Urbanism and the Struggle for Street Design. J Urban Des 10:39–59. https://doi.org/10.1080/13574800500062361
Heikkilä S (2014) Mobility as a Service – A Proposal for Action for the Public Administration Case Helsinki. Aalto University School of Engineering. https://aaltodoc.aalto.fi/bitstream/handle/123456789/13133/master_Heikkil%c3%a4_Sonja_2014.pdf?sequence=1&isAllowed=y
Heinen E, Buehler R (2019) Bicycle parking: a systematic review of scientific literature on parking behaviour, parking preferences, and their influence on cycling and travel behaviour. Transp Rev 1–27. https://doi.org/10.1080/01441647.2019.1590477
Henderson J (2015) From Climate Fight to Street Fight: The Politics of Mobility and the Right to the City. In: Cidell J, Prytherch D (eds) Transport, mobility, and the production of urban space. Routledge, New York ; London, pp 101–116
Henderson J (2009) The politics of mobility: De-essentializing automobility and contesting urban space. In: Conley J, Tigar McLaren A (eds) Car Troubles: Critical Studies of Automobility and Auto-Mobility. Ashgate, Burlington, VT, pp 147–164

Henry A, Ermans T, de Smet d'Olbecke F (2020) Un retour de la bicyclette, aussi à Bruxelles ? Bruss Stud 144:. https://doi.org/10.4000/brussels.4826
Hensher DA, Mulley C, Ho C, et al (2020) Understanding Mobility as a Service (MaaS): Past, Present and Future. Elsevier, Amsterdam, NL
Hermwille L (2016) The role of narratives in socio-technical transitions—Fukushima and the energy regimes of Japan, Germany, and the United Kingdom. Energy Res Soc Sci 11:237–246. https://doi.org/10.1016/j.erss.2015.11.001
Hietanen S (2017) Interview with Sampi Hietanen of MaaS Global/Whim
Hildermeier J, Villareal A (2014) Two ways of defining sustainable mobility: Autolib' and BeMobility. J Environ Policy Plan 16:321–336. https://doi.org/10.1080/1523908X.2014.880336
Hine J, Mitchell F (2017) Transport disadvantage and social exclusion: exclusionary mechanisms in transport in urban Scotland. Routledge, Abindon, UK
Hirsch JA, Stratton-Rayner J, Winters M, et al (2019) Roadmap for free-floating bikeshare research and practice in North America. Transp Rev 39:706–732. https://doi.org/10.1080/01441647.2019.1649318
Hirschhorn F, Paulsson A, Sørensen CH, Veeneman W (2019) Public transport regimes and mobility as a service: Governance approaches in Amsterdam, Birmingham, and Helsinki. Transp Res Part Policy Pract 130:178–191
Hodson M, Marvin S, Robinson B, Swilling M (2012) Reshaping Urban Infrastructure: Material Flow Analysis and Transitions Analysis in an Urban Context. J Ind Ecol 16:789–800. https://doi.org/10.1111/j.1530-9290.2012.00559.x
Hoffmann ML (2013) Our bikes in the middle of the street: community-building, racism and gentrification in urban bicycle advocacy. University of Minnesota
Hoffmann S, Weyer J, Longen J (2017) Discontinuation of the automobility regime? An integrated approach to multi-level governance. Transp Res Part Policy Pract 103:391–408. https://doi.org/10.1016/j.tra.2017.06.016
Hölscher K, Frantzeskaki N (2020) Navigating Transformations Under Climate Change in Cities: Features and Lock-ins of Urban Climate Governance Katharina Hölscher and Niki Frantzeskaki. In: Hölscher K, Frantzeskaki N (eds) Transformative Climate Governance: A Capacities Perspective to Systematise, Evaluate and Guide Climate Action. Springer International Publishing, Cham
Holtz G (2012) The PSM approach to transitions: Bridging the gap between abstract frameworks and tangible entities. Technol Forecast Soc Change 79:734–743. https://doi.org/10.1016/j.techfore.2011.10.005
Homan M (2017) Amsterdam gaat deelfietsen ruimen: "Grote kans dat we failliet gaan." RTL Nieuws
Hommels A (2005) Studying Obduracy in the City: Toward a Productive Fusion between Technology Studies and Urban Studies. Sci Technol Hum Values 30:323–351. https://doi.org/10.1177/0162243904271759
Hoogma R (2002) Experimenting for sustainable transport: the approach of strategic niche management. Taylor & Francis, Abingdon, UK
Hubert M, Corijn E, Neuwels J, et al (2017) Du « grand piétonnier » au projet urbain : atouts et défis pour le centre-ville de Bruxelles: Note de synthèse BSI. Bruss Stud. https://doi.org/10.4000/brussels.1551
Huijben JCCM, Verbong GPJ, Podoynitsyna KS (2016) Mainstreaming solar: Stretching the regulatory regime through business model innovation. Environ Innov Soc Transit 20:1–15. https://doi.org/10.1016/j.eist.2015.12.002
ITDP (2011) Europe's Parking U-Turn: From Accommodation to Regulation. Institute for Transportation & Development Policy, New York, NY
Jacobs I (2020) Fiets- en scooterdelen makkelijker door afspraken over samenwerking. Verkeersnet
Jeekel H (2017) Social Sustainability and Smart Mobility : Exploring the relationship. Transp Res Procedia 25:4296–4310. https://doi.org/10.1016/j.trpro.2017.05.254

Jenkins K, McCauley D, Heffron R, et al (2016) Energy justice: a conceptual review. Energy Res Soc Sci 11:174–182
Jenkins K, Sovacool BK, McCauley D (2018) Humanizing sociotechnical transitions through energy justice: An ethical framework for global transformative change. Energy Policy 117:66–74. https://doi.org/10.1016/j.enpol.2018.02.036
Jensen JS, Lauridsen EH, Fratini CF, Hoffmann B (2015) Harbour bathing and the urban transition of water in Copenhagen: junctions, mediators, and urban navigations. Environ Plan A 47:554–570
Jittrapirom P, Caiati V, Feneri A-M, et al (2017) Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges. Urban Plan 2:13. https://doi.org/10.17645/up.v2i2.931
Jones IH (2014) Road Space Allocation: The Intersection of Transport Planning, Governance and Infrastructure
Jones P (2016) A comprehensive basis for determining the allocation of urban street space. In: 14th World Conference on Transport Research, 10-15 July 2016. Conference: 14th World Conference on Transport Research, Shanghai
Jonuschat H, Stephan K, Schelewsky M (2015) Understanding Multimodal and Intermodal Mobility. In: Attard M, Shiftan Y (eds) Transport and Sustainability. Emerald Group Publishing Limited, pp 149–176
Kager R, Bertolini L, Te Brömmelstroet M (2016) Characterisation of and reflections on the synergy of bicycles and public transport. Transp Res Part Policy Pract 85:208–219. https://doi.org/10.1016/j.tra.2016.01.015
Kager R, Harms L (2017) Synergies from Improved Cycling-Transit Integration: Towards an integrated urban mobility system
Kahma N, Matschoss K (2017) The rejection of innovations? Rethinking technology diffusion and the non-use of smart energy services in Finland. Energy Res Soc Sci 34:27–36
Kamargianni M, Matyas M (2017) The Business Ecosystem of Mobility-as-a-Service. Washington DC, p 14
Kanger L, Schot J (2016) User-made immobilities: a transitions perspective. Mobilities 11:598–613. https://doi.org/10.1080/17450101.2016.1211827
Kansen M, van der Waard J, Savelberg F (2018) Sturen in parkeren. Kennisinstituut voor Mobiliteitsbeleid/Netherlands Institute for Transport Policy Analysis, The Hague
Kaplan RS, Norton DP (2001) Transforming the balanced scorecard from performance measurement to strategic management: Part I. Account Horiz 15:87–104
Karppanen M (2017) Regulating Ridesourcing Companies and the Employment Status of Drivers in the Sharing Economy-A Study on Uber. Master's Thesis in European Law, University of Helsinki. Retrieved from https://helda. helsinki. fi/handle …
Kemp R, Schot J, Hoogma R (1998) Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technol Anal Strateg Manag 10:175–198
KiM (2016a) Mobiliteitsbeeld 2016. Kennisinstituut voor Mobiliteitsbeleid/Netherlands Institute for Transport Policy Analysis
KiM (2016b) Cycling and Walking: the grease in our mobility chain. The Hague
KiM (2018) Mobiliteitsbeeld 2017. Kennisinstituut voor Mobiliteitsbeleid/Netherlands Institute for Transport Policy Analysis
Kishchenko K, De Roeck M, Salens M, Maroey CV (2019a) The Antwerp Marketplace for Mobility: partnering with private mobility service providers as a strategy to keep the region accessible. Transp Res Procedia 39:191–200. https://doi.org/10.1016/j.trpro.2019.06.021
Kishchenko K, De Roeck M, Salens M, Maroey CV (2019b) The Antwerp Marketplace for Mobility: partnering with private mobility service providers as a strategy to keep the region accessible. Transp Res Procedia 39:191–200. https://doi.org/10.1016/j.trpro.2019.06.021

Kivimaa P, Rogge KS. Interplay of Policy Experimentation and Institutional Change in Transformative Policy Mixes: The Case of Mobility as a Service in Finland. SPRU-Science Policy Research Unit, University of Sussex Business School; 2020 Oct.
Klímová A, Pinho P (2020) National policies and municipal practices: A comparative study of Czech and Portuguese urban mobility plans. Case Stud Transp Policy S2213624X20300936. https://doi.org/10.1016/j.cstp.2020.08.005
Kloppenberg G, ten Hage C. Robin Chase on the Value of Space, 12/08/20 (podcast). https://geertkloppenburg.nl/?s=robin+chase
Köhler J, Geels F, Kern F, et al (2019) An agenda for sustainability transitions research: state of the art and future directions. Environ Innov Soc Transit
Köhler J, Turnheim B, Hodson M (2020) Low carbon transitions pathways in mobility: Applying the MLP in a combined case study and simulation bridging analysis of passenger transport in the Netherlands. Technol Forecast Soc Change 151:119314. https://doi.org/10.1016/j.techfore.2018.06.003
Könnölä T, Unruh GC, Carrillo-Hermosilla J (2006) Prospective voluntary agreements for escaping techno-institutional lock-in. Ecol Econ 57:239–252. https://doi.org/10.1016/j.ecolecon.2005.04.007
Koops R (2017) Gemeente wil af van de deelfiets. In: Het Parool. https://www.parool.nl/amsterdam/gemeente-wil-af-van-de-deelfiets~a4508216/. Accessed 21 Aug 2017
Kruyswijk M (2017a) “Deelfiets? Nee, een huurfiets met app.” Het Parool Amsterdam.
Kruyswijk M (2017b) Deelfietsbedrijf FlickBike weg uit “conservatief Amsterdam”. Het Parool Amsterdam.
Kuipers G (2013) The rise and decline of national habitus: Dutch cycling culture and the shaping of national similarity. Eur J Soc Theory 16:17–35
Lan J, Ma Y, Zhu D, et al (2017) Enabling Value Co-Creation in the Sharing Economy: The Case of Mobike. Sustainability 9:1504. https://doi.org/10.3390/su9091504
Lanting B (2018) In beslag genomen of kapotte leenfietsen vormen metalen kerkhoven in China. Volkskrant
Latour B (1987) Science in action: How to follow scientists and engineers through society. Harvard University Press, Cambridge, MA.
Lecy JD, Beatty KE (2012) Representative literature reviews using constrained snowball sampling and citation network analysis. SSRN Electron J. https://doi.org/10.2139/ssrn.1992601
Levin-Keitel M, Mölders T, Othengrafen F, Ibendorf J (2018) Sustainability Transitions and the Spatial Interface: Developing Conceptual Perspectives. Sustainability 10:1880. https://doi.org/10.3390/su10061880
Li Y, Taeihagh A, Jong M de (2018) The Governance of Risks in Ridesharing: A Revelatory Case from Singapore. Energies 11:1277. https://doi.org/10/gdswj8
Li Y, Voege T (2017) Mobility as a Service (MaaS): Challenges of Implementation and Policy Required. J Transp Technol 07:95–106. https://doi.org/10.4236/jtts.2017.72007
Longhurst J (2015) Bike Battles: A History of Sharing the American Road. University of Washington Press, Seattle
Loorbach DA (2016) Governance of urban sustainability transitions. Springer, Berlin, Heidelberg, New York
Loukaitou-Sideris A, Ehrenfeucht R (2009) Sidewalks: conflict and negotiation over public space. MIT Press, Cambridge, Mass
Lucas K (ed) (2004) Running on empty: transport, social exclusion and environmental justice. Policy Press, Bristol, UK
Lugo AE (2018) Bicycle/Race: Transportation, Culture & Resistance. Microcosm Publishing, Portland, Oregon

Maassen A (2012) Heterogeneity of Lock-In and the Role of Strategic Technological Interventions in Urban Infrastructural Transformations. Eur Plan Stud 20:441–460. https://doi.org/10.1080/09654313.2012.651807
Machado C, de Salles Hue N, Berssaneti F, Quintanilha J (2018) An Overview of Shared Mobility. Sustainability 10:4342. https://doi.org/10/ggs4pb
Magalhães CD, Carmona M (2006) Innovations in the Management of Public Space: Reshaping and Refocusing Governance. Plan Theory Pract 7:289–303. https://doi.org/10.1080/14649350600841461
Mäkinen K, Kivimaa P, Helminen V (2015) Path creation for urban mobility transitions: Linking aspects of urban form to transport policy analysis. Manag Environ Qual Int J 26:485–504. https://doi.org/10.1108/MEQ-07-2014-0115
Manders T, Wieczorek A, Verbong G (2018) Understanding smart mobility experiments in the Dutch automobility system: who is involved and what do they promise? Futures 96:90–103
Marletto G, Ortolani C (2017) Testing the integration of political discourses into the socio-technical map of urban mobility. Working papers SIET 2017 – ISSN 1973-3208.
Maroey CV (2019) Antwerp's Marketplace for Mobility. https://www.polisnetwork.eu/wp-content/uploads/2019/11/4F-Chris-Van-Maroey.pdf
Martens K (2017) Transport Justice: Designing Fair Transportation Systems. Routledge, New York, NY
Martens K (2013) The Role of the Bicycle in the Limitation of Transport Poverty in the Netherlands. Transp Res Rec J Transp Res Board 2387:20–25. https://doi.org/10.3141/2387-03
Massa L, Tucci C, Afuah A (2017) A critical assessment of business model research. Acad Manag Ann annals-2014
May X (2017) The debate regarding the number of company cars in Belgium. Bruss Stud 8. http:// journals.openedition.org/brussels/1540
Mc Nally B (2018) Mapping Press Narratives of Decarbonisation: Insights on Communication of Climate Responses. Int J Clim Change Impacts Responses 10:39–57. https://doi.org/10.18848/1835-7156/CGP/v10i01/39-57
Meijers J (2018) De snelle service van Swapfiets. In: Fietsersbondnl Nieuws. https://www.fietsersbond.nl/nieuws/de-snelle-service-van-swapfiets/?gclid=CjwKCAjw9-HZBRAwEiwAGw0Qcbiab16GQAbKuI69wNHC1ZT4fvdnRH_0Qe17WoA8S9-H84BURQg7PxoCQ9oQAvD_BwE. Accessed 2 Jul 2018
Meurs H, Sharmeen F, Marchau V, van der Heijden R (2020) Organizing integrated services in mobility-as-a-service systems: Principles of alliance formation applied to a MaaS-pilot in the Netherlands. Transp Res Part Policy Pract 131:178–195. https://doi.org/10/ggs465
Mingardo G, van Wee B, Rye T (2015) Urban parking policy in Europe: A conceptualization of past and possible future trends. Transp Res Part Policy Pract 74:268–281. https://doi.org/10.1016/j.tra.2015.02.005
Ministerie van Verkeer en Waterstaat (Netherlands) (2009) Cycling in the Netherlands.
Mintzberg H, Ahlstrand BW, Lampel J (1998) Strategy safari: a guided tour through the wilds of strategic management. Free Press, New York
Mintzberg H, Waters JA (1985) Of strategies, deliberate and emergent. Strateg Manag J 6:257–272
Mladenović MN, Stead D (2021) Emerging mobility technologies and transitions of urban space allocation in a Nordic governance context. In: Urban Form and Accessibility. Elsevier, pp 63–82
Moezzi M, Janda KB, Rotmann S (2017) Using stories, narratives, and storytelling in energy and climate change research. Energy Res Soc Sci 31:1–10. https://doi.org/10.1016/j.erss.2017.06.034
Monstadt J (2009) Conceptualizing the Political Ecology of Urban Infrastructures: Insights from Technology and Urban Studies. Environ Plan Econ Space 41:1924–1942. https://doi.org/10.1068/a4145
Mullen C, Marsden G (2016) Mobility justice in low carbon energy transitions. Energy Res Soc Sci 18:109–117. https://doi.org/10.1016/j.erss.2016.03.026

Mullen C, Tight M, Whiteing A, Jopson A (2014) Knowing their place on the roads: What would equality mean for walking and cycling? Transp Res Part Policy Pract 61:238–248. https://doi.org/10.1016/j.tra.2014.01.009
Mulley C (2017) Mobility as a Services (MaaS) – does it have critical mass? Transp Rev 37:247–251. https://doi.org/10.1080/01441647.2017.1280932
Muñoz P, Cohen B (2016) The making of the urban entrepreneur. Calif Manage Rev 59:71–91. https://doi.org/10/gfgnfc
Murphy JT (2015) Human geography and socio-technical transition studies: Promising intersections. Environ Innov Soc Transit 17:73–91
Nello-Deakin S (2019) Is there such a thing as a 'fair' distribution of road space? J Urban Des 1–17. https://doi.org/10.1080/13574809.2019.1592664
Netherlands Government (2012) Integrale nota van toelichting van Bouwbesluit 2012. https://www.bouwbesluitonline.nl/Inhoud/docs/wet/bb2012_nvt/artikelsgewijs/hfd4/afd4-5/algemeen
Newell P, Mulvaney D (2013) The political economy of the 'just transition.' Geogr J 179:132–140. https://doi.org/10.1111/geoj.12008
Newman P, Kenworthy J (1999) Sustainability and cities: overcoming automobile dependence. Island Press; Washington, DC.
Nielsen J, Farrelly MA (2019) Conceptualising the built environment to inform sustainable urban transitions. Environ Innov Soc Transit 33:231–248. https://doi.org/10.1016/j.eist.2019.07.001
Nieuwland S, van Melik R (2018) Regulating Airbnb: how cities deal with perceived negative externalities of short-term rentals. Curr Issues Tour 1–15. https://doi.org/10.1080/13683500.2018.1504899
Nieuwstraten B (2019) Fietsdelen in de regio Amsterdam. Vervoerregio Amsterdam, Amsterdam. https://vervoerregio.nl/document/88adbb22-181f-4484-8439-7642f101a56f#:~:text=Deelfietsen%20zijn%20een%20duurzame%20aanvulling,meer%2D%20maals%20genoemd%20als%20kansrijk.
Niewold M (2017) FlickBike stopt met deelfietsen in Amsterdam, hoopt op comeback. RTL Nieuws
Nikolaeva A (2017) From Constructed Scarcity and Mobility Austerity towards Mobility Commons? In: Living Mobil. Transit. http://livinginthemobilitytransition.forumviesmobiles.org/2016/11/23/from-constructed-scarcity-and-mobility-austerity-towards-mobility-commons/. Accessed 4 Jan 2017
Nikolaeva A, Adey P, Cresswell T, et al (2019) Commoning mobility: Towards a new politics of mobility transitions. Trans Inst Br Geogr. https://doi.org/10.1111/tran.12287
Norton PD (2011) Fighting traffic: the dawn of the motor age in the American city. MIT Press, Cambridge, MA.
Nykvist B, Whitmarsh L (2008) A multi-level analysis of sustainable mobility transitions: Niche development in the UK and Sweden. Technol Forecast Soc Change 75:1373–1387. https://doi.org/10.1016/j.techfore.2008.05.006
Oldenziel R, de la Bruhèze AA (2011) Contested spaces: Bicycle lanes in urban Europe, 1900-1995. Transfers 1:29–49
Oldenziel R, Emanuel M, de la Bruheze AAA, Veraart F (2016) Cycling Cities: The European Experience: Hundred Years of Policy and Practice. Foundation for the History of Technology
Osterwalder A (2004) The business model ontology: A proposition in a design science approach. PhD, University of Lausanne
Pangbourne K, Mladenović MN, Stead D, Milakis D (2020) Questioning mobility as a service: Unanticipated implications for society and governance. Transp Res Part Policy Pract 131:35–49. https://doi.org/10/gf9sqd
Panozzo N (2017) Smarter Cycling Series: Pedaling Forward - Technology and Innovation for Bike Share Sustainability. In: Eur. Cycl. Fed. https://ecf.com/news-and-events/news/smarter-cycling-series-pedaling-forward-technology-and-innovation-bike-share. Accessed 12 Apr 2017

Park H, Yoon J (2015) A chance discovery-based approach for new product–service system (PSS) concepts. Serv Bus 9:115–135
Parker P, Johansson M (2011) The uses and abuses of Elinor Ostrom's concept of commons in urban theorizing. In: International Conference of the European Urban Research Association (EURA) 2011 - Cities without Limits 23-25 June 2011, Copenhagen. p 17
Parkes SD, Marsden G, Shaheen SA, Cohen AP (2013) Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. J Transp Geogr 31:94–103. https://doi.org/10.1016/j.jtrangeo.2013.06.003
Parkhurst G, Kemp R, Dijk M, Sherwin H (2012) Intermodal Personal Mobility: A Niche Caught Between Two Regimes. In: Automobility in Transition? Routledge, New York, pp 308–334
Payne A, Frow P (2014) Developing superior value propositions: a strategic marketing imperative. J Serv Manag 25:213–227. https://doi.org/10.1108/JOSM-01-2014-0036
Pereira RHM, Schwanen T, Banister D (2017) Distributive justice and equity in transportation. Transp Rev 37:170–191. https://doi.org/10.1080/01441647.2016.1257660
Petticrew M, Roberts H (2006) Systematic Reviews in the Social Sciences. Blackwell, Oxford
Petzer BJM, Wieczorek AAJ, Verbong GPJ (in press) The legal street: a scarcity approach to urban open space in mobility transitions. Urban Transform
Petzer BJM, Wieczorek AJ, Verbong GPJ (2019) Making sense of Cycling-as-a-Service in the Netherlands: a combined business models and transitions approach. Environ Innov Soc Transit. https://doi.org/10.1016/j.eist.2019.09.001
Petzer BJM, Wieczorek AJ, Verbong GPJ (2020) Dockless bikeshare in Amsterdam: a mobility justice perspective on niche framing struggles. Appl Mobilities 1–19. https://doi.org/10.1080/23800127.2020.1794305
Philippopoulos-Mihalopoulos A, FitzGerald S (2008) From Space Immaterial: The Invisibility of the Lawscape. Griffith Law Rev 17:438–453. https://doi.org/10.1080/10383618.2008.10854618
Pinkster FM, Boterman WR (2017) When the spell is broken: gentrification, urban tourism and privileged discontent in the Amsterdam canal district. Cult Geogr 24:457–472. https://doi.org/10.1177/1474474017706176
Ploeger J, Oldenziel R (2020) The sociotechnical roots of smart mobility: Bike sharing since 1965. J Transp Hist 0022526620908264. https://doi.org/10.1177/0022526620908264
Poderi G (2019) Sustaining platforms as commons: perspectives on participation, infrastructure, and governance. CoDesign 15:243–255. https://doi.org/10.1080/15710882.2019.1631351
Pojani D, Stead D (2015) Going Dutch? The export of sustainable land-use and transport planning concepts from the Netherlands. Urban Stud 52:1558–1576. https://doi.org/10.1177/0042098014562326
Polydoropoulou A, Pagoni I, Tsirimpa A, et al (2020) Prototype business models for Mobility-as-a-Service. Transp Res Part Policy Pract 131:149–162. https://doi.org/10/ggs45z
Pro Velo (2017) Observation du vélo en région de Bruxelles Capitale: Comptages et analyse des données, Rapport 2017. Pro Velo. https://data-mobility.brussels/media/indics/Obs_Bike_RBC_2017_fr.pdf
Prytherch D (2018) Law, Engineering, and the American right-of-way. Springer Science+Business Media, New York, NY
Prytherch D (2015) Rules of the Road: Choreographing Mobility in the Everyday Intersection. In: Cidell J, Prytherch D (eds) Transport, mobility, and the production of urban space. Routledge, New York ; London, pp 45–62
Pucher J, Buehler R (2008) Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. Transp Rev 28:495–528. https://doi.org/10.1080/01441640701806612
Pucher J, Buehler R (2017) Cycling towards a more sustainable transport future. Transp Rev 1–6. https://doi.org/10.1080/01441647.2017.1340234
Puylaert G (2018) Eén deelfietsvloot helpt MaaS vooruit. OV Mag.

Ramboll, MaaS Global (2019) WHIMPACT: Insights from the world's first Mobility-as-a-Service (MaaS) system. Ramboll, Helsinki. https://ramboll.com/-/media/files/rfi/publications/Ramboll_whimpact-2019.pdf
Rauschmayer F, Bauler T, Schäpke N (2015) Towards a thick understanding of sustainability transitions — Linking transition management, capabilities and social practices. Ecol Econ 109:211–221. https://doi.org/10.1016/j.ecolecon.2014.11.018
Raven R, Ghosh B, Wieczorek A, et al (2017) Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand. Sustain Sci 12:579–596
Raven R, Kern F, Verhees B, Smith A (2016) Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases. Environ Innov Soc Transit 18:164–180. https://doi.org/10.1016/j.eist.2015.02.002
Raven R, Schot J, Berkhout F (2012) Space and scale in socio-technical transitions. Environ Innov Soc Transit 4:63–78. https://doi.org/10.1016/j.eist.2012.08.001
Région de Bruxelles-Capitale (2007) Brussels-Capital Region (bike): Titre II - Normes d'Habitabilite des Logements, Art. 17 (French). Ministère de la Région de Bruxelles-Capitale Administration de l'Aménagement du Territoire et du Logement, Brussels
Reid C (2020a) How a Belgian port city inspired Birmingham's car-free ambitions. The Guardian
Reid C (2020b) Boost For Cycling And Walking In Birmingham's Pandemic Emergency Transport Plan. Forbes
Ritchie J, Lewis J, Nicholls CM, Ormston R (2013) Qualitative research practice: A guide for social science students and researchers. Sage, Los Angeles.
Roberts JCD (2017) Discursive destabilisation of socio-technical regimes: Negative storylines and the discursive vulnerability of historical American railroads. Energy Res Soc Sci 31:86–99. https://doi.org/10.1016/j.erss.2017.05.031
Rohracher H, Späth P (2017a) From Building Small Urban Spaces for a Car-Free life to Challenging The Global Regime of Automobility: Cases from Vienna and Freiburg. In: Urban Sustainability Transitions, First Edition. Routledge, Taylor & Francis Group, New York
Rohracher H, Späth P (2017b) Cities as Arenas of Low-Carbon Transitions: Friction Zones in the Negotiation of Low-Carbon Futures. In: Urban Sustainability Transitions, First Edition. Routledge, Taylor & Francis Group, New York
Rosenbloom D (2018) Framing low-carbon pathways: A discursive analysis of contending storylines surrounding the phase-out of coal-fired power in Ontario. Environ Innov Soc Transit 27:129–145. https://doi.org/10.1016/j.eist.2017.11.003
Rosenbloom D, Berton H, Meadowcroft J (2016) Framing the sun: A discursive approach to understanding multi-dimensional interactions within socio-technical transitions through the case of solar electricity in Ontario, Canada. Res Policy 45:1275–1290. https://doi.org/10.1016/j.respol.2016.03.012
Rottier JP (2018) Nieuwe coalitie Amsterdam wil stad autoluw maken. Verskeersnet
Rottier JP (2020) Flink meer fietsvlonders en fietstrommels in Rotterdam. Verkeersnet
Rutherford J (2020) Redeploying Urban Infrastructure: The Politics of Urban Socio-Technical Futures. Springer International Publishing, Cham
Salazar A (2015) Platform competition: a research framework and synthesis of game-Theoretic Studies. http://ssrn.com/abstract=2565337
Sarasini S, Linder M (2017) Integrating a business model perspective into transition theory: The example of new mobility services. Environ Innov Soc Transit. https://doi.org/10.1016/j.eist.2017.09.004
Schaltegger S, Lüdeke-Freund F, Hansen EG (2016) Business models for sustainability: A co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. Organ Environ 29:264–289

Schilling MA (1998) Technological lockout: An integrative model of the economic and strategic factors driving technology success and failure. Acad Manage Rev 23:267–284
Schipper F (2008) Driving Europe: Building Europe on roads in the twentieth century. Amsterdam University Press, Amsterdam
Schipper F, Schot J (2011) Infrastructural Europeanism, or the project of building Europe on infrastructures: an introduction. Hist Technol 27:245–264. https://doi.org/10.1080/07341512.2011.604166
Schippl J, Truffer B (2020) Directionality of transitions in space: Diverging trajectories of electric mobility and autonomous driving in urban and rural settlement structures. Environ Innov Soc Transit 37:345–360. https://doi.org/10.1016/j.eist.2020.10.007
Schrag ZM (2000) " The Bus Is Young and Honest": Transportation Politics, Technical Choice, and the Motorization of Manhattan Surface Transit, 1919-1936. Technol Cult 41:51–79
Schravesande F (2017) Amsterdam wil juist minder fietsen, niet méér. NRC Handelsbl.
Schravesande F, Amghar A (2017) De 'strooifiets' leidt meteen tot ergernis. NRC Handelsbl.
Schröter R, Dean P Urban Corridor Road Design: Guides, Objectives and Performance Indicators. https://www.roadspace.eu/wp-content/uploads/2019/11/MORE_D1_2_FINAL.pdf
Sengers F, Raven R (2015) Toward a spatial perspective on niche development: The case of Bus Rapid Transit. Environ Innov Soc Transit 17:166–182. https://doi.org/10.1016/j.eist.2014.12.003
Shaheen S, Cohen A, Chan N, Bansal A (2019) Sharing strategies: Carsharing, shared micromobility (bikesharing and scooter sharing), transportation network companies, microtransit, and other innovative mobility modes. Transp Land Use Environ Plan 237–262. https://doi.org/10.1016/B978-0-12-815167-9.00013-X
Sheller M (2018) Mobility Justice. Verso, London
Sheller M, Urry J (2016) Mobilizing the new mobilities paradigm. Appl Mobilities 1:10–25. https://doi.org/10.1080/23800127.2016.1151216
Shen Y, Zhang X, Zhao J (2018) Understanding the usage of dockless bike sharing in Singapore. Int J Sustain Transp 1–15. https://doi.org/10.1080/15568318.2018.1429696
Shill GH (2019) Should Law Subsidize Driving? University of Iowa College of Law. http://ssrn.com/abstract=3345366
Shoup D (2011) The High Cost of Free Parking. Routledge, Abingdon, UK
Shoup D (2017) The high cost of free parking: Updated edition. Routledge, Abingdon, UK
Shove E (2012) The shadowy side of innovation: unmaking and sustainability. Technol Anal Strateg Manag 24:363–375. https://doi.org/10.1080/09537325.2012.663961
Shrivastava P, Kennelly JJ (2013) Sustainability and place-based enterprise. Organ Environ 26:83–101. https://doi.org/10.1177/1086026612475068
Slütter M (2018) OpenBike, op weg naar één account voor alle deelfietsen. Fietsverkeer 17
Smith G, Hensher DA (2020) Towards a framework for Mobility-as-a-Service policies. Transp Policy 89:54–65. https://doi.org/10.1016/j.tranpol.2020.02.004
Smith G, Sochor J, Karlsson ICM (2018) Mobility as a Service: Development scenarios and implications for public transport. Res Transp Econ 69:592–599. https://doi.org/10.1016/j.retrec.2018.04.001
Sol J, van der Wal MM, Beers PJ, Wals AE (2018) Reframing the future: the role of reflexivity in governance networks in sustainability transitions. Environ Educ Res 24:1383–1405. https://doi.org/10.1080/13504622.2017.1402171
Sorrell S (2018) Explaining sociotechnical transitions: A critical realist perspective. Res Policy 47:1267–1282. https://doi.org/10.1016/j.respol.2018.04.008
Sovacool BK, Heffron RJ, McCauley D, Goldthau A (2016) Energy decisions reframed as justice and ethical concerns. Nat Energy 1:16024. https://doi.org/10.1038/nenergy.2016.24
Sovacool, B.K., Burke, M., Baker, L., Kotikalapudi, C.K., Wlokas, H., 2017. New frontiers and conceptual frameworks for energy justice. Energy Policy 105, 677–691.

Spinney J (2016) Fixing Mobility in the Neoliberal City: Cycling Policy and Practice in London as a Mode of Political–Economic and Biopolitical Governance. Ann Am Assoc Geogr 106:450–458
Spinney J, Lin W-I (2018) Are you being shared? Mobility, data and social relations in Shanghai's Public Bike Sharing 2.0 sector. Appl Mobilities 3:66–83. https://doi.org/10.1080/23800127.2018.1437656
Spurling N (2019) Dormant vehicles: Inverting urban mobility futures. Land Use Policy S026483771831367X. https://doi.org/10.1016/j.landusepol.2019.02.031
Stratta P, Panozzo N, Woolsgrove C, Mayne K (2017) Policy Framework for Smart Public-Use Bike Sharing. In: Eur. Cycl. Fed. https://ecf.com/system/files/Policy%20Framework%20SMART%20PBS%20v01Jul17.pdf. Accessed 24 Jul 2017
Surakka T, Härri F, Haahtela T, et al (2018) Regulation and governance supporting systemic MaaS innovations. Res Transp Bus Manag 27:56–66. https://doi.org/10.1016/j.rtbm.2018.12.001
Svensson O, Nikoleris A (2018) Structure reconsidered: Towards new foundations of explanatory transitions theory. Res Policy 47:
Swilling M, Annecke E (2012) Just Transitions: Explorations of Sustainability in an Unfair World. United Nations University Press, New York
SWOV (2018) Hoe verkeersveilig kan Nederland zijn in 2030? Mogelijkheden voor reductie in aantallen verkeersslachtoffers. SWOV, The Hague
Tates T (2017) Chinese stad zit in de maag met reusachtig leenfietsenkerkhof. AD.nl
Teece DJ (2010) Business models, business strategy and innovation. Long Range Plann 43:172–194
Teuling I (2017a) Amsterdam gaat deelfietsen weren die geen vaste stallingsplek hebben. In: Volkskrant. https://www.volkskrant.nl/economie/amsterdam-gaat-deelfietsen-weren-die-geen-vaste-stallingsplek-hebben~a4509374/. Accessed 3 Sep 2017
Teuling I (2017b) Deelfietsverbod Amsterdam maakt weinig indruk. Ned. Dagbl.
Tironi M (2015) (De)politicising and Ecologising Bicycles: The history of the Parisian Vélib' system and its controversies. J Cult Econ 8:166–183. https://doi.org/10.1080/17530350.2013.838600
Tour de Force 2020 (2017) Concept Uitvoeringsprogramma 2017-2018. In: Tour Force 2020. http://tourdeforce2020.nl/wp-content/uploads/2017/07/Concept-Uitvoeringsprogramma-2017-2018.pdf. Accessed 1 Sep 2018
Trouw Editorial (2017) Weg met die deelfiets, eigen fiets eerst. In: Trouw. https://www.trouw.nl/opinie/weg-met-die-deelfiets-eigen-fiets-eerst~ac0c7eeb/. Accessed 10 Aug 2017
Truffer B, Murphy JT, Raven R. The geography of sustainability transitions: Contours of an emerging theme. Environmental Innovation and Societal Transitions. 2015 Dec 1;17:63-72.
Turnheim B, Geels FW (2012) Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913–1997). Energy Policy 50:35–49
Turnheim B, Håkansson I, Berkhout F (2015) Regime analysis of Dutch mobility system: Analysis of stability and tensions in incumbent socio-technical regimes. PATHWAYS, London
UK DfT (2007) Manual for Streets. Telford, London
UN (1968) Vienna Convention on Road Traffic (amended 1993, 2006)
UN Habitat (2013) Planning and Design for Sustainable Urban Mobility: Policy Directions: Global Report on Human Settlements
Unruh GC (2000) Understanding carbon lock-in. Energy Policy 28:817–830. https://doi.org/10.1016/S0301-4215(00)00070-7
Unruh GC (2002) Escaping carbon lock-in. Energy Policy 30:317–325. https://doi.org/10.1016/S0301-4215(01)00098-2
Urry J (2004) The 'System' of Automobility. Theory Cult Soc 21:25–39. https://doi.org/10.1177/0263276404046059
van der Spek SC, Scheltema N (2015) The importance of bicycle parking management. Res Transp Bus Manag 15:39–49. https://doi.org/10.1016/j.rtbm.2015.03.001

van Goeverden CD, Godefrooij T (2010) Ontwikkeling van het fietsbeleid en-gebruik in Nederland. In: Bijdrage aan het 37ste Colloquium Vervoersplanologisch Speurwerk. Roermond
van Liere B, Beens O, Knol A (2017) Van wie is de stad? Milieudefensie, Amsterdam. milieudefensie.nl/duurzaamdoordestad
van Waes A, Farla J, Frenken K, et al (2018) Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing. J Clean Prod. https://doi.org/10.1016/j.jclepro.2018.05.223
Van Zeebroeck B, Charles J (2014) Impact et potentiel de l'usage du vélo sur l'économie et l'emploi en Région de Bruxelles-Capitale: Les effets directs et indirects de l'usage du vélo en 2002, 2012 et 2020. Pro Velo R&D, Brussels. https://data-mobility.brussels/media/indics/provelo_evaluation_impact_economique_velo_2014.pdf
van Zessen PC (2017) De deelfiets in Nederland: Over de potentie van de deelfiets in Nederland en de ruimtelijke effecten van de deelfiets in de stad. HBO, Hogeschool Utrecht
Verkade T (2017) Deelfietsen veroorzaken nu veel overlast in grote steden. Zo kan het wél. In: Corresp. https://decorrespondent.nl/7246/deelfietsen-veroorzaken-nu-veel-overlast-in-grote-steden-zo-kan-het-wel/2363910265926-2d32b502. Accessed 9 Sep 2017
Verkade T (2019) Het is tijd om de straat terug te geven aan fietsers en voetgangers. Corresp. https://decorrespondent.nl/8777/het-is-tijd-om-de-straat-terug-te-geven-aan-fietsers-en-voetgangers/4274968021687-51ad45e6
Vernaillen S (2020) Stijn Vernaillen interview 29052020
Villwock-Witte N, van Grol L (2015) Case Study of Transit–Bicycle Integration: Openbaar Vervoer-fiets (Public Transport–Bike) (OV-Fiets). Transp Res Rec J Transp Res Board 2534:10–15. https://doi.org/10.3141/2534-02
Vivanco LA (2013) Reconsidering the bicycle: an anthropological perspective on a new (old) thing. Routledge, New York
Vlaskamp M (2017) Deelfiets verovert de Chinese straten. In: Volkskrant. https://www.volkskrant.nl/nieuws-achtergrond/hoe-de-deelfiets-de-chinese-straten-verovert~b5c4db9f/. Accessed 1 Jul 2017
Voermans T (2017) Gemeenten balen van deelfiets - "Ze plempen ze overal neer." AD.nl
von Schönfeld KC, Bertolini L (2017) Urban streets: Epitomes of planning challenges and opportunities at the interface of public space and mobility. Cities 68:48–55. https://doi.org/10.1016/j.cities.2017.04.012
Wainstein ME, Bumpus AG (2016) Business models as drivers of the low carbon power system transition: a multi-level perspective. J Clean Prod 126:572–585. https://doi.org/10.1016/j.jclepro.2016.02.095
Walker R (2015) Building a better theory of the urban: A response to 'Towards a new epistemology of the urban?' City 19:183–191. https://doi.org/10.1080/13604813.2015.1024073
Ward K, Jonas AE, Miller B, Wilson D (2018) The Routledge handbook on spaces of urban politics. Routledge, Abingdon, Oxon ; New York, NY
Wells P (2013) Sustainable business models and the automotive industry: A commentary. IIMB Manag Rev 25:228–239. https://doi.org/10.1016/j.iimb.2013.07.001
Wells P, Wang X, Wang L, et al (2020) More friends than foes? The impact of automobility-as-a-service on the incumbent automotive industry. Technol Forecast Soc Change 154:119975. https://doi.org/10/ggw3p3
Wells P, Xenias D (2015) From 'freedom of the open road' to 'cocooning': Understanding resistance to change in personal private automobility. Environ Innov Soc Transit 16:106–119. https://doi.org/10.1016/j.eist.2015.02.001
Wesseling JH, Van der Vooren A (2017) Lock-in of mature innovation systems: the transformation toward clean concrete in the Netherlands. J Clean Prod 155:114–124. https://doi.org/10.1016/j.jclepro.2016.08.115

Westeneng A (2017) Overal in de stad staan fietsen, te huur via de app. https://fd.nl/ondernemen/1207837/overal-in-de-stad-staan-fietsen-te-huur-via-de-app
Westerhoff L, Robinson J (2013) Practicing'narratives: exploring the meaning and materiality of climate change. Proc Transform Chang Clim 19–21
Whitmarsh L (2012) How useful is the Multi-Level Perspective for transport and sustainability research? J Transp Geogr 24:483–487. https://doi.org/10.1016/j.jtrangeo.2012.01.022
Wieczorek AJ, Berkhout F (2009) Transitions to sustainability as societal innovations. In: Boersema JJ, Reijnders L (eds) Principles of environmental sciences. Springer, Dordrecht, pp 503–512
Wieczorek AJ, Raven R, Berkhout F (2015) Transnational linkages in sustainability experiments: A typology and the case of solar photovoltaic energy in India. Environ Innov Soc Transit 17:149–165
Wirtz BW, Pistoia A, Ullrich S, Göttel V (2016) Business models: Origin, development and future research perspectives. Long Range Plann 49:36–54
Wittmann J (2017) Electrification and Digitalization as Disruptive Trends: New Perspectives for the Automotive Industry? In: Phantom Ex Machina. Springer International Publishing, Cham, pp 137–162
Wong YZ, Hensher DA (2020) Delivering mobility as a service (MaaS) through a broker/aggregator business model. Transportation. https://doi.org/10.1007/s11116-020-10113-z
World Bank (2017) Global Mobility Report. https://openknowledge.worldbank.org/bitstream/handle/10986/28542/120500.pdf?sequence=6. Accessed 1 Jul 2018
Yin RK (2014) Case Study Research Design and Methods, 5th edn. SAGE Publications, Thousand Oaks, CA
Zijlstra T, Avelino F (2012) A Socio-Spatial Perspective on the Car Regime. In: Geels FW, Kemp R, Dudley G, Lyons G (eds) Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, London
Zott C, Amit R (2013) The business model: A theoretically anchored robust construct for strategic analysis. Strateg Organ 11:403–411. https://doi.org/10.1177/1476127013510466
Zott C, Amit R, Massa L (2011) The business model: recent developments and future research. J Manag 37:1019–1042

10 Addenda

10.1 Reflections on the Covid-19 Pandemic and the 'Great Reclamation' (Portfolio)

The Great Reclamation: urban space in the pandemic

This (reformatted) Twitter thread (@brettpetzer, 29/04/2020) was prompted by initial space reallocation actions in world cities in response to the distancing requirements of the first wave of the Covid-19 pandemic of 2020.

The Great Reclamation: I am losing track of the number of cities that have moved suddenly and ambitiously to reclaim hundreds of kilometres of streets from the car monopoly and reallocate these public commons for people walking, cycling and using wheelchairs. It is like watching decades of activism happen in a month. Like watching generations of 'cycling and walking plans' or 'sustainable mobility plans', which have always been aspirations, turn into facts (literally) overnight. The fight for urban space has turned competitive. It has taken a crisis that is new, sudden, total and full of unknowns to break, albeit briefly, the car monopoly on urban space which has been in place for 70-100 years in the rich West, and far less time elsewhere, but which has been profoundly successful in legitimating & reproducing itself. This has produced, as @_Anna_Nikolaeva et al call it, an artificial abundance of space for private cars both moving and stored, and an artificial scarcity of space for everything else – walking, cycling, sitting, wheelchairing, assembling, markets, etc. Maintaining this divide requires immense resources.

The consensus by which people driving cars have the right to abundant urban space, while everyone else fights over the margins, has been built up over decades, but like the Death Star, it *does* have a flaw. That flaw was always a potential systemic shock that broke, for a moment, the spell by which building our urban public realm around cars-first, everything-else-in-the-space-left-over has lasted this late into climate change. That spell is now broken, everywhere, for a bit. This lull means that the car-petrol-suburbs-malls-steel automobility complex has briefly left the arena in which physical urban space is fought over. Some cities have rushed in to reallocate space in the way they've been promising to do for generations. Briefly, the power dynamics are more equal; cities can mobilise the force of this emergency to unfreeze their decades-overdue response to the deeper emergencies that have lost their power to shock us: physical inactivity, motorists who kill, cities voided of collective life. Proviso: This systemic shock we're in has brought lonely deaths and frantic suffering to most of a planet at once; it has precarised or immiserated thirds or halves of entire societies at a stroke. Everything that can be done to fight it, should be done.

Personal space is newly and visibly political under this pandemic, especially in cities. It has always been, but well-resourced lobbies have been highly incentivised to make us forget that; to frame new images of children cycling freely in streets look like "the 80s". This obscuring of the spatial needs of motorists into building regulations, even heritage regulations (!), has worked until right now, when the wide river of tarmac is empty and we all squeeze past each other on the crowded banks, wondering why that is necessary. These new thoughts are powerful. The sudden necessity of 1.5m-2m distances between people, has produced by fiat an enormous and powerful 'walking lobby' of a kind that has always been (1) missing or (2) outgunned by the car lobby in the past, in most (esp. rich) countries. Suddenly this walking lobby is all of us, as if we'd received membership badges in our postboxes, at the exact moment when the car lobby is weaker than it has, perhaps, ever been, including the Oil Crisis of the 1970s.

This is the moment to seize space and not give it back. There is a brief window in which is it non-obvious that people should ask permission from cars to cross a road, rather than the inverse. It is briefly non-obvious that there should be lots of free parking but never free public transport. It is briefly non-obvious that one person driving a car should know, in advance and without checking, that they can drive it to the heart of any community; need no permission to pump smoke into nearby strangers' lungs; that most of our city commons should store cars. Most especially, it is non-obvious that the huge river of tarmac in front of your home isn't for children to play in or people to sit in or trees to grow in, that all those activities should continue to be physically risky, while piloting a car at speed is the sole OK use. If you live in a city that is doing this, please loudly and brightly support it. If you don't, please frame radical demands and disseminate. This is the moment in which it is non-obvious that you and the people you care about should (continue) not (to) have these things. If this thread is of interest, there are resources/writers that can provide orientation/insight.

The first and best port of call if you have time and want to learn is a free online course, the Cycling Cities MOOC https://coursera.org/learn/unraveling-the-cycling-city… by @fietsprofessor & co-conspirators. Recently, readable and (justly) provocative histories of street space allocation and the fight for cycling have been written. In my own research I use Peter Norton's 'Fighting Traffic', David Prytherch's 'Law, Engineering & the American Right of Way', and, for me, the gateway book, Ruth Oldenziel et al's 'Cycling Cities', an account of a century of these struggles in European cities http://cyclingcities.info. And of course, the Bruntletts' Building the Cycling City (2018) @modacitylifehttp://modacitylife.com/building-the-cycling-city… for a comprehensive account of how Dutch cities, in particular, have succeeded in charting a different course. Much, much more can be found at @Cycling_Embassy. Lastly, if you can access journal articles, some very pragmatic ones

are @NelloDeakin asking, What *is* a fair space allocation? and Anna Nikolaeva's work on 'commoning' urban mobility @_Anna_Nikolaeva. And finally, for all other questions, run, ride or wheel yourself to the Urban Cycling Institute, where the most beautiful templates for action and provocation have been carefully assembled by @georgeintraffic, @dutch_ish and others already mentioned. (end)

10.2 Summary (EN)

Across the developed world, cities seek an urgent transformation of their mobility systems away from domination by fossil-fuelled automobility and towards a mix of more sustainable modes (UN Habitat 2013). One such alternative is cycling-based mobility services (CBMS), which provide users with temporary access to a bicycle (Petzer et al. 2019). In the Netherlands, a mobility outlier where cycling has developed into a mature mass transport mode supported by excellent infrastructure, CBMS has met with mixed results and significant regulatory opposition. Opponents have most often targeted the legitimacy of the claims that some CBMS services, such as dockless bikeshare, make on scarce urban open space, which has become highly institutionalised through decades of contestation by the Dutch automobility and cycling regimes, among many other stakeholders (Turnheim et al. 2015; Albert de la Bruhèze and Oldenziel 2016).

While socio-technical and sustainability transitions research are well-equipped to account for how niche innovations like CBMS interact and compete with regimes, the case of CBMS in the cities of the Netherlands points to a gap in the scholarly understanding of lock-in that inhibits more effective analysis of the past performance and near-future prospects of CBMS. This thesis addresses that gap by drawing on transitions research and other disciplines to analyse the kind of lock-in produced by the modally-differentiated institutionalisation of urban open space as a common pool resource.

Lock-in has been acknowledged as a key concept in transitions from the first (Kemp et al. 1998; Geels 2002), and has been refined to include concepts such as infrastructural lock-in (Maassen 2012), and lock-in in mature innovation systems (Wesseling and Van der Vooren 2017). Space, (spatial) scale and place have also received increasing attention in this literature (Coenen and Truffer 2012; Raven et al. 2012), leading to an increased appreciation of the influence on transitions of relative proximity and distance, of place-bound disparities in resources and skills, and of the city in particular as both a locus *and* a focus of transitions. The particular obduracy (Hommels 2005) and inertia of the built environment has also been connected with particular mobility modes and thus socio-technical regimes (Mäkinen et al. 2015) as a form of lock-in. However, as Nielsen and Farrelly (2019) argue, these enquiries have yet to adequately conceptualise the material constraints of urban built environment as a significant form of lock-in in the aggregate. Köhler et al (2020) argue that

sustainable mobility transitions research to date continues to focus strongly on technology substitution as a driver of change, to the relative neglect of niche-regime relations.

As a result, lock-in of access to urban space remains under-theorised in transitions research, despite its primacy in empirical struggles around space allocation. The zero-sum allocation produced by the scarcity of urban space and the obduracy of buildings is inflected by the power of niche and regime actors to produce contestation that transcends particular socio-technical systems. Further, as mobility is a derived demand to move through urban space rather than a need in itself (such as energy, water or food), lock-in on space for some modes effectively locks out all others. This thesis seeks to develop a conceptualisation of lock-in on urban space that reflects its empirical significance for sustainable urban mobility transitions by asking: *Which key dynamics explain the form taken by cycling-based mobility services in the Netherlands, and their performance and prospects within the Dutch urban mobility system?*

Chapter 1 introduces the case of CBMS within the context of the Dutch urban mobility system, and provides an overview of how urban space has been conceptualised in transitions research and across urban disciplines (such as urban planning), respectively. CBMS in the Dutch context is defined as Cycling-as-a-Service, a niche in the cycling regime, and the business models of CaaS providers across the Netherlands are mapped and compared using the BMC (Osterwalder 2004). Fit/stretch strategies are applied to both the value propositions and technology choices and designs of these CaaS providers (Hoogma 2002). The resulting 2x2 classification clarifies why CaaS bikeshare providers that adhere closely to the cycling regime have experienced little regulatory opposition but are limited to fleet sizes that are too small to make an impact on local mobility offerings, while the inverse applies to providers with stretch/stretch strategies.

In Chapter 3, the work of Rosenbloom et al on niche framing struggles (2016; 2018) informs a narrative analysis of efforts by dockless bikeshare CaaS actors to legitimate their presence in the public realm in Dutch print and online media. This analysis is extended by a normative assessment of these struggles in light of Sheller's Mobility Justice framework (2018). The application of the conceptual tenets of Mobility Justice is found to yield novel framings that differ from those advanced by both proponents and opponents of dockless bikeshare. These framings emphasise the injustice of the status quo, and directly attend to non-users and immobility, as well as questions of distribution, in contrast to the emphasis in mobility transitions research on the potential for transformation, on users as actors, and on mobility.

In Chapter 4, this analysis of legitimation efforts and claims on public space is further developed into a framework that draws on urban law and urban history scholarship (in particular, Prytherch 2018)

to produce an abstraction of the regulations that apportion physical public open space to particular uses. This framework is applied to circulatory and parking space for automobility and cycling in Amsterdam, Brussels and Birmingham (UK) to assess the extent to which mode-specific differences in space lock-in reflect a logic of commodification or commoning. This chapter introduces a scarcity perspective on urban open space as an essential resource that is constantly contested by mobility modes. This perspective leads to the identification of spatial allocation mechanisms, which are mostly regulatory, and spatial appropriation practices, which reflect how users actually claim space for mobility modes, dormant vehicles, and non-mobility uses.

In Chapter 5, bikeshare-inclusive mobility services platforms in the Netherlands, Antwerp and Helsinki are examined as both collaborative business models and as a potential transition pathway for the upscaling of CaaS. This enquiry focuses on the influence of modal distinctions in the mechanisms by which space lock-in is maintained, and their relative effects on bikeshare versus other shared modes. The three cases are found to be characterised by a lack of commoning (bikeshare providers have little stake in the physical mobility commons), and by the prevalence of coerced collaboration (city governments impose particular 'collaborative' organisational forms on firms that are direct competitors). The meaning of 'collaborative' here differs from three key interpretations of the term that emerge from a systematic review of the literature on "collaborative business models".

Chapter 6 synthesises and discusses the findings of this thesis on lock-in on space as the major explanatory factor in the performance of CBMs in the Netherlands to date, and presents recommendations for countering lock-in to realise the potential of CBMS in the near future.

10.3 Samenvatting (NL)

Zie http://brettpetzer.com/nl-summary-of-thesis/ voor een samenvatting in het Nederlands

10.4 Curriculum Vitae

Online version, contact details and website: http://brettpetzer.com/cv

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Education

Eindhoven University of Technology (tue.nl) – PhD (expected submission 31 January 2021), School of Innovation Sciences, Bicycle Challenges Project (cyclingcities.info)

WTMC, 2017-2019: Participation in the graduate school programme (link).

University of Cape Town (uct.ac.za) – Master of City and Regional Planning, 2014-2016.

University of Amsterdam (Summer School) – Planning the Cycling City, July-August 2016.

University of Cape Town – Bachelor of Architectural Studies, 2008-2011

Rhodes University (ru.ac.za) – Bachelor of Social Science, 2005-7. Majors: Politics and International Studies, French (distinction), English. Minors: Economics.

PhD publications and experience

Journal articles, published:

Petzer BJM, Wieczorek AJ, Verbong GPJ. 2020. Cycling as a service assessed from a combined business-model and transitions perspective. Environmental Innovation and Societal Transitions 36: 255-269.

Petzer, BJM, Wieczorek AJ, and Verbong GPJ. 2020. Dockless bikeshare in Amsterdam: a mobility justice perspective on niche framing struggles. Applied Mobilities: 1-19.

Journal articles, accepted (01/2021):

Petzer, BJM, Wieczorek AJ, and Verbong GPJ. The legal street: a scarcity approach to urban open space in mobility transitions. Urban Transformations.

Peer-reviewed book chapters, in press (01/2021):

"Collaborative business models and platforms in shared mobility transitions: the case of bikeshare integration" in Aagard A, Lüdeke-Freund F, Wells P (eds). 2021. Business Models for Sustainability Transformation. Palgrave MacMillan: London.

Teaching

OSV40 – "Managing Sustainable Technologies", tutor, 2017-2020

USE Base, tutor, 2017-2020, "Digital Futures" track

Conference presentations:

Cycling Research Board 2018, Amsterdam

Cycling Research Board 2017, Amsterdam

Velo-City 2017, Arnhem-Nijmegen

(Chair) Cycling Research Board 2020, Eindhoven, 27 October 2020 – Session 4.2, Perspectives on Bike Sharing

Editorial assistance and responsibility for fundraising

Cycling Cities: The Johannesburg Experience, Stichting voor de Historie der Techniek (cyclingcities.info)

Areas of Interest – Academic

General: socio-technical transitions, power in transitions, geography of transitions

Specific: urban space as a commons and a commodity in urban (mobility) transitions

General: cycling cities, vélomobility, urban planning for slow mobility

Languages

English – C2	Mother tongue: fluency in reading, writing and speaking. The language of my secondary and tertiary education.
French – C1+	Second language: advanced proficiency in reading, writing and speaking. I am an accredited translator (UK DipTrans) from French to English.
Dutch, reading and listening – B2+	I have a high level of understanding of written and spoken Dutch, and was able to use this to conduct extensive narrative and press analyses of Dutch-language texts, as well as transcribing 20+ hours of Dutch-language interviews.
Dutch, speaking and writing – B1	I am currently pursuing weekly individual Dutch lessons focused on academic and professional communication with students and colleagues.

10.5 List of Publications

Table 23: Publications in this thesis

Journal articles, published:	Petzer, B.J.M., A.J. Wieczorek, and G.P.J. Verbong. 'Making Sense of Cycling-as-a-Service in the Netherlands: A Combined Business Models and Transitions Approach'. Environmental Innovation and Societal Transitions, 2019. https://doi.org/10.1016/j.eist.2019.09.001.
	Petzer, B.J.M., A.J. Wieczorek, and G.P.J. Verbong. 'Dockless Bikeshare in Amsterdam: A Mobility Justice Perspective on Niche Framing Struggles'. Applied Mobilities, 20 July 2020, 1–19. https://doi.org/10.1080/23800127.2020.1794305.
Journal articles, in press (01/2021)	Petzer, BJM, Wieczorek AJ, and Verbong GPJ. The legal street: a scarcity approach to urban open space in mobility transitions. Urban Transformations.
Peer-reviewed book chapters, in press (01/2021)	"Collaborative business models and platforms in shared mobility transitions: the case of bikeshare integration" in Aagard A, Lüdeke-Freund F, Wells P (eds). 2021. Business Models for Sustainability Transformation. Palgrave MacMillan: London.

Table 24: Other publications

Contributions and Book Reviews	Book review, *Les Mobilités partagées* by Maxime Huré, *Journal of Transport History* (2017) (DOI: https://doi.org/10.1177/0022526617717431).
One-pagers (EN)	P4 – Collaborative business models and shared mobility: a case of cooperative competition?
	P3 – Open space as a resource for mobility transitions: is there room for shared mobility? (English)
	P2 – Comparing fleet size and local government relations for Cycling-as-a-Service providers in the Netherlands
	P1 – What is Cycling-as-a-Service?
	Bicycle Challenges PhD: Cycling-as-a-Service in the Netherlands (2017-21)
One-pagers (NL)	P4 – Collaboratieve businessmodellen en deelmobiliteit: een geval van coöperatieve concurrentie?
	P3 – Open ruimte als bron voor mobiliteitstransities: is er ruimte voor gedeelde mobiliteit? (Nederlands)
Video	Youtube chat on Cycling-as-a-Service with George from the Urban Cycling Institute!

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