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Transformation beyond experimentation

Sustainability transitions in megacities

Bipashyee Ghosh

Thesis submitted for the degree of

Doctor of Philosophy

Science Policy Research Unit

University of Sussex

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Declaration

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature:

Bipashyee Ghosh

UNIVERSITY OF SUSSEX

BIPASHYEE GHOSH, DOCTOR OF PHILOSOPHY

TRANSFORMATION BEYOND EXPERIMENTATION

SUSTAINABILITY TRANSITIONS IN MEGACITIES

SUMMARY

World's megacities are facing acute sustainability challenges. Persistent problems such as urban pollution, resource depletion, climate change, poverty and social inequalities are shaping unsustainable futures for some of the world's most populated regions. How can these challenges be tackled? Focusing on the urban mobility regimes that contribute to the acute challenges, this thesis investigates if they can transition toward sustainability. According to sustainability transitions studies, experimentation is vital for making such a transition, through replacing existing unsustainable socio-technical regimes such as fossil fuel-based automobility. Besides niche experimentation, existing regimes can also undergo *transformation* towards sustainability, being enabled by regime actors. Both experimentation and regime transformation are explored in five studies covering cities like Kolkata, New Delhi and Ahmedabad in India and Bangkok and Chiang Mai in Thailand. However, the majority of the thesis has a strong focus on Kolkata.

Following an introduction, the thesis begins with a study exploring diversity in the meaning of sustainability of experiments in different social, spatial and systemic contexts. Focussing on niche experiments, the second study is an analysis of niche actors' strategies to 'empower' sustainable innovations, negotiating with incumbent regime actors in legal and policy spaces. Looking beyond experimentation, a third study focuses on different transition pathways in megacity Kolkata's public transport regimes. It proposes a new 'mapping tool' to identify changes in regime rules, trajectories and selection pressures. In the penultimate paper, a 'Wheel of Logics' framework is proposed to develop an understanding of the nature of dynamic stability of regimes in the Global South. Finally, a critical discourse analysis examines whether a smart city imaginary in Kolkata was politically transformative, by analysing the projected distribution of benefits among its citizens, the mechanisms used to democratize the process of constructing the imaginary, and the ways in which citizens' voices were articulated into the official imaginary.

These five studies, tied together, offer a critical understanding of sociotechnical transitions in megacities, by carrying out sustainability appraisals of experiments and developing theoretical frameworks and practical tools for understanding regime dynamics. This way, the thesis offers new conceptual and methodological insights for sustainability transitions, by emphasizing transformations beyond experimentation. These new insights are intended as contribution to shaping sustainable futures in megacities.

Declaration on incorporation of published work

This thesis includes the following publications. My contribution in each of these co-authored chapters is outlined in Chapter 1 Section 7 (Page 51-53).

1. Raven, R., Ghosh, B., Wieczorek, A., Stirling, A., Ghosh, D., Jolly, S., Karjangtimapron, E., Prabudhanitisarn, S., Roy, J., Sangawongse, S. and Sengers, F., 2017. Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand. *Sustainability Science*, 12(4), pp.579-596. <https://doi.org/10.1007/s11625-017-0438-0>

(Included as chapter 2)

2. Ghosh, D., Sengers, F., Wieczorek, A.J., Ghosh, B., Roy, J. and Raven, R., 2016. Urban mobility experiments in India and Thailand. *The Experimental City*, p.122-136.

(Included as chapter 3)

3. Ghosh, B. and Schot, J., 2018. Mapping socio-technical change in mobility regimes: The case of Kolkata. SPRU Working Paper Series (SWPS). 2018-16: 1-45. ISSN 2057-6668. Available at: <http://www.sussex.ac.uk/spru/research/swps>

- Revised and resubmitted to Energy Research and Social Science journal
- Conference proceedings. International Sustainability Transitions (IST) conference. Manchester (11-14th June 2018)

(Included as chapter 4)

4. Ghosh, B. 2018. The “Wheel of Logics”: Towards conceptualising dynamic stability of regimes in the Global South.

- Submitted to Environmental Innovation and Societal Transitions journal

(Included as chapter 5)

5. Ghosh, B and Arora, S. 2018. Smart as politically transformative? An analysis of ‘smart city’ socio-technical imaginary in an Indian megacity

- Under review in STEPS Working Paper series

(Included as chapter 6)

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Bipashyee Ghosh
London, September 12th 2018.

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List of abbreviations and acronyms

CSTC - Calcutta State Transport Corporation

CTC – Calcutta Tramways Corporation

IMT - Intermediate Means of Transport

JNNURM – Jawaharlal Nehru National Urban Renewal Mission

LPG - Liquefied petroleum gas

MCM – Multi-criteria mapping

MLP – Multi-level perspective

MoUD – Ministry of Urban Development, Government of India

NKDA – New Town Kolkata Development Authority

NtK – New town Kolkata

MITES - Rail India Technical and Economic Service

RTA - Regional Transport Authority

RVNL – Rail Vikas Nigam Limited

SDG – Sustainable Development Goals

WBTC – West Bengal Transport Corporation

Chapter 1. Introduction

1. Background and motivation

In the past century, the world has witnessed an astonishing event called 'Urbanisation'. By definition, this is a process by which people leave the countryside and start living in cities¹. The world in the nineteenth and twentieth century have seen millions of people across the world migrating into and creating urban landscapes, engaging in new economic activities beyond agriculture and pastoral activities; producing and consuming a whole range of new goods and services and embracing a new 'urban lifestyle' (Greenberg, 2000). Urbanisation is deemed to become a defining feature of the 21st century (Clark, 1998). More than half of the world's population lives in urban areas in the present day, and by 2030, 66% of the world population is projected to be urban (UN-DESA, 2018). Following the ongoing trends of urban growth, many bigger and denser urban settlements are likely to emerge, especially in Asia and Africa (Frey and Zimmer, 2001). Such gigantic cities, each with a population of more than ten million, are also known as *megacities*. The number of megacities around the world has proliferated from only two in the 1950s (New York and Tokyo) to thirty-three in 2018 (UN-DESA, 2018). By 2030, the world is expected to have 43 megacities, and most of them will be in developing countries (UN-DESA, 2018). New Delhi, currently the second largest city after Tokyo, with 29 million inhabitants, is projected to be the most populous city in the world by 2028. Several countries in Asia and Africa are bracing for enormous population pressure in urban regions in the near future.

This pattern of rapid urbanisation and population concentration has severe negative consequences on the sustainability and liveability of cities. Megacities, in particular, occupy the centre stage of urban sustainability challenges (Sorensen and Okata, 2010). In these giant cities, social, economic, environmental and political issues are prominent. Chronic urban sustainability problems ranging from poor air quality, congestion, carbon emissions, health and safety concerns, coupled with poverty, lack of social cohesion, political and economic tensions are

¹ Definition of Urbanisation, according to the Cambridge Dictionary.

most persistent and amplifying in bigger cities (Dimitriou, and Gakenheimer, 2011). Quality of life in megacities is adversely affected due to these problems which are further reinforced by additional issues such as increasing cost of living, unruly traffic, water constraints, and crime (Oliveira, 2015). These problems may be observed in all sized cities, but they are more intense and disastrous in megacities, owing to the sheer volume of people affected by these sustainability problems. For instance, a Kolkata based Cancer Research Institute reports that half of Delhi's 4.4 million school children have developed respiratory problems due to air pollution which are beyond recovery (Chatterjee and Ghosal, 2015). In 2017, an emergency was declared in Delhi, as some airborne pollutants rose to a level beyond what the air quality measurement instruments could measure (The Guardian, 2017). The Guardian (2017) further reports that the level of particulate matter (PM) 2.5 on a day in November was recorded as 710 micrograms per cubic metre, which is more than 11 times the World Health Organisation's safe limit. Reporting on World Health Organisation (WHO)'s data, one of India's leading newspaper - The Times of India reports that Kolkata is the second most polluted city in India after Delhi, where 14 million inhabitants were exposed to seven times higher mean PM 2.5 in 2016 than WHO's safe limit (Bandyopadhyay, 2018). More disconcerting is the fact that Kolkata's air quality is declining faster than that of Delhi's (ibid). These problems are however not unique to Indian megacities. Megacities like Bangkok (Thailand), Jakarta (Indonesia), Dhaka (Bangladesh), Shanghai (China), Lagos (Nigeria), Cairo (Egypt), Bogota (Columbia), Sao Paulo (Brazil) are facing similar sustainability threats and environmental degradation. Many of these cities are located in the world's coastal and deltaic regions - vulnerable to accelerated sea level rise owing to global warming, frequent storms and flooding (Pelling and Blackburn, 2014; Nicholls, 1995). A recent study shows that the current "...hothouse Earth trajectory would almost certainly flood deltaic environments, increase the risk of damage from coastal storms, and eliminate coral reefs... by the end of this century or earlier." (Steffen et al., 2018: 5). It is therefore important to focus sustainability transitions research on coastal and deltaic regions, among other urban regions. This attention - particularly to the megacities for the vulnerable regions - is vital, because the "larger the urban area, the greater the damage that natural hazards can inflict", even if a "perfect [early] warning system" is in place (Hunt, 2012). Responding to this need, this thesis delves into researching: *how can a sustainability transitions perspective help to address the severe and persistent sustainability issues faced by megacities in the Global South?*²

² Global South is category used to reflect poverty, inequality, and developmental characteristics of the developing, under-developed, low- and middle-income contexts in Asia, Africa, Latin America and the Caribbean (Rigg, 2007; Satterthwaite and Mitlin, 2012; Pagel et al., 2014)

Having witnessed many of these issues first-hand while growing up in Kolkata, served as personal motivation for working towards this thesis. The sustainability transitions research field provided an interdisciplinary field to translate this motivation into a specific scholarly focus. At the same time, day to day experience with Kolkata's and other megacities' variety of public and private transportation systems have fascinated me and prompted me to dig deeper into how, in the language of sustainability transitions and transformations, socio-technical mobility systems may evolve towards more sustainable futures. While I have included various megacities in my research, Kolkata is my main focus.

1.1 Mobility in a megacity

Mobility systems are the backbone of any city. The systems comprise the governance, operation and use of public and private transportation modes, either individual or shared, motorised like cars, buses or non-motorised like walking and cycling, and more recent on-demand "mobility-as-a-service" (MaaS) (Jittrapirom et al., 2017). Mobility systems allow people to access different parts of the city for education, health, employment and other purposes. A mobility system that is sustainable in a city is one of the most fundamental ways of ensuring good quality of life of citizens (Steg and Gifford, 2005). In densely populated megacities, mobility system served by public, shared and non-motorised transport modes are considered desirable from the perspective of social inclusion, accessibility and environmental impact (Morichi and Acharya, 2012; Reddy and Balachandra, 2012). I focus on mobility in megacities in this thesis, as I consider urban mobility to be one of the most dynamic and complex systems facing persistent unsustainabilities, therefore interesting and important for sustainability research. Currently, in most cities around the world, mobility systems are heavily dependent on fossil fuel usage and are heavily contributing towards greenhouse gas emissions (Morichi and Acharya, 2012; Chapman, 2007; Kenworthy, 2003). Megacities, particularly in Asia, are also witnessing increased motorisation and enormous growth in the number of privately-owned vehicles (cars, motorcycles) – feeding into air quality, congestion and other problems (Zhao, 2010). Owning cars and motorcycles is often associated with symbols of status and modernity for urban inhabitants in Asia (Sengers, 2016), amplifying the urban sustainability problems.

Private transportation is however not the only reason for megacities' sustainability problems. Kolkata – a megacity in the eastern part of India that I will focus on in my thesis, for instance, has the lowest percentage of people owning cars among other Indian megacities (Bansal et al., 2016). The city presents a wide range of public transport modes operating simultaneously and in parallel, to provide affordable and accessible mobility to its predominantly low-income citizens. However, moving around in this city in recent years has increasingly become a painful experience, with narrow, crowded roads, vehicles emitting toxic pollutants, honking drivers and slow movement of traffic. The city, which was once known for its green, open spaces and where the majority of people walked or bicycled - has experienced an 'explosion of cars, buses and auto-rickshaws', coupled with a lack of planning and efficiency in managing the city's chaotic transportation system (The Guardian, 2016; Banerjee, 2016; Chakrabartty and Gupta, 2014). In the past decade, the city governments and a variety of actors have however raised voices, planned and implemented some actions to decongest roads by building flyovers, widening motorways, increasing number of buses, metro lines, and overall attempting to 'modernise' the system (Banerjee, 2016; Sarkar and Tagore, 2011; Government of West Bengal, 2008). In spite of all actions, the megacity continues to struggle with environmental and social issues that make the transportation system unsustainable for the future. This struggle is common among most megacities, particularly in Global South. Finding ways to address these persistent sustainability problems to ensure that the astonishing event of urbanisation that started centuries ago, doesn't end up being destructive - is the most critical policy challenge that informs the writing of this thesis.

1.2 Urban Sustainability

. The need of addressing persistent urban sustainability problems has been discussed in many studies (McCormick et al., 2013; Nevens et al., 2013; Næss and Vogel, 2012; Hodson and Marvin, 2010). These studies highlight the multi-dimensionality of the problems, suggesting that cities need to 'design, practise and mobilise' low-carbon pathways in their own 'political, geographical and developmental contexts' (Luque-Ayala et al., 2018). Several chapters of this thesis will speak to this line of research, staying close to the efforts of transitions scholars to engage with urban sustainability problems. Several international organisations and collaborative endeavours have invested in defining, setting targets, measuring and monitoring

the processes of solving sustainability problems by nations, regions and cities including the Millennium Development Goals, Paris Agreement, and C40 Cities Summits. Sustainable Development Goals (SDGs) are among the most recent of these efforts, illustrating the range and magnitude of issues that need to be dealt with in order to achieve a sustainable future (United Nations, 2018). This sheer variety of sustainability issues indicate trade-offs – addressing one set of issue that often comes at the cost of another. For instance, in Kolkata, a ban on cycling to improve traffic flow in the roads costs the lower income groups their day-to-day livelihood while the higher income groups benefit from the cleared road space for car traffic (Switchon, 2013). Such examples suggest that actions for sustainable futures are highly political and contested in nature, and thus will be driven by asymmetries in power and self-interests of powerful socio-political and economic groups. Unsustainable socio-technical systems (mobility, energy) may be addressed with efforts by particular privileged social groups to offer specific technological solutions that they consider to be the ‘most sustainable’, ‘the best’ (Stirling, 2011), which in the end may serve their purposes solely. In order to move towards sustainability in these contexts, it is important to embrace diversity and plurality of options that can meet heterogeneous needs and preferences of different social groups (Stirling, 2008; Smith et al., 2005).

This thesis is my earnest attempt to explore diverse ways to tackle urban sustainability problems faced by mobility systems in Global South. I propose new conceptual frames and policy approaches that can help explain and inform *transformations* by addressing persistent unsustainabilities faced by mobility systems (as well as energy systems in the first chapter), particularly in Southern contexts. The premise is that megacities in the Global South need alternative ways of operating, governing and using mobility or energy systems. Scholars, policy-makers and other practitioners should not just copy or follow trajectories of Western cities like London, New York and Barcelona in resolving problems in Global South megacities, because the availability of resources, nature and scale of challenges in Northern cities ‘are incomparable with those of Nairobi, Mumbai and Lagos’ (Oliveira, 2015: para. 4). Sustainability transitions in Southern contexts need new ways of experimenting and transforming systems that match the availability of resources, existing technologies and infrastructures, international linkages as well as local socio-political-economic conditions. This recognition prompts me to take a closer look at existing approaches to system transitions, in order to identify what adaptations to transitions frameworks may be necessary, and make possible contributions to the literature.

In the following section, I discuss the theoretical concepts used in the thesis. In section 3, I present research questions along with research gaps addressed in each study. Section 4 contains

a brief discussion of the overarching methodological approaches and research design of the five studies constituting this thesis. The contribution to knowledge through this thesis is presented in section 5. Section 6 shows the structure and outline of this thesis in a tabular format – using the building blocks of each chapter of this thesis. In section 7, I declare my contribution to each of the co-authored chapters/publications.

2. Theories and conceptual frames

2.1 Socio-technical system transition

The concept of ‘socio-technical systems’ entails that systems of production and consumption are constituted by both social as well as technological elements (Geels, 2002). These systems are dynamic. Social and technological elements co-evolve and transform systems. This co-evolution and change dynamics are studied in the sustainability transitions literature, which primarily focuses on shifts from stable but unsustainable socio-technical configurations of systems to a more sustainable socio-technical configuration (Rip and Kemp, 1998; Elzen et al., 2004; Schot et al., 1994). As an example, an automobility transition may entail moving away from private transport (mostly car) dominated socio-technical configurations to systems composed of public, shared and non-motorised modes of mobility (Geels, 2012; Geels et al., 2011). According to the Multi-level perspective, a dominant framing in sustainability transitions, these new socio-technical systems are viewed as originating in and experimented within niches, but transitions to new systems will only happen when the existing regime opens up for change and is destabilised by niche and what is called socio-technical landscape pressures such as climate change. (Geels, 2002; 2005; Smith et al., 2010). Transition processes following this niche-regime-landscape interaction dynamics may follow a variety of pathways such as reconfiguration, technological substitution, de-alignment and re-alignment and transformation depending on nature of landscape pressures and level of development of niches (see Geels and Schot, 2007 for a detailed description of each pathway).

Sustainability transitions literature³ however, spans much broader foci and covers much more ground than MLP literature. Among the many ways of approaching systemic problems within transitions literature, prominent are studies using technological innovation systems approach (Wieczorek and Hekkert., 2012; Jacobsson and Bergek, 2011) and transition management approach (Kemp et al., 2007; Rotmans and Loorbach, 2009; Loorbach, 2010). These two approaches focus on issues and possibilities of strategic policy-making and multi-level governance of change processes, highlighting system failures and politics underlying transitions (Wieczorek and Hekkert, 2012; Weber and Rohracher, 2012; Kemp et al., 2007). Useful attempts to integrate these approaches with the multi-level perspective in innovation studies highlight their differences, yet pointing to their shared understanding of system change, based on the co-evolutionary processes of visioning, experimenting and learning (Weber and Rohracher, 2012; Kemp et al., 2007). In this chapter, I revisit the literature on quasi-evolutionary origins of sustainability transitions theory (based on evolutionary economics and institutional theory), to lay the foundation of this thesis.

2.1.1 Quasi-evolutionary foundations of socio-technical transitions

The origins of Multi-level perspective literature on socio-technical transitions can be traced back to Nelson and Winter (1977; 1982)'s work on the concept of a technical regime, where they argue that technical change happens through search processes structured by scientist, engineers and technicians' beliefs. They argue that "the sense of potential, of constraints, and of not yet exploited opportunities, implicit in a regime, focuses the attention of engineers on certain directions in which progress is possible, and provides strong guidance as to the tactics likely to be fruitful for probing that direction." (Nelson and Winter, 1977, p. 57). These beliefs, alongside collective and shared routines and heuristics, provide directions of change through setting trajectories. In these early conceptualisations of technical change, regimes develop from scientific breakthroughs and/or cumulative scientific developments; and coordinate and guide technical change in particular directions, leading to incremental innovation along what was called technological trajectories.

³ For systematic reviews of this literature, see Markard et al., 2012; Hansen and Coenen, 2015; Smith et al., 2010

The specific direction set by trajectories, guided by routines/heuristics has remained at the core of later developments in the quasi-evolutionary model of socio-technical change (Rip, 1992; Schot 1992; 1998; Van Lente, 1993). The unsustainability of socio-technical systems was conceptualised as a result of directions set by a socio-technical regime. The regime concept as advanced in evolutionary economics is associated with the idea of 'bounded rationality' and sets boundaries to limit the search process (Simon, 1982; 1991). Following the concept of bounded rationality, actors do not maximise their choices but operate within a set of perceived innovation options. These actors also go through individual and social learning processes which help them deviate from the existing trajectories (Simon, 1982). Within this bounded process of socio-technical change, market selection still decides on which trajectories get a chance to be developed. This brings me to the discussion on the two different types of selection pressures that is fundamental to the evolutionary thinking of socio-technical change and explored in this thesis.

Dosi (1982) introduced the notion of a technological paradigm, stressing the fact that technical change is cumulative, directed and selective. A paradigm is a model which consists of a set of solutions for a set of identified problems. In this model, a change process is initiated, not through actors or firms exploring the entire paradigm space or all innovation options. Instead, change is achieved by making certain choices like the choice of paradigm; choice of a set of technological trajectories; further choices within each technological trajectory. Actors make these choices, based on different types of selection pressures that promise success in the search process in a particular direction. According to Dosi, there can be two types of selection: ex-ante and ex-post. Ex-ante selection refers to the selection of technological paradigm, driven by expectations and anticipations about the future, in contrary to the regular market competition process. This type of ex-ante selection pressure can be perceived as the selection of the genotype in the socio-technical configurations (Rip, 1992; Schot, 1998). The concept of the socio-technical regime embodies this genotype – the underlying gene or DNA of the sociotechnical system. In evolutionary terms, ex-ante type of selection closely follows the theory of Lamarckian selection, which results in some form of directed variation and new species. Ex-post-selection, on the other hand, is further selection within the paradigm (existing species), guided by blind variation through a change in routines in Darwinian mode. This is a selection at the phenotype level – resulting in the change in the manifestation of the socio-technical systems. Owing to such prominent role of expectations and more generally, the idea of directed variation as an ex-ante selection mechanism, the transition dynamics are understood as quasi-evolutionary (Rip and Kemp, 1998; Schot, 1998). This implies that a socio-technical regime

transition is partly strategic and intentional; anticipating selection and the perceived characteristics of the selection environment. I have built on this quasi-evolutionary model in this thesis. Within this model, one prominent strategy in understanding socio-technical change has been to analyse the expectations of actors – in regimes and niches. I turn to the notion of expectation in the next section – which is crucial for this thesis.

2.1.2 Expectations and strategic niche management

Ex-ante selection is fundamental to transitions thinking, and so is the notion of expectations. In other words, the core assumption is that there are other factors at play, beyond market mechanisms, which lead “firms and individuals (to be) “betting” on different technological solutions.” (Dosi, 1982: 155). One critical ‘other factor’ is later elaborated as ‘cultural matrix of expectations’ that guides socio-technical change (Van den Belt and Rip., 1987; Rip, 1992). Contrary to technical change conceptualised by Nelson and Winter (1982), in the socio-technical system change literature, scientists and engineers are not the only actors driving change. There is a wide range of actors including policymakers, NGOs, businesses and users who voice, articulate and negotiate expectations about technological possibilities and thereby structure future developments (Van Lente 1993; Brown and Michael, 2003). This prompts the fact that the starting point for the development of a new paradigm or regime is not a scientific breakthrough, but rather the expectations that then drive scientific exploration and might lead to breakthroughs as well as incremental technological development (within existing trajectories). Expectations are therefore important cognitive rules that trigger changes in socio-technical regimes (Van Lente, 1993; Geels, 2004). They are mutually “shared, though flexibly interpreted, cluster of guiding visions” (Borup et al., 2006: 289). These visions transcend beyond just anticipating future selection. By legitimising investments in specific directions, expectations play a crucial role in the construction of niche protective spaces for nurturing alternatives (Rip and Kemp, 1998). In evolutionary thinking, niches represent variation and are built on early promises set by high expectations about the future of innovations (Geels and Smit, 2000). Variation and selection are two processes which are coupled with one another through voicing and negotiating expectations (Schot, 1992). As a result, articulation of expectation is an important step in Strategic Niche Management (SNM) and is the basis of niche experimentation (Kemp et al., 1998; Hoogma et al., 2005; Raven, 2008; Smith and Raven, 2012; Sengers et al.,

2016). Parts of this doctoral thesis (Chapters 2 and 3) explore niche experimentation strategies, which is why I briefly introduce literature on experimentation in the next section.

2.2 Experimentation

Experiments that are socio-technical and tailored towards sustainability are of key interest to transitions and strategic niche management community (Kemp et al., 1998; Hoogma et al., 2005; Raven, 2008). Unlike experiments in laboratories - which test, refine, establish facts and causal relationships, transition experiments are ones performed in societal settings involving a wide range of actors. These experiments shape the future of socio-technical systems through “connected social learning in relation to a new socio-technical configuration” (Sengers et al., 2016: 5). According to the quasi-evolutionary model of socio-technical change, experimentation happens in niches that provide innovative ‘alternatives’ to the incumbent unsustainable regimes (Schot et al., 1994; Schot and Geels, 2008). These alternatives need protection and nurturing before they can *become* regimes (Raven, 2006; Smith and Raven, 2012). Niches provide this protective space, where a variety of innovations flourish at an experimental stage, driven by scientists and entrepreneurs. They are seen as ‘front-runners’ in societies who anticipate a sustainable future and work towards it. The literature on Strategic Niche Management (SNM) for socio-technical transitions, therefore, focuses on understanding how experimentation happens, by whom, under what conditions and how these experimentations contribution to niche formation and scale up (Raven, 2006; Berkhout et al., 2010; Ghosh et al., 2016). Niche experiments and niche actors, therefore, occupy crucial positions in socio-technical transitions thinking, as they are believed to be the ones driving systemic change. One of the chapters in this thesis (chapter 3) investigates the role of niche actors and their strategies to reconfigure the incumbent regime through their experiments.

There is a vast array of literature on experimentation ranging from socio-technical experimentation to policy experimentation, climate governance experimentation, and urban experimentation (Turnheim et al., 2018; Kivimaa et al., 2017; Bulkeley et al. 2015; Castán Broto and Bulkeley, 2013; Hoffman, 2011; Evans and Karvonen 2011; Evans et al., 2016). These different strands of literature focus on specific issues such as reconfiguring socio-technical systems, mitigating climate change, and tackling urban sustainability problems. Irrespective of

the difference in focus, this literature details experimentation processes and discusses the potential of a positive outcome for the environment and societies. In this regard, Evans et al., (2016) observed that the socio-technical transitions community emphasises the potential for achieving ecological sustainability through experimentation, while urban scholars are more concerned with the degree to which experiments are “socially and democratically robust” (p. 4). In this thesis, both these aspects of experimentation are covered. I stayed close to the experimentation literature within socio-technical transitions scholarship, where the notion of sustainability experiments has been defined and applied in understanding innovation activities in different contexts. This literature is briefly introduced in the next section.

2.2.1 Sustainability experimentation

Sustainability experiments are defined as “Planned initiatives that embody a highly novel socio-technical configuration likely to lead to substantial (environmental) sustainability gains.” (Berkhout et al., 2010: 262). This definition captures many aspects of sustainability experimentation, for instance, the aspect of novelty, expectations about substantial positive influences and an emphasis on environmental benefits. This definition was formulated while understanding the socio-technical change processes in low income and rapidly developing countries (Berkhout et al., 2009). In these contexts, sustainability experiments are believed to hold a promise for radical change at the level of socio-technical systems like energy and mobility by creating alternative pathways tailored towards green growth strategies (Berkhout et al., 2009; Bai et al., 2010).

However, in the context of low-income countries, a sole focus on environmental issues was challenged by transitions scholars (Berkhout et al., 2009; Berkhout et al., 2010). It is clear that sustainability transitions need to address social challenges like inequality and poverty issues as well (Koehler et al., 2017). Transitions require responding to extremely varied and heterogeneous societal needs and values, arising from heterogeneous actors from different income groups, age, gender, physical abilities and religions. These differences make sustainability goals and problem-solving mechanisms ambiguous and even conflicting (Wieczorek, 2018). Under these circumstances, social learning from experimentation needs to be socially inclusive. Incorporating these new observations, Sengers et al., (2016) redefined sustainability experiment

as “inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of deep uncertainty and ambiguity.” (p. 11). They articulate that ambiguities arise from conflicting interests and values held by diverse social groups, which in turn make the direction, pace and impact of experiments uncertain. What remains unclear from this literature is how these uncertainties and ambiguities affect niche empowerment strategies, which requires an in-depth empirical analysis of experimentation in Global South contexts. In my thesis, I engage with these issues in the sustainability experimentation literature in two ways:

i) By making the uncertainties and ambiguities more explicit, while unpacking the diverse meanings of sustainability driving experimentation in Indian and Thai contexts (Chapter 2).

ii) By empirically studying niche empowerment strategies in specific mobility experimentation cases that illustrates the challenges for transitions in Global South (Chapter 3).

Studying experimentation can, however, be somewhat limiting and perhaps just one possible starting point for understanding sustainability transitions. SNM literature has predominantly focussed on experiments, the processes involved, and immediate outcomes in terms of networking, expectation development and learning (Geels and Raven, 2006; Raven, 2008). However, in order to fully understand socio-technical transitions towards sustainability, it is crucial to look beyond niche experiments and be reflexive about “how experiments can contribute to generating wider influence and change ... at the level of broader political and economic systems” (Turnheim et al., 2018: 217).

2.2.2 Beyond experimentation

The idea to look beyond experimentation is recently explored by Turnheim et al. (2018). They have emphasised that perhaps scholars and policy-makers should pay more attention to the process of embedding experiments in existing systems. They define embedding as a “more or less radical process of ‘fitting’ experiments and their outputs in post-experimental contexts ...[in which] experiments tend to be reframed, co-opted and altered to become more adapted to the existing ways of doing things and to existing norms and structures (Turnheim et al., 2018: 224). This definition echoes the ‘fit-and-conform’ strategy of niche empowerment (Smith and

Raven, 2012), which indicates a limited opportunity for transformative change. However, Turnheim et al. (2018) also explore how the experiments can radically alter the existing rules of the incumbent regimes and reconfigure the systems.

Experimentation has always been associated with transformative change. Not only in the SNM literature but also beyond, experiments are often posed as drivers of 'wider transformation' (Evans et al., 2016: 4). They are seen as "important seeds of change that may eventually lead to profound shifts in the way society functions" (Sengers et al., 2016: 1). The question is, however, how can we ensure that the experiments will deliver the wider transformation in socio-technical systems, beyond the time frame of experimentation? To address this issue Turnheim et al., (2018) propose four macro processes of 'embedding', which capture the processes in the aftermath of experimentation, and may be considered pivotal for transformative change. These processes are: scaling up, replication, circulation and institutionalisation (for definitions and examples of each process, see Turnheim et al., 2018: 229-234). Among these processes, circulation, for instance, entails mobilisation of ideas and expectations from experiments to the development of imaginaries and visions which are meant to assure the "transformation and reconfiguration of existing regimes" (ibid, p. 233). This narrative resonates well with the idea of transformation advanced in this thesis (see section 2.3 of this chapter).

Looking beyond experiments also involves acknowledging the dynamics at the regime level. The existing rules, actors and power dynamics in regimes determine whether the supposedly positive outcomes in the aftermath of experiments is going to sustain. Not only is the success of experiments decided through the multi-level interaction between niche and regimes, but the failures of experiments can also be attributed to the political, economic and socio-cultural context that supports the incumbent regime (Raven et al., 2010). Therefore, experimentation is just one side of the transition narrative. A way to capture the other side is to look beyond experimentation and into regime transformation. Recent literature recognises the role of incumbents or regime actors in driving regime change (Kungl, 2015; Geels, 2017, van Mossel et al., 2018). This discussion leads to the second concept that is central to this thesis: socio-technical transformation.

2.3 Socio-technical transformation

Many scholars have tried to explain what transformation might mean within the scope of the socio-technical system transitions literature, by creating definitions and steps, without resolving the question of how transformation is different from transitions. In fact, in the literature, both terms are often used interchangeably (Holscher et al., 2018; Geels and Kemp, 2007). Many scholars within transitions community seem to use the term transformation with an expectation to reach out to a wider audience and to appeal to more diverse fields of research, while transition as a term has mostly been confined within a closely-knit network of scholarship (Chappin and Ligtvoet, 2014). Through a bibliometric analysis, Chappin and Ligtvoet (2014) informs that transformation covers a much wider surface area in literature connected to the topic of transitions and "form the links between the topics" which helps in developing and enriching a broader and diverse scholarship around socio-technical change (Chappin and Ligtvoet, 2014: 721). This is illustrated in figure 1.

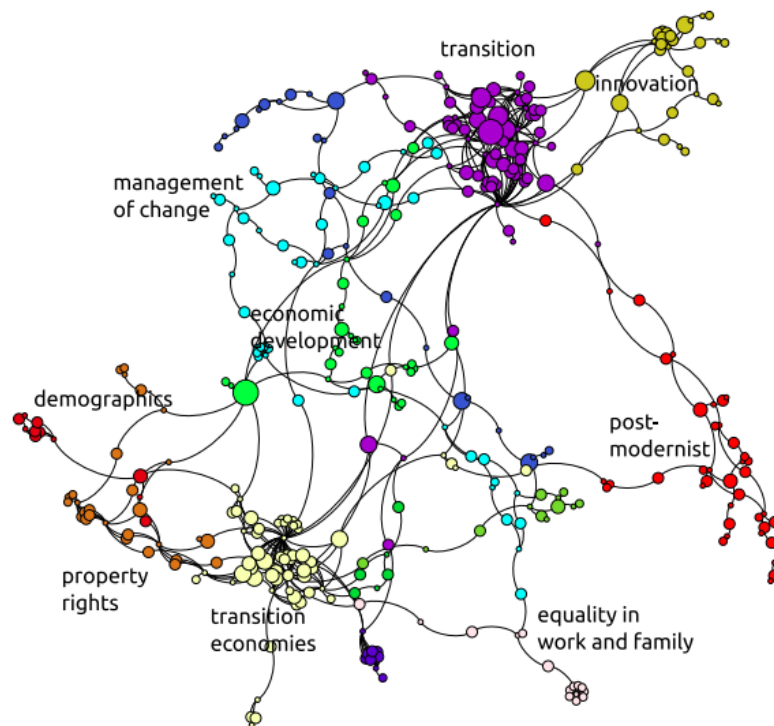


Figure 1. “The ‘transformation’ citation network with a rough indication of central topics (in colour).” (Source: Chappin and Ligtvoet, 2014: Fig. 5. pp. 721)

There are, however, a few authors who distinguish transformation from a transition. In dynamics between niche, regime and landscape levels as advanced by the multi-level perspective, a transition is understood as a shift from one regime to another through radical innovations originating in niches (Geels, 2002). Niches are therefore central to transition processes (Kemp et al., 1998; Schot and Geels, 2008). In contrast to transitions, transformations are then perceived as incremental innovations within the regime, as “the outcome of cumulative change driven by evolutionary mechanisms” (Van den Bergh et al., 2011: 11). In a similar vein, Geels and Schot (2007) propose transformation as one of the many pathways of transition. In this pathway, “new regimes grow out of old regimes through cumulative adjustments and reorientations”, where niche innovations are less sufficiently developed, and moderate landscape pressure is present (ibid, p. 407). Echoing a similar mechanism, Geels and Kemp (2007) call it transformation when regime actors “enact the redirection of the development trajectory of the existing system.” (p. 445). These conceptualisations of transformation hold regime central to change, instead of niches. The concept of transformation thus shifts the focus away from niche to the regime in itself, offering a lens to capture the complexity and politics of change in regimes, independent of the niche processes (Smith and Stirling, 2010). Several chapters in this thesis (chapters 4 and 5) contribute to this line of understanding of transformation, but with a particular focus in Global South and incorporating insights from other definitions of the term.

Recent studies show that regimes in Global South are rapidly transforming, in which transformation is mostly defined through terms like ‘wider’, ‘societal’, ‘gradual’, ‘large scale’ ‘structural change’ processes (Sengers et al., 2016; Raven et al., 2017; Wieczorek, 2018). In such mobilisations of the term, the meaning of the term remains abstract, open for interpretation and makes it difficult to identify what counts as transformation and what doesn’t. Such broad definitions of the term are abundant within and beyond academia. The Intergovernmental Panel for Climate Change (IPCC) for instance, defines transformation as “The altering of fundamental attributes of a system (including value systems; regulatory, legislative, or bureaucratic regimes; financial institutions; and technological or biological systems).” (IPCC, 2012: 3). One could question: how much (or what kind) of altering of those attributes would qualify as “transformation”. The World Social Science Report (UNESCO, 2013) also talks about “urgent and fundamental social transformation”. The idea of ‘fundamental change’ is repeatedly associated with transformation, indicating more profound changes in social, techno-economic, ecological, organisational, political and institutional structures (Walker et al., 2004; Markard, 2011; O’Brien, 2012). Complementing the idea of fundamental change with an emphasis on structural change

does not help in answering the question: transformation of what? In the introduction of the special issue titled “Advancing sustainable urban transformations”, McCormick et al., (2013: 1) call for a better understanding of “structural transformation processes - multi-dimensional and radical change - that can effectively direct urban development towards ambitious sustainability goals”. IPCC (2012) suggest that “Actions that range from incremental steps to *transformational* changes are essential for reducing risk from climate extremes.” (p.18). These statements help to visualise where transformations can lead us to. At the same time, in a world where social and economic injustices and inequalities are rampant, combating climate change is rather a limiting ambition for transformative change. These discussions on transformations still don’t answer the question of transformation of what. In the context of the work of the Transformative Innovation Policy Consortium, members of the consortium referred to transformation as “changes in the research system; industry structures; a move to a resource economy; shifts in exclusion patterns; or the integration of the informal economy into the innovation system.” (Schot et al., 2018: 6). In an urban context, transformation might mean a shift towards new urban infrastructure for meeting basic needs and basic human rights (Williams, 2000; McCormick et al., 2013; Patterson et al., 2016; Frantzeskaki et al., 2017) or changes in politics and lifestyles by “construction of a new life and urban persona” (Harvey, 2003: 4; Scoones et al., 2015). Following these different perspectives of understanding transformations and focussing on Global South, I want to understand transformation with a certain degree of clarity about questions like what is transforming, how can transformation happen and why transform at all.

An important aspect of thinking about transformation is to appreciate the underlying normativity attached to the term. In order to avoid transformation that is undesirable, Holscher et al., (2018) argue that ‘human agency’ characterised by motivation, cognition and emotions are crucial factors in formulating governance frameworks and interventions that are meant to be transformative (O’Brien, 2012; Olsson et al., 2014). Goals and visions for transformation are led by these human motivations and cognitions, who set the rationales and justifications for change. At the core of transformation and transformative change is, therefore, the “vision of doing things differently to achieve radically different outcomes, ...that inspires hope for breaking the vicious circle of poverty, inequality and environmental destruction confronting people and the planet.” (UNRISD, 2016: 3). The latter part of this statement attaches normativity to the term transformation, which is also crucial for transformative innovation policy (Schot and Steinmueller, 2018). Innovation policies which are transformation oriented may focus on asking normative questions about the desirability of specific directions of socio-technical change (Weber and Rohracher, 2012). These directions can be diverse and multifaceted, and therefore

transformation entails considering multiple voices, which makes the inherent politics of change explicit in the discourses and actions towards transformations (Stirling, 2008; Leach et al., 2010). In other words, transformations need to embrace ‘plurality’ in options, directions and pathways (Stirling, 2011: 87). Studies mobilising the term socio-technical transformations advocate this plurality through emphasising collective learning and participatory decision-making processes in order to achieve long-term radical structural change (Grunwald, 2017; Smith and Stirling, 2010; Byrne et al., 2011; Panebianco and Pahl-Wostl, 2006).

Transformation, as a term, is widespread and gaining momentum even beyond academic publications. Global initiatives like STEPS (Social, Technological and Environmental Pathways to Sustainability) [<https://steps-centre.org/>], TIPC (Transformative Innovation Policy Consortium) [tipconsortium.net], Future Earth transformations [www.futureearth.org/future-earth-transformations] showcase the acceptance and ever-increasing importance of the concept in addressing sustainability issues in a real-world context. At the same time, buzzwords are prone to misuse and misinterpretation (The Wall Street Journal, 2014). As Foela (2015) puts it, “high conceptual elasticity and lack of empirical grounding of the concept of transformation generate the risk of voiding the term of meaning, and consequently easily co-opted by actors who aim to defend the status quo rather than promoting radical societal change” (p. 377). It is true that transformation as a term is a favourite among policy-makers and practitioners. Indian Prime Minister Narendra Modi, in his keynote speech at World Economic Forum Annual summit in Davos repeatedly emphasised that India is transforming:

“Our present development agenda is based on five pillars. First and foremost, we do understand that our systems need to change. Hence, we are persisting with far-reaching structural reforms. Thus, our first pillar is our mantra of reform, perform and *transform*... Second, we are using Technology to *transform* governance and deliver public entitlements and services.” (The Indian Express, 2018).

Former UNDP Director Helen Clark commented that “Fundamental *transformations* in the way the world lives, works, and does business are needed for building the low carbon, climate resilient, green and inclusive economies and societies of the future.” (UNDP, 2015: *emphasis added*).

Utilising this current momentum and weight of the term to my advantage, while being aware of the dangers of using it in a broad and undefined way, I have mobilised the term transformation in this doctoral thesis in four ways:

1. To empirically demonstrate how some dimensions of the regime are more 'transformable' than others. This has implications on whether the niche experiments can stabilise in mobility systems (Chapter 3).

2. To systematically define change in socio-technical regimes without posing niches and experimentation as central to radical change (towards sustainability). The concept allows looking beyond niche experimentation and nurture change within regimes, faced with unprecedented sustainability challenges (chapters 4 and 5).

3. To appreciate the multi-directionality of change, showing that transformation can be of many kinds, depending on how sustainability is defined and which institutional logics operate in regimes (chapter 2 and 3).

4. To critically engage with the politics of imagining a smart city. Here, the emphasis is on the political aspects of furthering equality and deepening democracy in the deployment of new 'smart' technologies for smart and sustainable futures (Chapter 6).

3. Research questions

This thesis consists of five chapters in the form of independent research articles, each with individual research questions. In this section, I introduce each of these research questions, by briefly stating the motivation to ask such a question. These motivations highlight the common threads that run across all the chapters of the thesis.

In chapter 2 (and first article) of this thesis, the focus is on unpacking the notion of sustainability – in its plurality, asking questions such as sustainability according to whom, where and with what implications. The starting point of this paper is that sustainability transitions literature in the past two decades has black-boxed the notion of sustainability, while exploring niche experimentation processes, searching for new and alternative systems and their ability to drive transitions. The concept of sustainability, however, needs unpacking since it is in fact, multi-faceted and heterogeneous in meaning and is an outcome of negotiations and contestations between different social groups (Walker and Shove, 2007; Eames and McDowell, 2010). The meaning of sustainability is also diverse and varies across geographies, actors, and sectors. This diversity of understandings is often black-boxed, resulting in biases towards

particular options in policies and governance of sustainable socio-technical systems. In an attempt to address this problem, the article develops a pragmatic framework for unpacking the diverse ways in which different actors perceive sustainability across multiple sets of experiments in different national and sectoral contexts.

The research question for this chapter is: How are emerging innovation trajectories for solar PV and urban mobility appraised by various actors under different perspectives in India and Thailand?

Experimentation is presumably done by 'niche actors' who compete with existing regimes. These actors enter into a continuous struggle with incumbent actors, as their innovation experiments challenge established rules of the incumbent regime. In chapter 3 (and second article) of this thesis, the focus is on these niche actors and their niche empowerment strategies. The goal is to understand how these actors navigate tensions emerging from a mismatch with a regime, by stretching and transforming some dimensions of the regime, while at the same time, trying to fit and conform to other dimensions of the regime (Smith and Raven, 2012). This chapter is situated in the strategic niche management literature within sustainability transition studies, from where the concepts of empowerment, fit and conform, stretch and transform niche strategies are borrowed. Mobilising these concepts as theoretical lenses, the chapter analyses empirical cases of four niche experimentation in mobility system in India and Thailand.

The research question for chapter 3 is: How do the actors involved in sustainability experiments navigate the tensions that arise when introducing innovations?

The reliance on niches as sources of change, however, reflects a western bias. Patterns of change originating at niches may be widely observed in contexts, such as Western Europe, the USA and Japan. In Kolkata - a megacity in India, different patterns of change can be observed. Faced by persistent sustainability problems, regime actors in Kolkata are more concerned to improve and upgrade the existing public transportation system, instead of substituting it with alternative 'niche' systems. In Chapter 4 (and third article) of this thesis, the aim is to explore regime transformation as a pathway in between regime optimisation and regime transition pathways. The paper develops a new method for mapping socio-technical change through the change in rules across different regime dimensions (Geels, 2004; Geels and Schot, 2007; Geels and Kemp, 2007). Mobilising this new theoretical framework, the paper maps the changes in a variety of public transport regimes in Kolkata.

The research question for Chapter 4 of this thesis is: How can we analyse different pathways of change in socio-technical regimes comprising public transportation system in Kolkata?

It was evident from researching changes in regimes in Kolkata in chapter 4 that these regimes should not be considered as entirely stable socio-technical configuration, neither are they unstable. In this paper, I focus on understanding the nature of stability of regimes in the Global South. These regimes, characterised by constant internal tensions, informalities, a multiplicity of actors and their values, may be considered 'dynamically stable' (Geels and Schot, 2007), as they constantly change, yet retaining the stability of their configuration in one form or the other. Chapter 5 (and fourth paper) of this thesis delves into exploring the nature of this dynamic stability (and change), using the lens of institutional logics that constitute regimes (Fuenfschilling and Truffer, 2014). Developing a new framework called 'Wheel of Logics', the paper aims to establish different forms of dynamic stability of regimes, shaped by the different institutional logics guiding each regime.

The research question for Chapter 5 is: How can we assess the dynamic stability of regimes in Global South, with the help of institutional logics?

Chapter 6 of (and the fifth paper included in) this thesis concerns the process of urban transformation in India through focussing on the imaginary of a smart city. The concept of socio-technical imaginaries (Jasanoff, 2015) was mobilised in this paper to understand the making of a smart city proposal by New Town Kolkata. The goal was to understand how various actors, especially citizens have played important roles in the process of imagining a smart city. The paper is aimed at critically examining whether imagining a smart city in Kolkata was politically transformative, by distributing benefits among its citizens, democratising the process of constructing the imaginary and allowing citizens' voices to be articulated into the official imaginary.

The research question consequently is: How *distributed, democratic and articulated* was the imagining of the smart city New town Kolkata?

Answering these research questions can help to fulfil the aim of this thesis, which is to offer a critical understanding of socio-technical transitions in the Global South, by carrying out sustainability appraisals of experiments and by developing theoretical frameworks and practical tools for understanding transformation.

4. Research design/methodological approaches

Each chapter in the dissertation elaborates on its methodological approach. Chapters 2 and 3 include multiple cases – four in each chapter. In chapter 2 however the unit of analysis was the stakeholders appraising the sustainability of the experimentation trajectories that emerged in each case. Chapter 3 presents a comparative case study analysis between niche mobility experiments in four different cities in the Global South. The rest of the chapters include single case study analysis, focussing on studying the transformation processes. For chapter 4 and 5, the single case study on mobility system in Kolkata, however, included multiple units of analysis in line with multiple socio-technical regimes comprising the case. For the final chapter, the unit of analysis has been the two drafts of smart city proposal presented by New town Kolkata, in comparison to the National smart city mission guidelines in India. The overall dissertation followed a qualitative case study approach (Yin, 2015) for data collection and analysis.

Empirically, this dissertation can be positioned at the interface of Global South, megacities and mobility. Previous research on sustainability transitions in the Global South suggests that countries need to follow alternative growth models, which are less resource- and pollution-intensive; support and learn from each other through ‘transnational linkages’ and invest in initiatives (experiments) targeting to achieve sustainability (Berkhout et al., 2010; Bai et al., 2010). For the first two chapters in the body of this thesis, we have chosen India and Thailand as lower middle-income and upper middle-income countries respectively for studying sustainability experimentation in developing contexts. Chapter 3 captures different actor strategies in mobility experimentation in cities such as Delhi, Ahmedabad and Bangkok. For chapters 4, 5 and 6 - the megacity of Kolkata was chosen. A variety of public transport regimes dominate the mobility system in Kolkata. Thus, Kolkata's mobility system offers an opportunity to study different pathways of regime change and for understanding different forms of dynamic stability of mobility regimes in the Global South. Focussing on Kolkata in the later chapters also provides an interesting counterpoint to the cities studied in Chapters 2 and 3, by demonstrating transformation within regimes instead of regime destabilisation through niches. For Chapter 6, New town Kolkata was chosen to critically examine whether the making of a smart urban imaginary in India could be considered transformative.

Kolkata is chosen as the megacity in focus for much of this thesis, due to multiple historical and current reasons. Kolkata is one of the largest urban agglomerations in India, coupled with

one of the world's highest population densities (World population review, 2017). It is a former capital of India under colonial rule and has historically witnessed events like the Bengal famine in the 1940s, population influx in 1970s during the independence of Bangladesh, the decline in growth and business since 2000 and end of decades of leftist political rule in 2010 (Bose, 2015). The legacy of British colonial rule is prominent in the city's architecture, infrastructural facilities including road and railways. Narrow and crowded roads, a variety of transport modes on land, rail and water, old and dying systems coupled with new and modern infrastructure, socio-economic and environmental sustainability challenges faced by this mobility system of the city makes it a fascinating case, for studying socio-technical change towards sustainability.

Majority of the dissertation focussed on the socio-technical system of mobility. It is one of the systems that are prone to unsustainability (Morichi and Acharya, 2012; Banister, 2005). It is one of the main contributors to greenhouse gas emission, air and noise pollution in cities. It is also a system that is critical to the livelihood and the standard of living of people of all sections of society, irrespective of gender, class and ethnicity. In contexts such as those of Indian and Thai megacities where income inequality, class and gender-based discrimination are present (Bird et al., 2011; Batra and Reio Jr., 2016), mobility system is a critical case to study transformations, first as a pathway situated in-between regime transitions and regime-optimization, and second, a process that is inclined towards achieving democratization and social inclusion in and through future urban imaginaries. Mobility transition is a well-recognised topic in transitions literature⁴, which predominantly engages with low carbon energy transition in automobility system mostly in European countries like UK, USA and Western Europe (Hoogma et al., 2005; Koehler et al., 2009; Geels, 2012; Geels et al., 2011). In addition, mobility transitions literature also focusses on sharing economy, electrification, aero-mobility, automation and cycling innovations, still very much concentrated in countries in the Global North (Truffer, 2003; Nykvist and Whitmarsh, 2008; Cohen, 2009; Marletto, 2014; Nilsson and Nykvist, 2016; Sovacool, 2017; Hopkins and Schwanen, 2018). The justification for selecting public transportation in an Indian megacity for socio-technical transition study is, therefore, to expose an underexplored empirical-regional context for transitions research, with a clear potential to provide sufficient in-depth evidence of the vulnerabilities and problematic nature of change in public transport systems in these contexts. Even though domination of public transport in the

⁴ A systematic review of the literature applying MLP for studying urban mobility transitions can be found in (Moradi and Vagnoni, 2018)

mobility system can be considered 'unique' to Kolkata in the context of the global trend of rising car ownership in middle-income countries, several aspects of the results from the research like, i) contested and plural meanings of sustainability, ii) nature of change of regime rules and consequent emergence of meta-rules, iii) institutional logics constituting public transport regimes, and iv) inclusion/democratization in the politics of imagining smart cities - are relevant to megacities across the Global South and perhaps also in the Global North.

The data analysed in chapters of this thesis are collected in three phases:

i) Stakeholder workshops in Kolkata (India) on November 2013 and in Chiang Mai (Thailand) on May 2014.⁵

ii) Fieldwork in Kolkata phase I: October 2015- January 2016

iii) Fieldwork in Kolkata phase II: November 2016 – January 2017

Much of the first phase of fieldwork in Kolkata was dedicated to scoping for interviews and in attempts to gain access to official documents. In this phase, interviews in semi-structured and often in an unstructured format were conducted to understand the points of concerns, things that are "of central significance to" the interviewees (Bell, 2014: 182). The interviewees ranged from being academics, government officials, urban planners and police officials to transport operators, consultants, union leaders and commuters. The second phase of fieldwork included fresh as well as repeat interviews, field visits and focus group discussions. Across these two phases, I conducted 48 in-depth semi-structured interviews, out of which 31 were audio-recorded, while notes were taken for other interviews due to lack of consent to recording. There were further informal and shorter conversations with experts, academics and daily commuters – which were transcribed during and/or immediately after the interaction. In addition to one-to-one interviewees, two focus-group discussions were held - each with around 20 women and children from lower income group at an NGO based in South Kolkata.

During the fieldwork, I have also gained access to official reports and documents – often in hard copies which I read and scanned selected pages with prior permission from the officials.

⁵ This fieldwork was conducted within the scope of the NWO/WOTRO project on Sustainability experimentation in Asia. Project number W 01.65.330.00. For more information see <http://www.nwo.nl/onderzoek-en-resultaten/onder-zoeksprojecten/75/2300159375.html> and <http://www.sustainabilityexperimentsasia.org/Home.html>. The data was analysed and presented in the paper within the scope of the PhD programme. For other related outputs from this research project, see Ghosh (2014), Wieczorek et al. (2015), Sengers (2016) and Jolly (2016).

Detailed project reports (DPRs) for all the metro expansion projects, preliminary survey and engineering reports, government notifications, books detailing West Bengal Motor Vehicles Act, reports containing proposals for entering “Smart city challenge” are some of the examples of accessed documents. Other historic reports accessed (and taking notes from hard archival copies) include: “Perspective plan for Calcutta 2011” (1990), The Calcutta Metro: Design and Construction (1991), “Master Plan for Traffic and Transportation in Calcutta Metropolitan Area” (1994), “Vision 2025: Perspective Plan for CMA” (2001), Study to Improve Ridership on Kolkata Metro (2005), Comprehensive Mobility Plan for Kolkata (2008) and a few others. Many of these reports were not directly used as sources for the empirical analyses but served as background material that was helpful in the interpretation of new rules, logic and imaginaries. This is because quantitative and qualitative data and narratives of these reports proved to be useful for understanding the current regime, future projections, scope and limitations of various policies/infrastructure development projects in Kolkata. Field visits were conducted to a particular resettlement area for urban poor with the help of a local NGO. Interaction with men and women in the area helped in understanding their mobility patterns, main concerns regarding mobility and the sustainability problems that they face. Statistical data is also collected for sub-urban rail, metro, bus and tram services from respective organisations. The most common type of data received for all these modes of transport are earning per kilometre (EPKM) and passenger growth over time. These data are valuable since they showcase the relative importance of the mode(s) of transport in terms of usage and economic sustainability of the service provision, therefore giving a clear sense of the current regime.

The data collected during fieldwork are stored and managed in the qualitative data analysis software, NVivo (Bazeley and Jackson, 2013). Figure 2 is a screenshot of the NVivo interface where the data was categorised under different types of sources and separated in different ‘nodes’ and ‘cases’. This exercise of sorting the data in different categories, following early conceptualisations of theoretical lenses such as technological trajectories and institutional logics offered a preliminary method of cleaning and digesting the data, before moving to in-depth interpretative analysis (Denzin and Lincoln, 1994).

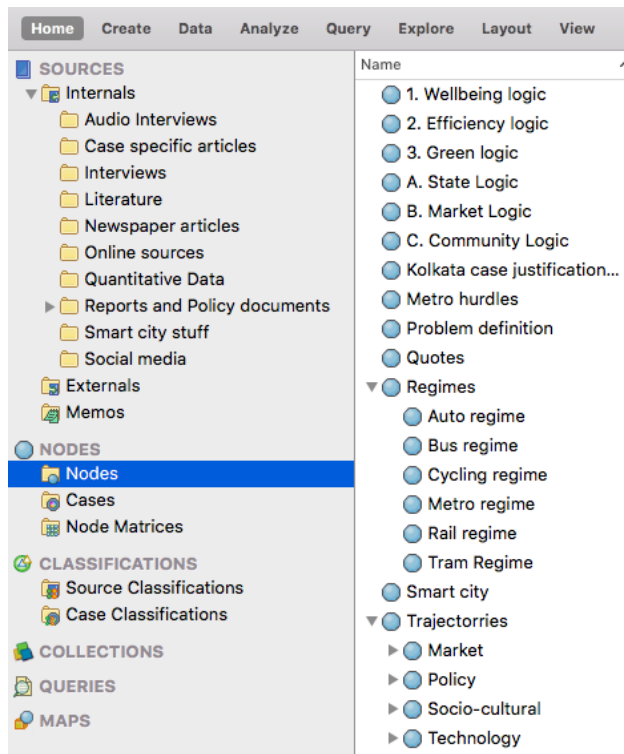


Figure 2. NVivo software interface screenshot taken on 18th June 2018

Multi-criteria mapping – a hybrid quantitative, qualitative tool was used for data collection, recording and analysis for chapter 2 (Coburn and Stirling, 2016). The tool provides a unique opportunity to combine quantitative scores, weights assigned to options, criteria with qualitative explanations about the justification of each number assigned. Following the application of this method, several graphs comparing the outputs from multiple cases were produced in Microsoft Excel.

Majority of this thesis is written with a pragmatic epistemological approach to science which justifies the use of mixed methods, and interpretation of data and results (Tashakkori and Teddlie, 1998: 28). The final chapter in the body of this thesis uses critical discourse analysis for illustrating whether the smart city imaginary of New town Kolkata was politically transformative. Critical discourse analysis treats texts as words (and language) embedded in their context (Chiapello and Fairclough, 2002). It draws attention to partial interests, inequalities and contestations that may be hidden through the use of specific words and phrases. In this way, discourse analysis is geared toward revealing the hidden relations of power, such as those of exclusion, which are constitutive of (public policy) texts (Woodside-Jiron, 2004).

5. Contributions

The thesis offers new conceptual and methodological insights for sustainability transitions in megacities by emphasising transformations beyond experimentation. In this section, I attempt to discuss these possible contributions, while trying to locate them in a spectrum between conceptual and empirical, as well as a scale between more and less context-specificity of each of the contributions.

A. Understanding of diversity and plurality in meanings of sustainability for transitions scholarship in the Global South

The way sustainability transitions are governed, is determined by what socio-technical options are available, who decides what is sustainable, how and in what geographical context. By investigating these questions, chapter 2 of this thesis offers a clear understanding of the diversity and plurality in the meaning of sustainability in different contexts. The theoretical contribution is towards socio-technical transitions - particularly sustainability experimentation literature which focusses on experiments with niche innovations – black-boxing the subjectivity, ambiguities and uncertainties associated with the sustainability of these innovations. The theoretical framework developed for appreciating ‘performance diversity’, ‘appraisal diversity’, ‘sectoral diversity’ and ‘geographical diversity’ in Chapter 2 highlights the fact that what sustainability means, how it should be assessed, and with what kind of implications, is very much context-dependent. Moreover, this context is not only sectoral (energy or mobility) and geographical (India or Thailand) but also based on relative sustainability performance (of innovation trajectories) and appraisals (of different actor perspectives). Empirically illustrating these theoretical claims, the chapter shows that whether the appraisal is on mobility or solar energy experiments, whether these experiments are happening in India or Thailand - makes a substantial difference in how individual experts, stakeholders and/or social groups perceive sustainability and assess relative potential of the various experimentation trajectories. An online reflexive tool called multi-criteria mapping (MCM) is applied for appraising sustainability of experimentation trajectories. This innovative hybrid qualitative/quantitative methodology allowed an empirically grounded, rigorous understanding of sustainability in the settings of stakeholder workshops (Coburn and Stirling, 2016). The novelty of the new methodological approach lies in the fact that it challenges conventional methods like integrated assessment - conveniently offering a clean and objective picture of a ‘best’ or ‘worst’ technological option.

Such diverse understandings of sustainability are later mobilised in chapter 5 of this thesis, where three different sustainability values are proposed as components of ideal-type institutional logics. These sustainability values, namely well-being, efficiency and green are defined in this chapter using multiple criteria proposed by practitioners in India as well as the Global Mobility report (2017). This chapter shows that regime transformations can happen in multiple directions, depending on the sustainability values held by actors. Moreover, the directions are influenced by the unequal distribution of power. Under such conditions, the implication of a non-reflexive and homogenous understanding of sustainability (showing a uni-directional path), perceived by and biased towards privilege social and economic groups is problematic for India's vision for urban transformation. The political process of imagining a smart and sustainable future is investigated in Chapter 6, where 'smart city' as a socio-technical imaginary is scrutinised (with the eventual aim of contributing to alternatives to technocratic visions of the future). Contrary to the insights from chapter 2, a partial understanding of sustainability seemed to be guiding the vision of the smart city, where the needs, preferences and well-being of poor and marginalised groups were not fully articulated in the imaginary. Chapter 5 and 6, therefore, complement the contributions from chapter 2, by showing directionalities of change in public transport regimes and by suggesting constructive ways of accepting diversity in imagining smart and sustainable future.

Overall Chapters 2, 5 and 6 contribute to an important line of research that cautions against attaching a singular and objective status to sustainability in transitions studies in the Global South.

B. Understanding of regime transformation in a non-western context

One of the core contributions of this thesis is the analysis of regimes, challenging the western bias in the understanding of the concept of a regime - their stabilisation and change processes in transitions literature. Majority of transitions theories have been developed based on case studies in specific contexts, such as Western Europe, the USA and Japan. The patterns of change observed in these contexts are referred to as 'western', even though other terms like 'Global North', 'developed countries' are in use too. Contexts, where socio-technical systems and their change patterns are different from that of the Western context, is therefore named 'non-western', 'Global South' or 'developing' contexts, irrespective of its geographical location. This thesis investigates such a 'non-western' context – the megacity of Kolkata, where there is

different nature of regime stability, influence of social inequality, poverty, informalities in regime operations, and multiple pathways of regime change. Most interestingly, the dominance of public transportation in mobility system of Kolkata provides a different starting point for transition analysis, compared to the dominance of private automobility in the West. Chapter 4 of this thesis rests on the premise that efforts for expanding, modernising and improving the existing public transport system in a city in order to address sustainability issues should be considered to be of no less importance than a transition to a new alternative system. Such efforts should perhaps not be overlooked by the transition scholars as just optimising effort of the existing old-fashioned and outdated regimes. Thus, the concept of regime transformation is mobilised to represent changes in between regime optimisation and regime transition. Even though regime transformation has been conceptualised as a pathway of transition in existing literature, the novelty of the paper included as Chapter 4 of this thesis lies in the fact that it offers a systemic way of mapping the different pathways of change through using concepts that constitute evolutionary and institutional foundations of the regime concept.

The new mapping tool developed in Chapter 4 is a methodological contribution of this doctoral thesis. The tool involves a “mapping change” exercise in a table with different regime dimensions (as row headers) and different types of regime rules (as column headers), along with qualitative descriptions justifying each change mapped in the table. Such an exercise allows recognising the pathway of change for each regime, based on thresholds set to define regime optimisation, regime transformation and regime transition. This is also a fundamental theoretical contribution towards transitions literature, by providing a nuanced understanding of regime change as well as a systematic way of executing a regime change analysis that is missing in socio-technical transitions literature.

An interest in understanding the transformation of regimes led me to rethink the notion of regime stability. Regimes, in transition theory, are considered as inherently stable socio-technical configurations, while some transition scholars marked regimes in the Global South as unstable. I argued that under conditions where regimes are continually transforming, regimes might be considered dynamically stable. Chapter 5 contributes towards a better understanding of the nature of dynamic stability of regimes in Global South, moving beyond the debate around whether a regime is stable or unstable. Since stability and change share a dialectic relationship (Koehler et al., 2017), three types of dynamic stability (ordered, directed and fragmented) are considered, related to single-ordered, multi-ordered and switching -ordered transformation – each proposed using a newly developed framework of institutional logics. This new framework

– “Wheel of Logics” – depicts nine ideal type institutional logics that constitute the composition of a socio-technical regime. This framework is a crucial theoretical contribution towards transitions literature, as it draws from the institutional logics literature and showcases combinations of institutional orders and sustainability values that are relevant for studying transitions in the socio-technical system of mobility. Despite the focus on the regime and its transformation in the majority of this thesis, Chapter 3 of this thesis illustrates the niche actor's strategies to ‘empower’ their innovations. One such strategy is to ‘stretch-and-transform’ the regime, which means altering the selection environment in favour of the niche. As a contribution to the theory of niche empowerment in Strategic Niche management literature, this chapter shows that niche actors prefer to ‘stretch and transform’ some dimensions of a regime, while ‘fit and conform’ to other dimensions. These results have significant policy implications for designing future experiments and future strategies undertaken by niche actors in the particular city contexts. Through this chapter, the thesis has a significant empirical contribution for the cities of Delhi, Ahmedabad and Bangkok.

Overall, chapters 3, 4 and 5 contribute theoretically and empirically towards an understanding of regime transformation – which I argue to be a central concept to explain the socio-technical change in non-western/Global South contexts.

C. Understanding politically transformative change in Global South contexts

Change that can be considered transformative can never be straightforward and apolitical. While the chapters focussing on the concept of regime captures the mechanisms of socio-technical change, several chapters in this thesis contribute towards an understanding of transformation as a process that is almost inherently political. A direct contribution of this thesis towards understanding the deeply political nature of urban transformations in Global South is through Chapter 6, which analyses the proposal for smart city put forward by New Town Kolkata to understand whether this smart city imaginary can be considered *politically transformative*. The theoretical contribution towards smart cities literature through this chapter lies in the fact that the paper presents a framework consisting of three aspects which will help to rethink the concept of smart in normative terms – to be politically transformative. These aspects cover grounds to ensure that a politically transformative change is socially inclusive by reducing prevailing socio-economic inequalities and minimising the concentration of power in the hands of the few. The critical discourse analysis in the paper stays close to the empirical case study as it carefully assesses multiple participatory forums/techniques used in the construction of an

ostensibly people-centred and socially-inclusive smart imaginary. This chapter, therefore, backs a significant empirical contribution of this thesis - suggesting urban policy-makers to adopt a decision-making process that *opens up* to include a wide diversity of voices and interests, including those of the most marginalised.

The empirical contribution in chapter 6 can, in fact, be traced back to the contributions of Chapter 2. Appraisal of sustainability by diverse actors, across different sectors and geographical contexts brings to the fore the politics of governing sustainability transitions. Even though Chapter 2 does not directly discuss transformative change, the call for appreciating the diverse meanings of sustainability embodies the principle of political transformation. The paper builds on the criticism of political preferences of closing down debates around sustainability, thereby contributing towards envisioning sustainable futures that are transformative in a normative sense. Such politically transformative change inevitably requires the involvement of a wide range of stakeholders in appreciating sustainability and the inclusion of the most marginalised voices in imagining sustainable futures. Building on this, Chapter 6 investigates how diverse voices were articulated in the making of imaginaries for urban sustainability transformations. Thus, Chapters 2 and 6 together contribute towards the democratization of sustainability transformations through the inclusion of diverse voices and interests, and by holding to account the stakeholders in-charge of imagining, designing and implementing policy instruments (including those implicated in organising the forums and techniques for democratic participation by a wider, more diverse range of voices and interests).

While chapter 2 and 6 focus on the question of what could be a politically transformative change towards sustainability, chapter 3 of this thesis highlights the constraints in bringing about such change. The chapter shows that niche innovators find it too risky to stretch and transform the 'public policy and political power' dimensions of regimes. In most cases, the niche experiments conform to existing power and political dynamics. This chapter contributes towards a better understanding of the empirical contexts where niche actors fall short of enabling politically transformative change.

Overall, Chapter 2, 3 and 6 make a substantial contribution towards an understanding of politically transformative change in Global South contexts.

These three substantial contributions from the thesis can be mapped in figure 3 - visualising the combinations of chapters that together support each of the substantial contributions. The figure below offers this visual representation. The diagram also suggests that the three

contributions are not mutually exclusive. There are overlaps between all the contribution through the mobilisation of the concepts of sustainability, non-western, transformation and experimentation.

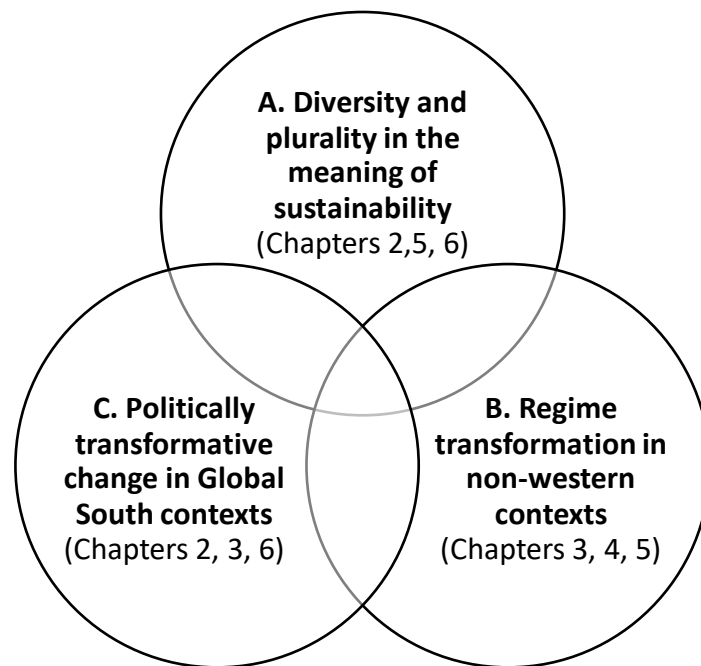


Figure 3. Visualising thesis contributions

6. Structure and outline of the thesis

Table 1. Summary of each chapter that constitutes the body of this thesis.

Building blocks	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6
Title	Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand	Urban mobility experiments in India and Thailand	Mapping socio-technical change in mobility regimes: The case of Kolkata	The “Wheel of Logics”: Towards conceptualising dynamic stability of regimes in the Global South	Smart as politically transformative? An analysis of ‘smart city’ socio-technical imaginary in an Indian megacity
Aim of research	Unpacking the diverse ways in which various actors perceive sustainability across various sets of experiments, in different national and sectoral contexts.	Understanding the strategies that niche actors deploy to navigate the challenges posed by incumbent socio-technical regimes.	Mapping different pathways of regime change within mobility regimes through the change in regime rules.	Assessing different forms of dynamic stability of regimes, and different ways of transformation in regimes through shifting combinations of logics in a regime.	Analyse the process of constructing a socio-technical imaginary of smart transformation in parts of megacity Kolkata, in order to understand whether it is politically transformative.
Research question	How are emerging innovation trajectories for solar PV and urban	How do the actors involved in experiments navigate the tensions that arise when introducing such innovations?	How can we analyse different pathways of change in socio-technical regimes comprising public	How can we assess the dynamic stability of regimes in the Global South?	How <i>distributed, democratic and articulated</i> was the imagining of the smart city New town Kolkata?

	mobility appraised by various actors under different perspectives in India and Thailand?		transportation system in Kolkata?		
Literature	Governance of sustainability transitions; debates on definition and appraisal of sustainability	Strategic niche management – Niche empowerment strategies; Regime dimensions	Evolutionary and institutional origins of regime concept; socio-technical regime and rules; Regime transition pathways	Regime stability in Global South context; Institutional logics, Institutional orders and sustainability values	Discourses on smart city and smart mobility
Case study	<p>Solar PV experimentation in India,</p> <p>Solar PV experimentation in Thailand,</p> <p>Urban mobility experimentation in India,</p> <p>Urban mobility experimentation in Thailand.</p>	<p>1. Electric rickshaws in New Delhi</p> <p>2. Motorcycle taxi-meters in Bangkok</p> <p>3. Bus Rapid Transit (BRT) systems in Ahmedabad</p> <p>4. Bus Rapid Transit (BRT) systems in Bangkok.</p>	<p>Public transport regimes in Kolkata:</p> <p>1. Metro</p> <p>2. Tram</p> <p>3. Ferry</p> <p>4. Cycle-rickshaws</p> <p>5. State bus</p> <p>6. Auto-rickshaw</p> <p>7. Taxi</p> <p>8. Cycling</p>	<p>Three public transport regimes in Kolkata</p> <p>1. Metro</p> <p>2. Auto-rickshaw</p> <p>3. Cycling</p>	<p>New Town Kolkata smart city proposal (two drafts) – in comparison with India's national smart city mission guidelines</p>

Contribution	Opening the black-box of (the meanings of) sustainability in transitions literature.	Understanding niche actors' strategies to empower their innovations and experiments in niches and how such strategies differ across different regime dimensions.	A nuanced understanding of different pathways of regime transition in non-western context; a tool to map changes within regimes, by mobilising the rules concept	Understanding of dynamic stability of regimes in the Global South; A novel framework of institutional logics	Bringing the politics of the process of collective imagining to the fore; showing that the more or less democratic process of imagining influences what official socio-technical imaginary is produced
Dissemination/ outreach	Published in Sustainability Science, June 2017; Presented at INOGOV workshop, Helsinki Finland in February 2015.	Published in "The Experimental City" by Routledge in 2016	Best paper award at INGENIO PhDays, Valencia, May 2018; Conference proceedings, IST conference, Manchester, June 2018; Resubmitted to Energy Research and Social science journal; Published in SPRU working paper series	Presented at SPRU Wednesday seminar, December 2017; SPRU Forum June 2018; Submitted to Environmental Innovation and Societal Transitions journal	Presented at Association of American Geographers (AAG) Annual Meeting, Boston, April 2017; Global South Conference, University of Cambridge, July 2017; SPRU Forum June 2018; Under review for STEPS working paper series

7. Declaration on contribution

The five papers constituting the body of this thesis is produced together with supervisors and several other co-authors. Below I detail my contribution in each paper- included as chapters in this thesis.

The paper “Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand” was an output of the NWO-WOTRO project on sustainability experimentation in Asian context⁶. In the capacity of research assistant in the project for two years, I was engaged in the preliminary data collection and creation of a database of more than three hundred sustainability experiments across two countries. Building on this desk-based research, I was also involved in and co-facilitated stakeholder engagement workshops in two countries - which was the primary source for data analysis in the paper. In the course of writing this paper, I was responsible for cleaning, processing, interpreting and visually representing the stakeholder inputs – which forms the core of the empirical section of the paper. I have written and amended several drafts of the empirical section, based on co-authors’ feedback and provided extensive feedback to co-authors in several phases of writing the theoretical and methodological sections. In initial discussions, I have suggested ideas for the overall design of the study. My doctoral work also includes responding to reviewers’ comments from the journal and extensive revisions of the text and diagrams based on the comments.

In the book chapter “Urban mobility experiments in India and Thailand”, I was responsible for analysing and writing up an empirical case study included in the chapter. I also contributed to the discussion on the theoretical framework, co-ordinated with co-authors of three other case studies to ensure symmetry and coherence in the narratives and provided feedback on all other sections of the chapter within the scope of the doctoral programme.

The article “Mapping socio-technical change in mobility regimes: The case of Kolkata” is conceived and co-authored with one of my PhD supervisors within the scope of the doctoral programme. My work for this paper included data collection, analysis and writing most of the sections of the paper. My co-author suggested the theoretical concepts and helped in

⁶ NWO/WOTRO project number W 01.65.330.00. For more information see <http://www.nwo.nl/onderzoek-en-resultaten/onder-zoeksprojecten/75/2300159375.html> and <http://www.sustainabilityexperimentsasia.org/Home.html>

interpreting the data, alongside providing extensive comments through track changes to refine arguments and improved the write-up of numerous early drafts of the paper. We submitted the paper to a journal, and I am the corresponding author. We received peer review comments, and I have written the majority of the responses to reviewer's comments. The doctoral work also included substantial revision of the manuscript (to the version included in this thesis), based on the comments.

The chapter titled “The “Wheel of Logics”: Towards conceptualising dynamic stability of regimes in the Global South” is also conceived and written by me, with the guidance of both supervisors. This is a solo-authored paper, and my work on this paper includes reviewing relevant literature, developing the theoretical framework, data collection, analysis, interpretation and drawing conclusions. Supervisors helped in streamlining and strengthening the arguments and overall flow of the paper through extensive comments, and feedback on successive drafts.

The paper “Smart as politically transformative? An analysis of ‘smart city’ socio-technical imaginary in an Indian megacity” is also produced entirely within the scope of the doctoral programme and co-authored with one of my PhD supervisors. For this paper, I have collected data, analysed, wrote and revised several drafts of the paper, based on comments through track changes and revisions in-text by the co-author. The theoretical framework used in the paper is inspired by a blog by the co-author (Arora, 2016). He also helped in strengthening the arguments by revising and suggesting improvements to the overall structure, style and content of the paper.

The table below holds a visual account of the contributions by the PhD candidate in each of the chapters.

Table 2. An account of contribution by the PhD candidate in each of the chapters.

	Design of the study/ chapter	Literature review (+ framework)	Data collection	Data analysis	Interpretation of results	Writing main text	Corrections and feedback
Chapter 1. Introduction	X	X	N/A	N/A	N/A	X	
Chapter 2: Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand	X		X	X	X	X	X
Chapter 3: Urban mobility experiments in India and Thailand			X	X	X	X	X
Chapter 4: Mapping socio-technical change in mobility regimes: The case of Kolkata	X	X	X	X	X	X	
Chapter 5: The “Wheel of Logics”: Towards conceptualising dynamic stability of regimes in the Global South	X	X	X	X	X	X	
Chapter 6: Smart as politically transformative? An analysis of ‘smart city’ socio-technical imaginary in an Indian megacity	X	X	X	X	X	X	
Chapter 7. Epilogue	X	N/A	N/A	N/A	N/A	X	

N/A = Not applicable

Chapter 2.

Unpacking sustainabilities in diverse transition contexts:

Solar photovoltaic and urban mobility experiments in India and Thailand

(Paper I)

Rob Raven¹, Bipashyee Ghosh², Anna Wieczorek³, Andy Stirling², Duke Ghosh⁴,
Suyash Jolly³, Eakanut Karjangtimapron⁵, Sidtinat Prabudhanitisarn⁵, Joyashree Roy⁴,
Somporn Sangawongse⁵, Frans Sengers¹

¹ Utrecht University, Copernicus Institute, Netherlands

² Science Policy Research Unit, University of Sussex, UK

³ Eindhoven University of Technology, School of Innovation Sciences, Netherlands

⁴ Global Change Programme, Jadavpur University, India

⁵ Sustainable Land Use and Natural Resource Management Program, Chiang Mai
University, Thailand

Abstract

It is generally accepted that the concept of sustainability is not straightforward, but is subject to ongoing ambiguities, uncertainties and contestations. Yet literature on sustainability transitions has so far only engaged in limited ways with the resulting tough questions around what sustainability means, to whom and in which contexts. This paper makes a contribution to this debate by unpacking sustainability in India and Thailand in the context of solar photovoltaic and urban mobility experimentation. Building on a database of sustainability experiments and multicriteria mapping techniques applied in two workshops, the paper concludes that sustainability transition scholarship and associated governance strategies must engage with such questions in at least three important ways. First, there is a need for extreme caution in assuming any objective status for the sustainability of innovations, and for greater reflection on the normative implications of case study choices. Second, sustainability transition scholarship and governance must engage more with the unpacking of uncertainties and diverse possible socio-technical configurations even within (apparently) singular technological fields. Third, sustainability transition scholarship must be more explicit and reflective about the specific geographical contexts within which the sustainability of experimentation is addressed.

Keywords:

Sustainability, Transitions, Multicriteria mapping, Appraisal, Experiment, Asia

1. Introduction

Sustainability transitions is a growing field of research (Markard et al. 2012; Chappin and Ligtoet, 2014). This literature argues for sustainability experiments (Sengers et al., 2017; Farrelly and Brown, 2011; Kemp et al., 1998) as key alternatives to incumbent, unsustainable systems. Experiments constitute emerging innovation trajectories, which, in turn, can shape broader development pathways (Berkhout et al., 2009; 2010; Rock et al., 2009). As such, experiments are considered instrumental in large-scale transformation of unsustainable

systems currently providing human needs such as energy, health or mobility. Such a transformation denotes not only technological but also societal change; hence, the transformation of systems towards sustainability is often referred to as socio-technical systems innovation, or sustainability transition. It is increasingly argued that sustainability experiments may play particularly important roles in 'emerging economies' in achieving socio-economic development with minimal adverse impact on the environment (Berkhout et al., 2010; Wieczorek et al., 2015).

The various models developed to better understand the way in which transitions unfold, such as the multi-level perspective (Rip and Kemp, 1998; Geels, 2002; Smith et al., 2010) make useful contributions to understandings of the process of radical change in general, but they have been criticised for underplaying the evidently political underpinning of sustainable development in general (Scrase and Smith, 2009; Kern, 2010) and experimentation in particular (Smith and Raven, 2012; Raven et al., 2016). The argument is that sustainability is not a neutral exogenous feature in transition processes, simply to be assumed as self-evident or objective. Instead, sustainability is the outcome of negotiations and contestations across plural social interests and involving contrasting power relations in decision-making processes (Walker and Shove, 2007; Voss et al., 2006; Leach et al., 2010; McDowall and Eames, 2007; Eames and McDowall, 2010; Smith, 2007; Smith and Stirling, 2010; Swilling and Anneck, 2012; Newig et al., 2007). Also, at times sustainability is an instrument strategically chosen by decision makers in any highly contested negotiation process. This matters in particular in situations where there is a multitude of innovation options available to decision makers, because they have to decide which options to support in what ways, and which to ignore.

Taking these debates on sustainability and diversity in approaches and motivations seriously has major implications for the governance of sustainability transitions (Smith et al., 2005; Loorbach, 2010). Rather than simply assuming a priori some technological options to be sustainable, or seeking single objective rankings of 'the best', 'most sustainable' or 'economically most efficient' technological solutions, transition governance requires decision making in the context of multiple, often diverging appraisals of socio-technical options (Stirling, 2011; Smith and Stirling, 2007).

It is quite a challenge to those involved in decision making for governing sustainability transitions, and thus for those involved in niche experimentation. For decision makers, the challenge is how to decide which options to support given the legitimate need for economic development that is socially just and within ecological safe limits? Indeed, a popular perception

is that economic development and ecological impacts are in conflict and future developmental choices are uncertain. How can we orchestrate fair decision making on these issues in the light of political economies that prioritise some options over others?

This paper aims to make a contribution to this debate through analysis of the diverse ways in which different actors in different contexts appraise sustainability of niche experiments. The empirical analysis covers two national contexts (India and Thailand) and two sectoral contexts fields (solar photovoltaic (solar PV) and urban mobility). The paper develops a pragmatic framework to map a number of different kinds of diversity relating to sustainability transitions—in terms of the performance of experiments, the appraisal of these experiments by different social groups and individuals, the different sectors and the different national contexts. The research question is formulated as follows: How are emerging innovation trajectories for solar PV and urban mobility appraised by various actors under different perspectives in India and Thailand?

The paper is structured as follows. Section 2 discusses the relevance of diversity in sustainability transitions as well as the analytical approach in this paper. Section 3 discusses the background and methods for our empirical work. Section 4 presents results. Section 5 discusses and concludes.

2. Diversity and governance in sustainability transitions

Diversity is an important facet in the governance of sustainability transitions (Stirling, 2011; White and Stirling, 2013). Diversity in possible options/trajectories for sustainability transition can offer benefits in the capacity to adapt in the face of future uncertainties and unexpected developments. By avoiding ‘betting on one horse’, but instead maintaining multiple differing socio-technical variants, a given socio-technical system can improve its capacity to deal with future shocks. Diversity is also seen to matter in terms of improving competition and shaping effective innovation processes, as well as in developing socio-technical systems in such a way that they are better tailored to the variety of spatial conditions present in different regions, communities, countries or other kinds of contexts. Finally, diversity is also argued to be important in sustainability transitions as a way to navigate—and potentially accommodate—

complex and plural social and economic interests that may be irreconcilable in other ways (Stirling, 2010).

Maintaining a balanced variety of disparate innovation options is thus considered an important condition in the governance of sustainability transitions. Yet the notion of sustainability itself is not a straightforward concept, but subject to ongoing ambiguities, uncertainties and contestations (Voss et al., 2007; Meadowcroft, 2007; Hugé et al., 2013; Stirling, 2010). This presents decision makers engaged to decide which innovations to support (or not) with a challenge, because there are no universally supported environmental, economic and social sustainability goals that can apply to any given context. Such aims and priorities are deeply connected to contrasting cognitive understandings, value positions and social interests (Shove and Walker, 2007). Limited knowledge and uncertainty about future relationships between society, technology and nature also complicate present decision making about which niche experiments to support and which not. What may be perceived as appropriate at some point in time within a given, but inherently limited set of knowledge about future environmental, social and economic implications, may turn out to be rather unsustainable when new relationships and implications are later on uncovered. The above implies that the governance of sustainability transitions is a deeply political and complex, controversial process, because appraisal of the diverse range of innovations is not a straightforward, singular process. Social learning and engagement of diverse groups in society in decision-making processes is, therefore, crucial in these processes.

Very few studies have paused to investigate empirically the diversity in sustainability transitions articulated around various experiments competing for political and societal attention and resources, across a diverse set of sectoral and geographical contexts. Smith (2007), for instance, has demonstrated how the meanings and understandings of what is considered sustainable changed and diversified when eco-housing and organic farming experimentation grew out of their initial grassroots niches to become part of incumbent socio-technical regimes. A notable exception is also provided by Eames and McDowall (2010) and McDowall and Eames (2007). Building upon pioneering work by Truffer et al. (2008), they report on experiences with a comprehensive approach using visioning techniques, workshops and multicriteria mapping, to envision and assess various pathways towards a hydrogen economy. More generally, the current

paper is positioned in sustainability assessment literature, for which different analytical frameworks have been proposed, and critically reviewed in earlier work (Stirling, 1999; 2006).⁷

It is against this background that the ambition and main contribution of this paper are to contribute to this lively debate by unpacking empirically how the notion of sustainability is perceived in the context of experimentation in developing countries. Our approach is similar to that developed by Eames and McDowall (2010), though different in some of its theoretical assumptions.⁸ Moreover, the work is situated in emerging Asian economies, with a particular focus on solar PV and urban mobility experimentation in India and Thailand, whilst the existing transitions work is mostly located in well-developed economies (Berkhout et al., 2010; Wieczorek et al., 2015). These cases and countries were chosen, because solar PV and sustainable urban mobility are receiving major policy attention in both the countries, whilst India and Thailand represent both a lower middle-income and an upper middle-income country, respectively.

As a starting point this paper develops a pragmatic framework for unpacking the diverse ways in which various actors perceive sustainability across various sets of experiments (to which we will refer as 'experimental trajectories'), and in the context of different national and sectoral contexts. This framework resulted from iterative analyses and comparing results, and rests in mapping diversity in the following dimensions:

- Performance diversity: diversity in terms of sustainability performance observable across a variety of experimental trajectories in the focal field. This diversity aims to offer the starting point for analysis and allows us to unpack further forms of diversity in terms of socio-political perspectives, geographical locales and sectoral contexts.

⁷ See for instance relevant contributions in Sustainability Science, such as frameworks to assess sustainability of water governance alternatives (Kuzdas et al., 2016), livelihoods (Veisi et al., 2014), urban systems (González-Mejía et al., 2014), entire regions (Hara et al. 2009), intra-regional partnerships (McLarty et al., 2014), food systems (Cochran et al. 2016), policy driven agricultural practices (Purushothaman et al., 2013) and agricultural systems such as rice farming (Roy et al. 2014), wheat-based cropping system (Moeller et al. 2014), and irrigated commercial maize production (Bausch et al. 2014).

⁸ Eames and McDowall followed the Transition Management approach (Loorbach, 2010), which implies the development of visions, followed by the appraisal of these visions in multi-stakeholder dialogues. In contrast, the current paper takes outset in the literature around Strategic Niche Management (Kemp et al., 1998), which emphasises aligning expectations on the basis of ongoing experimentation. Hence, the identification of options for appraisal took place on the basis of a newly constructed database of ongoing sustainability experiments rather than envisioned futures.

- Appraisal diversity: diversity in terms of divergent understandings and priorities in appraisal and associated differences in patterns of performance as appraised under different relevant perspectives. This aspect of diversity allows us to unpack how different actors use different kinds of criteria for assessing sustainability, with different levels of uncertainty, and how they frame different kinds of priorities in the ranking of experimental trajectories.
- Sectoral diversity: diversity in the nature of sustainability appraisal as applied across contrasting socio-technical systems, in this case solar PV and urban mobility. This aspect of diversity allows us to unpack differences in the kinds of appraisal criteria used in different sectoral contexts and explore associated implications for different notions of sustainability.
- Geographical diversity: diversities in the character of appraisal and associated rankings as between different spatial contexts, in this case national situations. This aspect of diversity allows us to unpack how different arrays of criteria are used in different national contexts and how these shape different pictures of performance rankings.

In the following section, we discuss the methods used to address these central objects of interest.

3. Methods

The methodological approach for exploring sustainability in Asian experiments involved a threefold process: the construction of a database of sustainability experiments, multiple stakeholder workshops in India and Thailand, and the use of the multicriteria mapping (MCM) software.

3.1 Database

The first methodological step concerns the identification of the range of sustainability experiments with solar PV and urban mobility that are taking place in India and Thailand, brought together in an excel database. The database contains factual information about

experiments such as the location, start/end date and triggers; actors involved and outcomes of the experiments. Data were collected for initiatives started in the period 2000–2012 based on online search of websites and databases maintained by: governmental actors⁹, industry, knowledge institutes (identified through a Scopus search on relevant publications), domestic and international NGOs, international organisations. Some websites provided existing overviews of projects. In other cases, we browsed organisational websites for relevant data or used search-boxes on the websites to find project descriptions. This search results were initially grouped by the research team into ‘experimental trajectories’ (categorising similar experiments into aggregate groups) and provided insight into the historical evolution of solar PV and alternative urban mobility in both countries (see Table 3). The initial grouping was discussed with stakeholders during the workshops, which mostly confirmed the initial grouping exercise. The groupings were used as a starting point for the multicriteria mapping analysis in step 3. Database construction, including a discussion of its methodological details and limitations, is described in detail in Wieczorek et al. (2015).

Table 3. Experimental trajectories in solar PV and urban mobility in India and Thailand.

	India	Thailand
Solar PV	Solar lanterns	Off-grid generation systems
	Solar home systems	Solar home systems
	Micro-grids	Mini-grids
	Rooftop solar	Rooftop solar
	Solar power plants	Solar power plants
	Solar city	
	Walking	Cycling and walking

⁹ For Thai solar PV initiatives, we have used the official Energy Regulatory Commission website as of January 2012: <http://www.erc.or.th/ERCWeb2/Default.aspx>.

Urban mobility	Cycling	Shared transport (shared bikes, cars, songthaew ^a)
	Alternative public transport (bus rapid transit/BRT)	Alternative public transport (BRT, mass rapid transit/MRT, monorail)
	Electric vehicles	Electric vehicles
	Alternatively fuelled vehicles (CNG)	Alternatively fuelled vehicles: (ethanol, CNG, hybrid, solar)
	Vehicle parts innovation	

The names and groupings of the experiments and trajectories differ in the two countries, because they are identified through inductive, bottom-up analysis, taking into account local specificities.

^a A songthaew is a shared transport vehicle in Thailand, also known as ‘red trucks’

3.2 Stakeholder workshops

Despite the general agreement that sustainable technologies, such as solar PV or ‘Bus Rapid Transit systems’ (BRT), have the potential to make a significant contribution to sustainable development policy goals, the future of these technologies is often contested while the views on the meaning of sustainability are potentially conflicting (e.g. McDowall and Eames, 2007). To complement this systematic search for experiments, we organised a consultation process with a number of solar PV (17 in India, 15 in Thailand) and urban mobility experts (12 in India, 17 in Thailand) in stakeholder workshops that took place in November 2013 in Kolkata and in May 2014 in Chiang Mai, and which were part of a larger research project on sustainability experimentation in India and Thailand.¹⁰ The workshops were composed predominantly of stakeholders from each nation. The selection of participants was grounded in in-depth

¹⁰ See for instance Ghosh (2014), Wiecek et al. (2015), Sengers (2016) and Jolly (2016).

understanding of each case, and developed relationships, as part of a 4-year international research project. Different perspectives in relation to professional background of the participants have been considered, such as a governance perspective (comprising people from ministries, local or regional governmental bodies), academic perspectives (comprising professors, researchers associated with a university or an independent research institute) and industry perspectives (comprising people representing a private firm or organisation) (Table 4). Participation was entirely voluntarily and those who attended came to participate based on their own interest and decision. Participants did not receive a fee, but payments for travel and hotel were made. Participants received a report with project results afterwards. Many of those who attended articulated that an important benefit from participation was exposure to new knowledge and new methods for research. They got introduced to a new overarching framing concept for assessing sustainability experiments, and realised that there is wide diversity in understanding of the concept of sustainability. Participating foreign nationals were not engaged in the appraisal of options but facilitated the workshop and explained the framework.

Table 4. Perspectives and individuals in each sector and country.

Country	Sector	Perspectives	Number of individuals
India	Solar PV	Academics	9
		Governance	2
		NGO	2
		Industry	2
		Consultancy	2
	Urban mobility	Academics	8
		Governance	2
		NGO	2
Thailand	Solar PV	Academics	8

		Governance	3
		Industry	4
	Urban mobility	Academics	8
		Governance	2
		Consultancy	5
		NGO	2

Academics refer to individuals working at universities. Governance refers to individuals working in public policy institutes and those closely related to public policy decision making. NGO refers to individuals working in non-governmental organisations. Industry refers to individuals working in industrial organisations related to the field. Consultancy refers to individuals working in technical consultancy organisations.

The stakeholders with experience through long years of engagement in these domains were invited to present their perspectives on each of the emerging trajectories in interactive plenary sessions, which provided participants with an initial understanding of each of the trajectories. In sector-specific intensive workshops, each of the relevant stakeholders appraised the trajectories according to their own notions of sustainability and understandings of the performance of the different trajectories. Although this cannot be claimed as a definitively robust and representative sample of all relevant views, such a concept is in any case intrinsically problematic (O'Neill, 2011). What is more relevant to the mapping of diversities is confident coverage of an envelope of perspectives in the key relevant dimensions (Coburn and Stirling, 2016). The present disparity of perspectives was certainly sufficient for the purpose of our key interest in exploring the existence and relevance of diversity in appraising sustainability. In particular, the elicited diversity provided ample substantiation of the central aim of demonstrating the relevance of a great diversity of views on sustainability experiments. If the range of stakeholders engaged in the present study can be regarded as somewhat narrow, then it follows that a more wide-ranging recruitment process would correspondingly have yielded an even greater degree of diversity.

3.3 Use of MCM software

The method used to ensure systematic and symmetrical attention across diverse trajectories and perspectives was a novel hybrid quantitative/qualitative web-based software tool called multicriteria mapping (MCM). For more detailed descriptions of MCM, we refer to previously published work (for details see Stirling 1999; Stirling and Mayer 2000, 2001; Stirling et al. 2006; Burgess et al. 2007; McDowall and Eames 2007; Eames and McDowall 2010; Coburn and Stirling 2016).¹¹ In short, MCM is concerned to help ‘broaden out’ and ‘open up’ societal debates about political choices through: (1) a systematic articulation of all relevant perspectives (on, for instance, new technologies); (2) illuminate the range of uncertainties within and ambiguities between each of these perspectives; and (3) document qualitative data concerning the reasons and arguments constituting these perspectives and uncertainties. Hence, MCM has the particular feature that it focuses equally on quantitative representations of performance under different perspectives, at the same time as documenting qualitative information concerning the reasons for performance patterns and uncertainties under each perspective.

In a group workshop providing both for collective deliberation and individual appraisals, trained facilitators recorded through a series of steps, a diversity of stakeholder perspectives. Together these permitted collection of relevant qualitative and quantitative data concerning: the framing and constituting of technological options and their contexts; contrasting ways to conceive and evaluate notions of sustainability itself; divergent understandings and associated uncertainties with regard to the sustainability performance of specific technologies; and individual and collective rankings of the experimental trajectories. The data gathered, therefore, encompassed a deep and wide diversity of issues, including insights concerning the most salient factors distinguishing a plurality of interpretations and positions taken in the sustainability debate around specific innovations. As a result, MCM allowed the mapping of many key sensitivities concerning the performance of particular trajectories as seen under different relevant perspectives, along with details concerning associated uncertainties and framing assumptions. Figure 4 summarises this process.

¹¹ Prioritising faithful attention to multiple stakeholder’s own perspectives on complex contentious issues in science and technology, this new method systematically captures qualitative and quantitative information concerning alternative framings and evaluative priorities across a range of different options, and illuminates the variety of different appraisals that arise.

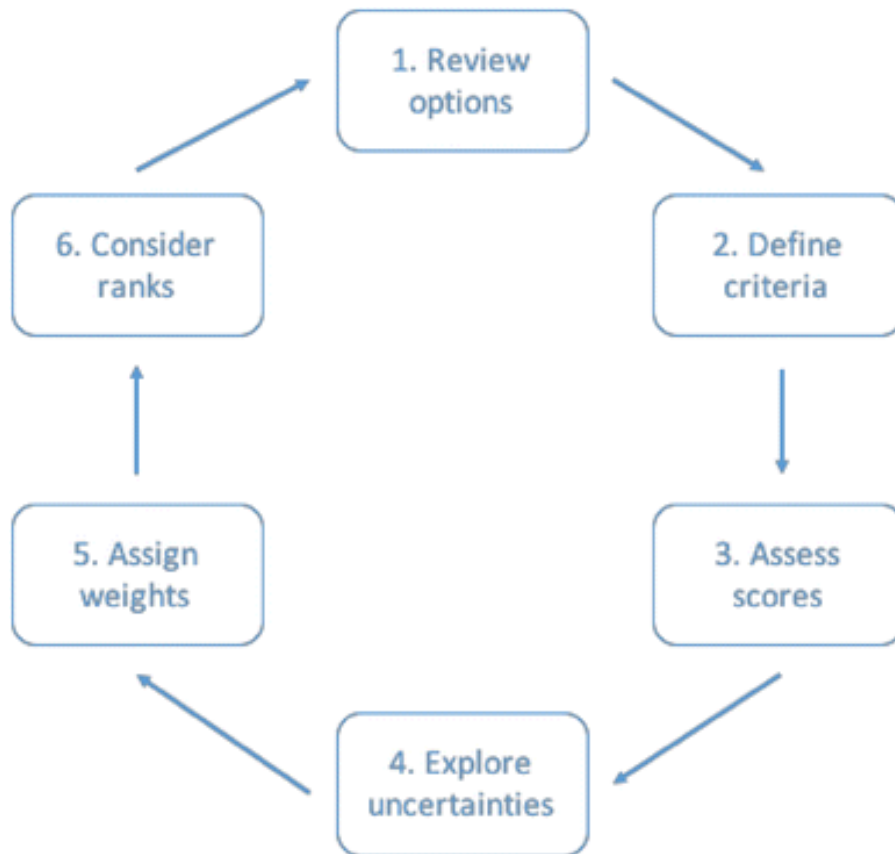


Figure 4. The multicriteria mapping process

To ensure the necessary basic common understanding of the exercise as a whole, the project team first introduced the participants to the prior characterisations of the 6–7 experimental trajectories (in MCM, these are referred to as ‘options’; we use these terms here interchangeably). In reviewing these options, participants could also introduce into their own appraisal any relevant variants or wider possibilities that had not been pre-defined. But in this exercise, these ‘additional options’ were not systematically appraised by all other participants.

Second, in the define criteria stage, participants were informed of a literature survey concerning relevant sustainability criteria. This was simply to prompt thinking about the kinds of issues as they might each see them, in order to address what might otherwise be concerns on the part of participants over the need for supporting information. However, there is no necessity on grounds of rigour or consistency in such a process, for participants all to use the same criteria scheme or data. So full flexibility was afforded to participants to formulate whatever they considered under their own perspective to constitute the most relevant

sustainability criteria for the context in hand. This was informed by the common data where participants wished, but they could also depart from this common data set where they felt appropriate, in which case qualitative reasons for such departures were documented during appraisal. To this end, facilitators ensured that participants described exactly what they meant by each criterion and why.

Third, in the assess scores stage, participants were again able to consult background data provided by the research team to inform their own understandings where they wished, concerning the performance of each option under each criterion. But participants were again not forced simply to adopt the provided data but were instead free to express divergences—with associated reasons again being documented by facilitators. This process involved assigning scores on an arbitrary ascending interval scale from low to high performance with respect to each criterion. Participants could use any scale they felt comfortable with (typically 1–10 or 1–100)—but this could vary without incurring comparability problems. The software converted raw scores to normalised intervals and it is these relative orderings that are the subject of comparison, not the absolute values of the raw scores.

As part of this scoring process, a fourth feature of the MCM appraisal was that participants were encouraged to pay due attention to any uncertainties they might hold concerning possible differences between optimistic and pessimistic futures of the options. This meant assigning two scores for each option under each criterion: the first on the basis of reasonable assumptions that they feel would yield the most optimistic outcome, the second relates to reasonable assumptions under which a pessimistic outcome might be anticipated for the chosen option. If a participant experienced no uncertainty, these scores could be the same. This unusual feature of MCM captures the degree of fine-grain uncertainty and variability associated with particular features of the performance of specific experimental trajectories under a given criterion. Participants were again asked to talk about the assumptions lying behind these different scores, and these qualitative data were transcribed. In a relatively efficient way, this captured the effects of uncertainty concerning how sustainable an option might prove in practice in any given setting, variability with respect to contrasting possible settings, and sensitivity to wider contextual conditions underlying all settings together.

Fifth, in the assign weights stage, participants were asked to assign simple numerical weights to express the relative importance (in their own view) of each criterion in comparison to others. Prompted by the software, what this involved was the comparing of relative importance for each participant, of the difference between best and worst performance under

each criterion. This task was undertaken interactively, informed by the consequent changes in the overall resulting rankings as any weighting changes were applied. Discussion was again documented for comparison with appraisals of other actors.

In the sixth and final stage of the MCM appraisal, participants were asked to consider ranks. This involved each participant examining in detail the visual representation of the overall rankings of the different experimental trajectories—according to their own criteria, scores, uncertainties and weightings. The software calculated these ranks based on a standard ‘linear additive weighting’ procedure, with appropriate normalisation of each score and weighting scale. This enables the ranking patterns of different participants to be compared in terms of their contrasting normalised intervals. No appraisal was regarded as complete, until the participant in question had expressed themselves to facilitators to be positively satisfied with their own ranking pattern as a reasonable expression of their own view concerning the relative performance of the different options.

In the resulting ranking charts (see e.g. Fig. 5), the thin blue lines represent the range between extrema defined between the lowest pessimistic rank and the highest optimistic rank obtained by any participant for each experimental trajectory. The thicker orange bars represent the difference between the mean pessimistic rank and the average optimistic rank across all participants for a given trajectory. So, the right end of each bar represents performance of that trajectory under high optimistic scores on average, while the left end of the bar represents average performance of that trajectory under pessimistic scores. In general, the further the bars and lines extend to the right the more sustainable the experimental trajectory is considered to be.

It is crucial to this process as a means to map divergent perspectives that participants could see the overall patterns of performance and uncertainty derived for the different options in their appraisal and were actively invited to reflect on whether this conformed to their initial expectations and feelings. If not, participants could make a back-up of the original appraisal, and explore other weighting schemes, or revisit their criteria and scoring. Where any such changes were made, facilitators would enquire and document the associated reasons. Only in this way can there be confidence that results authentically reflect the perspectives of different participants, rather than serving to ‘fix’ these through the initial framings imposed by researchers or contingent features of the analysis. The attention to documenting reasons at every stage also provides a means to guard against strategic behaviour on the part of participants themselves.

After the workshops, the research team analysed the qualitative and quantitative data collected. Initial reading and interpretation resulted in two kinds of groupings, each iteratively explored during analysis. First, we grouped individuals in different ways, such that they reflect different notions of what might constitute relevant social perspectives. Second, we grouped criteria in different ways, to explore contrasting ways to divide up sustainability issues across social, economic, environmental and technical factors. Experimental trajectories themselves could also be grouped in different ways if wished. With each permutation of groupings in analysis, associated qualitative descriptions provided in the stakeholder interviews were clearly displayed by the software, in order to ascertain the associated kinds of reasoning in each case. This proved especially helpful in addressing ambiguities between different perspectives in interpreting different criteria. In the case of Thailand, for instance, we added a fifth group of criteria—policy—because Thai stakeholders placed much stronger emphasis on these than did the Indian participants. This facility in MCM to integrate qualitative and quantitative factors in analysing contrasting groupings of key parameters assisted in meaningful interpretations of diversities across perspectives, sectors and geographies.

In the next sections, we present the results of our analysis. Given the vast amount of available material, we opted not for a complete presentation of all results, but decided to highlight the most salient results in relation to the aim of this paper, which is to show diversity in appraisals of sustainability of socio-technical options.

4. Results

4.1 Performance diversity

Performance diversity refers to the differences that can be observed in the overall sustainability performance for each of the solar PV and urban mobility trajectories in the two countries. Aggregating the appraisals of all individual stakeholders, this diversity is expressed as contrasting ranking intervals compared across the different socio-technical options within each sector. Figure 5 illustrates this for the Thai urban mobility case.

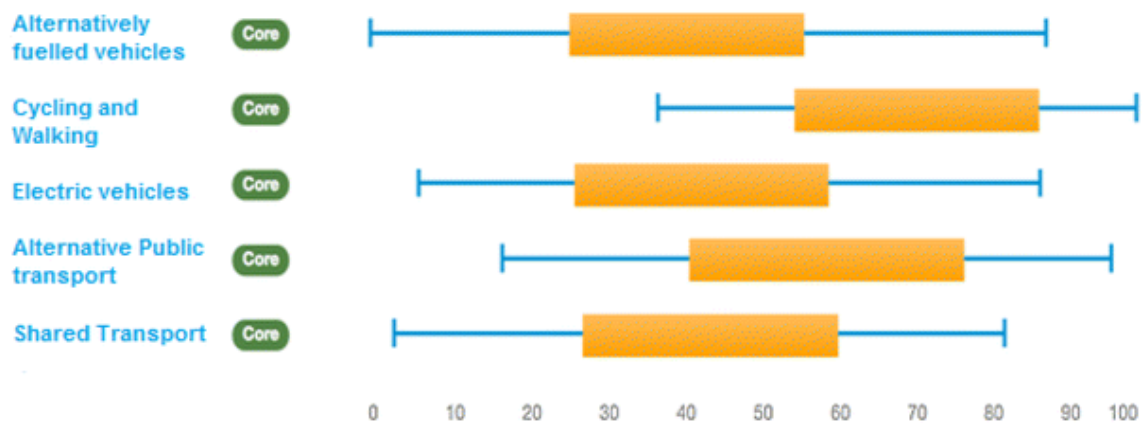


Figure 5. Performance diversity for the Thai urban mobility case

In this figure, the overlaps in the ranges for different trajectories show (as is typical in MCM) the combined effect of a high degree of uncertainty, ambiguity and variability in the performance orderings of different options. This uncertainty is typically understated in other kinds of appraisal method. This said, it might cautiously be observed that non-motorised transport (such as walking and cycling) received relatively high optimistic scores on average, compared to all other trajectories. A majority of stakeholders in this case agreed that non-motorised transport is the most desirable, as they perceived that they are flexible, affordable and least harmful to the environment. One of the Thai stakeholders adds “...in addition, walking and cycling provide better and easier access to the small alleys (soi) in Thai cities.” This strong preference is reflected in a relatively high mean ranking for the non-motorised trajectories (the mean ranking being the midpoint of the thick orange bars).

The mean ranking for the alternative public transport trajectory is also quite high. Despite the carefully documented differences, stakeholders agreed that alternative public transport systems such as bus rapid transit are in general more inclusive, provide better accessibility and minimise congestion. Where a method (like MCM) avoids forcing closure in appraisal, the emergence of such convergence is correspondingly more robust. Likewise, both cycling and walking as well as alternative public transport trajectories tend to be perceived in general as more sustainable options than the alternatively fuelled vehicle such as CNG cars, electric vehicles and shared transport trajectories in Thailand. This result might be thought significant in relation to frequent patterns of emphasis in innovation for sustainable urban transport.

Interestingly, the mobility trajectories that appear most sustainable are those which are less dependent on high-tech innovations, are more reliant on behavioural shifts and are

compatible with existing infrastructure. Alternatively, fuelled vehicles and electric vehicles received considerably lower ranks, as the stakeholders argued that these require high initial investment; they are non-affordable by the poor and middle-income groups (that constitutes a large section of the population) and, therefore, are non-inclusive in nature. Shared transport systems mainly received pessimistic scores due to their current non-environment friendly fuel use and a substantial role in creating congestion, air and noise pollution in the cities of Thailand.

Analysing performance diversity for solar PV trajectories in India, we observed even more pronounced uncertainties, ambiguities and variabilities in final rankings—measured through high ranges of optimistic and pessimistic scores resulting in substantial overlaps in the sustainability performances of the various trajectories. Figure 6 illustrates this.

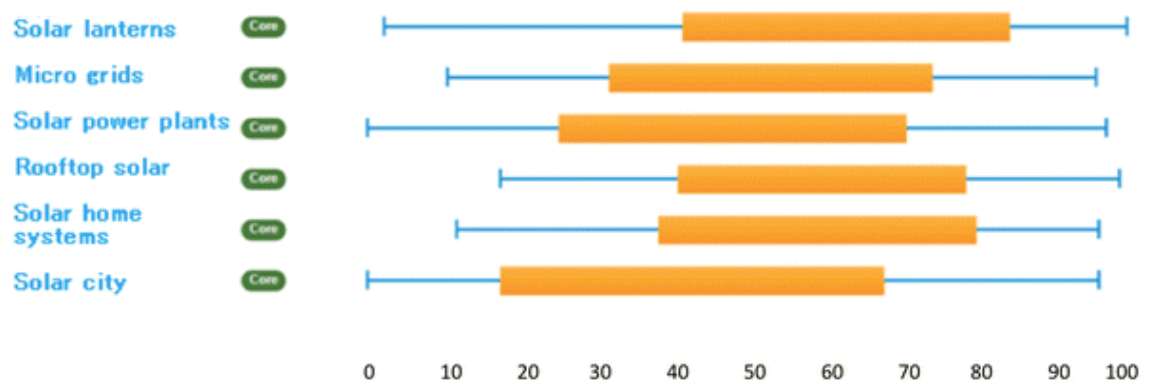


Figure 6. Performance diversity in Indian solar PV case

This is despite the fact that the different trajectories in this case involve much more similar kinds of technologies than in the transport sector (since all in this case involve photovoltaic cells). One finding in this respect is that decentralised solar PV options like solar lanterns, solar home systems (SHS), and rooftop solar applications seem to display somewhat higher sustainability performance in terms of highest average ranks, compared to centralised large-scale solar PV applications like large grid connected solar power plants and solar cities. This picture is revealed by the qualitative discussions of participants during appraisal, where it was argued that decentralised options tend to display advantages over large-scale systems in terms of cost minimisation, easy and quick installation, and operation and maintenance facilities. An Indian stakeholder summed it up in her comments during the interview process “...these small-scale individual household based applications will have maximum positive social, economic and environmental impact through maximum accessibility to remote areas deprived

of electricity, minimum emission and transmission losses and everything, assuming the subsidies continue for some time; the production and disposal of the equipment are hazard-less.”

Overall, these findings urge caution over more simplistic accounts of the sustainability performance of the different innovation trajectories in either solar PV or mobility. The picture is not straightforward and depends on highly specific visions of what is meant by sustainability. In itself, this holds important implications for notions of transitions and experimentation in which sustainability or its technological implications are held to be self-evident. A key implication is that manifestly divergent informed opinions led to quite extreme ranges in scoring. This underscores the importance of uncertainties in individual perspectives, ambiguities across contrasting perspectives and variabilities across different contextual condition that can often be missed in appraisal. This understanding leads us to the next dimension of diversity, namely appraisal diversity.

4.2 Appraisal diversity

Appraisal diversity is defined as contrasts in understandings, perceptions and values as between different stakeholders participating in the appraisal process. These divergent perspectives on the meanings of ‘sustainability’ were reflected in participants’ selection of criteria, the ways in which these criteria are weighted, divergent patterns of scoring and expressions of uncertainties under individual criteria. This appraisal diversity can be captured by comparing the responses of the stakeholders either at an individual level or at a semi-aggregated level where each of a number of variously definable groupings of stakeholder perspectives can be compared with each other.

As an example of this analysis at a semi-aggregated level, we compared the weights assigned to each group of criteria (technical, social, environmental and economic) under stakeholder perspectives disaggregated across ‘consultancy’, ‘industry’, ‘NGO’, ‘governance’ and ‘academics’). Results from the solar PV case in India are shown in Figure 7.

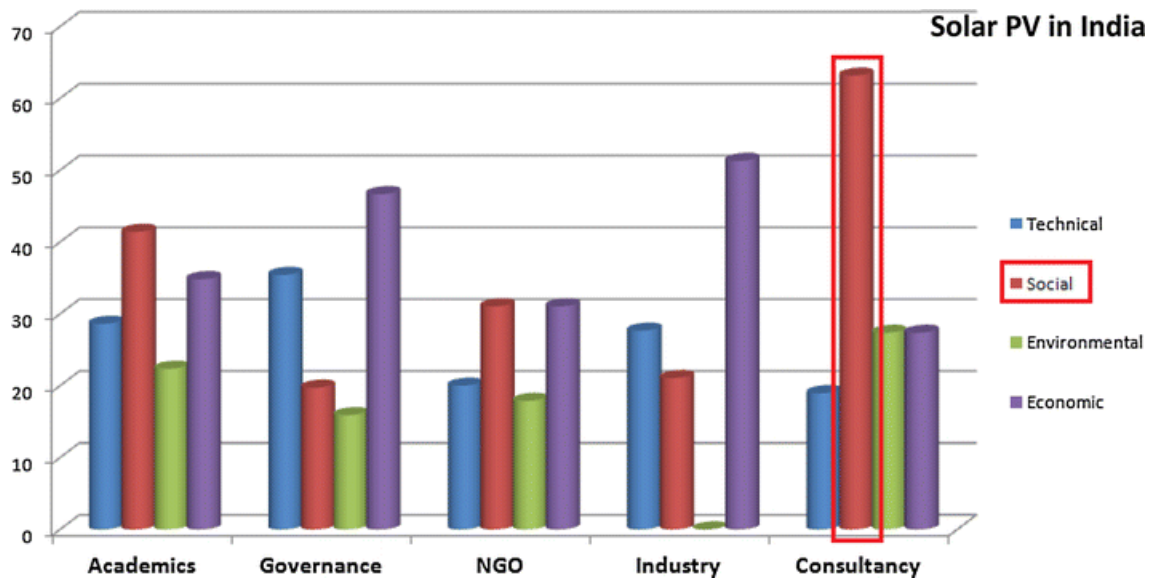


Figure 7. Appraisal diversity in assigning weights to each group of criteria for solar PV case in India

It is noteworthy that the individuals identified on the basis of their affiliations as consultants assigned strikingly higher weights to social criteria in the appraisal of solar PV in India. They emphasised the importance of local skill development for decentralised maintenance and operation of the solar PV systems, need for supportive policy targeted towards the benefit of “common people”. Another interesting result in Figure 7 is that the individuals identified as industry actors assigned almost negligible weight to the environmental aspects of sustainability. In expressing their own framings of sustainability criteria, these actors in India emphasised the more socio-economic ‘sustainability’ criteria (like policy and awareness, value of stakeholders, profitability, affordability and entrepreneurship opportunities).

The consultants also expressed significantly higher levels of uncertainty for the centralised solar PV options like power plants and solar cities. Technical consultants tended to take into account the subsequent risks of the systems being highly subsidy dependent, and the policy strategies and financial schemes being less transparent and heavily subject to corrupt practices. An illustration of this point can be quite clearly seen in Figure 8 (below), where the green and orange bars representing solar power plant and solar city trajectories, respectively, are manifestly tallest for the consultancy perspective.

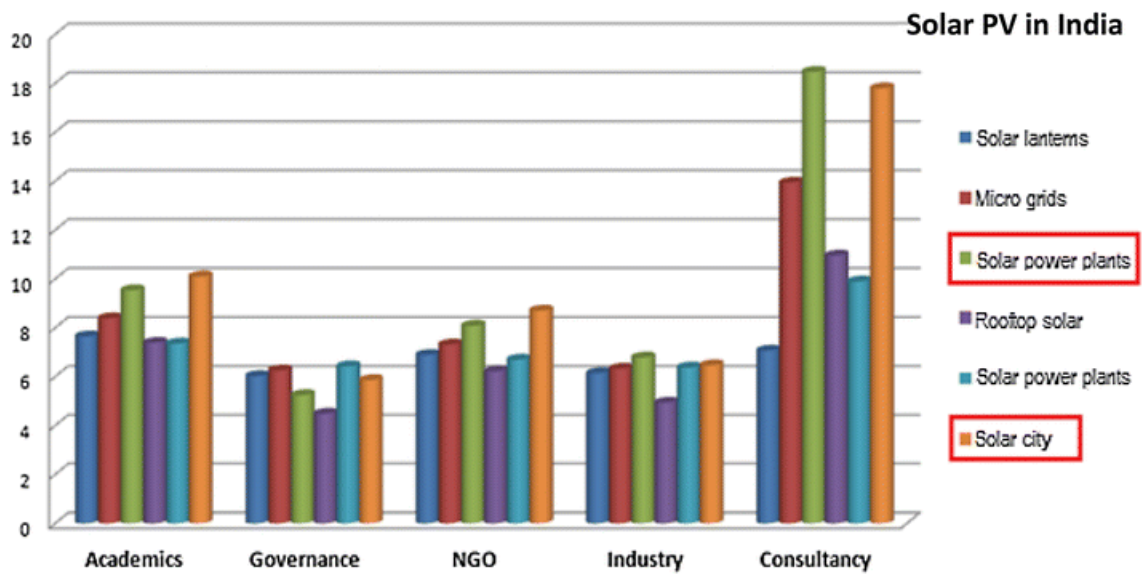


Figure 8. Appraisal diversity in expressing uncertainties for each solar PV trajectory in India

In the urban mobility cases in both countries, it was quite striking that it was the governance actors who assigned the highest importance to social sustainability of the emerging mobility trajectories (in India alongside NGOs). This is depicted in Figure 9.

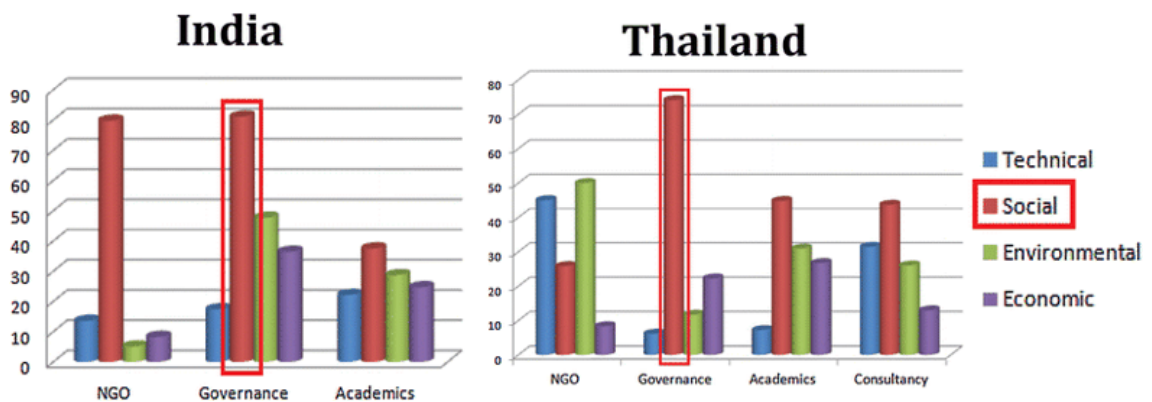


Figure 9. Appraisal diversity in assigning weights to each group of criteria for urban mobility case in India and Thailand

One qualitative substantiation of this result emerged when one of the participants, categorised as a governance perspective in India, explained that people will only prefer a mode of mobility if they think it matches with their status and position in the society. The criteria are thus closely linked with judgements concerning social and cultural perceptions and mind sets about the different forms of mobility. Under a criterion of community involvement, this participant also emphasised the importance of sufficient knowledge dissemination as a social criterion.

Looking carefully at the graph for the Thai Urban mobility case, (Figure 9) it can be observed that there is a considerable difference across stakeholder groups, in the assignment of weights to what might be considered more ‘technical’ criteria in the framing of sustainability. These criteria typically included time predictability of mobility services and minimisation of travel time as well as energy efficiency, adaptive-ness and compatibility in energy systems. The governance actors and the researchers assigned very low weights to these technical issues, when compared to the consultants and NGO representatives.

As mentioned in the beginning of this section, appraisal diversity also refers to the differences in ranking patterns at an individual level of contrasting viewpoints. Figure 10 demonstrates the comparison of the appraisals by two individual stakeholders for urban mobility in the Indian case. We can interpret that the engineer at a state pollution control board (left graph) was highly uncertain about sustainability of bus rapid transit (BRT) systems and CNG vehicles in spite of being overly optimistic about the fact that both are sustainable options. He was also optimistic about trajectories like Walking and Cycling and pessimistic about vehicle parts innovation like ultra-capacitor and electric vehicles with moderate degree of uncertainty. In contrast to his appraisal, however, another stakeholder from a science technology and development research institute (right graph) expressed high optimism for sustainability of walking and cycling trajectories and pessimism for BRT—all with negligible amount of uncertainty.

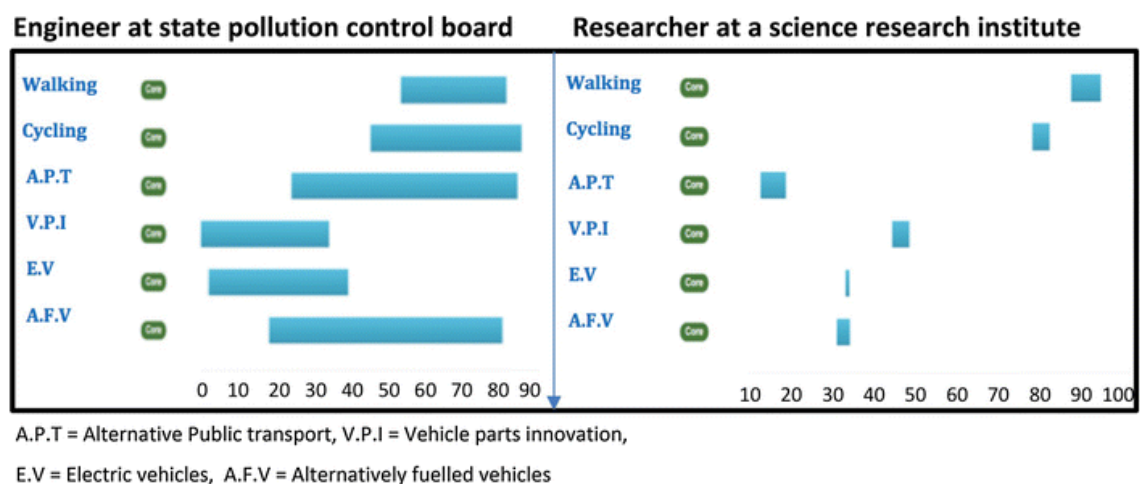


Figure 10. Appraisal diversity at an individual level for urban mobility case in India for an engineer at a state pollution control board and a researcher at a science and technology research institute

The qualitative information collected in this MCM analysis tells us that appraisal diversity can also be identified if we look carefully into the ways in which each stakeholder perceived the scope and potential of each trajectory. For example, although the ‘solar city’ trajectory is considered a centralised system by some stakeholders, others consider this trajectory to be a ‘collection of technologies’, or even an ‘enabling environment to experiment with different solar technologies—each of which can be managed in small units’. From this point of view, solar city is a desirable option if there is a community or household ownership of individual applications constituting a large solar city project. This ‘if’ resulted in the especially diverse extreme ranges displayed in the scoring the trajectory. Some stakeholders argued that the solar city concept has great potential to address environmental sustainability issues, thus assigning high optimistic scores to this trajectory. Others explained that policy framings of this option are currently quite opaque, resulting in less confidence in more optimistic scenarios for the performance of this trajectory.

This section has demonstrated the importance of highlighting differences in criteria and uncertainties across social groups—as well as their associated patterns of reasoning. These may easily be missed in attending only to the aggregate picture in Section 4.1. The next section continues with differences in sustainability across different sectors.

4.3 Sectoral diversity

Diversity can also be observed across the two sectors studied in this research (energy through solar photovoltaic and urban mobility). This is evident, for instance, in respect of criteria, definitions and uncertainties as between degrees of optimism and pessimism. One of the striking differences between the two sectors is that criteria for environmental sustainability did not seem to be as important, either in numbers or in weights for the solar PV trajectories compared to urban mobility. Figure 11 (below) shows this diversity across the two sectors in India.

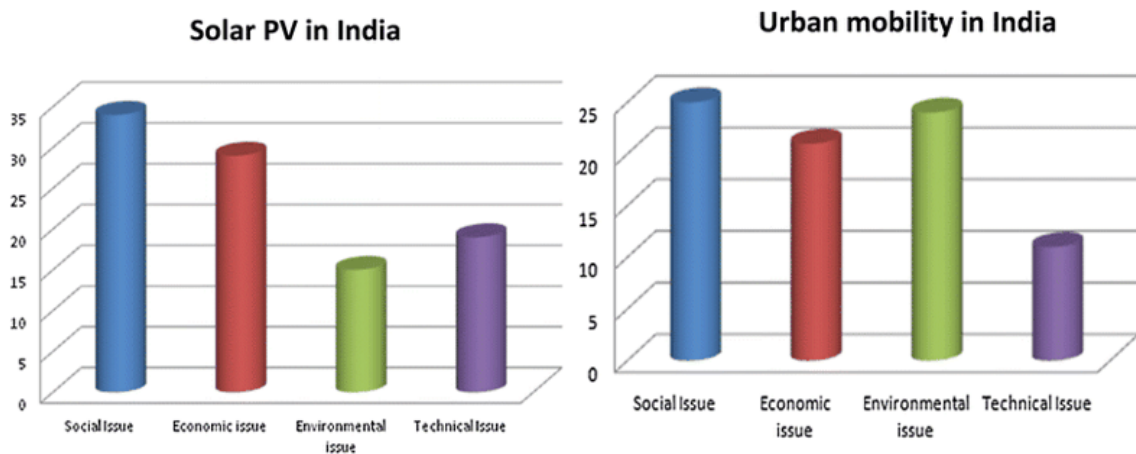


Figure 11. Sectoral diversity in number of criteria proposed for each group in solar PV and urban mobility in India.

Here, we can observe that the number of criteria proposed to assess environmental sustainability of solar PV systems was significantly exceeded by the criteria proposed for social, economic or technical issue (the graph to the left). In contrast to this, for urban mobility (Figure 11, graph to the right), environmental issue contains the second highest number of criteria, which follows after the highest number of criteria proposed for social issues of sustainability. In light also of associated qualitative findings, we can conclude that concerns over environmental sustainability were notably more pronounced and nuanced in the urban mobility sector cases in both countries.

The relatively low salience of environmental aspects of sustainability in the solar PV case in both countries can be interpreted in two ways. First, stakeholders suggesting environmental criteria in this case tended to assign relatively low weights to these criteria. Associated comments suggest that many of them simply assumed solar applications to be environmentally sustainable and, therefore, felt it more important to evaluate other (social, economic or technical sustainability) aspects more relevant to distinguishing between the relative merits of these trajectories. Second, many stakeholders mentioned just one or two environmental criteria, defining these such as to incorporate several environmental concerns in a single criterion. As an example of this, one stakeholder named her criterion in this case, 'Reduction in environmental impact'. In the description of this single criterion, she talked about local air pollution, noise pollution, global climate mitigation strategies all the same time.

From a sectoral diversity point of view, this is an interesting observation, since such integration of several concerns in one criterion can only be seen in the solar PV cases. In the urban mobility cases, by contrast, criteria were much more reflective of specific environmental aspects of sustainability. Notwithstanding this overall pattern, it is all the more striking that a few stakeholders in the solar PV appraisal did raise specific concerns about provision for battery disposal for solar home systems, and use of agricultural land for construction of power plants. It can be concluded that even if the solar PV trajectories are perceived to be using fairly similar technologies, there were some instances when concerns arose over particular environmental issues under which options performed differently.

Diversity across the two sectors is also reflected in the expression of uncertainties, as illustrated in Figure 12 for the two sectors in Thailand.

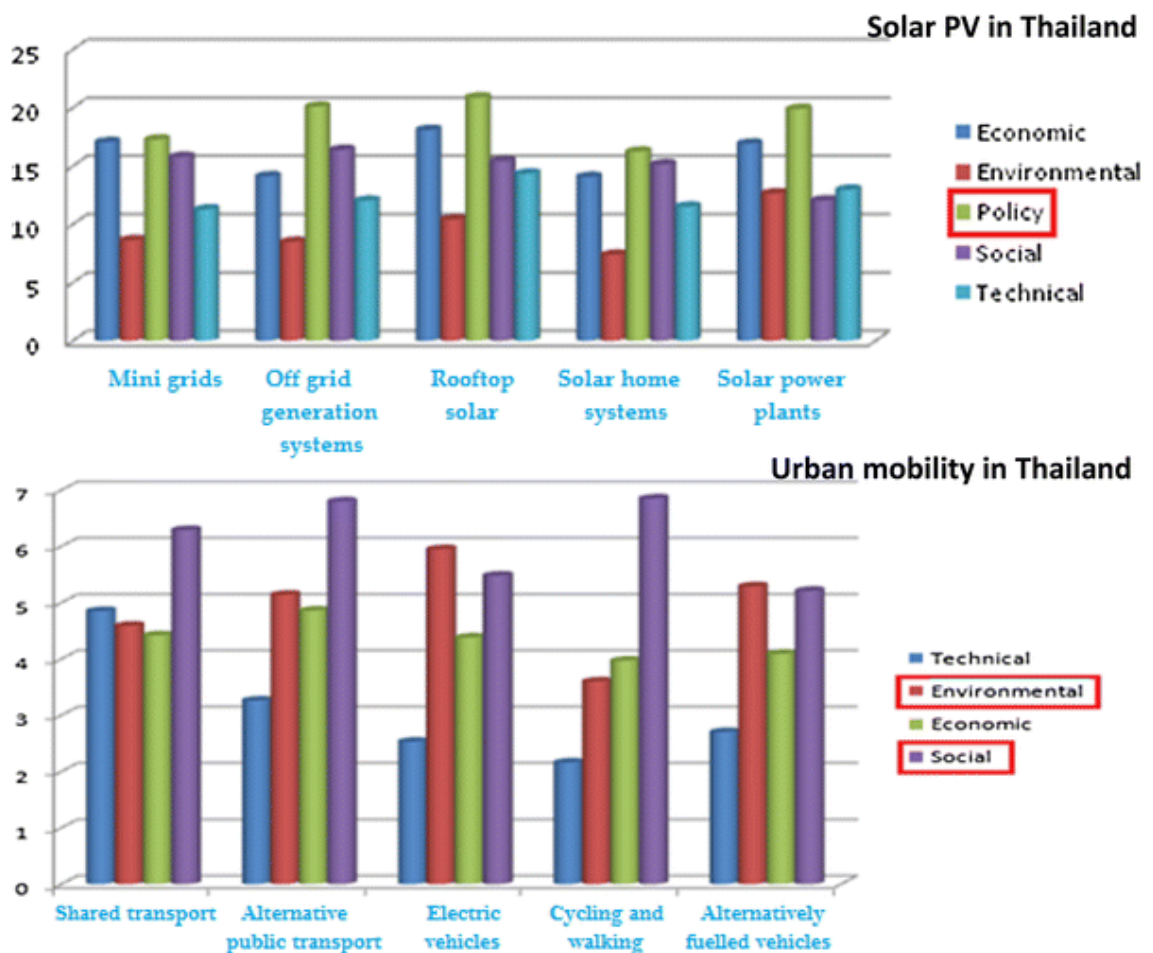


Figure 12. Sectoral diversity in the range of uncertainties for each trajectory in solar PV case and urban mobility case in Thailand.

For the solar PV case (at the top), the highest range of uncertainties was expressed for policy-related criteria (rather than environmental, economic, social and technical criteria), while for urban mobility case (at the bottom), uncertainties were most prominent for social and environmental sustainability criteria. For mobility trajectories, none of the stakeholders even mentioned a supportive policy environment to be a relevant sustainability criterion. Instead, the stakeholders were more concerned about sustainability of urban mobility trajectories in terms of providing accessibility to all areas and to all people of the society and in terms of their capability to reduce pollution, congestion, emissions, etc. This difference, observed for two sectors in the same country, is intriguing because this implies that the stakeholders perceive that sustainability of solar PV systems is more dependent on enabling policy and governmental support than is the case for urban mobility systems.

In sum, this analysis of sectoral diversity demonstrates that even within the same country, the perception of sustainability differs markedly across energy and mobility sectors. Not only are the sustainability criteria and their respective weights different across the two sectors, but the ambiguities and uncertainties about the sustainability of the various trajectories also differ. Such diversity would have been less easy to observe, in a technique involving prior definition by the analyst of what constitutes ‘sustainability’. Finally, in the next section, we will turn to the diversity exhibited across the two countries.

4.4 Geographical diversity

Geographical diversity concerns the contrasting difference in the appraisal results in the two case study countries, namely India and Thailand. One of the first observations in this regard can be presented in terms of the diversity of sustainability criteria expressed in the two countries. Affordability, for instance, is proposed as a crucial economic sustainability criterion by almost all the participants in India, while it is mentioned only once in Thailand. On the other hand, many stakeholders state safety issues as sustainability criteria in the urban mobility workshop in Thailand, but not much in India. These qualitative differences in type and frequency of the criteria proposed shows that, even while appraising the same types of trajectories-stakeholders in India and in Thailand, participants reflected upon their local and regional context and experiences and thereby set different priorities in ensuring sustainability of the systems.

Another notable geographical diversity for solar PV appraisal is that a far greater number of criteria related specifically to governmental support and policy incentives in Thailand than in India. Qualitative data in this regard justify distinction in Thailand but not in India, of a separate group of criteria under the heading of ‘policy’. In the appraisal of solar PV trajectories in Thailand, these policy criteria also received higher average weightings than did social, economic, environmental and technical sustainability criteria. This result is illustrated in Figure 13, where the graph on the top represents the situation in Thailand, as compared to India in the bottom where participants rated social and economic issues of sustainability the highest.

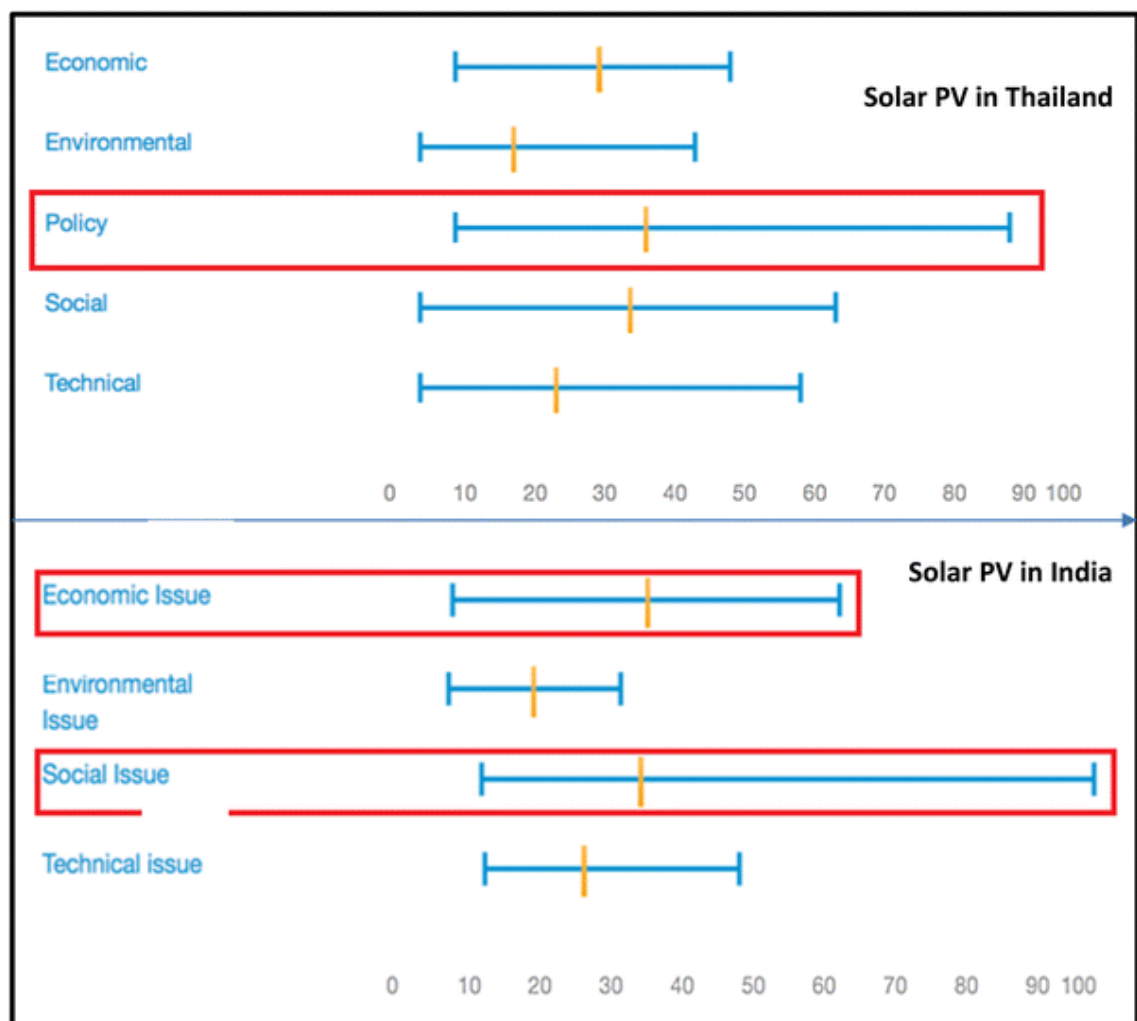


Figure 13. Geographical diversity in assigning weights to respective criteria groups (issues of sustainability) for solar PV appraisals in Thailand and India.

Following this assignment of highest significance to policy-related criteria in Thailand (but not India), it is perhaps relevant (despite major uncertainties) that Thai participants appraising solar PV tended also to express a discernibly stronger preference towards those solar trajectories that receive governmental policy and financial support. These trajectories (namely rooftop solar and solar power plants) were considered to be more sustainable options (in terms of higher optimistic scoring) in the final ranking of the trajectories. Figure 14 presents this result.

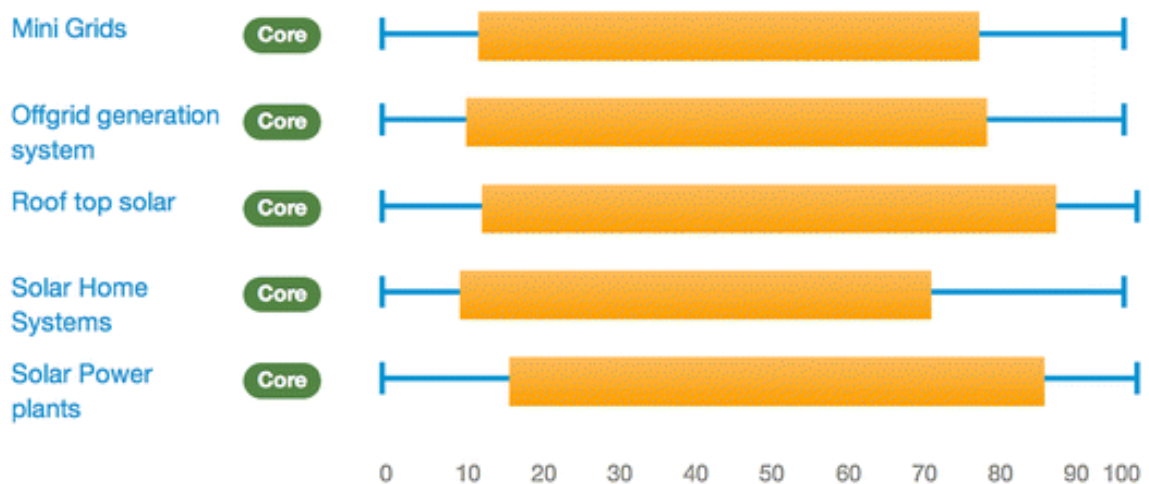


Figure 14. Performance diversity in solar PV case in Thailand

This trust and dependency on institutional policy and financial schemes seemed to be absent in the appraisal of solar PV trajectories in India, where the stakeholders were rather pessimistic and uncertain about sustainability of solar power plants in spite of supportive policy instruments like the National Solar mission in place. Here, they raised concerns over what were expressed in qualitative statements to be huge investment costs, long implementation times, transmission and distribution losses and land allocation requirements.

One of the other striking aspects of diversity between appraisal results in the two countries is in the levels of uncertainties with which the stakeholders appraised the trajectories. Relatively high levels of uncertainty can be observed in the appraisal of all trajectories for both solar PV and urban mobility systems in Thailand. Indeed, the high levels of uncertainty here contributed to a serious difficulty in interpreting aggregated performance diversity, in that it is difficult to see any clear overall difference in the sustainability performance across different trajectories (see Figure 14, solar PV in Thailand). In the case of India, however, contrasting patterns of optimistic and pessimistic scoring contributed to a greater degree of confidence in

interpreting the differences in sustainability appraisal of the different trajectories. (see Figure 6 on solar PV in India).

Comparing the urban mobility cases for both countries, it can be observed that in India, stakeholders from an academic perspective expressed less uncertainty than other stakeholder groups. Interestingly, the opposite is true in Thailand, where academic stakeholders expressed the highest uncertainties when compared with other stakeholder groups in Thailand. This result is displayed in Figure 15, where relatively short blue bars in the graph at the top represent the relative uncertainty level expressed by academicians in India, while the relative tall blue bars in the graph at the bottom represent the relative high levels of uncertainty expressed by Thai academics.

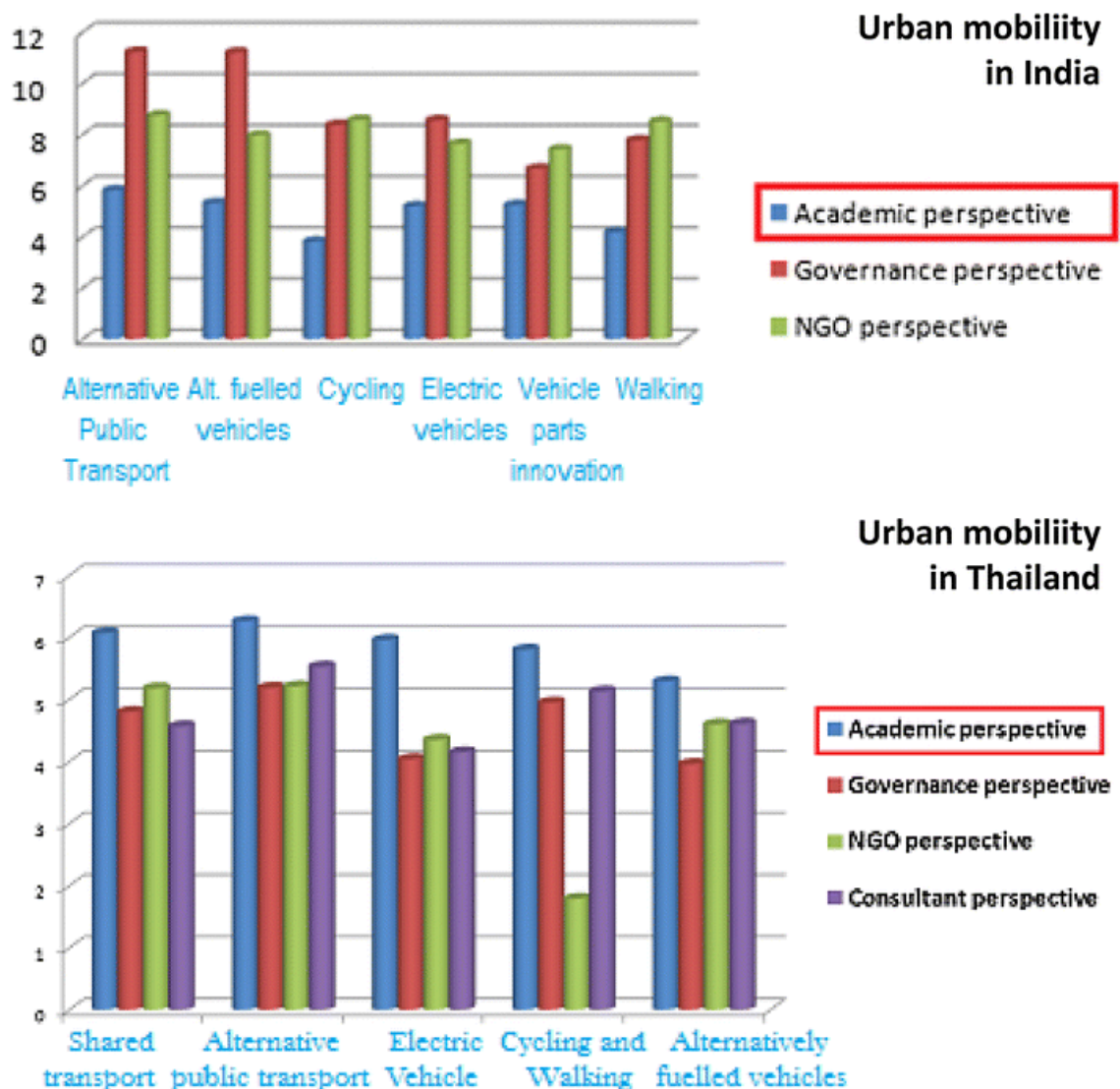


Figure 15. Geographical diversity in the range of uncertainties by each stakeholder group in urban mobility case in India and Thailand.

As with the other parameters analysed here, it would be hazardous to generalise to an entire country, the differences in pictures interpreted here as geographical diversity. Any such analysis would need to be based on more detailed analysis of the qualitative data to substantiate the extent to which divergent cultural factors may or may not be implicated. For the purpose of simply documenting the potential salience of diversity, however, this evidence serves quite well. Given the overall similarities in the final rankings displayed by the different experimentation trajectories in the two countries, it is quite striking that the underlying perceptions of sustainability and the specific ways in which these trajectories are appraised (optimistic, pessimistic views, expression of uncertainties and ambiguities) are so contrasting between the two countries. Following results in other MCM studies (Burgess et al., 2007), this underscores the importance of not over-interpreting the practical policy implications of wide discursive differences, and not over-interpreting any similarities in practical policy implications as indicating wider contextual similarities. Either way, it appears that diversity of many kinds remains a crucial factor to analyse.

5. Conclusion

This paper started with the ambition of contributing to debates around questions of what sustainability means, to whom, in what contexts, and with which kind of implications. Building upon extensive research in India and Thailand, this paper asked the question: How are emerging innovation trajectories for solar energy and urban mobility appraised by various actors under different perspectives in India and Thailand? The following conclusions can now be drawn.

As a preface, we note that the current approach has of course only taken a snapshot in time. It is reasonable to assume that sustainability appraisal may be expected not only to be highly context specific, but also temporally specific. This can especially be expected for rapidly industrialising parts of the Global South where the quest for sustainability transitions is tied up with other far-reaching processes of societal transformation. So, conclusions must be cautious and qualified concerning the generalisability of any specific patterns noted here.

This said, the first conclusion to draw is that this paper mobilised an innovative methodology and developed a novel pragmatic framework for unpacking sustainability in terms

of performance, appraisal, sectors and geography. The application of this framework to solar PV and urban mobility experiments in India and Thailand demonstrates a vast degree of diversity in terms of criteria, uncertainties and rankings across different sectoral and national contexts and between different social groups and individuals. The magnitude and pervasiveness of these diversities remain a crucial issue, irrespective of any questions that may be raised about the particularities of the individual findings or the completeness or representativeness of the appraisal as a whole.

Simply in their own right, the existence of such diversities implies that those involved in transition analysis must be extremely cautious in assuming any objective status for the 'sustainability' of sustainability experiments on the basis of more conventional approaches such as integrated assessment that simply calculate and rank options. Moreover, which 'niches' or 'cases' to choose for analysis is not a neutral choice, but is evidently highly normative, and deserving of considerable further reflexive thought. For instance, our analysis demonstrated that participants in the present appraisal exercise highlighted a sustainability preference for slower forms of mobility, such as walking and cycling—cases which are rather unconventional empirical domains in the study of sustainability transitions. In parallel, cases that have been studied more in-depth such as cleaner transport fuels were received with more reservation.

Second, our research suggests that even within apparently singular socio-technical fields, there exists a high degree of uncertainty and ambiguity concerning future sustainability performance. For instance, the ranking ranges are massively overlapping for all socio-technical options considered in relation to solar PV. Hence, whether decentralised options such as lighting or roof top systems or solar home systems are more or less sustainable than centralised options, such as large-scale power plants or solar cities, is highly uncertain and dependent on assumptions and perspectives concerning the unfolding of particular socio-technical configurations as well as possible future conditions. For the study of transitions, this implies that research could engage more with unpacking these uncertainties and diverse possible socio-technical configurations, even within (apparently) singular technological fields. Again, this finding applies without any need to claim completeness or representativeness for the particular perspectives engaged here.

Third, the analysis of what is here called appraisal diversity demonstrated a high degree of diversity in the kinds of criteria and levels of uncertainty displayed across contrasting social perspectives as well as different individuals. Perhaps more important is the qualitatively informed finding that diversity in criteria and uncertainty persist when comparisons span

sectoral and national contexts. The implication is that what sustainability means, how it should be assessed, and with what kind of implications, is very much context-dependent. This research, for instance, showed that criteria relating to policy conditions were held to be crucially important for nearly all participants in Thailand, whilst these kinds of criteria were hardly mentioned by participants of any kind in India. Whilst not exploring these reasons empirically here (which may have to do with the differences in political regimes in India and Thailand), the broader implication is that the study of sustainability transitions must be addressed within specific geographical contexts. Whilst national boundaries have been taken for granted as key spatial level of analysis, future research must explore empirically what the relevant special scales for unpacking sustainabilities are (Raven et al., 2012).

Fourthly—and perhaps most importantly—it follows from the present analysis of these different kinds of diversity, that sustainability in any practical policy context like those addressed here—is a significantly more political matter than is typically conceded in many kinds of academic and policy analysis in this field (Leach et al., 2010). Where appraisal tends to deliver results to policy making that assert singular (apparently prescriptive) pictures of the relative performance of different options for action, then it can have the effect of ‘closing down’ appreciation for the kinds of uncertainties, ambiguities and variabilities documented here (Stirling 2008). Where these are not deliberately illuminated in analysis, their existence will remain correspondingly neglected in policy—and vulnerabilities are exacerbated to strategic behaviour in the design or implementation of analysis.

The crucial question that arises then, in this regard, is about how in the light of all these kinds of diversity, policy actors can reasonably proceed to make decisions on crucial matters like the sustainability of energy or transport infrastructures.¹² The answer here lies in the qualities of humility and reflexivity in appraisal: a willingness to acknowledge that the policy interventions are typically not justifiable purely by means of analysis (Stirling, 2006). It will almost always be the case in complex field like those addressed here that value judgements and other subjectivities will also play determining roles. In this respect, a method like MCM has the virtue that it is rigorous not only about contrasting technical understandings and their respective uncertainties, but also about divergent political and normative positions. By presenting appraisal results in plural and conditional (rather than unitary and prescriptive) ways (Stirling, 2010), a ‘mapping’ method like MCM arguably allows not only enhanced rigor in the illumination of these unavoidable dilemmas, but also greater democratic accountability and social

¹² We thank one of the reviewers for asking these relevant questions.

robustness in the justification of resulting decisions, and as such may have high relevance for policy making. Decisions can still be made, but must be justified as much in relation to explicit evaluative perspectives, as to ostensibly technical analysis. With worldwide political trends increasingly challenging the role of democracy in decision making, this attribute is arguably becoming increasingly salient.

6. Acknowledgements

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Chapter 3.

*Urban mobility experiments in
India and Thailand*

(Paper II)

Duke Ghosh¹, Frans Sengers², Anna J. Wieczorek³, Bipashyee Ghosh⁴,

Joyashree Roy¹, Rob Raven²

¹ Global Change Programme, Jadavpur University, India

² Utrecht University, Copernicus Institute, Netherlands

³ Eindhoven University of Technology, School of Innovation Sciences, Netherlands

⁴ Science Policy Research Unit, University of Sussex, UK

1. Introduction

Asia's rapidly growing cities are gearing up to meet increasing mobility needs while simultaneously striving to achieve sustainability goals. A number of new innovations are being introduced in the form of experiments aiming to change the systems and rule-sets that currently dominate the provision of mobility services in Asian cities. This chapter analyses selected cases of mobility experiments in India and Thailand and explores the strategies that the niche actors deploy to navigate the challenges posed by incumbent socio-technical regimes. The chapter concludes that whilst niche actors tried to stretch-and-transform technological, infrastructural and cultural dimensions of regimes, they opted to fit-and-conform with public policy and political power dimensions.

Many cities in Asia are witnessing an urgency to reorganize, reconstruct and reorient themselves in response to rapid urbanization (United Nations, 2014). Simultaneously, they are striving to conform to the goals of sustainability and liveability (Hildebrand et al., 2013) as 'the battle for sustainability will be won or lost in cities' (Bai et al., 2010: 312). It is widely recognized that experimentation with new socio-technical configurations – whether in the form of 'urban climate change experiments' (Bulkeley et al., 2015), 'urban labs' (Karvonen and van Heur, 2014) or 'niche experiments' (Hoogma et al., 2005) – is a promising but challenging way to bring about sustainability transitions in cities in a variety of societal domains.

As both a driver and an outcome of rapid growth, mobility is an integral part of urban development and one key area where environmental sustainability is proving to be a major challenge (Moriarty and Honnery, 2008; Banister, 2011; GEA, 2012; Geels et al., 2012; IPCC, 2014). Many Asian cities are responding to this challenge by experimenting with new transport technologies and novel mobility practices that embody the promise of sustainability gains. Since these innovative socio-technical configurations seek to undermine some of the established rules of the game, their introduction implies a struggle with incumbent actors and routines. In the context of this struggle, an important research question is: how do the actors involved in these experiments navigate the tensions that arise when introducing such innovations?

In this chapter, we explore four selected cases in cities in India and Thailand to tease out some of the interesting features of the navigational strategies followed by experimental actors. The chapter is built around three parts. First, we discuss the theoretical framework and the research methodology. Next, we delve into the empirical cases to demonstrate the dynamics by

which the actors negotiate the pressures from the incumbent regime. And in conclusion, we summarize our main argument and consider the patterns that emerge from our cases.

2. Empowerment and niche strategies

The ‘sustainability transitions’ literature argues that achieving sustainability requires a systemic and radical change in the way human needs are being satisfied (Markard et al., 2012). Because of their path-dependent character, these systems are often referred to as ‘socio-technical regimes’ that embody the ‘rules of the game’ that structure the provision of particular societal needs such as mobility. Path-breaking innovations offering alternative ways of meeting the needs frequently emerge outside of the regime; that is, in ‘niches’ that act as protective spaces, where experiments with novel socio-technical configurations can develop relatively free of the full brunt of mainstream market selection. A system transformation occurs when radical novelties are sufficiently developed and when the ‘landscape’, defined as a broad exogenous environment, exercises sufficient pressure on the prevailing regimes, alters them and makes them unstable (Geels, 2002).

The process of regime change, however, is not easy because regimes are stabilized on a number of dimensions. Smith and Raven (2012, based on Geels, 2002), depict six such dimensions. The first dimension relates to existing industry structures that encompass established network relations, user–producer interactions, shared routines and heuristics, existing capabilities and resource allocation procedures. The second dimension concerns dominant technologies and infrastructures that are supported by articulated technical standards and infrastructural arrangements. Third is the established knowledge base with its guiding principles and socio-cognitive processes. The fourth covers markets and dominant user practices stabilized by market institutions, supply and demand, price mechanisms, user preferences and routines. The fifth includes status quo public policies and political power stabilized by means of the prevailing regulations, policy networks and relations with incumbent industries. Finally, the sixth dimension considers cultural and symbolic meanings of technology and innovation. As such, socio-technical regimes may lead to premature rejection of alternative novelties, because their costs are not represented in end-user prices, because they require inconvenient user practices, because insufficient resources are attributed to new knowledge development, because they do not fit with existing industry structures, and so on.

To deal with the stability of the regimes and to link to the wider processes of social change, niche actors deploy various strategies. Smith and Raven (2012) identify two different strategies of empowerment. The first strategy involves processes that make niche innovations competitive within unchanged selection environments. This is referred to as a 'fit-and-conform' strategy. In this case, niche protection is no longer necessary and can be removed because the innovation is 'empowered' and its growing competitiveness enables its widespread diffusion. The niche innovation is developed in a way that it fits into and conforms to a relatively unchanged selection environment. The second empowerment strategy can also occur when the niche innovation contributes to changes in mainstream selection environments in ways favourable to that niche innovation (a 'stretch-and-transform' strategy). In this case, some of the niche practices and features are institutionalized as new norms and routines in a transformed regime. Because of stretching and transforming regimes, this strategy is not only dependent on internal niche dynamics but also on the external processes of regime destabilization and changes in the broader landscape context.

To understand the empowerment strategies in our case studies, we take a navigational approach based on following the niche actors. This diverges from the dominant approach in Transition Management that is based on defining the regime from the outset of the study (see, for example, Verbong et al., 2008). By following the niche actors, we can learn about the challenges these actors face in the process of system change, whether through fit-and-conform or stretch-and-transform strategies. In order to understand where the critical tensions and struggles occur, we analyse the regime dimensions – industry structure, technology and infrastructure, knowledge base, public policies and political power, users' relations and markets, and cultural significance and associations of the regime – and identify the type of strategy that the niche actors deploy (fit-and-conform or stretch-and-transform) to link to the wider processes of social change.

We apply this approach to four cases: electric rickshaws in New Delhi, motorcycle taximeters in Bangkok and Bus Rapid Transit (BRT) systems in Ahmedabad and Bangkok. The cases form part of a larger research project carried out in the context of the NWO-WOTRO Integrated Programme on 'Experimenting for Sustainability in India and Thailand: A transitions perspective on sustainable electricity and mobility initiatives' (see Ghosh et al., 2013; Sengers and Raven, 2014, 2015). In this chapter, we highlight the dimensions of 'technology and infrastructure', 'cultural significance' and 'public policy and political power'. These dimensions reveal important controversies and navigational issues in our cases and highlight elements that have been

mentioned as lacking in other accounts of niche experiments and mobility transitions, notably politics/power (Smith and Raven, 2012; Tyfield, 2014) and culture (Sheller, 2012; Valderrama and Vogel, 2014).

The primary means of data collection for this research included semi-structured and exploratory interviews with a range of actors involved in the experiments. Consultations with technology developers and implementers revealed the articulations, motivations and goals of the experiments, as well as the struggles and tensions they confronted. Interactions with policy makers and governments highlighted the dominant paradigms of the existing regimes. Interviews with users and, in some cases, members of civil society helped to reveal a range of socio-cultural perspectives. In addition, we collected secondary data from grey literature.

3. Case studies

3.1 Electric rickshaws in New Delhi

In Indian cities, cycle rickshaws occupy a significant position. As a form of non-motorized intermediate means of transport (IMT) they carry both people and goods across short distances.¹³ The mode provides employment to millions of poor and unskilled people (Rajvanshi, 2002).¹⁴ With little improvement in design, cycle rickshaws have been described as being ergonomically inefficient (Rajvanshi, 2002), causing chronic health problems to the drivers (McMichael 2000).¹⁵ Diseases including tuberculosis, physical weakness, and so on, are common amongst the drivers (Begum and Sen, 2004; Maji et al., 2010; Khan et al., 2012).

Scientists and planners in India have long been trying to re-engineer and redesign cycle rickshaws to improve the drivetrain and reduce stress on the drivers (Maji et al., 2010). These

¹³ Starkey (2000) defines a short distance as 0.5–5.0 km.

¹⁴ Estimates in 2002 revealed that there were about 2 million cycle rickshaws on Indian roads carrying 6 to 8 billion passenger kilometres per year (Rajvanshi, 2002). More recent estimates suggest that there are about 10 million cycle rickshaws in India (SMV Wheels Pvt. Limited, 2011).

¹⁵ 3 Drivers of rickshaws are colloquially referred to as 'rickshaw-pullers'. However, in this article we use the term drivers.

efforts resulted in the development of electric rickshaws (e-rickshaws) driven by a mix of motor and manual power. E-rickshaws were launched in New Delhi in 2008 (Figure 16).¹⁶ In 2010, the Municipal Corporation of Delhi (MCD) decided to replace the fleet of cycle rickshaws with e-rickshaws. This decision resulted in the partial replacement of conventional cycle rickshaws as well as auto rickshaws. In 2013/2014, approximately 100,000 e-rickshaws operated in New Delhi (Chakravarty, 2014). Their introduction influenced the fleet mix in the IMT space in the city but because of the incompatibility of the e-rickshaws with the existing regime dimensions, a number of conflicts emerged. Beyond the various techno-economic conflicts that the actors associated with the experiment had to address, cultural and policy dimensions merit specific attention.



Figure 16. E-rickshaws on the streets of Delhi.

¹⁶ The launch on 2 October was the anniversary of the birth of Mahatma Gandhi. The inauguration was hosted by the Minister of Science and Technology, Government of India and the Chief Minister of New Delhi. The launch was a highly visible affair that demonstrated the political commitment and involvement of these national institutions.

Describing cycle rickshaws as slower and inhumane and auto rickshaws as polluting as a major strategy to garner public support, the e-rickshaw was proclaimed as a 'clean pedicab' (CMERI, 2010). Simultaneously, improved income opportunities were promised for the drivers of e-rickshaws, through higher speed and thus, more passenger kilometres (Maji et al., 2010). This 'stretch-and-transform' strategy linked e-rickshaws to the sustainability paradigm and presented them as having the potential for considerable sustainability gains (Maji et al., 2010) – including health and income benefits and reduction of emission and pollution.

An interesting interplay between the state institutions, political actors and technology developers was evident. E-rickshaw manufacturers designed the technology following Central Motor Vehicles Rules (CMVR)¹⁷. The rules carry a provision whereby vehicles with motor power of less than 250 watts are designated as non-motorized vehicles (NMV). Governed by the rules of the municipal authorities, NMVs enjoy a special legal space.¹⁸ They are not required to have insurance and/or a licence for a driver. The technology developers paid close attention to this provision of the law and restricted the motor power of the vehicles to within this limit. The strategy reduced the net cost of ownership of the vehicle and enabled anyone to drive an e-rickshaw. The strategy helped city authorities to negotiate with the unions controlling cycle rickshaws to substitute cycle rickshaws with e-rickshaws. The MCD permitted e-rickshaws to ply anywhere in New Delhi (Chakravarty, 2014), as no new or additional road infrastructure was required for these vehicles. Cycle rickshaw drivers saw this as an opportunity for accessing larger service areas. As a result, an increasing number of e-rickshaws rapidly filled the streets of New Delhi.

However, within a short time, the e-rickshaws attracted controversy by causing a number of road accidents (TOI, 2014) attributed to untrained and unlicensed drivers. Further, the absence of insurance deprived the victims of compensatory benefits. Additionally, some studies revealed that many of the vehicles exceeded the stipulated motor power (Delhi High Court, 2014). This initiated a debate concerning whether e-rickshaws needed to be regulated by the CMVR. In April 2014, the Central Ministry for Road Transport imposed a temporary ban on e-

¹⁷ CMVR is the legal and regulatory framework that guides issues such as driving licences, motor vehicle registration, and traffic control in India.

¹⁸ The CMVR, administered by the national and sub-national governments, is more or less uniform across the country. However, individual municipal authorities have specific regulations that are outside the CMVR.

rickshaws in New Delhi. Subsequently, the court declared the plying of electric rickshaws in the city as 'illegal' until appropriate legal provisions are in force, citing 'prima facie they are a hazard to other traffic as well as citizens' (Delhi High Court, 2014: 25). The issue is 'sub judice'. This case suggests that the actors navigated through the cultural significance of the regime through 'stretch-and-transform' strategies. They also adopted 'fit-and-conform' strategies to negotiate the legal and policy space of the existing regime. However, the latter strategy backfired as larger legal and social issues were not adequately addressed.

3.2 Motorcycle taxi-meters in Bangkok

In 2010, two entrepreneurs developed a small electronic gadget to be used as a taxi-meter. As opposed to other taxi-meters installed in air-conditioned cabs, this portable device was designed specifically for mounting on the handlebars of motorbikes (Figure 17). Because there is a great, and growing, number of motorcycle taxis in cities throughout the developing world (Gwilliam, 2002; Kumar, 2011) – all of which operate without meters¹⁹ – the entrepreneurs thought that there might be a lucrative market for such a product. However, before any promise of a potential multi-million dollar industry for metered motorbike mobility could be realized, the newly designed device would first have to be trailed and tested in 'real-life' conditions. Because they were based in Thailand, the two entrepreneurs decided to try and set up a small-scale pilot project in Bangkok.

As part of the feeder system essential to the city's mobility, 200,000 motorcycle taxis utilize Bangkok's roads and alleyways on a daily basis. Although over half of the drivers are formally registered, most are nonetheless forced to pay bribes to locally powerful people (army, police, politicians, and so on) who control a particular area. In recent years, however, a number of high-level politicians (most notably ex-prime minister Thaksin Shinawatra), as well as a new union-like association of politically active motorcycle taxi drivers, mobilized to rid the sector of this kind of institutionalized corruption (or 'dark influence' as it was called in a government campaign). One of the key challenges for setting up an experiment with the new metering device

¹⁹ Today, fares are informally standardized or determined through haggling.

would revolve around how to operate within this murky socio-political environment. In other words, how would the entrepreneurs navigate the regime dimension of public policy and political power?



Figure 17. Motorcycle taxi-meter trial in Bangkok.

To start this process of navigation, the two entrepreneurs devised two opposing strategies for the experimental introduction of their taxi-meter. The first potential strategy would be to ‘inject a virus into the system’ that involved the organic, bottom-up introduction of their device by approaching drivers directly. They reasoned that ‘buying out’ a queue and mounting the device on a few motorcycles might give these drivers an edge over their competitors and that their metering gadget might spread like wildfire. Confronted with this new phenomenon, the authorities would eventually need to come to terms with the changed reality and implement some kind of meaningful regulation to address this new technology. The second potential strategy would be to cooperate with government officials from the start. In this scenario, the entrepreneurs would first try to find willing partners inside the transport authority and negotiate on the possibilities for experimentation, possibly setting up a formal pilot project. The advantage here would be that having ‘done the dance’ with government agencies from an early stage would pay off in the long run, through the establishment of a legal fare rate and meters as a legal requirement for all motorcycle taxis.

The entrepreneurs opted for the second strategy, aware that the success of the experiment would hinge on the actions of a bureaucratic system mired in stifling polarization and political crisis. Even if interested officials could be found within the plethora of transport agencies with unclear and overlapping mandates – each with their own interests, affiliations and factions – there would be no guarantee that they would want to work together with the entrepreneurs and, indeed, with each other.

In late 2010, the entrepreneurs – aided by a few charismatic friends whom they perceived as skilled in the art of political navigation – approached government officials. After the deputy governor responded favourably, a public meeting was held by representatives of the governor, the Ministry of Transport, the Treasury Department and district chiefs of police. All parties pledged their support in setting up an experiment. In the process of negotiating the details of the upcoming trial, some of the authorities suggested that a massive demonstration project be conducted by supplying meters to all the motorcycle taxi queues around Victory Monument, one of the city's busiest traffic intersections, with the media present in full force at the launch. The entrepreneurs rejected these suggestions, because they feared that some actors might then publicly oppose the device for political gain. They would rather conduct a small-scale trial elsewhere with less at stake.

In late 2011, a small-scale trial was started in another part of town with only 30 devices and with the support of local police chiefs and two groups of drivers. Up to this point, the union-like motorcycle taxi association had been excluded because many of the involved officials did not view it as a legitimate stakeholder. One week into the trial, however, the entrepreneurs sent an envoy to the association headquarters armed with three things: a device (to demonstrate how the taxi-meter worked), an iPad (to show a movie clip of the experiment), and a bouquet of red roses. The colour red was not a coincidence since the entrepreneurs viewed the association as supporters of ex-prime minister Thaksin and the red-shirt movement established in his tracks. As a gesture of approval, the association presented the entrepreneurs with their association flag.

As such, the 'going to government' strategy combined with the appeasement of the motorcycle taxi union was not geared to directly challenge power relations. Rather than seeking to 'stretch-and-transform' the motorcycle taxi system, it points to a cautious approach geared to 'fit-and-conform' to political power as a way of navigating the socio-political context. Reflecting on this process of political navigation in setting up the experiment, one of the entrepreneurs recounted: 'of course you never know what's really going on in the inside ... but

at least those people in power didn't look at [the device] as a threat'. In the eyes of the entrepreneurs, however, equipping motorcycle taxis with their device had broader implications. In their view, the device was more than a meter; it was a platform upon which additional functionalities could be built, such as a black-box recorder to be called on in case of an accident and a GPS tracker to realize localized advertising to passengers. As a technology of surveillance, such a device might reshape power relations to the detriment of the drivers, but as a technology of mediation it might work to their benefit. The mere fact of having a motorbike with a meter conveys the image of a 'bona fide' taxi driver, which could be instrumental in legitimizing the motorcycle taxi profession. Indirectly, we might speculate, if motorcycle taxi drivers perceive this as a way to empower themselves and their profession, it could possibly even help to undermine the reproduction of certain informal institutions such as paying informal site rent and the associated chain of privilege and corruption. Argued along these speculative lines, the entrepreneurs represent their device as a 'mediating technology (Furlong, 2010: 1) – a small piece of additive technology, which might be capable of bringing about big changes by shifting long-accepted socio-technical relationships in cities. As such, it represents a potential Trojan horse geared to 'fit and – eventually – transform' public policies and political power.

3.3 Bus Rapid Transit (BRT) in Ahmedabad

Like most Indian cities, Ahmedabad's mobility regime is marked with the coexistence of various modes of transport – motorized and non-motorized, public and private. Ahmedabad Municipal Transport Services (AMTS) is a major actor in the provision of public buses, a service that has deteriorated over the years (Mahadevia et al., 2013). This made the public transport regime in Ahmedabad unstable. Rapid economic growth of the state had also contributed to a gradual modal shift towards motorized and private transport. The shift resulted in traffic congestion, air and noise pollution and other negative impacts.

It was against this backdrop that the JANMARG BRT project was launched in 2006. The goal was to meet the demand for faster and reliable public transport to provide access to the expanding limits of the city, while simultaneously addressing congestion and environmental problems. Operational since 2009, the JANMARG BRT consists of a fleet of sophisticated buses that runs along dedicated corridors (Figure 18). The project was supported by India's national

government through the Jawaharlal Nehru National Urban Renewal Mission (JnNURM) and National Urban Transport Policy (NUTP). However, in its attempts to displace private vehicles, this experiment faced challenges in coexisting with and competing against the private transport regime. In discussing some of the strategies through which the actors navigated these challenges, we focus on the regime dimensions of technology and infrastructure and cultural significance.

The existing regime infrastructure had already been proven inadequate to handle the traffic of the city. Using the existing infrastructure for the BRT experiment would have meant compromising on the speed and time of public transit while further aggravating congestion. Thus, the BRTs would become a source of irritation to the citizens of Ahmedabad. To overcome the challenges posed by the incumbent infrastructure, the actors decided to create dedicated BRT corridors. This approach allocated a separate space for the BRTs and ensured that the existing traffic remained unaffected. Together, based on the results of user surveys, the actors accorded importance to the provisioning for IMT and non-motorized transport that would act as 'feeders' to the BRT. Dedicated footpaths and cycle lanes were integrated in the infrastructure design for the BRT. As such, a potential co-benefit of the project involved more facilities for walking and cycling, even amongst non-BRT users. The actors asserted that the experiment not only created new infrastructure but fostered a systemic change in the overall mobility infrastructure of the city.

The experiment was positioned as a constellation of a set of new and novel technologies – markedly different from the technologies existing in the incumbent system. Buses with improved fuel efficiency (promising reduced emission per unit of distance travelled) and exhaust (promising reduced pollution), and an intelligent tracking system (promising reliability) were introduced. With the systemic change in the infrastructure and deployment of novel technologies, the actors described the experiment as a 'sustainable' and 'reliable' solution to the anticipated increase in future transport demand. The actors successfully communicated the promises of sustainability gains accruing from the experiment, together with the shortcomings of the regime in harnessing financial resources required for the experiment. Notably, the articulations and communications were based on a high degree of background research and knowledge support by academic institutions and policy research organizations to underpin their claims.



Figure 18. Bus Rapid Transit in Ahmedabad.

Further, the actors stated clearly that the experiment was not intended to replace the different existing modes of transport. Rather, the BRT would stretch the limits of the incumbent mobility infrastructure while ensuring that the experiment also fitted comfortably into the regime by complementing other modes of transport. The technology strategy was ‘stretch-and-transform’, while the cultural strategy was ‘fit-and-conform’, promising a comprehensive and sustainable transport network in the city of Ahmedabad.

In developing economies, vehicle ownership shares a positive relation with rising economic affluence and social status (Gakenheimer, 1999). Against this cultural backdrop, the experiment in Ahmedabad needed to increase acceptability of the public BRT and induce drivers to shift away from private vehicles. Simultaneously, the experiment had to struggle also against the cultural bias of buses as a service for low-income residents. Further, when many other cities in India (e.g. Kolkata, New Delhi, Mumbai) were expanding or implementing metro rail, pitching for the BRT was a challenge. Strategies were designed to promote a positive image of buses and make the system acceptable to the public. By nature, these strategies were ‘stretch-and-transform’.

Naming the system ‘JANMARG’, meaning ‘people’s pathway’ was a device to signify ‘inclusivity’. Further, at the inception stage, the transit system was framed as connecting to the

need for an ‘international look of Ahmedabad’ (Mahadevia et al., 2013).²⁰ The United Nations highlighted this project to demonstrate how addressing climate change is not a burden (Goswami, 2012) and this endorsement was advertised heavily to enhance the image of the BRT. Buses plying in the BRT are designed for improved comfort and convenience when compared with conventional buses, while the use of an Intelligent Tracking System (ITS) helped increase their predictability and reliability. These are a few of the strategies to transform the negative notion of public transport in the existing regime. Summing up, the BRT experiment in Ahmedabad adopted both ‘fit-and-conform’ as well as ‘stretch-and-transform’ strategies of empowerment.

3.4 Bus Rapid Transit in Bangkok

If cities are characterized by the modes of transport that dominate everyday mobility, then Bangkok can be viewed as a traffic-saturated ‘bus city’ (Barter, 1999) where most people depend on inadequate public buses or informal bus services (minivans, converted pick-up trucks, and so on). While the privileged middle-class car drivers are the root cause of increasing congestion, buses still constitute an important and affordable option for many Bangkokians.²¹ In the 1980s, Bangkok had a reasonable network of bus-only lanes but with rapidly growing car ownership, the network became increasingly ineffective due to a lack of enforcement and faded into oblivion (Marler, 1982; Tanaboriboon, 1992). Thirty years later, faced with massive congestion and an increasingly pervasive regime of unrestrained (car-based) motorization, a number of actors set themselves the task of rebuilding a niche for priority bus-based transport. Under the auspicious label of BRT, they have recently created a system based on fancy air-conditioned buses, smart card payment, elevated boarding platforms and, of course, dedicated busways. The

²⁰ The process involved citing examples of cities like Curitiba, Sao Paulo, and Beijing where BRT systems have been successful.

²¹ Over the last 15 years, Bangkok also developed two fast, efficient urban rail systems to cater to a privileged audience and ‘splinter’ the infrastructural city (Graham and Marvin 2001). In terms of the number of trips, bus-based modes (36 per cent) are far more prevalent than urban rail (4 per cent) in Bangkok (IBP 2013).

story of implementing the pilot route of the Bangkok BRT system in 2010 can be seen as struggle to 'stretch-and-transform' the regime dimension of technology and infrastructure.

Around the turn of the millennium, inspired by a successful and revolutionary BRT system in the city of Bogota, Colombia, the idea of a new comprehensive bus system with bus-only lanes became popular among transport specialists and policy makers in Bangkok. Two different coalitions of experts developed their own BRT plan. One group was mandated by a national-level authority (OTP), the other group by a city-level authority (BMA). Because both authorities controlled different parts of the city's road infrastructure, it was unclear who would be in charge of designing and implementing the new system. Eventually the city-level authority won out and their ideas were embraced by Apirak Kosayodhin, a politician who used the promise of a BRT system as part of his electoral platform to successfully run for governor of Bangkok.

When the first pilot route was opened in 2010, it was difficult to lay claim to the allocated road space in practice. Some motorists in Bangkok were impatient with the heavy traffic and would use the BRT-only lane. The police often turn a blind eye to this kind of behaviour, because of their everyday battle with chronic congestion, much the same as they had done with the busways of the 1980s. The city's heavy traffic burden and constant gridlock created a situation in which police officers spent much of their time trying to relieve traffic jams. They viewed it as their mandate to 'make the traffic flow' and to them the idle BRT-only lane offered additional space. Owing to objections by car drivers and police, certain stretches of BRT-only were soon no longer formally off-limits to general traffic during rush hour (Figure 19). 'Bangkok BRT never reached its full potential ... it functions like a cripple', complained one of the interviewed consultants responsible for its design and implementation, 'the problem is that we have compromised too much on dedicated road space'.

The BRT-only lane, which was designed and constructed to ensure that buses could move quickly and unimpeded, is a defining feature that makes or breaks a BRT system (ITDP 2013). This type of dedicated infrastructure was incompatible with the paradigm of unrestrained motorization and the idea that a single-occupant car has the same right to the road as a bus filled with passengers. In the struggle to 'stretch-and-transform' technologies and infrastructures, BRT represented an alternative socio-technical configuration that conflicted with the aims of car drivers (whose road space was taken away) and the traffic police (whose mindset was geared to regulate mixed traffic situations). In a situation where, old routines of regulating traffic proved obdurate and where a growing number of middle-class car drivers

wielded considerable power, the struggle for road space and a transition to infrastructural systems based on a different logic provided a significant challenge.



Figure 19. Bangkok BRT bus stuck in traffic in its own lane.

4. Conclusion

In this chapter, we have summarized four distinct mobility experiments in three Asian cities, with an aim to unpack the ways in which niche actors try to navigate tensions emerging from a mismatch with regime structures. Experiments compete against complex, multi-dimensional regimes of urban space, suggesting that navigational strategies occur on various dimensions. This chapter has demonstrated that navigational strategies are different across regime dimensions – that is, whilst experimental actors may follow a fit-and-conform strategy in one regime dimension, they may follow a stretch-and-transform dimension in another, depending on the particularities in each case and how these are assessed by the actors involved in experimentation. Nevertheless, a pattern is emerging from the analysis. Stretch-and-transform strategies occurred in the technology and infrastructure dimension (BRT experiments in both cities) and cultural significance dimension (e-rickshaws and BRT in Ahmedabad). In the case of public policy and political power, the strategies found are fit-and-conform (e-rickshaws and motorcycle taxi-meters) in nature. An explanation could be that niche actors perceive stretching-and-transforming political power to be too risky, as suggested by both cases in Bangkok. Whether or not a socially just sustainability transition in India and Thailand is possible without rebalancing political power, is a question for future research.

Chapter 4.

Mapping socio-technical change in mobility regimes:

The case of Kolkata

(Paper III)

Bipashyee Ghosh¹, Johan Schot¹

¹Science Policy Research Unit, University of Sussex, UK

Abstract

Mobility systems in megacities are facing persistent sustainability problems. A focus on regime shift in transitions literature in addressing these problems reflects a western bias as it relies on niches as sources of change. In megacities like in Kolkata, India, public transportation is dominant, and actors are more concerned to improve and upgrade a variety of public transport regimes. In this paper, we develop a framework for such regime analysis and explore regime transformation as a pathway in between regime optimisation and regime transition pathways. Drawing from evolutionary and institutional theories of socio-technical change, we characterised these three pathways of regime change through changes in trajectories, rules and selection pressures. Applying this novel framework, we study socio-technical changes in the past 15 years in multiple urban public transportation regimes in Kolkata through a mapping tool which may be useful in policy contexts. We find that regime actors can act as front-runners in these change processes and that meta-rules guide directionality of change. We conclude on how sustainability transitions can happen right away within existing regimes, without recourse to niche development.

Keywords

Regime transformation, sustainability transition, regime rule, public transport, urban mobility, megacity

1. Introduction

Megacities around the world are witnessing acute sustainability problems in mobility systems. Transport is by far one of the most polluting sectors and a major source of social injustice and inequality issues related to citizen's mobility (Mullen and Marsden, 2016; Busby and Shidore, 2017). In this article, we will address persistent mobility problems in one of the largest megacities in India, namely Kolkata. Public transportation is the dominant system for mobility in Kolkata and consists of a wide variety of road, rail and water-based systems like metro, trams, trains, buses, ferries, auto-rickshaws, cycle rickshaws etc. Actors in Kolkata are responding to these persistent mobility problems by improving the existing public transportation system, instead of substituting it for alternative systems. Such improvements are seen in the sustainability transitions literature as regime optimisation which may enhance the performance of the regime but will never be sufficient for confronting persistent problems. The latter needs a regime-shift or a transition (Grin et al., 2010; Elzen et al., 2004).

In this article, we argue that a sole focus on transitions as regime-shifts reflects a western bias. By the term western, we refer to a transition pattern which tends to be dominant in specific contexts, such as Western Europe, the USA and Japan. Patterns that are different from that observed in these contexts can be considered non-western. Other similar distinctions could be used such as Global North and South, developed and developing world. All of them have a geographical reference but are not bound by geographical markers. Instead, they represent specific transition patterns, compared from the perspective of the west, Global North or the developed world. In western contexts, mobility transition predominantly means shifting away from the carbon and energy-intensive private automobility regime or "car culture" and towards shared and mass transport systems (Geels et al., 2012; Mattioli, 2016; Cheyne and Imran, 2016; Sovacool, 2017). Most transition case studies in the west focus on niche experimentation with car-sharing, automation and electrification (Truffer, 2003; Bergman, 2017; Sprei, 2017). These niche innovations may be present in non-western cities such as Kolkata, the case-study for this article; however, they are not the dominant way of approaching problems that Kolkata is experiencing every day. Kolkata is a densely populated city where a majority of people rely heavily on many forms of public transportation for everyday life. Regime actors involved in governing and operating public transportation systems in Kolkata are heavily invested in expanding, modernising and improving the existing public transport system of the city in order

to address sustainability issues without necessarily reducing the variety of options. This, we argue in this paper, to be of no less importance than a transition to a new system and should perhaps not be perceived as just optimising the existing old-fashioned and outdated regimes. We thus need more nuanced ways of understanding and analysing regime-change prompted by regime actors without relying on niche innovations. For this purpose, we would mobilise the concept of transformation.

In the sustainability transitions literature, the term 'transformation' is commonly used, loosely referring to 'wider', 'societal', 'gradual', 'large scale' 'structural change' processes (Sengers et al., 2016; Raven et al., 2017; Wieczorek et al., 2017). Many authors have used the notion of transformation and transitions interchangeably (Hölscher et al., 2017; Patterson et al., 2016). Some have defined an opposition: transitions being more top-down and transformations being more bottom-up (Stirling, 2014; Scoones et al., 2015). Whatever is the case, scholars engaging with either transition or transformation concepts or both, share a "common interest in understanding and supporting desirable societal change" (Hölscher et al., 2017: 2). In this paper, we have built on authors who define transformation as a specific pathway, but we use a new method to operationalise the differences between the pathways. Geels and Schot (2007; see also Geels and Kemp 2007) identified four transition pathways next to the regime optimisation pathway. Three of them are niche based: substitution, reconfiguration and de-alignment and re-alignment, while the fourth transformation pathway relies on actions taken by regime actors. More in general transitions literature has so far attached incumbency and resistance to change to regime actors, while niche actors are considered real 'innovators' who drive transitions (Geels, 2002; 2004). Many studies continue to emphasise niche creation and regime destabilisation as central to transitions (Geels et al., 2017; Roberts, 2017). Recently, there is an emerging literature which recognises the role of incumbents or regime actors in driving regime change (Kungl, 2015; Geels, 2017, van Mossel et al., 2018). Mobilising the transformation pathway, this paper can be situated in the later stream of literature since we put more emphasis on change coming from within the regime. Most importantly, however, we offer a systemic way of mapping regime optimisation, regime transformation and regime transition pathways (bringing all niche-based pathways from Geels and Schot (2007) under the umbrella of the third pathway) building on a new operationalisation of the regime concept. This allows us to answer our research question: how can we analyse different pathways of change in socio-technical regimes comprising public transportation system in Kolkata?

As we will show from our literature overview, despite the importance of the regime concept in the sustainability transitions literature, it has not been operationalised adequately for in-depth analysis. In order to understand the differences between various change patterns, we revisit the evolutionary and institutional foundations of the regime concept which then lead us to a new framework for mapping regime change. This framework will allow us to decide whether a pathway can be considered optimisation, transformation or transition. This is important because we get a better understanding of various pathways for unlocking existing unsustainable socio-technical systems and moving to more sustainable ones. Furthermore, it may help regime actors to unlock the potential of prevailing public transportation systems and work on a plurality of possible pathways from optimisation to transformation and transition – necessary for addressing the persistent problems in the mobility system of non-western megacities.

In the next section, we review the literature to unpack the regime concept and various pathways of socio-technical change. In section 3, we introduce our theoretical framework. This includes a set of propositions for distinguishing between regime optimisation, regime transformation and regime transition. In section 4, we propose the methodology for the case-study. In section 5, we present the analysis. The results are discussed in section 6 and conclusions are drawn in section 7.

2. Literature review

2.1 Evolutionary origins of regime concept

The origins of the regime concept as used in the sustainability transitions literature lie in the evolutionary theory of technical change (Nelson and Winter, 1977; Nelson and Winter, 1982; Dosi, 1982). The technological regime was defined as “technicians’ beliefs about what is feasible and at least worth attempting” (Nelson & Winter, 1977: 57). They argued that technicians’ beliefs are bounded, work in a specific direction and thus result in trajectories. Regimes are structured by shared and collective beliefs, routines (which can be formal or tacit) and heuristics (which make search processes less random, thereby promising but not guaranteeing success) (Rip, 1992). These beliefs or as Simon (1982) calls ‘bounded rationalities’ guide technical change in particular directions, leading to incremental innovation along “natural trajectories” (Nelson

and Winter, 1977: 56-57). In other words, a regime not only defines boundaries but also “trajectories to those boundaries” (Nelson and Winter, 1977, p. 57). Nelson and Winter (1977) assume that regimes come from scientific breakthroughs, and/or combinations of cumulative scientific developments and engineers and scientist are the carriers of the regime. As a range of incremental innovations emerges along the trajectories, the market competition acts as an ex-post selection pressure which decides which innovations get a chance to be developed (Dosi, 1982). This is Darwinian selection mode, where blind variation and selective retention are dependent on existing routines and operate within firms that embody those routines (and technical options) (Schot, 1998; Schot and Geels, 2007). In this path-dependent process of evolution of regime, it is impossible to know ex-ante, about which options will be successful owing to a lack of sense of direction.

Dosi (1982) challenged the concept of a technological regime with ‘technological paradigm’ and introduced the idea of ex-ante selection (p. 155). Ex-ante refers to firms making choices before the setting of market selection. In biology, this is Lamarckian selection - which is not blind but directed based on fundamental decisions made by scientists, engineers and firms. Dosi (1982) defines technological paradigm as “a "model" and a "pattern" of solution of selected technological problems, based on selected principles derived from natural sciences and on selected material technologies” (p. 152). Actors can choose between paradigms, sets of technological trajectories within a paradigm; and further options within each technological trajectory. Dosi (1982) stressed that technical change is cumulative, directed and selective. Choices within each trajectory are ex-post Darwinian selection, while Lamarckian ex-ante selection leads to choices in a set of trajectories and consequently shift in technological paradigm.

Ex-ante selection not only operates through scientific discoveries but is also based on promises and expectations of the future success of specific scientific and technological options (Van den Belt and Rip, 1987; Rip, 1992). This then drives scientific exploration as actors engage in strategic games that are intentional and in anticipation of future market selection. This might lead to breakthroughs and exemplary achievements like paradigm or regime shift by bringing together a set of heuristics as well as a cultural matrix of expectations (Van den Belt and Rip, 1987: 138). Actors voice, articulate, negotiate and stabilise expectations about technological possibilities, which subsequently structures future developments (Van Lente, 1993). Stable

expectations are translated into rules and routines which orient future trajectories.²² This dynamic is what Rip (1992) as quasi-evolutionary since the ex-ante expectations provide a strategic direction and guide the "steps in the process of variation and selection [which] may be more important than the properties of a technology at any particular moment." (p. 92). The work on quasi-evolution led to (and fed into) the development of several new fields of research like sociology of expectations (Brown and Michael, 2003; Borup et al., 2006; Van Lente, 2012), strategic niche management (Kemp et al., 1998; Hoogma et al., 2005; Schot and Geels, 2008), Multi-level perspective (Geels, 2002) - which informed the development of the four transition pathways by Geels and Schot (2007).

2.2 Socio-technical regime and rules

Sociological elaboration of the quasi-evolutionary model led to further development of the regime concept. In quasi-evolutionary theory, heuristics and routines are crucial to explaining technical change. But how do these routines operate? How do they relate to the agency of actors? These questions led to the introduction of the sociological rule concept derived from the work of Giddens (1984). Schot (1998) argues that heuristics and routines follow cognitive, social and institutional structures.

At the same time, the concept of the technological regime was broadened to socio-technical regime due to a broader set of actors involved in the quasi-evolutionary model of transitions thinking. Rip and Kemp (1998) defines socio-technical regime as: "the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills, and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures (p.338)." This is built on Science and Technology Studies work arguing about there is a deep relationship between the social and the technical and the fact that technological change is not a process dominated by engineers and scientists (Pinch and Bijker, 1984; Bijker et al., 1987). This was an important step, not only because it recognises social groups like users, businesses, policymakers, NGOs as

²² The concept of expectations was also central to early actor-network theory work in particular by Callon (1987) who stressed the dynamics between actor-worlds (expectations) and actor-networks. This dimension was lost in later actor-network work.

innovators, but also because it means that regimes consist of different type of rules, not just heuristics which guide engineers. Other types of rules include those in user preferences, policy and governance mechanisms, industry structure and strategy. Subsequently, it becomes possible to make a distinction between strong regimes in which these different rules (and actors) are aligned and weaker regimes in which they are less aligned. Alignment refers to rules reinforcing each other, being coordinated and working in the same direction. It does not mean full consensus among all actors. In general, one might assume that rules are never fully aligned, and therefore it makes sense to refer to regimes as semi-coherent (Rip and Kemp, 1998; Geels 2004).

Building on neo-institutional theory (DiMaggio and Powell, 1983; Scott 1995), Geels (2004) argues that regimes contain three types of rules: Formal/regulative, cultural-cognitive and normative ones. Regulative rules are laws, regulations and standards; cognitive rules are belief systems, guiding principles, problems definition, heuristics and normative rules are role relationships, values and behavioural norms. Each group of rules evolves along a regime dimension, forming a trajectory (science and technology; policy and governance; Industry structure and strategy, market and user preferences; social-cultural meaning). Both steps together create a matrix as presented by Geels (2004, p. 906). A clean version of this table is reproduced below.

Table 5. Examples of regime rules [derived from Geels, 2004: 906]

	Formal/regulative	Cognitive	Normative
Technology and product	<ul style="list-style-type: none"> - Technical <i>standards</i> - Product <i>specifications</i> - Functional <i>requirements</i> - Accounting rules to establish profitability for R&D projects - Expected capital returns rate for investment - R&D <i>subsidies</i> 	<ul style="list-style-type: none"> - <i>Search heuristics</i> - <i>Routines</i> - <i>Exemplars</i> - <i>Guiding principles</i> - <i>Expectations</i> - Technological <i>guideposts</i> - Technical <i>problem agenda</i> - presumptive <i>anomalies</i> - problem-solving <i>strategies</i> - technical <i>recipes</i> - user <i>presentations</i> 	<ul style="list-style-type: none"> - Companies own <i>sense of itself</i> - <i>authority structures</i> in technical communities or firms - testing <i>procedures</i>

		<ul style="list-style-type: none"> - <i>interpretative flexibility</i> and technological frame - <i>classifications</i> 	
Science	<ul style="list-style-type: none"> - Formal research programmes - professional boundaries - rules for government subsidies 	<ul style="list-style-type: none"> - <i>Paradigms</i> - <i>Exemplars</i> - <i>criteria and methods</i> of knowledge production 	<ul style="list-style-type: none"> - Review procedures for publication - <i>norms</i> for citation - academic <i>values</i> and norms
Policy	<ul style="list-style-type: none"> - Administrative <i>regulations</i> and procedures which structure the legislative process - formal regulations of technology - subsidy <i>programs</i> - procurement programs 	<ul style="list-style-type: none"> - <i>Ideas about effectiveness</i> of instruments - guiding principles - problem agendas 	<ul style="list-style-type: none"> - Policy <i>goals</i> - <i>interaction patterns</i> between industry and government - <i>institutional commitments</i> to existing systems - <i>role perceptions</i> of government
Social-cultural	<ul style="list-style-type: none"> - Rules that structure the <i>spread of information</i> - production of cultural symbols 	<ul style="list-style-type: none"> - <i>Symbolic meanings</i> of technologies - <i>ideas about impacts</i> - <i>cultural categories</i> 	<ul style="list-style-type: none"> - Cultural values in society or sectors - <i>ways</i> in which users interact with firms
Users, markets and distribution networks	<ul style="list-style-type: none"> - <i>construction of markets</i> through laws and rules - <i>property rights</i> - product quality <i>laws</i> - liability rules - market subsidies - <i>tax credits</i> to users - <i>competition</i> rules - safety requirements 	<ul style="list-style-type: none"> - User <i>practices</i> - user <i>preferences</i> - user <i>competencies</i> - <i>interpretation</i> of functionalities of technologies - <i>beliefs</i> about efficiency of (free) markets - <i>perceptions</i> of what 'the market' wants 	<ul style="list-style-type: none"> - Interlocking <i>roles and relationships</i> between users and firms - Mutual perceptions and expectations

The article (Geels, 2004) is highly cited, but the matrix of rules and trajectories is hardly applied systematically. One exception is an article by Verbong and Geels (2007), where rules are mapped in the regime transformation in Dutch electricity system (1960-2004). Their analysis of rule changes is suggestive and not comprehensive. This is symptomatic for the sustainability transitions literature.

3. Regime change framework

Using the regime dimensions and rules outlined by Geels (2004), we aim to make a more systematic and measurable distinction between regime optimisation, regime transformation and regime transition. Regime change starts with a regime becoming less coherent, often leading to more political tensions between actors. This happens when actors do not share rules, and they begin to question and change them, which may eventually lead to a regime transformation or transition. Among the three types of rules, regulatory rules we assume can be seen as less fundamental than a change in cognitive rules because they can be adopted for instrumental reasons without a change in cognitive beliefs of different social groups. Cognitive rule changes of scientists and engineers may lead to the development of new standards, which then influences new user preferences and eventually lead to the construction of new markets and new relationships between users and producers. Other routes are possible too. New relationships and new norms represent a change of normative rules, which are even deeper and more fundamental change than cognitive ones. Moving away from the matrix of Geels (2004), we suggest that changes in normative rules are not specific to trajectories. Normative rules set the 'ground rules' through universal values and norms that guide the operation of the whole regime.

To be able to make a distinction between regime optimisation, transformation and transition, we argue for a threshold when the optimisation turns in either to transformation or transition. Using the quasi-evolutionary concepts of trajectories, rules and ex-ante and ex-post selection pressures, we propose characterising each pathway of regime change as follows:

a) Regime optimisation:

Characterised by i) change in at the most two individual regime dimensions forming different trajectories, which will let the regime perform better on those dimensions; ii) Change in regulative rules and rarely cognitive rules, while normative rules remain unchanged; iii) Change originates from and generates ex-post selection pressures which are competition and response to current problems.

b) Regime transformation:

Characterised by: i) change in three or four regime dimensions forming a bundle of trajectories which are aligned and connected with one another and together shapes a common directionality of change. We propose changes in three dimensions (out of five, see below) as a threshold for transformation because change is more systemic with new trajectories emerging in more than half of the number of dimensions - having a deeper impact on the regime. We call the bundle of trajectories - a 'super-trajectory', characterised by the alignment and shared connection between three or four new trajectories, which results in a substantial redirection of the socio-technical regime; ii) Change in regulative as well as cognitive rules. Normative rules, still stay mostly stable, even though there are indications of emerging new norms; iii) Change comes about through a mix of ex-post and ex-ante selection pressures.

c) Regime transition:

Characterised by i) change in all regime dimensions, representing a shift in paradigm, which is a complete redirection of the socio-technical system; ii) Change in all three types of rules particularly normative ones; iii) Change originated mainly from ex-ante selection pressure, leading to niche construction, thereby investment in socio-technical alternatives.

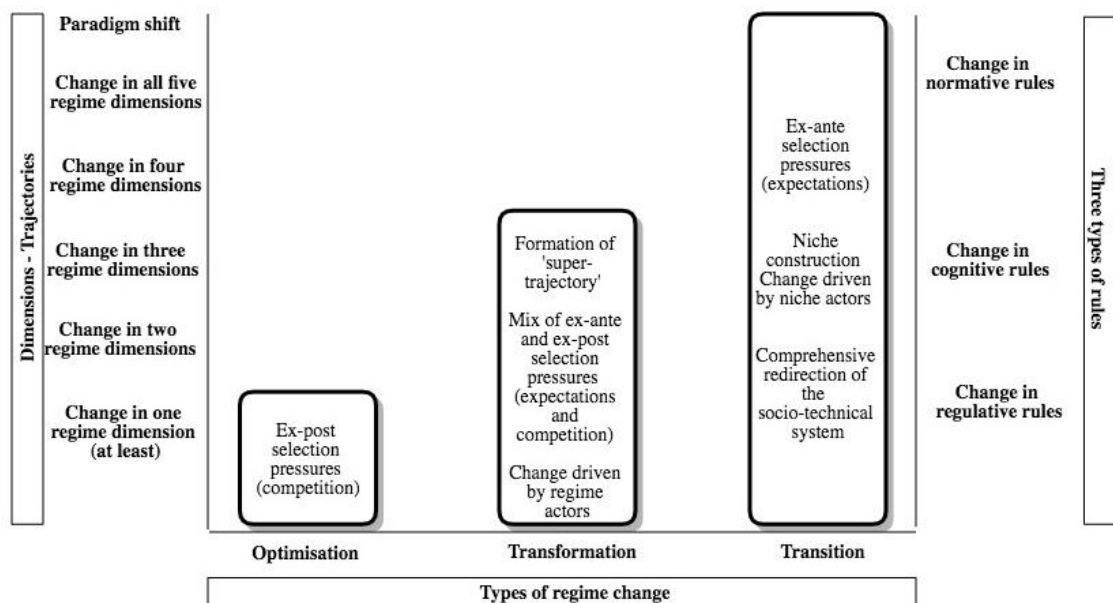


Figure 20. Regime change framework

To explore these propositions, we suggest three steps for application of the framework.

Step 1: Identify new trajectories across regime dimensions

Reviewing sources like Geels, (2002: 1263; 2004: 906) and Sengers and Raven (2014: 456), we came up with five regime dimensions:

1. Science and technology – includes design, artefacts, engineering side as well as the knowledge and research used to develop & justify technological decisions;
2. Policy and governance – includes policy directions, ideas, measures, mechanisms to govern
3. Market and users – includes market size, market composition, user preferences, and projected user preferences by producers and policymakers.
4. Industry structure and strategy – includes supply-side actors and arrangements, planning for operation, financing, service provision, maintenance and other aspects of day to functioning.
5. Socio-cultural dimension – includes acceptance and symbolic meaning of change in society – considering gender, ability and income class aspects.

Step 2. Identify change of rules along each regime dimension

Three types of rules can be identified following keywords based on Table 5. We expect that normative rules (defined in terms of deep underlying values and norms) are shared across all dimensions of the regime since they “define legitimate means to pursue” beliefs and standards (Scott, 2001: 55). Cognitive and regulatory rules might also be shared, but beliefs, expectations, laws and standards (constituting cognitive and regulative rules) are more likely to be specific to each regime dimension.

Step 3. Identify ex-ante and ex-post selection pressures

This step is to identify mechanisms for change: whether changes originate from ex-post selection or ex-ante selection pressures. An ex-post selection means response to existing problems and competition, mainly through new regulative rules. Ex-ante selection captures actors’ anticipation of future problems that they feel cannot be solved by following current rules. This is often manifested through the change in cognitive and normative rules.

4. Case selection and methodology

Using the framework, in the next sections we attempt to characterise ongoing changes in the public transportation regimes in Kolkata. Kolkata is the capital city of the state of West Bengal, located in east India. It is the fourth most populous city in India and one of the most densely populated cities in the world (World population review, 2017). The majority of its population belong to lower middle-income group – 53.68 per cent earning 15,000 - 30,000 Indian rupees (\$250-500) per month (Government of West Bengal, 2008). A ‘tiny minority’ of the population, which is the wealthier class, can afford a car (The Guardian, 2014). As a result, Kolkata has the lowest percentage of private car ownership among all megacities in India (Bansal et al., 2016). Despite low car ownership, Kolkata has one of the highest rates of peak hour congestion in the country (Chin et al., 2018). This results from lowest percentage of space available for transportation (6% of total land) coupled with high travel demand (Government of West Bengal, 2008). Majority of Kolkata’s citizens heavily rely on public transportation for their day to day mobility purposes. Kolkata offers an incredible variety of road, rail, water-based public transportation which requires attention for the mobility system to be more sustainable in the future. In the past decade, there have been “ambitious plans to expand transport networks [in the city], especially by building modern metro lines.” (Chin et al., 2018: 10). Many of the ongoing changes in public transportation are targeted to attract potential car users back towards public transport. These facts suggest that in order to understand sustainable mobility transition in Kolkata, we need to study changes in existing and dominant public transport regimes, instead of analysing a shift from private to public transport as is often done for western contexts (Geels et al., 2011).

Focussing on the public transportation system of the city, we define the socio-technical configuration around each of the different public transport modes in Kolkata as a socio-technical regime. The bus, metro or auto-rickshaw systems have their respective actor-networks, technologies, and rule-sets which qualifies them as independent regimes (Geels, 2004). These regimes could also be seen as ‘sub-regimes’ constituting the overarching ‘public transport regime’ of Kolkata (Elzen et al., 2011). However, for this paper, we treat them as individual regimes since our primary aim is to map different pathways of change in each of the mode-centric systems. This leaves open questions about multi-regime dynamics. We come back to this issue in the final section.

The empirical data for this research is collected through semi-structured interviews, reports, government notices and statistical data accessed during two phases of fieldwork in Kolkata

[October 2015-January 2016 and November 2016-January 2017]. The primary objective was to explore changes in the different transport regimes in Kolkata in the past 15 years. Twelve transport experts and professionals were interviewed (as shown in Appendix I), to gain knowledge about problems faced by the specific regimes; regime actor's expectations about the future of the regime; how do they see these expectations to be fulfilled and what are the planned course of action. The interviews were done with regime actors, but given the focus on the paper, this seems adequate. Each interview lasted an hour on average. The interviews provided the basis for identifying the emergence of new trajectories by prompting new rules such as new regulations, changing beliefs and underlying values. This understanding was enriched through insights gathered from informal conversations with government office employees (while waiting for scheduled interviews), transport operators (while commuting), professors and researchers in local university (who helped find many more sources and reach interviewees) and middle and lower-income citizens (users of public transport) during fieldwork. These personal communications were further complemented by and validated through information from documents, including statistical data about routes, passengers in the respective regimes; governmental notifications on route rationalisation, issuance of permits, policy reports like comprehensive mobility plan, metro-rail 'detailed project reports' (DPR)s. These data were triangulated by information from sources like local and national newspapers accessed online, posts and interactions in social media and previous case studies published in books and journals. This triangulation exercise was done between January and March 2018.

This data collected during and after the fieldwork was mobilised to identify new rules in particular dimensions in each regime. The key method of operationalising the framework for case analysis was locating rules through interpretation of the data primarily by the first author, followed by in-depth discussion, re-interpretation and evaluation of the robustness of the results by both authors. The subsequent challenge was placing changes in rules in the 'right' boxes in the mapping tables. This challenge was navigated through debating many aspects between authors in several phases. These aspects are 1) the type of rule indicated in a particular interviewee's statement or document; 2) the dimension of regime in which the rule change applies, 3) whether the selection pressure identified in, for instance, the objectives of policies are ex-ante or ex-post selection pressure; 4) whether or not there is a change in norms in the particular regime. The authors provided feedback to each other on these aspects from their interpretation of the data, which strengthened the analysis. Finally, the narrative of each case study was tailored to the sequence of rule changes showcased in the tables, so that the qualitative descriptions justifying each ticked box in the table is presented to the reader.

5. Empirical Analysis

We have studied twelve regimes, which co-constitute the public transportation system in Kolkata. Four out of these twelve regimes are hardly changing according to our framework in the past 15 years. These are the private bus, sub-urban and circular rail, hand-pulled rickshaw and walking regimes. Even though new technologies and rules are emerging in the regimes, they are either inadequate and/or quickly failed, thereby reverting the regime to its existing rules and trajectories. We leave these four regimes out of analysis in this paper and focus on the rest of the eight regimes that are either optimising, transforming and transitioning in the past 15 years.

5.1 Optimising regimes

5.1.1 Metro

Table 6. Metro regime optimisation

		Regime rules		
		Regulative	Cognitive	Normative
Regime Dimensions	Science & Technology	X	--	--
	Policy & Governance	--	--	
	Industry structure & strategy	--	--	
	Market & users	--	X	
	Socio-cultural meaning	--	--	
	Total	1	1	

X = Rules changed

-- = Rules remained the same

Kolkata was the first city in India to get a mass rapid transit system (metro) in the early 1980s. Kolkata metro carries more than 500,000 passengers a day, making it second busiest public transport mode in the city, after buses. Post-2000, a dominant new trajectory in the metro regime has been expansion and modernisation of infrastructure through construction of new corridors (including India's first under-water metro tunnel, procurement of rakes or rolling stock), new station facilities, platform screen doors, centralised operations control (Kolkata Metro Rail Corporation, 2018). These are new regulative rules along the science and technology dimension. The expansion accounts for an additional 111Kms, alongside 27kms of existing metro

corridor, currently under different stages of construction (Metro Railway Kolkata, 2016). The ex-post pressure guiding this trajectory is to decongest roads by substituting car trips and provide commuters with an option of fast and safe travel [Interviewee 5].

Optimisation along the technological trajectory is also visible in the currently operational stretch of metro corridor. Automatic flap gates were installed in all 23 stations in for efficient fare collection, and RFID-based contactless smart card and smart tokens were introduced in the year 2009. New facilities and amenities include new AC rolling stock, automatic card recharge machines, train timing indication boards, passenger announcement systems, directional signs for exit gates, surveillance cameras on platforms, water coolers, chemists' stalls (Metro Railway Kolkata, 2016). These facilities underline new expectations about user preferences for convenience and comfort – indicating new cognitive rule in the market and user dimension.

Once the new metros corridors become operational, the metro regime holds a strong promise of changing rules in other dimensions of the regime. For instance, citizens in neighbourhoods around the new metro corridors are willing to accept and use the metro instead of buses as their primary mode of transport [Interviewee 5]. This suggests new rules to be expected to emerge in market and user as well as socio-cultural dimension, promising a future super-trajectory. This will make metro regime likely to be a case of transformation in coming years.

5.1.2 Tram

Table 7. Tram regime optimisation

		Regime rules		
		Regulative	Cognitive	Normative
Regime dimensions	Science & Technology	X	--	--
	Policy & Governance	--	--	
	Industry structure & strategy	--	X	
	Market & users	--	--	
	Socio-cultural meaning	--	X	
	Total	1	2	

X = Rules changed

-- = Rules remained the same

Kolkata tram is the oldest operating electric tram service in Asia, running since March 27, 1902 (Calcutta Tramways Corporation, 2014). For several decades tram regime witnessed a decrease in the number of passengers, frequent breakdowns and derailment of coaches, stock-out of spare parts, lack of cost recovery, high operational costs, and ticketless travel. Major complained against trams is its slow speed and dependency on tracks which are often occupied by other modes. From about 750,000 passengers in 1980s, trams today average less than 160,000 annually as commuters opt for speedier forms of transport. Given these ex-post selection pressures, Calcutta Tramways Corporation (CTC) officials are under the impression that “trams need to be slowly phased out, make room for faster options” [Interviewee 4]. Following this development, CTC discontinued multiple routes and suspending many other routes for metro construction – which marks new regulative rule in technology dimension.

At the same time, here are alternative trajectories are emerging in industry strategy dimension. Despite calling tram “slow moving, electrical reptile”, CTC officials acknowledge that “tram lends Kolkata an old-world charm and add to the romantic element to the city.” (Calcutta Tramways Corporation, 2014). To save the regime from destabilisation, a new industry strategy since 2008 has been to attract commuters and make up for the loss by upgrading and modernising the tram infrastructure as well as integrating with metro, circular rail and suburban rail network [Interviewee 3] (Government of West Bengal, 2008). Following this strategy, nineteen newly designed tram coaches, some of which are air-conditioned were manufactured between 2008 and 2013 (Calcutta Tramways Corporation, 2014). These indicate another trajectory in the technology dimension.

Furthermore, acknowledging the nostalgic sentiments attached to trams in Kolkata, CTC decided to maintain a few scenic routes for “touristic and heritage value” and “to avoid public outrage” [Interviewee 4]. This indicates a new symbolic meaning attached to trams – from an essential mode of daily commute to a “joy ride” by “heritage on tracks” (Calcutta Tramways Corporation, 2014). One of the single coach AC trams were introduced to offer a touristy ride in collaboration with State tourism department, also as a way to recover costs of operating trams in the city.

NGOs, activists and groups in social media are also lobbying against the plan for phasing out trams from Kolkata. “Kolkata-Melbourne Tramjatra movement” brought tram enthusiasts from Kolkata and Melbourne together, to resist the planned closure of Kolkata tram network through campaigning and artwork to raise awareness (Coates, 2016). These plans and initiatives indicate tensions within the regime and the direction of regime change is yet to be determined.

5.1.3 Ferry

Table 8. Ferry regime optimisation

		Regime rules		
		Regulative	Cognitive	Normative
Regime Dimensions	Science & Technology	X	X	--
	Policy & Governance	X	--	
	Industry structure & strategy	X	--	
	Market & users	--	--	
	Socio-cultural meaning	--	--	
	Total	3	1	

X = Rules changed

-- = Rules remained the same

Ferry services along the river Ganges carry more than 300,000 passengers daily through 42 ferry ghats (stops). The number of passengers is expected to double by 2021 (Government of West Bengal, 2008). In recent years, the state indicated new standards for improvement of this water transport regime. Strategies include renovation of 'ghats' with assistance from World Bank, replacing existing 'Bhutbhuti-s' by safe and secure mechanically propelled boats, converting existing diesel run ferries into e-ferries. According to a plan for electrification of public transportation in Kolkata plan published in 2017, a total of six ferry boats in two most popular passenger ferry routes (each carrying around 7000 passengers daily) are selected for conversion to electric ferries in next couple of years (Ahuja et al., 2017). These are new infrastructure, guided by the new cognitive rules of safety, self-employment as well as environmental sustainability in science and technology dimension. In the policy dimension, the State transport department introduced a new scheme - 'Jaladhara' in 2017 for providing financial assistance to 'Bhutbhuti' operators for buying and operating ferries with improved designs (Government of West Bengal, 2017). This regulative rule is guided by an ex-post pressure of lack of affordability of boat operators to upgrade and ensure safety and sustainability.

Overall the optimisation towards an improved ferry regime is triggered by a new industry structure formed through the integration of the organisations responsible for bus, tram and ferry regimes in Kolkata. According to the Minister of Transport, Government of West Bengal, "Not just road transport, even the water transport will have a new edge with the constructive efforts of West Bengal Transport Corporation (WBTC)" (MPost, 2016). Owing to new regulative

standards of integrated organisation (WBTC), further improvements in the ferry regime are anticipated through smart card integration with other regimes managed by WBTC, as well as through planned conversion of all ferries into electric ferries in near-term (3-5 years) (Ahuja et al., 2017).

5.1.4 Cycle Rickshaw

Table 9. Cycle rickshaw regime optimisation

		Regime rules		
		Regulative	Cognitive	Normative
Regime Dimensions	Science & Technology	X	X	--
	Policy & Governance	--	--	
	Industry structure & strategy	X	--	
	Market & users	--	--	
	Socio-cultural meaning	--	--	
	Total	2	1	

X = Rules changed

-- = Rules remained the same

Approximately two million cycle-rickshaws ply on Indian roads, carrying about 6–8 billion passenger-km/year (Rajvanshi, 2002). Among all states, West Bengal has the highest number of cycle-rickshaw pullers (30.23%), operating in local neighbourhoods as a ‘para-transit’ mode (Pradhan et al., 2008).

Since 2010-2011, a new science and technology trajectory has emerged. A new technological prototype called “Soleckshaw” was designed by the Council for Scientific and Industrial Research (CSIR), with an expectation to improving working conditions for rickshaw-pullers by easing the effort of carrying passengers through motorisation yet keep in ‘green’ through use of solar power. “Rickshaw pullers live a difficult life with the fear of suffering from diseases like chest infections and tuberculosis. We thought of gifting a better life to these men, and hence soleckshaws came about,” Director General, CSIR quoted in TNN (2011). The quote indicates the ex-post selection pressure leading to a new cognitive belief about the need for green motorisation.

In recent years, there are new entrants in industry guiding the regime. From January 2016, a new commercial bank - 'Bandhan Bank' committed to offering loans to rickshaw pullers, who are normally dependent on microfinance. This is a new regulative rule in industry structure and strategy, which is expected to facilitate easy access to funds for the poor and unemployed members of poor households to be able to own a rickshaw to earn a living. The Bank's mission indicates an ex-post selection pressure - to create self-employment opportunities for those "overlooked by the formal banking system" (Bandhan bank, 2017).

5.2 Transforming regimes

5.2.1 State Bus

Table 10. State bus regime transformation

		Super-trajectory 1: Modernisation of Bus service			State Bus Super-trajectory 2: Organisational integration and digitalisation		
		Regulati ve	Cogniti ve	Normati ve	Regulati ve	Cogniti ve	Normati ve
Regime Dimensions	Science & Technology	X* → X	X* → X	--	X	X	--
	Policy & Governance	X*	X*		X	--	
	Industry structure & strategy	--	--		X	--	
	Market & users	X	X		--	X	
	Socio-cultural meaning	X	--		--	X	
	Total	4	3	--	3	3	--

X*= Change at the national level X = Change of rules at the city level

-- = Rules remained the same

New expectations and the first set of change of rules may emerge at the national level, while cities respond to opportunities and resource flow at a later period. National Urban Renewal

Mission, launched by Government of India in 2005 marks the first push towards a new super-trajectory of modernisation of bus service in Kolkata. The national policy was formulated in response to the ex-post selection pressure of 'rapid urban growth' and "tremendous pressure on urban basic services and infrastructure" (MoUD, 2005: 2). At the same time, the policy was shaped by new cognitive expectations of "Reforms driven, fast track, planned development of identified cities with a focus on efficiency in urban infrastructure/services delivery mechanism, community participation and accountability of Urban Local Bodies (ULBs)/Parastatals towards citizens." (MoUD, 2005: 2).

Resulting from this policy trajectory, the new national level science and technology trajectory is marked by "Specifications for Urban Buses in 2008 for the first time in India." (Lohia, 2013). Bus manufacturing companies like Volvo, Ashok Leyland followed these guidelines of the engine, fuel, air-conditioning systems, floor heights etc., to produce a large number of 'variants'. The low floor buses also followed the latest emission standards (BS-III/BS -IV whichever applicable), following new national regulations on vehicular emissions. These new standards are guided by new cognitive beliefs of taking "cognizance of the need to focus on comfort, safety, reliability and efficiency of bus-based public transport system in urban areas" (Lohia, 2013). The new regulatory standards and cognitive beliefs on the latest technologies were appropriated by Kolkata when in 2010, the state of West Bengal received grants under this national mission to buy and introduce 1200 new 'JNNURM' branded buses in Kolkata (Gopalakrishnan, 2010).

The government of West Bengal expected JNNURM buses to offer a modern and efficient bus service to the urban middle-class citizens of Kolkata, who will be willing to pay a premium fare for comfortable and reliable bus service [Interviewee 1]. The focus on comfort and convenience of the emerging middle class in the city marks a new cognitive rule in market dimension and ex-ante expectation from the bus system, distinct from the earlier sole emphasis on affordability by common people [Interviewee 6]. The State transport officials also suggest that the low floor and advanced ergonomic designs improved the accessibility of buses by senior citizens, women, children and disabled. The new buses were seen by the operators as an opportunity to change the poor brand image of state buses from old, obsolete, broken system, to a modern, efficient system which is inclusive and accessible by all [Interviewee 2, 7]. The buses were put forward as new cultural symbols - indicating new rules along the socio-cultural dimension (Gopalakrishnan, 2010). As a manifestation of the new rule, "A Volvo AC city bus, which did a week-long trial run recently, has recorded the highest revenue ever by any public bus service in the city." (Niyogii, 2009). The quote reflects the enthusiasm about the

sophisticated functionality and comfort offerings of JNNURM buses – to which users and operators attached positive socio-cultural meaning.

The beginning of a second round of transformation in state bus regime is marked by a new policy and governance trajectory of “route rationalisation” in 2014 (Bandyopadhyay, 2014). The objectives of this policy were to increase operational efficiency by catering to the travel demand, eliminating overlapping routes, adding new routes, fleets and by reducing competition and increased coordination between state transport undertaking organisations like CSTC, CTC [Interviewee 1, 2, 7] (Bandyopadhyay, 2014). These changes were in response to ex-post pressures of increasing operational cost and competition from private buses. A new regulative rule in industry dimension complemented this change policy trajectory by an organisational restructuring of the regime in 2015, whereby a new State Government entity, West Bengal Transport Corporation (WBTC) was formed. This entity is an integrated organisation in charge of state bus, tram and ferry regimes - led by Joint Managing Directors from three different pre-existing organisations. This new trajectory is guided by ex-post pressures of correcting existing inefficiency and lack of coordination. The key expectation guiding this industry structure was to be able to achieve economies of scale by reducing cost as well as to operate smoothly, by “bringing the three corporations under one umbrella” [Interviewee 2].

WBTC’s strategy to invest in new digital infrastructure since 2014-2015 marks new science and technology trajectories. This includes technological solutions clubbed under “Intelligent Transport Management system” namely cashless ticketing system, Automated Fare collection system, Vehicle tracking system, Fleet management system (Managing Director CSTC, 2015). The main selection pressures guiding this trajectory are mostly ex-post - aiming to create a competitive environment in which bus drivers and conductors are accountable for time and financial losses, eradication of the practice of ticketless travel among users, addressing in-service inefficiency operation and improve the reliability of public bus services in the city [Interviewee 1]. However, there are also ex-ante expectations about the effectiveness of these technologies in assuring transparent and efficient bus system management and operation. This marks a new cognitive rule in the science and technology dimension.

At the same time, there were new ex-ante expectations about user needs and preferences. Working together and learning from cities in Europe, the bus operators share new cognitive expectations about the market and users of the state bus regime. They believe that users will benefit from being able to track the arrival of buses real-time through a smartphone, know the crowdedness of the buses beforehand, use a “panic button” and pay bus fares using smartcards

[Interviewee 2,7,8]. Based on these expectations, the State Transport department introduced an all-in-one Transport card and a new app called “Pathadisha” in 2017. These add to the technological trajectory targeted towards the convenience of users. The cognitive rule in the market and user dimension, however, didn’t yet lead to a new regulative/formal rule in the same dimension.

Currently, there are several efforts by media and bus regime actors to attach positive symbolic meaning to these initiatives. For instance, a national news platform reports: “Kolkata becomes the first city in the country to introduce an all-in-one transport card... Thanks to this move, people will no longer have to worry about carrying the exact fare for their transport. All they would have to do is swipe and pay.” (Subramanian, 2017). This quote indicates anticipation for a future, an ‘idea about impact’ on how citizens of Kolkata will experience public transportation differently – thereby depicting a new cognitive rule in socio-cultural dimension.

5.2.2 Auto-rickshaw

Table 11. Auto-rickshaw regime transformation

		Super-trajectory 1: Fuel conversion			Super-trajectory 2: Formalisation		
		Regulati ve	Cogniti ve	Normati ve	Regulati ve	Cogniti ve	Normati ve
Regime dimensions	Science & Technology	X	--		--	--	X
	Policy & Governance	X	X		X	X	
	Industry structure & strategy	--	--		--	--	
	Market & users	X	--		X	X	
	Socio-cultural meaning	X	X		X	X	
	Total	4	2		3	3	

X = Rules changed

-- = Rules remained the same

The auto-rickshaw (motorised three-wheeler) regime is becoming an increasingly indispensable public transport mode in Kolkata. One of the prominent directions of change in Kolkata's auto-rickshaw regime in past ten years is the legal mandate for conversion to a cleaner fuel. Calcutta High court ordered to phase out all two-stroke engine driven auto-rickshaws by December 2008 (Additional Chief Secretary to the Government of West Bengal, 2008). The aim of this new regulative rule in policy trajectory was to reduce emission and air pollution originating from this regime. The facts that "Auto emissions account for over 60% of the city's air pollution and close to 50% of the city's residents suffer from major respiratory disorders"(IAC, 2018) served as ex-post selection pressures (IAC, 2018). New cognitive rules guiding this policy trajectory is the ex-ante expectation of presenting auto-rickshaws as a sustainable mode of future transportation in Kolkata [Interviewee 12]. By 2009, auto-rickshaws, previously run on cheap "Kata-tel" (a toxic mixture of petrol, kerosene and naphtha) were forced to be abandoned, and a new auto-rickshaws run on Single mode liquefied petroleum gas (LPG) Auto-rickshaw took over the city. The new green autos run by LPG marks a new standard in the science and technology dimension of the regime.

This substitution was possible through new market incentives introduced by the state government. Tax exemptions included road tax for the first year of registration, replacement, endorsement fees etc. for existing owners to replace their old vehicles with new ones within the period of 31.03.2009. In August 2012, RTA offered another window of additional six months for auto-owners to benefit from the subsidy of five thousand Indian rupees for replacing the engine in an existing vehicle or ten thousand Indian rupees for replacing the whole vehicle (Secretary to the Government of West Bengal, 2012). These incentives were partially in response to the resistance of the auto-owners and intended to encourage registered auto-operators²³ to embrace this shift – representing ex-post pressures to the new market rules.

As a result of these changes in the policy, technology and market dimensions, auto-rickshaws gained a new symbolic meaning as eco-friendly public transport options for Kolkata. This fuel conversion super-trajectory marks the beginning of a shift towards recognition of autos as one of the important modes of transport in Kolkata, moving away from the perception about autos being noisy, polluting, indiscipline and unregulated paratransit mode. The altered appearance of green coloured autos showcases a new 'rule that structured the spread of

²³ In 2006 almost 70,000 auto-rickshaws plied through the city of which roughly 30,000 were illegal. The latter is the auto-operators who are not registered with RTA (Arora et al., 2016)

information' about the acceptability of autos – in the socio-cultural dimension. Expectations about the social acceptability of green autos were ex-ante, marked by new cognitive beliefs about the future stability of the auto-rickshaw regime. Newer technological alternatives like battery operated E-rickshaws (locally known as 'Toto's) emerged. LPG conversion of autos also promoted healthy and environmentally conscious citizenship (Banerjee et al., 2012). This indicates a strong push for change in deep-rooted underlying norms about the perception and use of auto-rickshaw in Kolkata.

Complementing the fuel conversion super-trajectory, the state government took new initiatives to formalise and integrate the auto-rickshaw system within the public transportation network of Kolkata. The "Auto-policy", introduced in October 2016, represents new regulative rule in policy and governance dimension. The aim is to formalise routes and fare structures of auto operations in the city, driven by ex-post selection pressures of addressing existing inefficiencies, illegal operation of autos with no permits, and corrupt practices in the locally managed auto-rickshaw regime. So far, local political party affiliated 'unions' informally led the regime and supposedly protected the interest of auto operators. The new cognitive expectations guiding this policy and governance trajectory is that, in this new arrangement, RTA and Kolkata Police will have more power to regulate and control operation of auto-rickshaws.

The policy trajectory resulted in new rules along the market and user dimension of the regime. Previously, the auto operators allegedly distorted the market through cutting, extending, deviating routes and distorting, inflating fares for maximising income (CPR, 2014). The auto-policy intends to mitigate this fragility in the system by issuing permits tied to specific routes, badges for auto-drivers, vehicles fitted with High-Security Registration Plates (allowing "quick identification, legal conformity, and in its absence, fast prosecution") (TNN, 2016). These represent new regulative rules for re-constructing the market. In March 2017, RTA published the number of auto-rickshaws permitted to operate in each of the 125 routes determined by RTA (Joint Secretary to the Government of West Bengal, 2017). The new beliefs about the efficiency of the market to be achieved by regulating and monitoring operations, curbing distortions and corruption – represent a new cognitive rule in the market dimension.

User behaviour played a crucial role in shaping new ex-ante expectation about the future of the auto-rickshaw regime. New demand for auto-rickshaws is emerging from the urban middle class, especially women and children, who are increasingly dependent on autos for quick and

multiple trips. A study shows “women comprise about 40% of auto-rickshaw riders in KMC 24 ... women use auto-rickshaws for a variety of activities through the day, including household chores, dropping and picking children and social activities, besides education and work trips.” (Arora et al., 2016: 35-36). Women find auto-rickshaws to be easily accessible, convenient and comfortable mode of transport, therefore holds a positive perception about autos being a formal mode of public transportation. This evidence suggests that there are new cognitive rules in market and user dimension as well as in the socio-cultural meaning of auto-rickshaws in Kolkata. Appreciating women’s preference towards this mode, auto unions are taking initiatives to train women as auto-drivers, which was a male-dominated profession (Millennium Post, 2018). The ex-post pressure guiding this new regulative rule in socio-cultural dimension is that autos operated by female drivers will be considered safe and therefore more socially acceptable by women users.

This super-trajectory also hints at changing normative rules through a shift from informal to a formal system, from locally managed to a strictly regulated system. These indicate shifting underlying values that guide the regime. Moreover, values associated with autos by users are also shifting from last mile paratransit mode towards accepting autos as an indispensable mode for the main leg of the journey (Arora et al., 2016). This suggests new norms, routines and habits emerging on use and acceptance of autos by citizens of Kolkata.

²⁴ Kolkata Municipal Corporation area - representing the core city covering an area of 200.71 square kilometres (KMCGov.in, 2018)

5.3 Transitioning regimes

5.3.1 Taxi

Table 12. Taxi regime transition to ‘app-cab’ services.

		Regime rules		
		Regulative	Cognitive	Normative
Regime Dimensions	Science & Technology	X	X	X
	Policy & Governance	X	--	
	Industry structure & strategy	X	X	
	Market & users	X	X	
	Socio-cultural meaning	X	X	
	Total	5	4	1

X = Rules changed

-- = Rules remained the same

Kolkata’s taxi regime is constituted by the city’s iconic yellow taxis, which operate with permits from the State Transport department. However, in the past decade, refusals to go to user’s chosen destination allegedly tampered meters, taxi drivers haggling for a tip, frequent strikes called by unions - led to a fall in user’s dependability on the yellow taxis. Together with this internal instability, the taxi regime is also facing a new threat of alternative ‘app-cab services’. Around 2014-2015, app-cab/ride-hailing companies like Uber and Ola gained quick momentum to offer reliable taxi service in Kolkata, and within 2017, the number of taxis registered with these app cab companies exceeds the number of yellow cabs registered with RTA (Bandyopadhyay, 2017).

The app-cabs are inherently technological niches emerging out of the ex-ante expectation of user preferences for ‘on-demand’ mobility service. The stabilisation of niches is enabled through new trajectories in all regime dimensions, namely policy and governance mechanisms (where the state controls market entry and size of companies through regulating the number of vehicles each company can register), industrial structure (where the companies provide a platform and owns no vehicle of its own, interested drivers register with the companies, undergo a training, receive permit and ply their vehicles with the companies), market and users (where ‘tech-savvy’ young population willing to shift from driving own cars to using on-demand cabs) and socio-cultural meaning (where app-cabs improve the mobility of people who are

dependent on taxis and are better accepted due to transparency in transaction and safety promises) (Julka and Shrivastava, 2015). Change of cognitive and regulative rules along all these dimensions indicate a transition, alongside ex-ante expectations future of taxi service. This transition is also resulting in changes in deeper underlying values, routines and practises associated with a taxi service. New values like trust in the app mechanism, enhanced levels of comfort, quality of service leading to the satisfaction of users mark new normative rules in the taxi regime. Kolkata's yellow taxi regime actors are also signing up in the new arrangements, to be booked online through Ola's platform as well as through new apps dedicated to yellow cabs, adapting to the direction of regime change (Press Trust of India, 2017). At the same time, the app-cab companies are also facing recent backlashes with strikes and fall in numbers, due to cut-back on incentives (Velayanikal, 2017). This transition is on-going, and the results are yet to be determined.

5.3.2 Cycling in New Town Kolkata

Table 13. Cycling regime transition to cycle sharing services.

		Regime rules		
		Regulative	Cognitive	Normative
Regime Dimensions	Science & Technology	X	X	X
	Policy & Governance	X	X	
	Industry structure & strategy	X	X	
	Market & users	X	X	
	Socio-cultural meaning	X	X	
	Total	5	5	1

X = Rules changed

-- = Rules remained the same

New town Kolkata, formerly aspiring to be "smart city", now "Green city" planned to incorporate cycling as a key transport mode for the city. The introduction of Kolkata's first dock-less cycle sharing scheme "PEDL" in 2017 marks change in all dimensions of the regime (Zoomcar, 2017). Newly designed artefacts and infrastructure include cycles fitted with GPS, self-service stations, cycling tracks, a new smartphone app. A new actor in the industry include Zoomcar, a private company leading in car-sharing business in India, who took charge of implementing the system. New governance strategy involves ultimate regulatory and governing power resting with the city's governing body – New town Kolkata Development Authority

(NKDA). New market-arrangements involve NKDA's plan to open up the market for more actors to offer the same service, making the system competitive and less monopolistic [Interviewee 8] (Maitra, 2017). The middle class and higher income young and active residents of New town are the target user groups, which is distinguishable from the existing cycling regime users, suggesting a new socio-cultural meaning attached to a cycle by this group. The ex-ante expectation guiding this transition is the vision for an environment-friendly city where users will appreciate a healthy and eco-friendly mobility option, which is cheap, hassle free and on demand. They are also expected to prefer the convenience of individualised, app-based service, as opposed to shared mobility options. New norms, values and role-relationships emerging in the regime are expressed around environmental and healthy living discourses, which is new, compared to the existing rationale for cycling among low-income households, such as affordability. The cycling regime, therefore, enters the threshold to be considered a case of regime transition, supported by the emergence of cycle sharing niche experimentation. The scope of this transition is however limited in the spatial boundaries of New town Kolkata and recently a few other neighbourhoods of Kolkata. For the cycling regime to transition to an alternative regime of cycle sharing, this initiative needs to stabilise and scale up.

6. Discussion

Our analysis of individual public transport regimes led to findings that can improve the theoretical framework proposed in this paper. The results may also help regime actors to implement changes strategically in the real world.

The cases of optimisation, namely metro, tram, ferry and cycle-rickshaw regimes show changes in not more than two dimensions, except the ferry case which does change on three dimensions but almost no change in the category of the cognitive rule. However, the empirical cases sometimes deviated from the qualitative characterisation of optimisation as being primarily driven by changes in regulatory rules. In several instances, the only rule change has been cognitive, for example in market and user dimension in the metro case or the industry strategy dimension in tram regime. This observation may point towards a possible sequence or route of rule change where cognitive rules change first, and regulative rules follow. New

cognitive rules are indicative of ex-ante selection pressure. Even though all optimisation cases are predominantly driven by ex-post competition (thereby confirming third proposition), there were speculations about future market preference, and anticipations about new socio-cultural meanings to be attached in future of these regimes. Regimes which show such indications are optimising but may be closer to transformation than others. This observation led us to reflect below on the boundaries between three pathways of regime change.

The two transforming regimes also show that rule change threshold works for both cases. There are new rules in four dimensions to form super-trajectory. One of the key observations here is the presence of multiple super-trajectories in both regimes, indicating what we call 'cycles of transformation'. In case of the auto-rickshaw regime, the super-trajectories are complementary – the LPG conversion super-trajectory in the first cycle prompted the second and ongoing cycle of transformation through formalisation super-trajectory. Both auto-rickshaw and state bus regimes also re-confirm the earlier empirical observation that cognitive rule change precedes change in regulative rules. An additional observation from the case of state bus regime transformation is that change of rules and origin of trajectories are not always local. National policies like JNNURM play an important role in the formation of super-trajectories at the city level. As theoretically assumed, we see a mix of ex-post as well as ex-ante selection pressures in transforming regimes, even though ex-post pressures dominate the mix.

Most importantly ex-ante selection mechanism works without niche intervention and is entirely initiated by regime actors. This is a crucial contribution challenging the conventional transitions thinking where regime actors are seen as conforming agents, whereas niche actors are the one who 'stretch and transform' (Smith and Raven, 2012). We also found that deeper underlying normative rules also start to shift in the course of transformation and an opening up process to create spaces for niches. Electric buses, electric rechargeable batteries driven auto-rickshaws are beginning to gain momentum, and ex-ante expectations about sustainability future of public transport are taking front seats in discourses. These findings make yet another case for reconsidering the boundaries between the pathways.

To examine the boundary issue, we tried to visually locate each of the public transport regimes from Kolkata in a scatter plot depending on the evaluation of their pathway of change (Figure 21).

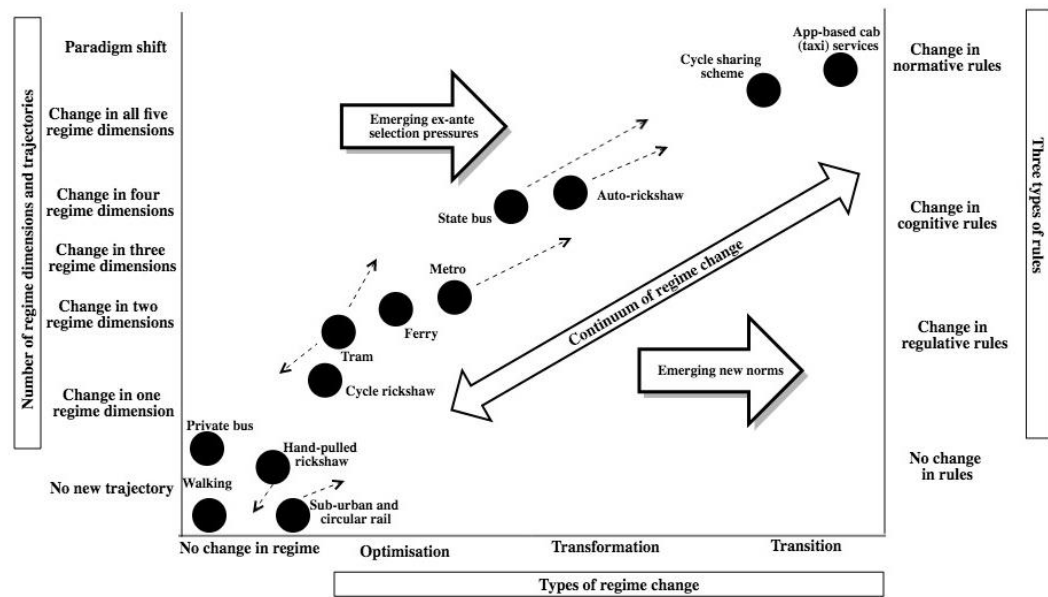


Figure 21. Plotting public transport regimes of Kolkata in regime change framework

We find that regimes perform unexpectedly on the emergence of cognitive rules, ex-ante selection pressures and normative rules and tend to move beyond their respective thresholds. As a result, we argue that some regimes operate in the 'in-between' space of optimisation-transformation and transition pathways. The three pathways are therefore not discrete categories or 'pockets of change' that are detached from one another. Instead, they represent interconnected and overlapping processes within a continuum of change. This interconnection is visible through the possibilities of movement of regimes from the optimisation to transformation space, or from transformation to transition space. The dotted arrows in Figure 21 indicate these possibilities as further change happens. For instance, metro regime shows potential to transform, as new rules emerge in other regime dimensions once the construction of corridors is completed. Tram regime can move to transformation space if a new super-trajectory of modernisation of tram services emerge. Alternatively, it may also continue to optimise and may even completely destabilise. Four regimes that are non-changing therefore left out of the analysis, also show movements. While rail regime is likely to optimise along technological and policy trajectories in coming years, hand-pulled rickshaw regime is going to destabilise on humanitarian grounds and is likely to be substituted by battery-driven rickshaws. Other regimes whose movements are not indicated by arrows indicate that their direction of change remains unpredictable from the study of past 15 years.

Given these results, we argue that the framework of regime change looks promising to map and analyse sustainability transition in particular contexts where conventional regime destabilisation and niche led substitution storyline is not so dominant. The ambiguity about boundaries between the pathways may prove to be a challenge in the application of the framework. We believe that an explanation for this fluidity of the pathways could be that all regimes constituting public transportation in Kolkata are following three broad rules in the course of change. Examples of broader rules are digitalisation, decongestion, and pollution mitigation. According to Schot and Kanger (2018), these can be considered 'meta-rules'. The rule of digitalisation is at the core of new cognitive rule emerging in multiple regimes aiming to meet new user preferences of convenient, efficient and on-demand mobility services. Digitalisation meta-rule also explains the emergence of niches in taxi and cycling regime. The decongestion meta-rule is prominent in metro and tram regimes. The meta-rule is prominent in both state bus and auto-rickshaw regimes in their course of transformation. The pollution mitigation meta-rule is manifested in 'going green' initiatives: e.g. in fuel efficiency choices, investments in bike sharing and mass transit infrastructure. In the course of multi-regime interaction, these meta-rules drive towards deeper change processes, encompassing changing in more regime dimensions and different types of rules in individual regimes. Presence of these meta-rules also helps explaining why similar rules and similar trajectories are emerging across multiple regimes. Therefore, the overlaps and interconnections between the three pathways within the continuum of change are not random. The meta-rules indicate the directions of change in the public transportation system of Kolkata.

7. Conclusion

We began this article with the premise that the focus on niche led transition in the sustainability transitions literature may carry a western bias. In non-western contexts, the ongoing efforts of improving already dominant public transportation regimes may perhaps be seen as different pathways of transition and not just optimisation efforts insufficient for addressing the persistent sustainability problems. We argue that the conceptual framework developed in this paper can capture regime change (change in genotype) through mapping changes in rules, trajectories and selection pressures. The framework allows us to recognise three different pathways of regime change: optimisation, transformation and transition. Similar pathways have been identified in Geels and Schot (2007) and Geels and Kemp (2007) but based

on a different method, notably in the former the specific interaction between niches, regimes and landscapes and in the later whether change emerged from the regime or niche actors. The advantage of the mapping tool advanced in this article is that it provides a more nuanced and fine-grained overview over regime change as well a systematic way of executing a regime analysis that is missing in socio-technical transitions literature.

Applying this framework, we analysed the change in public transport regimes in Kolkata in the past 15 years. This is relatively a short period, compared to historical case studies in transitions literature. However, with urban sustainability problems getting worse since the turn of the millennium, cities around the world are undergoing a rapid transition. Despite the limited factual data about specific ongoing trends of development of public transportation in Kolkata, the analysis allows capturing the escalated pace of change in just over the last decade in the mobility system in Kolkata through identifying new rules and trajectories. Based on the results of the subsequent empirical analysis, we argue that all three pathways are significant for sustainability transitions. They work together and in parallel – and reflect ongoing changes in the socio-technical system (phenotype) of mobility in Kolkata. They also help to generate meta-rules which may push towards transformation of the entire mobility system. The emergence of meta-rules may be considered as one of the primary mechanisms which trigger multi-regime dynamics (Raven and Verbong 2007) and may lead to whole system reconfiguration (Geels, 2018).

One contribution of this paper is to illustrate that regime actors in Kolkata hold considerable credit and agency to facilitate many forms of change. They seem to understand that today's persistent mobility problems in the city are going to worsen if not quickly acted upon. As a result, they are open to alternative futures and are willing to work in those directions, albeit not in a radical way by supporting entirely new alternatives. This openness to some form of change is reflected in their investments in various ongoing innovations. Of course, regime actors we interviewed are influenced by many actors, including social movements and users. We did not focus on that in this article, instead just focussed on the mapping of the change of rules.

The regime change framework, interconnections between the three pathways and the presence of meta-rules have significant policy implications. The mapping tables for each regime highlight the regime dimensions in which rules so far didn't change. We suggest that policy actors may think of using this mapping tool to identify gaps and invest in developing new trajectories in dimensions that are neglected so far. This is a way in which they can shape further transition in sustainable directions, by unlocking existing systems, even if through a series of

incremental steps. The results of the mapping exercise will also bring out the implied directionality of the change processes by mapping the change of rules. The policy aim should be to introduce new rules along existing trajectories and initiate new trajectories along more regime dimensions; as a result, move up the framework. Policy actors may also target to surpass the thresholds of the existing pathway of change and move on to the next pathway. However, forcing all regimes towards transition pathway may not be desirable either. While the meta-rules will provide directionality across regimes, the variability of change processes in different regimes may also be desirable.

The regime mapping tool we propose needs further development, and more testing, in a wide range of western and non-western contexts and for a broader range of regimes. A future research agenda will be to further integrate the concept of meta-rules in the regime change framework. This integration will allow tracing multi-regime dynamics and whole system change. The current framework may be further refined by developing specific indicators of rule change. If this development and testing are done in a wide range of contexts, it may help to bring out systematic differences between the Global North and Global South without implying that specific transition pathways are superior to others.

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9. Appendix

Table 14. List of interviewees for mapping public transport regime change in Kolkata

Interviewee No.	Individual	Organisation	Interview date	Regime
1	Depot Manager	CSTC	January 2016, December 2016,	State Bus
2	Senior Official	WBTC	November 2016	State bus, Tram, Ferry
3	Senior Official	CTC	November 2015 & January 2017	Tram and State buses
4	High Official	CTC	December 2016	Tram and State buses
5	Senior Official	RITES	November 2015	Metro
6	Senior Official	Metro Railway, Kolkata	October 2015	Metro
7	Senior Official	State Transport Department	November 2016	Metro, Bus, Tram, Auto, Cycling
8	Senior Official	NKDA	December 2016	Cycling in New Town
9	Union Member	Joint Council of Bus Syndicates	December 2015	Private buses
10	Union leader	Eastern Railway Men's association, Howrah	December 2016	Suburban rail
11	Official	Eastern Railways Howrah Division	December 2015	Suburban rail
12	Engineer	West Bengal Pollution Control Board	November 2016	Auto- rickshaw

Chapter 5.

The “Wheel of Logics”: Towards conceptualising dynamic stability of regimes in the Global South (Paper IV)

Bipashyee Ghosh¹

¹Science Policy Research Unit, University of Sussex, UK

Abstract

The notion of stability of regimes is central to transitions thinking, yet transitions scholars have found it problematic to understand regime stability in the context of the Global South. They portrayed regimes in the Global South as unstable and chaotic, yet these regimes have persisted and thrived for decades. This begs the question: Should regime stability be differently understood in Global South contexts? In this paper, we explore different forms of regime stabilities, based on the presence of multiple institutional logics guiding socio-technical system transformations. A novel framework – ‘Wheel of Logics’ is developed in which regimes are composed of multiple ideal-type institutional logics, and transformation of regimes are characterised through the change in the composition of regimes, which influences the directionalities of such change processes. Understanding regime stability as dynamic, the paper argues that there can be many forms of dynamic stabilities – each associated with a specific transformation pattern proposed through the framework. Public transport regimes in a Southern city – Kolkata are used as empirical cases to demonstrate the different forms of dynamic stabilities and different directionalities of regime transformation. The paper concludes that regime stabilities in the Global South need to be assessed in relation to critical factors including power dynamics, informality, and social exclusions that are prevalent in Southern contexts.

Keywords

Regime, Stability, Transformation, Institutional logic, Global South

1. Introduction

In transitions literature, regimes are stable configurations, resulting from alignment of rules and actors’ routinised behaviour (Rip and Kemp, 1998; Geels, 2002; Fuenfschilling and Truffer, 2014). However, the notion of stability of regimes has been scrutinised and found to be

problematic to define in contexts of transitions in the Global South (Verbong et al., 2010; Furlong, 2014; Wieczorek, 2018; van Welie et al., 2018). In cities in developing parts of Asia and Africa, for instance, socio-technical regimes are seen as highly unstable due to the presence of multiple rationalities, conflicting interests, high levels of informalities, uncertainties and competing rules. At the same time, some recent literature suggests that the nature of stability may be different in the Global South²⁵, where configurations appear superficially unstable but may, in fact, be deeply stable and survive for a long period (Wieczorek, 2018). This is the case in Kolkata, the city I focus on, in this article. Kolkata is a megacity²⁶ in India, where multiple socio-technical regimes around public transport systems can be found to operate in parallel over decades, with a very diverse range of actors, technologies and institutions guiding them. This heterogeneous composition of actors and rules can create misalignments and tensions within regimes. Yet the regimes have persisted and thrived for decades. This begs the question: How can we assess the dynamic stability of regimes in the Global South?

The concept of stability of regimes in transitions thinking corresponds to the idea that regimes represent deep underlying structures, consisting of a semi-coherent set of rules. Recently, Fuenfschilling and Truffer (2014) argued that the 'content and coherence of structures' can be explained by the presence of institutional logics guiding regimes. These logics "...highlight how (regime) actors are influenced by their institutional context... [and how] institutions regularise behaviour, but at the same time enable agency and change." (Fuenfschilling & Truffer, 2014: 775). In their view, each socio-technical regime is guided by one or more institutional logics which structures operation of the regime, both stability and change. In this paper, I mobilise and develop this concept of institutional logics to show that it is a useful theory for understanding stability and change of regimes in a fine-grained way. In order to characterise the stability of regimes, this paper introduces a new framework of institutional logics relevant to socio-technical system transformations. This framework is coined the 'Wheel of Logics'. The wheel has two components: institutional orders (representing the type of transformation and stability) and sustainability values (representing the directionality of

²⁵ Global South is an actor category used for developing, under-developed, low- and middle-income contexts in Asia, Africa, Latin America and the Caribbean, primarily characterised by presence of poverty, inequality and rapid economic growth (Rigg, 2007; Satterthwaite and Mitlin, 2012; Pagel et al., 2014). It is thus not just a geographically marker; it is referring to a specific context which may exist in parts of Europa and the USA too.

²⁶ A megacity is defined by more than ten million inhabitants in an urban agglomeration. As on 2016, there are 31 megacities in the world, out of which 24 are located in the Global South. (UN-DESA, 2016).

transformation and stability). Interactions between these two components result in nine ideal type institutional logics that comprise the wheel. The mobility system in the megacity Kolkata offers a revealing case study for the empirical understanding of regimes, composed of institutional logics and how this composition changes over time.

In the next section, I review the literature on institutional logics and develop the wheel of logics framework. Section 3 discussed the method and case selection for the empirical exploration of the framework. Then in section 4, I present the results of the analysis of three specific regime cases of the Kolkata public transportation system: metro, auto-rickshaws and cycling. In section 5 I discuss the results and present conclusions, spelling out the contributions of the paper, its limitations and a future research agenda.

2. Theory and framework

2.1 Stability and transformation of regimes

The idea of regime stability is at the heart of socio-technical transition studies (Elzen et al., 2004). Regimes are defined to be stable socio-technical configurations, owing to an alignment of rules and actors' shared expectations (Rip and Kemp, 1998; Geels, 2004; 2014). However, even in the multi-level perspective, regimes are not seen as completely peaceful space of operation. Despite the emphasis on the 'shared-ness' and 'alignment' that stabilise regimes, various studies have shown that disagreements and tensions bring questions about the degree of stability and level of coherence to the fore (Van Driel and Schot, 2005; Campbell and Sallis, 2013). Scholars have argued that regime stability is not constant and it is relative to the stability of niches and landscapes (Berkhout et al., 2004; Geels, 2011).

What determines stability and how regimes stabilise and destabilise can be examined from different perspectives. From an evolutionary perspective, regimes represent a 'dynamic stability' with ongoing incremental changes which creates path dependency and reproduction of regimes, while radical changes can destabilise the regimes, overcoming the lock-in leading to transitions (Rip, 1992; Geels and Kemp, 2007). On the other hand, early institutional theorists would understand the stability of an institutional environment (regime) in terms of the

conformity of individuals and social groups to organisational values (DiMaggio and Powell, 1991; Greenwood and Hinings, 1996). Recently, more actor-centric approaches towards understanding transitions have engaged with the notion of stability more critically, suggesting that political actors, corporations and social movements hold power to destabilise established regimes and support stabilisation of new regimes (Meadowcroft, 2011; Hoffman, 2013; Kivimaa, 2014). These different perspectives indicate that calling a regime either stable or unstable is a rather simplistic way of analysing regimes. The simplification arises from the fact that scholars in Global North have often presented regimes to be homogenous, monolithic structures, despite appreciating and developing the idea that rules guiding regimes are semi-coherent (Rip and Kemp, 1998; Geels, 2004). What semi-coherence means is an important question that this paper seeks to address (Rip and Kemp, 1998; van Driel and Schot, 2005; Smith et al. 2005; Geels, 2011). In my analysis, I will draw on Hoffman (2013: 263) who argues that the multi-level perspective “hides from view how action is implicated in alternative webs of relations with different, and sometimes contradicting logics and ‘rules of the game’.” The ‘Wheel of Logics’ presented below allows to explore these web-of-relations and contradictions as well as represents a way to characterise the semi-coherence and stability of regimes, which I consider to be dynamic.

The task of defining regime stability or instability is complex in the Global South contexts. Recent studies in Global South have established that regimes work in different ways in cities in Asia, Africa, Latin America (Ghosh et al., 2016; Wieczorek, 2018; van Welie et al., 2018). Regimes in these parts of the globe are observed as fragile and chaotic, yet they exist over decades (Wieczorek, 2018; Sengers and Raven, 2014). The prevalence of informal institutions²⁷ is readily observable as a key characteristic of the regimes (Ghosh et al., 2016; Wirth et al., 2013). Some informal rules and practices exist as ‘twilight institutions’ operate in between public and private realms, where local parties, unions, ‘strong-men’ exercise public authority and control (Lund, 2006). These institutions guide the regime independently and over a long period, in absence or failure of formal regulatory and/or market institutions, highlighting that the framing of informality as the source of instability of regimes in Global South is problematic (Minh et al., 2014; van Welie and Romijn, 2018). In such contexts, transitions may happen in a different way than is often assumed in sustainability transition studies where regime destabilisation and niche development are presented as two fundamental processes. The risk of mobilising only these two processes in studying regimes in the Global South is that, as Verbong et al., (2010) show in their study of Biomass gasification in India, regimes considered unstable are seen as barriers for niche

²⁷ Sengers and Raven (2014) provides examples of informal institutions in mobility in Thailand as site-rent or bribes associated with a chain of privileges and corruption (page. 461).

development. Such analysis of regime transition does not consider the normality of malfunctioning; apparently unstable regimes that people adapt to and work with, for an extended period (van Welie et al., 2018; Furlong, 2014). The lack of infrastructure, for instance, actually often “frees them from the pressure of replacing it” (Wieczorek, 2018: 208-209). The diversity of actors, technologies and practices in a single regime often proves to be useful for minimising risks, in facing unprecedented sustainability challenges (Meadowcroft, 2011; Stirling, 2010). In such conditions, the western idea of the shifting from one stable and uniform regime to another in the process of a sustainability transition may not apply. Instead, “fostering coexistence – as opposed to uniformity – in a socio-technical system” is proposed as a desirable strategy to meet basic and differentiated needs, unfulfilled by current regimes (Furlong, 2014: 141). Co-existence of rules, options, practices in a heterogeneous regime also helps in navigating change towards sustainable directions (Raven et al., 2017).

Transition studies have always acknowledged that stability and change share a dialectic relationship (Koehler et al., 2017). Regimes being dynamically stable incorporates the idea that regimes are continually evolving, as not just optimisation but also transformation happens within the regime (Ghosh and Schot, 2018). Sustainability transitions studies have argued that transition can happen in a range of different ways depending on the nature of the multi-level interactions, for example, Geels and Schot (2007) presents four possible pathways: transformation, reconfiguration, technological substitution, and de-alignment and re-alignment. In this paper, an alternative approach towards the variety of possible ways a sustainability transition can happen will be put forward. I will use the concept of transformation instead of transition in order to emphasise the focus on change that is happening within the regime context. Attending to the dialectic relationship between stability and change in regimes, I will define the dynamic stability of regimes in the Global South in relation to different patterns of transformation of regimes – that can be observed by mobilising the concept of institutional logics. The latter is introduced in the next section.

2.2 Institutional logics and regime transformations

Institutional logics is a useful theory to study socio-technical systems and its change. An institutional logic is defined, for example, as “...socially constructed, historical patterns of

material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality" (Thornton and Ocasio, 1999: 804; Thornton et al., 2012). Drawing on elements of this definition, we can say institutional logics represent a particular alignment between different rules, thereby embodying the definition of a socio-technical regime. The importance of regime actors is apparent in the definition, as their values and practices help construct the logics. At the same time, logics 'regularise' people's behaviour in a given context (Fuenfschilling and Truffer, 2014). Institutional logics, therefore, co-evolve with actors' changing practices and new values embraced by these actors in the course of socio-technical change in regimes.

Institutional theorists have developed ideal types of institutional logics to "facilitate systematic comparison of empirical variation" of institutional logics (Goodrick and Reay, 2011: 378; Thornton and Ocasio, 2008). These are "intelligible and distinct characterisation of a particular meaning scheme (here, an institutional logic) that can be used as a yardstick to compare actual behaviour" (Fuenfschilling and Truffer, 2014: 777). Ideal types are therefore useful analytical constructs to determine all possible values and characteristics constituting a socio-technical regime. Different authors use different terminologies to characterise ideal type institutional logics. Fuenfschilling and Truffer (2014) use 'logic elements' like sector logic, values, mission, technologies, main actors, expertise, organisational form and funding to characterise each ideal type institutional logic that they define in the context of the Australian water sector. Thornton et al., (2005: 135,144, 151) define 'attributes' of an institutional logic like: economic system, sources of identity, sources of legitimacy, sources of authority, basis of mission, basis of attention, basis of strategy, logic of investment, governance mechanism etc (see table 15 below). These elements help in defining ideal type institutional logics, that are comprised of institutional orders and sustainability values. Specific combinations of an order and a value constitute an institutional logic. More than one institutional logic can co-exist in socio-technical regimes, owing to the presence of multiple orders and multiple values in a socio-technical system (Smink et al., 2015).

Conceptualising regimes to be constituted by multiple logics has important implications for understanding the stability of the regimes. It becomes relevant to understand how the presence of multiple ideal type logics are co-existing in a regime, including the relationships between conflicting values and rationales, and how such multiple logics and underlying values and rationalities, in turn, affects the stability of regimes. Smink et al., (2015) argue that even when multiple logics co-exist, regimes can be considered stable, "given the embeddedness and

stability of logics” (pp. 235). This embeddedness and stability of logics are in particular highly relevant in the context of Global South, where in the course of change, old logic(s) are almost never completely destabilised as new logics appear in regimes. This is due to the diversity of socio-economic needs, socio-political pressures to uphold existing values and planning for future uncertainty in these contexts (Wieczorek, 2018). Under such conditions of presence of multiple logics, transformation cannot be simply portrayed as a shift from "an old to a new logic" (Greve and Zhang, 2017: 673). It is instead a shift from an old composition to a new composition of logics comprising the regime. Along the course of this changing composition of logics, the stability of regimes can only be interpreted by looking systematically at the relationship between existing and emerging ideal type institutional logics (Greenwood et al., 2010; Thornton et al., 2012; Smink et al., 2015). Such a systematic exploration can be done using two components – institutional orders and values. Both will now be introduced in more detail.

2.2.1 Institutional orders

Friedland and Alford (1991: 244) define institutional order as the entity which “shapes the mechanisms by which organisations are able to conform or deviate from established patterns.” These established patterns can be considered as existing rules and/or logics guiding a regime. In this definition, the actors are ‘organisations’, however, an individual can follow a particular institutional order too. Scholars have used other terminologies to refer to the institutional orders such as ‘institutional sectors’ or ‘societal sectors’ (Thornton and Ocasio, 2008; Fuenfschilling and Truffer, 2014). They argue that these terms “help to understand why actors behave in a certain way”, and also legitimises action (Smink et al., 2015: 226).

Examples of institutional orders include the State, market, community, profession, corporation, family, religion (Thornton et al., 2012). Among these seven institutional orders, the State, Market and Community are the relevant institutional orders governing and responsible for the change in socio-technical systems (Smith and Stirling, 2010; Koehler et al., 2017: 32). Other institutional orders like the family, professions, corporations and religions may be present in systems; however, they are hardly ever dominating the governance and change of a whole socio-technical system like mobility in a city. The presence of State, market and community orders, is on the other hand commonly present in many studies in sustainability transitions field

(Koehler et al., 2017). For instance, in a 'multi-actor' process of transitions, Avelino and Wittmayer, (2016) articulates that actors belong to either state, market, community and a third sector²⁸. Transition happens through a shifting of power from one set of actors to another. Johnstone and Newell (2018) articulate the role of the state in sustainability transitions as incumbents, promoters of niche innovations, powerful political actors who are sensitive to their institutional contexts. Role of market order in driving transitions is apparent in investment strategies, incentive structures and business models for sustainability transitions (Geels, 2013; Loorbach and Wijsman, 2013). Markets have an explicit presence in the transition literature, where market constitutes pricing mechanism, user preferences in a socio-technical regime as well as the creation of 'market niches' alongside 'technological niches' (Geels, 2004). Presence of community order is predominant in a section of sustainability transitions literature focussing on grassroots innovation, promote the idea of socio-technical transition through bottom-up initiatives in local contexts (Seyfang and Smith, 2007; Seyfang and Haxeltine, 2012). It seems reasonable to argue that these three institutional orders drive sustainability transitions and system-level change.

It is also worth mentioning that many actors can operate simultaneously under each of these institutional orders. For instance, the state order may consist of different public entities including national and regional governments, municipalities. The market as an institutional order, on the other hand, may include public entities alongside private firms, individuals and organisations as actors - as long as they follow basic principles of a 'market order' (see Table 15). Any actors including individual users, non-profit, non-governmental organisations, activist groups, neighbourhood based, gender-based networking and public engagement groups can follow the logic of a Community institutional order. Actors' ways of doing things can be interpreted to follow particular institutional orders, judging by different characteristics. These characteristics are presented in the table below.

²⁸ Third sector, according to Avelino and Wittmayer (2016) is the intermediary sector in between the state, market and community, which includes voluntary, non-profit organisations. We will categorise these actors within the State-Market-Community typology.

Table 15. Institutional orders relevant to socio-technical systems.

(Source: Fuenfschilling and Truffer, 2014: pp. 787)

CHARACTERISTICS	STATE	MARKET	COMMUNITY
ROOT METAPHOR	State as a redistribution mechanism	Transaction	Common boundary
SOURCE OF LEGITIMACY	Democratic participation	Share price	Unity of will, belief in trust and reciprocity
SOURCE OF AUTHORITY	Bureaucratic domination	Shareholder activism	Commitment to community values and ideology
SOURCE OF IDENTITY	Social and economic class	Faceless	Emotional connection, Ego-satisfaction and reputation
BASIC OF NORMS	Citizenship in nation	Self-interest	Group membership
BASIS OF ATTENTION	Status of interest group	Status in market	Personal investment in group
BASIS OF STRATEGY	Increase community good	Increase efficiency profit	Increase status and honour of members and practises
INFORMAL CONTROL MECHANISMS	Backroom politics	Industry Analysts	Visibility of actions
ECONOMIC SYSTEM	Welfare capitalism	Market capitalism	Cooperative capitalism

The table shows nine ways of differentiating between the three institutional orders. When characterised through the features in the first column, different institutional orders can be seen to operate differently. For instance, under the header of 'source of authority', the State institutional order follows 'bureaucratic domination', the Market follows 'shareholder activism', and the Community order can be identified through 'commitment to community values and ideologies' (Fuenfschilling and Truffer, 2014: pp. 787). The State exerts authority through bureaucracy; is guided by principles of redistribution, democracy and represents a socio-political organisation for promoting the welfare of citizens. The Market operates through pricing and transaction; strategising to increase efficiency and profit through competition and represents an economic organisation for maximising benefits and minimising costs in society. The Community relies on trust and reciprocity of groups; guided by common ideologies and practises and representing a socio-cultural organisation for co-operation, commitment and unity for a shared cause (Thornton et al., 2012). These characteristics distinguish the State, Market and

Community institutional orders from one another. This implies that multiple institutional orders can co-exist in a regime, because different actors in a single regime may follow distinctively different institutional orders.

Following the institutional logics literature, each of the three institutional orders (State, Market, Community) carry their respective 'logics' (Thornton et al., 2012). The multiplicity and shift of institutional orders in a regime can be considered an important variable to interpret different patterns of transformation and dynamic stability of a regime. However, regimes as socio-technical configurations, are more complex than to be defined by just actors' differentiated behaviours portrayed by institutional orders. Persistent unsustainabilities in regimes in the Global South push these actors to innovate and transform regimes in (many) sustainable directions (Ghosh and Schot, 2018). Institutional orders do not allow understanding the directions of change of regimes. Values associated with solving sustainability issues drive this directionality. Sustainability values are therefore a second important factor at play in determining the form of dynamic stability in the course of transformation of regimes.

2.2.2 Sustainability values

Understanding the dynamic stability of a regime is incomplete without analysing the direction of the change of the regime. Stirling (2009) rightly points out that there can be multiple directions of change, given that there are "divergent values and interests" (pp. 5). These divergent values, in context of sustainability transitions, can be understood as sustainability values, which are themselves diverse and plural, particularly in the context of the Global South (Raven et al., 2017). For regime change to be transformative, Schot and Steinmueller (2016) argue that change needs to be directed towards addressing multiple social and environmental challenges. The multiplicity of these challenges makes assessing the directionalities of regime change - a challenging endeavour. Transitions literature had so far black-boxed the directionality aspect of change and focussed on the multi-level dynamics with which stability and instability of regimes respectively hinder and enable niche-led change process (Raven et al., 2017; Miller et al., 2014; Smith and Stirling, 2010). Faced with persistent sustainability problems, transition scholars need to pay attention to multiple directionalities of change that influence the dynamic stability of regimes in cities in the Global South.

In this paper, I develop the concept of (institutional) values as a way to understand different directionalities of regime change. Values are already central to the definition of institutional logics. For instance, in framing ideal type institutional logics in a transition case study of the Australian water sector, Fuenfschilling and Truffer (2014) defined values as the security of (water) supply, social equity, environmental sustainability, liveability and economic efficiency. These are a few examples of the diverse values that guide sustainability transitions. In transitions literature, sustainability is mainly targeted towards addressing environmental degradation and climate change-related problems (Geels, 2004; Berkhout et al., 2004; Grin et al., 2010). This homogeneity in definition led to an understanding of transition as if it is uni-directional (Stirling, 2009). In the context of the Global South, sustainability is seen to carry heterogeneous meaning and need to be understood using several criteria (Raven et al., 2017; Wiecek, 2018) (See table 18 in Appendix for criteria defining each aspect of sustainability). Given the multi-dimensional nature of sustainability, a broader conceptualisation of sustainability values is, therefore, a crucial starting point for appreciating multiple directionalities of the transformation of regimes.

Incorporating the social, economic and environmental dimensions of sustainability, I propose that there are broadly three values that need attention in transforming different socio-technical systems in the Global South. These are 1) Well-being, 2) Efficiency and 3) Green. Based on Sustainable Development Goals (SDGs) developed by the United Nations for 2030 and review of recent transitions literature in the Global South, I argue that these are the sustainability values (each defined through a number of criteria) that are predominantly setting directions for transformation in socio-technical systems such as mobility or energy (Rogers et al., 2012; UN, 2015; Raven et al., 2017) (see table 16 in section 3.1 for specific characterisation of these values in a local context). Within the literature on sustainability transitions, the well-being value incorporates accessibility and safety dimensions, which are often highlighted in social innovations and societal transformations literature (Avelino et al., 2017; Pel and Bauler, 2014; Rogers et al., 2012). The value of efficiency includes economic considerations like cost minimisation, cost recovery, sustainable business models, self-sufficiency, profit maximisation. Cases of low carbon transition focus on achieving energy efficiency, as well as reducing cost through new technologies and new institutional arrangements (Geels et al., 2017; Hodson and Marvin, 2012). The objectives of green mobility concern mostly with environmental sustainability – eco-friendliness, reduction of emission, climate mitigation and adaption at local, regional or global scale.

Presence of multiple sustainability values in policy discourses and initiatives for change are not uncommon. It is highly likely that an actor justifies his/her actions using more than one sustainability value²⁹. Therefore, sustainability values are disconnected from/independent of institutional orders. Combining these two components, I develop a conceptual framework of ideal types institutional logics, relevant for studying socio-technical system transformations. I have coined this framework as "Wheel of Logics".

2.3. Wheel of Logics

Most studies define ideal-type institutional logics for their specific empirical cases [for examples in the water sector see Fuenfschilling and Truffer, (2014); for accounting, architecture and publishing see Thornton (2005) and for health care see Raey and Hinnings, (2009)]. In this paper I aim to develop an institutional logic-based framework, using which I hope to be able to characterise dynamic stability and transformation of regimes in a general way, across a range of socio-technical systems. This framework, which I call "Wheel of Logics", is illustrated in the figure below.

²⁹ Sustainability values are drivers of action, as argued above. However, in researching the ongoing transformation of regimes, values are to be found in discourses put forward in documents and visions of actors. Therefore, in the empirical analysis of this paper, I treat sustainability values as mechanisms of justification of action (which I assume to drive action in future transformation), based on the interviews with actors.

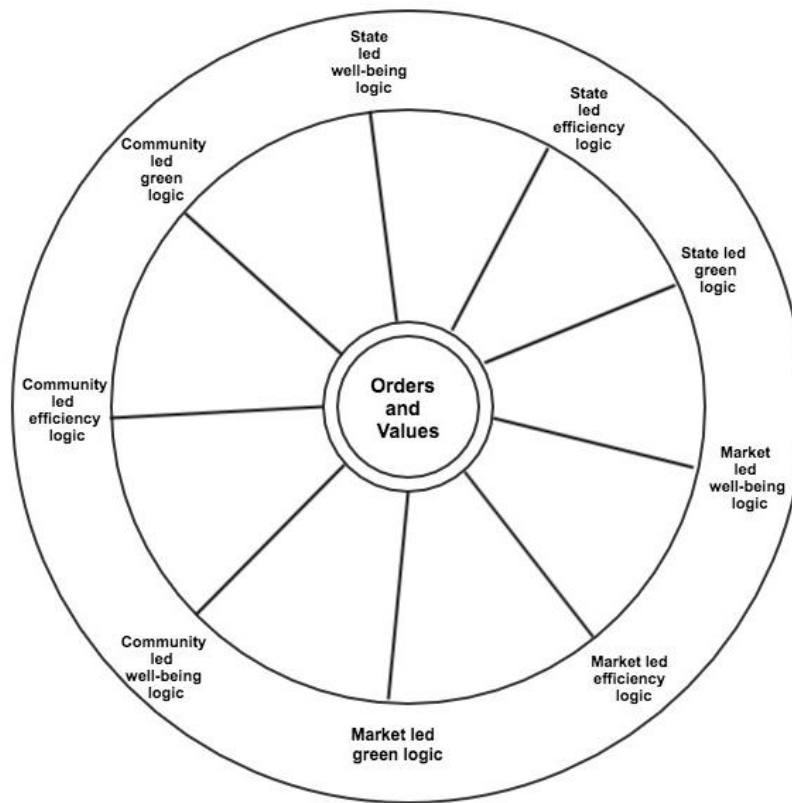


Figure 22. The Wheel of Logics framework

The nine logics illustrated in the wheel are ideal types, which means that the framework allows for the fact that there can be other institutional logics possible at the intersection of the ideal-types. One of the critical assumptions in the framework is that no particular combination of orders and values are more likely than others. For instance, the state order does not have a natural tendency to be combined with a well-being value. Furthermore, change in one component (order or value) doesn't affect change in other components over time. That is, a shift to a state order does not imply a shift to well-being value to be an intuitive next step. Using this Wheel of Logics framework, allows exploring the dynamic stability and transformation of regimes, as is shown in the next section.

2.4 Composition of regimes with institutional logics

In the sustainability transitions literature, a socio-technical regime represents a stable configuration with one dominant institutional logic, defined by a particular alignment of a set of rules (Geels, 2011; Fuenfschilling and Truffer, 2014). For instance, in the Australian water sector, the hydraulic logic, representing the alignment of the rules of the state order with large-scale system configuration, emphasis on national security and welfare, ‘engineering culture’ and importance of technical expertise seemed to be dominant (Fuenfschilling and Truffer, 2014). Other scholars have shown, however, that regimes may be composed of multiple institutional logics (Greenwood et al., 2010; Smink et al., 2015). According to these scholars, multiple logics co-exist and comprise socio-technical regimes. These multiple logics, comprised of different combinations of orders and values determine the ‘composition’ of the regime. Identifying such composition of a regime is a way to understand the nature of dynamic stability of regimes. This composition is what characterises and alters the dynamic stability of regimes as regimes transform. This is the line of thought I am developing using the Wheel of Logics framework.

2.5 Transformations and dynamics stability of regimes

Regime transformation, applying the Wheel of Logics framework can be depicted as a changing composition of ideal type institutional logics in a socio-technical regime. I propose that three types of regime transformation are possible – each associated with a unique form of dynamic stability: 1) Single ordered transformation and ‘ordered stability’, 2) Multi-ordered transformation and ‘directed stability’, 3) Switching ordered transformation and ‘fragmented stability’. I elaborate each in detail below.

1) Single-order transformation and ‘ordered stability’

As the composition of the regime changes along the course of transformation, one institutional order may remain or become dominant over others. New actors following the existing order may emerge with new values, or old actors drive transformation with new sustainability values. Multiple institutional logics may still comprise the regime, due to multiple

sustainability values. A regime, therefore comprised of multiple ideal type institutional logics following a single institutional order can be interpreted to have 'ordered stability', in contrast to regimes where multiple orders are present. The directionality of the change process is determined by the sustainability values appearing in the new composition of the regime. The sheer number of logics constituting the regime may also increase as a consequence of multiple values. However, dynamic stability in a single-order regime transformation process is defined by the coherence and coordination between actors operating under the guidance of the same institutional order.

2) Multi-order transformation and 'directed stability'

As regimes change, the presence of more than one institutional order in a regime is not uncommon. A multi-order transformation may happen in situations where actors following a new institutional order start operating in parallel to the existing order. This hybridity may create conflict within regimes, and the dynamic stability of the regime may begin to be compromised. However, there will still be an opportunity for the longstanding dynamic stability of the regime, if the sustainability values are shared across the actors following different orders. In the course of a multi-order transformation, the sustainability values may provide common directionalities of change. The consequent form of dynamic stability is, therefore, a 'directed' one - where a particular set of values are shared even if there are multiple values present in the composition.

3) Switching ordered transformation and 'fragmented stability'

The third type of transformation is when neither of the above two types of composition of a regime is relevant. Regimes in the Global South often transform in specific geographical pockets in the city, and not as a whole, evenly across the city. In this type of transformation, an existing institutional order is replaced by a new institutional order, but only in a specific part of the city, for instance. This replacement process echoes the substitution pathway of transition (Geels and Schot, 2007). In the course of 'switching order' transformation, new actors may exercise their power, social connections and/or propose new values, undermining the pre-existing values to rise to a position of dominance in the regime. Changes in technologies and governance will be directed towards fulfilling these new sustainability values. The direction of change is contextual since the actors following new institutional order may also carry similar sustainability values as the actors from the previously dominating institutional order. However, owing to the fragmented nature of change, the new directionality does not apply to the whole regime. The new dominant institutional order and new values ensure dynamic stability in a

specific part of the city, while in other parts the stability of regime is uncertain - determined by the negotiation between old and new actors. This type of transformation through switching and substitution between orders, thus result in a 'fragmented stability' of the regime in certain geographical pockets.

I propose these three types of regime transformations and consequent forms of dynamic stability to be stylised representations of the different ways in which regimes may transform and dynamic stabilities may vary. These stylised propositions are illustrated through the case study in public transport regimes in Kolkata.

3. Methods

3.1 Application of the Wheel of Logics

The goal in the remainder of this paper is to empirically demonstrate the dynamic stability of regimes corresponding to the three forms of regime transformation outlined in section 2.5. For this purpose, it is first required to identify the institutional orders operating in each regime and those that are newly emerging in the regime. In this step, we follow the characteristics outlined in Table 15 to understand whether the State, Market or Community orders guide the regime. The dominance of one particular institutional order, in the presence of other orders, is interpreted through identifying dominant actors in governing the regime, and understanding how these actors legitimise their actions.

Identifying institutional orders is one part of applying the framework. In the second step, one needs to identify sustainability values guiding change in the regime. The three sustainability values, integral to the framework are well-being, efficiency and green. These three values echo the three pillars/dimensions of sustainability, namely social, economic and ecological aspects (Gibson, 2006). These three aspects are also prominent in a recent Global Mobility Report prepared by 'Sustainable Mobility for all' (2017), which offers insights into how sustainable mobility systems can help in reaching Sustainable Development Goals (SDGs), developed by the United Nations for 2030 (UN, 2015). The report suggests four global objectives for sustainable mobility – 1. Universal access, 2. Safety 3. Efficiency and 4. Green. Since I focus on mobility

system in the empirical part of this paper, I have adopted these four objectives related to sustainable mobility for the application of the 'Wheel of Logics' framework in this paper. Universal access and safety are integral to well-being value, while efficiency and green are considered as separate individual values.

Urban sustainability transition studies, especially in emerging economies such as India and China - have focussed on environmental sustainability as the main driver for change, while well-being and efficiency values have been largely ignored (Raven et al., 2017). Treating all three values with equal importance is crucial for understanding sustainability transitions. This multi-dimensionality of sustainability is captured in the list of sustainability criteria suggested by stakeholders in a mobility workshop in India. In November 2013, 12 mobility experts – academics and practitioners in Kolkata performed a multi-criteria appraisal of sustainability of emerging mobility innovations in India (Ghosh, 2014)³⁰. The stakeholders for the workshop comprised of policy professionals, urban planners, NGO representative, consultant, engineers and social scientists, who were encouraged to suggest their own criteria for assessing sustainability of innovations in walking and cycling, alternative public transport (bus rapid transit/BRT) electric vehicles, alternatively fuelled vehicles (compressed natural gas, to be specific) and vehicle parts innovation (Ghosh, 2014). In this multi-criteria mapping exercise, they proposed criteria for social, economic and environmental dimensions of sustainability. In this paper, these different categories of criteria are adopted as indicators of well-being, efficiency and green sustainability values respectively.

Ghosh (2014) lists all criteria suggested by each stakeholder in the workshop. This list includes duplicates, since a single criterion like 'reduced air pollution' or 'affordability' are proposed by multiple stakeholders in the workshop. Similarly, the Global Mobility report lists a range of indicators and objectives for each of the four sustainable mobility goals, namely universal access, safety, efficiency and green. The table below presents a comprehensive (non-exhaustive) list of criteria fitting under each of the three institutional values. This table is derived from a more detailed table (table 18 in Appendix) with all objectives and criteria from both sources, including repetitions of the same criteria mentioned by more than one stakeholder in the workshop.

³⁰ Details of the workshop method can be found in Ghosh, (2014); Raven et al., (2017). The project and the workshop were funded by NWO (<https://www.nwo.nl/en/research-and-results/research-projects/i/47/5947.html>)

Table 16. Indicative list of criteria for three institutional values for sustainable mobility.

(Consolidated from Sustainable Mobility for All, 2017 and Ghosh, 2014)

Well-being value	Efficiency value	Green mobility value
Equity of access across income groups, gender, age, disability status, and geographical location (reduced barrier and affordability)	More efficient use of resources (including energy, technology, space, institutions and regulations)	Reduced air pollution
Improved access to jobs and productive opportunities	Decoupling of GDP growth and energy consumption for transport	Reduced noise pollution
Improved access to markets and basic services as health and education	Good Governance	Reduced GHG emission
Reduction of fatality, injury, and crash rates	Average age of vehicle fleet	Reduced CO ₂ emission
Reduced risks for vulnerable groups, such as pedestrians, bicyclists, and children	Economic feasibility	Resilience to climate disasters
Reduction of social costs of transport related (such as health costs and forgone productivity)	Accessibility of technologies	Preservation of Ecosystems
Comfort of commuters	Profitability of service provider	Reduction of health costs associated with poor air quality and noise levels
Improved health and peace of mind	Minimisation of Cost (capital, operation, maintenance)	Climate Change Mitigation
Improvement in quality of life	High economic benefit to cost ratio	Climate change adaptation
Active community participation	Control over operation and misuse of public resources	Potential to mitigate CO ₂ emission
Robust and inclusive actor-network	Complete and robust value chain	Use of renewable energy
Awareness among all stakeholders	Possibility of Income generation and expansion of market	Preservation of natural resources
Use of indigenous capacity (knowledge and technologies)	Job security	Minimisation of non-renewable energy usage

Acceptability/ possibility of emotional attachment	Positive impact on economy	Waste minimisation
Fulfilment of status symbol		Easy and efficient waste disposal
Possibility of fun and hassle-free travel		Minimal and efficient land use
Existence of conducive and coherent governance policy		No compromise with agricultural land
Knowledge dissemination and awareness		
Public outreach		

The table includes criteria specific by mobility experts in India and excludes inter-city and international mobility criteria from the report (2017). The table is produced by clubbing together similar criteria (thereby removing duplicate criteria) proposed by multiple stakeholders from Ghosh (2014). In applying the framework in this paper, I utilise the criteria in this table as indicators of sustainability values emerging in each case of regime transformation. I do not claim this to be an exhaustive list of criteria for defining each of the three institutional values. Other criteria can be possible, particularly in other socio-technical systems in other spatial contexts. The above table is an indicative list of criteria that are claimed to be crucial for global sustainable mobility as well as those that seemed vital locally by practitioners in the Indian context.

3.2 Case selection

The paper adopts a descriptive and analytical case study approach for exploring regimes with different nature of stability and directionalities of change (Yin, 1994). Mobility system in Kolkata offers such an opportunity because of the diverse range of public transport modes (each comprising a regime) operating simultaneously in the city. The regimes studied in this paper can be characterised by informality; a multiplicity of values, actors' behaviours and interests; presence of persistent sustainability problems and relentless efforts to change, led by regime actors (Wieczorek, 2018; Koehler et al., 2017).

Kolkata is one of largest megacities of the world, located in the eastern part of India. The city has one of the world's highest population densities of 24,000 people per square kilometre or 63,000 per square mile (World Population Review, 2017). In such a dense urban space, mobility is a real challenge, given only 6% of land are available for transportation, "with a whole gamut of modes from hand-pulled carts to tractor trailer trucks sharing the same carriageway" (Government of West Bengal, 2008: iv). Kolkata has a wide range of public transportation options like buses, metros, trams, train, ferries, auto-rickshaws, cycle-rickshaws, cycles, taxis etc. Each of these public transport regimes is uniquely comprised of specific combinations of institutional logics. Each of these regimes has existed for decades, despite the presence of internal conflicts and tensions. Such characteristics make these regimes interesting cases for understanding the dynamic stability of regimes. Empirically, this paper attempt to show how stabilities and directionalities of change in various public transport regimes in Kolkata can be explained through the shift in institutional logics.

The mobility system in the megacity Kolkata offers a revealing case study for the empirical understanding of the different forms of stability and types of transformation conceptually proposed in the paper, using the Wheel of Logics framework (Yin, 1994). I focus on three public transport regimes which are different from one another in terms of actors, governance arrangements, technologies and sustainability values. More specifically, the paper studies shift in the composition of institutional logics in metro, auto-rickshaw and cycling regimes of Kolkata in the past 15 years. These three regimes in particular, among other public transport regimes in Kolkata, offers 'diverse' units to capture different types of transformation, satisfying a 'maximum variation sampling technique' within the domain of public transportation system in the city (Seawright and Gerring, 2008; Patton, 1990).

3.3 Data collection and analysis methods

A key method of data collection for this research is fieldwork in Kolkata (and briefly in Delhi) in two phases (2015-2016 and 2016-2017) for a total duration of seven months. Semi-structured interviews were conducted with twelve government officials, transport planners, transport operators, academics, consultants and users (their roles and the regimes they represent are presented in table 17 in Appendix). Repeat interviews were conducted with four of these

interviewees to understand the changes better and validate preliminary results. Interviewees were selected for information on each of the specific regimes as well as for being experts and users of the overall transportation system of Kolkata. Besides the semi-structured interviews, short interviews were conducted with auto-rickshaw operators, drivers, cyclists, cycle shop owners. The interviews were aimed to understand the governance mechanism, the underlying rationale and specific sustainability values guiding ongoing changes in the regimes. These interviews were complemented by access to several policy reports, policy guideline documents ranging from 'Detailed Project Reports' for metro; city level transportation plans; government circulars; and reports by consultancy organisations – either specific to each of the regimes or on overall mobility system. These sources complemented the interviews as evidence of change in each of the public transport regimes in Kolkata.

The data was further triangulated through conversations with citizens (as users of each mode), which helped in understanding the context-specific characteristics of change like prevailing informality and political, cultural biases that are instrumental in day to day functioning of the regimes (Flick, 2004). The second round of triangulation and validation of the empirical data was done online – searching through secondary literature, websites of local and national newspapers and social media presence of the organisations. These sources provided an excellent overview of the follow-up changes until September 2018 as well as brought up the heterogeneity in perceptions of different actors about the positive and negative aspects of the change processes.

I analysed and interpreted the data following the steps of application of the framework (see section 3.1). Through this analysis, I will show that different combinations of ideal-type institutional logics are at play in different public transportation regimes in Kolkata. The interpretation of the data and possible results of the analysis are discussed and cross-checked with peers, colleagues in several stages of writing this paper as well as with experts in Kolkata, as an effort to make this analysis credible and useful for the stakeholders (Petty et al., 2012).

4. Analysis

4.1. Metro regime transformation

Kolkata Metro is India's first rapid transit system which started its journey in October 1984. The operators of Kolkata Metro are Government of India enterprises, with some of the new metro corridors being implemented fully by the Ministry of Railways. In case of one corridor, in particular, there is a 74:26 share of equity between Ministry of Railways and Ministry of Urban Development, Government of India (Railway Board, 2018). The day-to-day operation of the metro along a single corridor is managed By Metro Railway Kolkata – a public organisation, and 'wheels of bureaucracy' dictates and often restricts the course of change in the regime (Acharya, 2016). Currently, 111 kilometres of new metro corridors are in different stages of implementation, which mark a change in the technology dimension of the regime. These corridors were initially envisioned by regional representatives in the National government, and subsequently, funds were allocated in the national railway budget under the political pressure from the State. This change is thus primarily driven by political actors, which coupled with the bureaucratic control suggest that the State institutional order governs the metro regime of Kolkata.

The key sustainability value guiding the metro regime during its early years in the 1980s can be interpreted as that of well-being. This value is clearly observable in the quote by an official, who explained that Kolkata's the then Metropolitan planning authorities deemed buses to be incapable of meeting future demand for travel. *"the [existing] mass transit system was going to be crammed after say 20 – 30 years or so, so it was his (Minister of Railway: 1982) planning to have an underground railway."* [Interviewee 7]. The remark further highlights that Kolkata metro was primarily the plan of a visionary politician, and the underlying rationale was to maintain quality and accessibility of public transport through creating a superior alternative to the bus, which would ensure faster and more comfortable travel. At the same time, another criterion for well-being was met through the emphasis on the affordability of metro by Kolkata's low -income earning citizens. The first metro fare was set at a level lower than break-even point of the project cost, necessitating an annual subsidy of ten million Indian rupees. (Metropolitan Transport Project, 1972). The significant change in the past 15 years in this regime has been scaling up the system, for making other areas of Kolkata accessible by metro. Universal

accessibility of metro, as a criterion to ensure the well-being of more citizens served as the first trigger for the ongoing transformation of the metro regime³¹.

Over the course of change in the regime, state institutional order remained as the centre of governance of this regime, while new values are emerging. State-led efficiency logic can be seen to be an emerging new logic guiding the regime in the past 15 years. The new sustainability value of efficiency is apparent in the understanding that metro guarantees the most efficient utilisation of space (through facilitating an 'underground city') and through carrying large volumes of commuters at the same time (Prasad, 2015; Chow et al., 2002). Given the limited share of land available for road transportation in Kolkata, policymakers believed that building metro corridors is the only way to keep public transport system efficient [Interviewee 1, 8, 9]. At the same time, the new metro projects detail energy saving measures like modern rolling stock with low energy consumption, 30% regenerative capacity, energy-efficient electrical equipment, control and monitoring of power systems (RITES, 2014: 19-20). Energy efficiency is also proposed as a way to reduce operation and maintenance cost – together constituting State-led efficiency logic. Besides efficiency, the green value has also emerged to direct the ongoing changes. Metro is considered free from air pollution, low on noise pollution and generally an eco-friendly transit system (Prasad, 2015). National Metro Rail policy, published in 2017, reinforces this State-led green logic, indicated by 'substantial reduction in per capita pollution emission bringing down various chronic diseases', serving as a rationale to invest in transit-oriented development in Indian cities including Kolkata (MOHUA, 2017).

In spite of the new emphasis on efficiency and green values, metro regime actors continue to be concerned with the affordability and overall well-being of metro users. The criteria of universal access through affordability of metro still seem predominant. As an official at RVNL notes, "...for metro, as far as our work is concerned, we study the prospect of the corridors from a passenger viability point of view. The metro has to be highly economical to its users." [Interviewee 6] This vision is supported by another official from Metro Railway Kolkata, who stressed that the starting fare of Kolkata metro is, in fact, lower than that of buses and by keeping the fares low they ensure metro to be accessible for the poor [Interviewee 7]. According to Sadhukhan et al., (2017), 60% of the metro users do not own a car, and 49% of total commuters use metro more than three times a week. Therefore, keeping the fare low is an

³¹ Note that this is a case of ongoing transformation of the regime. Current efforts of expansion of metro can be seen as efforts to optimise the regime and not (yet) a transformation. However, the regime is moving in the direction of a transformation pathway (for details on the different pathways of change, see Ghosh and Schot (2018)).

important criterion of well-being, since most metro users are from the lower or middle-income group of the society (Sadhukhan et al., 2017). Besides affordability, the safety of users and operators also gained prominence as a criterion for the value of well-being. This is evident in the motto for the construction of the new East-West Metro corridor: "Safety first and last, along with comfort" (Kolkata Metro Rail Corporation, 2016). Several safety measures including platform screen doors, noise level assessment, fire protection, real-time monitoring of conditions of buildings near tunnels and stations as well as safety guidelines for construction workers. There have also been "disaster management drills" in metro stations to promote awareness and rescue strategies in case of terrorist attacks (Bose, 2016). To increase accessibility of the metro, as a measure for well-being, authorities have emphasised the reduction of barriers to access metro by old and disabled people, while increasing convenience for all users by introducing smart cards, lifts, escalators, wheel-chairs, ATM's and other facilities in metro stations. There is also an emphasis on comfort through air-conditioned coaches, entertainment systems, seating facilities (Metro Railway Kolkata, 2016). These facilities target the relatively wealthier class of citizens, who might seek traffic-free daily commute using the metro, without compromising health and quality of life that they could avail by using private cars. Reduction of travel time also appeared as a reason for users (including car owners) to avail the metro (RITES, 2014). Finally, the new metro alignments touch the old and new business districts of Kolkata – Dalhousie and Sector V respectively – therefore promising access to jobs, fulfilling another criterion of well-being.

Therefore, the metro regime is composed of all three State-led logics from the wheel. The Metro Railway Policy presents all three sustainability values to be necessary for the transformation of the metro regime. Statements like *"appraisal of metro rail projects should entail economic and social cost-benefit analysis. Metro rail projects provide larger economic and social benefits to the society in terms of reduction in cost and time of travel, substantial reduction in per capita pollution emissions resulting in reduction in chronic diseases, reduction in road accidents, bringing down noise pollution etc."* shows the multi-faceted nature of sustainability in metro regime transformation (MOHUA, 2017: 5). Based on this discursive evidence, I conclude that multiple actors following the State order share the sustainability values, thereby agreeing on the directions of the regime transformation. In the course of analysis, I also found that well-being value is more prominently enforced through multiple criteria compared to efficiency and green values – suggesting that this transformation is predominantly towards addressing societal challenges. The dynamic stability of this regime is therefore enabled by the single (State) order that is governing the regime since the 1980s. The presence of multiple institutional logics in the

composition of the regime does not adversely affect this dynamic stability. Change is slow and controlled, which further characterises a regime with ordered stability.

4.2. Auto-rickshaw regime transformation

The auto-rickshaw is a motorised three-wheeler, acting as a prominent public transport option in Kolkata. The central actors in the auto-rickshaw regime are individuals who own and operate autos. Some owners may rent out autos to drivers with a contract for sharing profits between the owner and the driver. There are other actors in the market, like 'starters' - individuals who maintain time schedules at the auto-stands; 'agents' who are middlemen bridging access of operators to RTA, 'unions' who locally maintain stands, regulate fare, routes, operations (Arora et al., 2016). These actors follow the principles of Market as an institutional order, which can be observed in competition and transactions to match demand for auto service, the motivation of actors to profit and generate an income by providing this mobility service.

Market-led efficiency logic is predominant in the localised governance of the auto-rickshaw regime. This is a regime which is almost entirely managed on the ground through informal (/semi-formal) governance arrangements, which ensure earnings and livelihood for the auto-rickshaw drivers. Unlike other cities in India, in Kolkata, autos operate as a shared mode of transport in fixed routes and fares. However, in order to increase their meagre incomes, auto-rickshaw drivers may sometimes cut some routes short, extend other routes, or deviate from them (Arora et al., 2016: 29) (see Figure below). In spite of the RTA being the legitimate authority to issue permits upon registration of auto-vehicles and fix fares in the auto-rickshaw regime, many auto-drivers operate without an official permit as the government stopped issuing permits in order to control the growth of the number of auto-rickshaws in the city. However, high demand for this mode of transport was matched with the supply of auto-rickshaw without legal permit, often financed by private financiers (Basu, 2017). Furthermore, fares are also allegedly distorted through "haggling and overcharging", and these vary across routes in great proportion (Harding et al., 2016). These instances show that the Market-led efficiency logic primarily governs the auto-rickshaw regime.

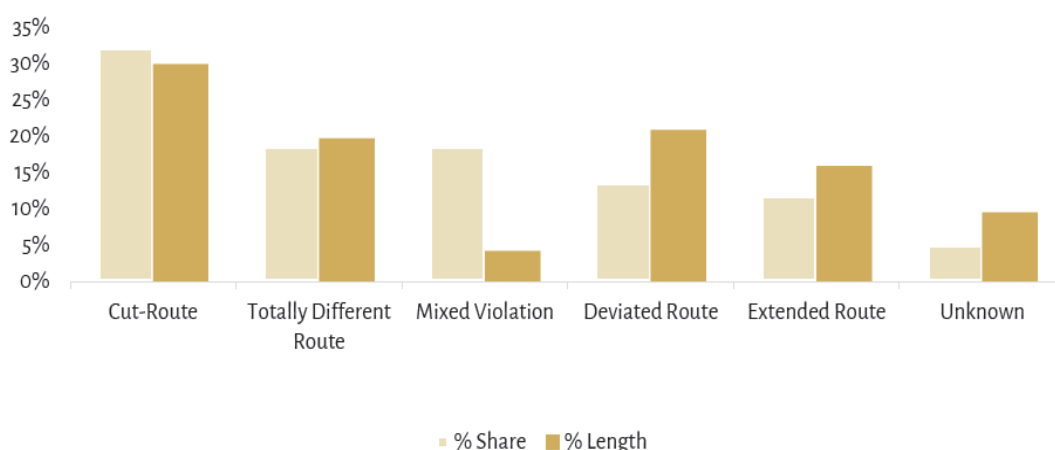


Figure 23. Share of different kinds of deviations in surveyed routes in auto-rickshaw regime

(source: Arora et al., 2016: 30)

At the same time, some criteria for well-being value were also met in this market-led auto-rickshaw regime. Certain sections of the population like women with children, old and differently-abled³² people prefer to use auto as it offers easy accessibility and comfortable travel. Autos being much smaller and lighter vehicle, the drivers skilfully manoeuvre their way through the congested streets of Kolkata much faster than other modes to take commuters to their destination. As a result, young urban middle-income population prefer autos for a quick commute and savings on journey time. On the other hand, my conversation with several auto-rickshaw drivers in Kolkata suggests that they predominantly come from lower-income families. The regime, therefore, provides them with ‘access to jobs’ – fulfilling another criterion for well-being logic.

In the past five years, the West Bengal government took measures to gain control of the auto-rickshaw regime. This is apparent in State Transport department and Regional Transport Authorities’ increasing interventions in the regime through implementing policies, regulations, monitoring and punishment mechanisms to regulate and formalise the regime. These reforms are however introduced in consultation with local trade unions operating the auto-rickshaws on the ground, a majority of which are affiliated to the ruling party of the State of West Bengal. The state government officials exercised power to take control of the governance in this regime.

³² Term used as a substitute for disabled or handicapped, as is common practice in many parts of India. Source: <http://www.yourdictionary.com/differently-abled>

Thus, the state as an institutional order is newly emerging to govern the auto-rickshaw regime in parallel to the market. The emergence of state-led efficiency logic in the regime is visible in the new “Auto Policy” unveiled by West Bengal government in 2016. According to the official notification about the policy, the objective of this policy was to ensure efficient use of the road space by controlling the growth of autos and govern the system effectively to provide an essential public transport service in the city. Some of the new measures under the policy include route-specific permits, standard fare charts, badges for auto-drivers, vehicles fitted with High-Security Registration Plates (TNN, 2016). The Regional Transport Authority, in March 2017, published the number of auto-rickshaws permitted to operate in each of the 125 routes (Joint Secretary to the Government of West Bengal, 2017).

This State-led efficiency logic, however, clashes with the market-led efficiency logic predominant in the regime. Formal regulations and control mechanisms proposed in the policy aim to ensure that the auto-drivers do not deviate from regulated routes, do not charge higher than permitted fares, do not overload passengers and/or do not operate without a legal permit. Therefore, attempts are being made to substitute the efficiency value held up by the market mechanisms that characterise the governance and operation of the regime, by the State-led efficiency value. The latter is expected to dominate the auto-rickshaw regime from September 1st 2018 (Bandopadhyay, 2018).

However, some directions of change in the regime are shared between the actors following the Market and State orders. Complementing the State-led efficiency logic, a new State-led well-being logic has also gained momentum. The State government aims to improve the accessibility of auto-rickshaws to users by reducing existing unpredictability and unreliability of the service. The well-being value is fulfilled through the criteria of safety and reduced vulnerability of pedestrians. This issue of safety, especially that of women is given utmost importance in the government’s recent discourse of change in this regime, which the auto-operators on the ground agreed with (in my interviews). The agreement is also reflected in the fact that the political party affiliated auto-rickshaw unions recently took initiatives to encourage women to join the profession of driving auto-rickshaws and are training them as auto-drivers in order to eliminate the safety concerns of women auto users (Millennium Post, 2018). The emphasis on safety and accessibility of marginalised user groups attempts to challenge the male-domination in the profession, and at the same time, assurance for women to feel safe in using autos indicates the shared sustainability value of well-being between actors of State and Market orders (Interviewee 5; Kabiraj, 2018).

The actors following the State order, however, didn't replace the existing actors following the Market order. Both institutional orders continue to operate in the regime. The fact that the auto-rickshaw regime is currently guided by institutional logics incorporating both State and Market orders makes it a case of multi-ordered transformation. Besides the presence of multiple actors following different orders, some actors such as the auto-rickshaw unions operate at the boundary of the State and Market orders. Affiliated with political parties, the unions are geared towards protecting and advancing the welfare of auto-drivers, but at the same time they may resort to bribery and self-promotion as leaders to serve their status, self-interest and profit (Arora et al., 2016; Ghosh, 2016). Yet, due to their continued presence and prominence, the unions also lend stability to the regime. This suggests that the presence of actors following two (or more) institutional orders in parallel, could be constitutive of a regime's dynamic stability rather than being detrimental to it. Regimes operating in between two or more logics, may not be disrupted by apparent tensions (e.g., those between the informality of market-led logics, as observed above, and the formality of state-led logics characterised by legal regulations and control mechanisms to govern the market). Having said this, the dynamic stability in the auto-rickshaw regime can be explained through the shared sustainability value of users' well-being. Actors from both institutional orders agree on the importance of well-being of users (characterised by safety, accessibility, comfort and convenience criteria). The shared sustainability value of well-being, which governs the direction of change in the regime, points to a 'directed' dynamic stability of the regime. This well-being value seems to be commonly embraced by a majority of actors in the regime. State-led and Market-led well-being logics – focussing on safety and accessibility together seem to be predominant in shaping the future of auto-rickshaw regime of Kolkata. This case study further shows that apparent instabilities in a regime (rooted at a different understanding of efficiency by State and Market orders) is not necessarily a weak point for a regime, as long as the directionality of regime transformation is set towards addressing important social challenges. These differences in governance strategy on one hand, and a shared sense of directionality of change, on the other, provides the regime with a continuous directed 'momentum' for improvement and sustainability in the long run (Furlong, 2014). Owing to such momentum, the regime will continue to transform (adapting to new technologies, new demands) and is unlikely to be destabilised entirely and substituted by another socio-technical system.

4.3. *Cycling regime transformation*

Cycling in Kolkata has predominantly been a personal means of transport for individuals and households in the lower and middle-income groups. Cycling in India is traditionally considered a 'poor man's mode of transport', and is continuously threatened by the aspiration of people to own motorised vehicles (Joshi and Joseph, 2015; Rahul and Verma, 2013). Based on my interviews (respondents 1, 9, 10, 12), I argue that a Community-led well-being logic is prominent in this regime, based on the prevalence of mutual trust, dependencies and co-operation in (low-income) communities using bicycles as their primary mode of transportation.

The presence of the Community institutional order can be observed in the social relationships between cycle owners, cycle users, parking space owners, repair shop owners – which go beyond market transactions. Through conversations with cycle owners and parking shop owners in the suburban region of Kolkata, I understood that the competition between different shops is overruled by long-established personal connections which dictate a fixed customer base for each supply-side actor. The cyclists and cycle shop, parking space owners look after each other and families in times of distress. The well-being logic is apparent in the affordability and easy accessibility of bicycles which are used to earn a livelihood (including commuting) by groups such as milkmen, newspaper delivery men, repairmen, and workers in sectors ranging from construction to security (Tiwari and Jain, 2008). Many consider cycling short and medium distances to save on transport fares (Rahul and Verma, 2013). The regime provides access to markets, health and education services and is sometimes characterised by emotional attachment of individuals to their own (often old, broken and non-personalised) bicycles (personal interviews).

The cycling regime in Kolkata is currently witnessing a 'switching order transformation', as discussed in section 2.5. New actors following the Market order are gaining prominence as those governing the regime in specific geographical pockets of Kolkata. In 2017, New town Kolkata, formerly aspiring to be "smart city" considered cycling as a key ingredient for smart and green transport mode for the city. This is mainly envisioned by the governing authorities, New Town Kolkata Development Authority (NKDA). Private companies were invited to invest and implement strategies to introduce cycling sharing infrastructures. Following this invitation, Zoomcar, a firm leading in car-sharing business in India took charge of implementing the first dock-less cycle sharing scheme of Kolkata, named "PEDL" (Maitra, 2017). Going by the principles

of the Market as an institutional order, this new addition to the regime assumes cycle as a public transport mode and cycle sharing as a service provided to the users following market rules of competition, transactions and profit (Interviewee 9). This change requires setting up new cycling infrastructure in the city and a new arrangement where cycles are not owned by the individuals, but by Zoomcar, which users can use through app-based payments. This change in cycling regime of Kolkata is predominantly guided by Market-led green logic. The green sustainability value is evident in the expectation that bicycle sharing and new cycling paths are the way forward to promote eco-friendly, green and clean transportation for the city (Mateo-Babiano et al., 2017; Interviewee 9). An official at NKDA articulates this newly emerging logic in local context: *“Traditionally cycles have been ridden by people like milkmen, for whom it has been the cheapest conveyance. We want to bring about a change whereby people ride cycles not because they cannot afford cars but because they care for the environment.”* (Interviewee 9). This vision indicates that the transformation through an emerging order (Market) and value (green) in cycling regime in Kolkata is seen as a necessary measure to reduce the carbon footprint from transportation in the city. This desired transformation is aimed to be achieved by encouraging people from wealthier class to shift to bicycling from cars (Interviewee 1, 9). However, the existing value of well-being indicated through affordability and accessibility criteria is also present in the new cycle sharing system. The PEDL bike sharing scheme is proposed to offer last mile connectivity in New town, ensuring easy accessibility of people to metro and bus stations from the residential areas. The scheme is also promoted to be affordable, with prices set as low as two Indian rupees per hour, which is less than a third of the cheapest bus ride in Kolkata (Kabiraj, 2017). Riding these bikes are also promoted to be fun and hassle-free due to locking, unlocking and payment mechanisms with a smartphone app. The company also encourages and promotes bicycling as a way forward for ‘healthy cities’ (Pucher and Buehler, 2010).

These new changes in the cycling regime in Kolkata is particularly interesting when compared to the contrasting nature of stability and change of the regime in other parts of the city. Alongside the attempts to introduce the new cycling sharing scheme, there was also an ongoing process of destabilising the existing cycling regime. The prevailing Community-led regime is under threat due to a ban imposed on cycling in major arterial roads of Kolkata in 2012 (Gowen, 2013). The governance actors imposed the ban, as an effort to curb congestion and ‘ease traffic’ by going against the well-being of millions of lower-income populations of the city (Interviewee 1, 10, 11; PTI, 2014). Thus, the efforts of maintaining dynamic stability in the regime are ‘fragmented’, because the transformation of the cycling regime remained partial and concentrated in specific neighbourhoods of Kolkata. The value of well-being is shared between

Community and Market actors, yet the latter focussed on the well-being of higher and middle-income groups residing in relatively wealthier neighbourhoods of Kolkata. Thus, this fragmented stability of parts of the cycling regime, resulting from the parallel efforts of promoting cycle-sharing for the (upper) middle classes and criminalising many existing cycling practices of low-income groups, paves the way for exclusion of and discrimination against the poor of the city (Gowen, 2013; PTI, 2014). The direction of this switching-ordered transformation of the regime is geared toward ensuring an eco-friendly, healthy and convenient lifestyle of higher-income groups of wealthy neighbourhoods, at the expense of the well-being of marginalised citizens of Kolkata.

5. Discussion and conclusion

Regimes in the Global South are often portrayed as inherently unstable. Yet they persist and thrive for decades without being destabilised or replaced by new regimes. In the multi-level perspective, this is explained either through the absence of niches and/or the lack of sufficient landscape pressures (Geels, 2002; 2004). However, unequal distribution of power, heterogeneous preferences, social and economic differences between actor groups, multiple persistent sustainability problems are at play in regimes especially in Southern contexts, which demands a different understanding of the nature of stability of regimes. I argue in the paper that as these regimes continuously transform, they can instead be considered dynamically stable. This paper aims to characterise different forms of dynamic stability of regimes in a fine-grained way. In this vein, a framework is developed with nine ideal-type institutional logics – each consisting of an institutional order and a sustainability value. These nine logics constitute the 'Wheel of Logics', which offers a useful approach to theorise different types of regime transformation and stability, based on the relations and contradictions between multiple institutional logics constituting a regime (Hoffman, 2013). The conceptual framework in this paper associates a particular type of regime transformation with a particular form of dynamic stability of the regime. Each of the three types also reveals directionalities of transformation.

The metro, auto-rickshaw and cycling regime transformation cases from Kolkata provide interesting insights into the nature of dynamic stability within regimes. First, the metro regime transformation case shows ordered stability, as the State order continues to dominate the governance of the regime. The case exposes the underlying *politics* of such transformations and

shows that ordered stability does not necessarily guarantee a conflict and tension-free regime. The national and regional political actors operationalise their power to transform the metro regime towards an envisioned future. In order to enable this future, they use multiple sustainability values in policy discourses to legitimise ongoing courses of transformation. The case, among others, illustrates how sustainability transitions in Southern contexts are inherently 'political enterprise', and are primarily driven by rationalities (logics) of those who benefit from the unequal distribution of power (Gopakumar, 2010; Ahlborg, 2017). The case is a vivid example of how 'single-ordered' governance structures, active involvement of political actors and large-scale infrastructural lock-in characterise 'dynamic stability' of regimes in the Global South (Frantzeskaki et al., 2010; Monstadt, 2009).

The second case study on auto-rickshaw regime demonstrates directed stability, associated with multi-ordered transformation. Here, the presence of informality in governance and operation of the regime, despite the presence of State order can hardly be ignored. The auto-rickshaw regime highlights a greater diversity of actors as multiple institutional orders are at play, which brings the conflict of interests between State and Market actors to the fore. The case analysis demonstrates that the Market actors continue to fight for *their* efficiency values that are distinct from and contradicts the efficiency values put forward by the State actors. However, the 'directed stability' of this regime stem from an agreed directionality of transformation shaped by well-being value, the meaning of which is shared between the State and Market actors. The case demonstrates 1) Presence of informality does not necessarily mean lack of stability of regime; 2) shared envisioned directionality of change can ensure the dynamic stability of sustainable regimes. As a corollary of the continued momentum for change, the auto-rickshaw case also demonstrates 'fluidity' in a regime, which can be a unique gift for survival in Southern contexts. Regimes that are driven by informality and may seem unstable open up to a greater diversity of logics and more suited for meeting heterogeneous needs. Scholars agree that such diversity can be pivotal as necessary 'back-up', in the face of uncertainties, unexpected threats and system failure (Berkhout et al., 2009; Wieczorek, 2017).

The third and final case study was the cycling regime of Kolkata. The case portraying fragmented stability in the course of switching order transformation is a unique example of how some transformations can increase urban inequalities and lead to social exclusion (Thorns, 2017). This case offers a critical insight into the distributional aspect of stability of regimes. The case study shows that stability of the existing cycling regime can be torn apart in parallel to efforts of stabilising an alternative practice (cycle sharing) – to constitute the cycling regime in

Kolkata. This partially transformed cycling regime is on offer for the (upper)-middle classes, 'smart citizens' of Kolkata, while the freedom of cycling by the poor and 'ordinary' citizens are taken away. The case study shows that regimes in the Global South can be fragmented and can be operationalised for certain (privileged) sections of the population in an exclusionary and discriminatory process of transforming. This is an important case that invites transition scholars to think whether stability that is fragmented, exclusive and partial - is desirable after all.

The study is not without its limitations. The framework suggests nine ideal type institutional logics. The corollary of proposing ideal types is that there are logics at the intersection of the ideal types. The case studies associated one institutional order to each actor, while acknowledging that many actors can be seen as located in the 'grey area' between two institutional orders. Similarly, many sustainability criteria can be for instance, in between well-being and green values. The choice made for associating an actor or a criterion to a particular order and value should be considered a highly stylised interpretation of reality (Jørgensen, 2005; Oltra and Jean, 2005). This stylised representation should perhaps not be treated as a weakness of the analysis, as it is useful to "reinforce the differences" and is a common practice in transitions literature (Jones and Summer, 2009: 38). One of the main difficulties of mobilising this framework is the way sustainability values are defined. Sustainability goals are context-dependent (Meadowcroft, 2011). This means sustainability values may differ across actors, contexts and socio-technical systems. A way to address this issue is to follow the Sustainable development Goals (SDGs) (UN, 2015) and enlist consequent sustainability indicators for the specific socio-technical system under investigation. This paper follows the SDG approach and further complements the global objectives with local sustainability criteria proposed by mobility stakeholders in Kolkata.

One methodological limitation of this paper could be that majority of the sustainability values in empirical cases are picked up from policy and other discourses – which are justifications of action to be undertaken in the mobility socio-technical system, not descriptions of actual practices performed in the system. In the auto-rickshaw regime, one can ask, how will the new auto-policy be implemented and what kind of practices will come into place? This is an important question to consider in understanding the actual sustainability transformations of the regime. However, the discourses studied for this research play a critical role in governing such transformations, that are guided and regularised by prevailing institutional orders and sustainability values. This understanding of institutional orders and sustainability values provides the basis for interpreting the dynamic stability of regimes in a fine-grained way, which

is the core aim of the paper. Furthermore, the application of the framework for case studies is currently highly dependent on the researcher's interpretation of the ongoing change processes. While this flexibility makes the framework widely applicable, the framework has scope for further refinement in order to provide more guidance for objectively identifying institutional logics in the empirical contexts.

Future applications of the framework in other contexts and socio-technical systems will improve the robustness of the framework. Besides, extending the Wheel of Logics into a method of identifying overarching logics of multi-regime interaction in complex socio-technical systems could be an important future research agenda, since systems like public transportation are often comprised of multiple regimes and shaped by the interaction between them (Konrad et al., 2008).

The main contribution in this paper is to bring to the fore the less-explored issue of stability of regimes and offer a nuanced and fine-grained way of understanding the dynamic stability of regimes in the Global South, moving beyond the (rather simplistic) dichotomy between stable and unstable regimes. This contribution is made possible by developing and applying the Wheel of logics framework. Unlike the conceptualisation of regimes in transitions thinking, where regimes are dominated by particular (set of semi-coherent) rules, the Wheel of Logics framework offers the option to explore the presence of multiple logics. This may be an approach which is more suitable for the Global South, where a diverse set of actors and their interests, priorities, beliefs and rationales are simultaneously at play. The framework allowed understanding the *composition* of regimes by multiple institutional logics. Therefore, in this paper, less attention is paid towards identifying which logic *dominates* the regime, but more towards which combination of logics are *co-constituting* a regime and how regime composition shifts along the course of transformation. The framework is not just useful for transition scholars but practitioners too. In cities where multiple regimes are transforming, but in different ways embracing diverse forms of dynamic stability, this framework allows identifying which institutional logics are emerging and which ones are disappearing from the regimes. Such understanding is necessary for practitioners to evaluate whether the ongoing transformation is desirable and find ways to navigate the change processes in directions that are more sustainable.

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7. Appendix

Table 17. List of interviewees for understanding dynamic stability of public transport regimes in Kolkata

Interviewee No.	Position	Organisation	Interview date	Regime
1	Senior official	Department of Transport, Government of West Bengal	January 2016	All three
2	Senior official	West Bengal Transport Corporation	December 2015 and November 2016	All three
3	Engineer	West Bengal Pollution Control Board	November 2016	Auto - rickshaw
4	Senior Official	Public Vehicles Department, Government of West Bengal	January 2017	Auto - rickshaw
5	Official	Public Vehicles Department, Government of West Bengal	January 2017	Auto - rickshaw
6	Senior Official	Rail Vikas Nigam Limited	November 2016	Metro
7	Senior Official	Metro Railway, Kolkata	October 2015 and December 2016	Metro
8	Senior official	RITES, Kolkata	November 2015 and November 2016	Metro

9	Senior official	New Town Kolkata Development Authority	December 2016	Cycling
10	Transport researcher and consultant	Indian Institute of Technology-Delhi	November 2015	Cycling
11	Official	Kolkata Police	December 2015 and November 2016	Cycling
12	Representative	A Kolkata based NGO	December 2016	Cycling

Table 18. Full list of expected outcomes and criteria for sustainable mobility

Institutional value	Sustainable Mobility for All, 2017	Ghosh, 2014
Well-being	Equity of access across income groups, gender, age, disability status and geographical location – thus leaving “no one behind”	Sufficient knowledge dissemination
	Improved access to jobs and productive opportunities	Access to energy for mobility
	Improved access to markets and basic services as health and education	Existence of local practices and community involvement
	Reduction of transport barriers for groups such as women and girls	Significance as a status symbol
	Reduction of fatality, injury and crash rates across all modes of transport	Acceptability and public outreach (Commuter behaviour)
	Reduced risks for vulnerable groups, such as pedestrians, bicyclists, and children	Involvement of civil society (in monitoring quality of infrastructure)
	Reduction of social cost of transport related (such as health costs and forgone productivity)	Existence of conducive and coherent government policy
		Presence of acceptability among people
		Road safety
		Fun of travel
		Change in people's behaviour

		Accessibility of other services through mobility
		Improved health and peace of mind
		Active community participation
		Awareness among all stakeholders
		Robust and inclusive actor network
		Inclusivity of marginalised group of people and access to service
		Improvement in overall quality of life
		Social inclusivity
		Positive health impact; activeness
		Inclusivity of poor and marginalised people
		Comfort of users
		Indigenous development of technology without foreign technical assistance
		Comfort and accessibility of users
		Use of indigenous capacity (knowledge)
Efficiency	Better and faster access to world markets	Affordability
	More efficient use of resources (including energy, technology, space, institutions and regulations)	Economic feasibility for governments to subsidise
	Decoupling of GDP growth and energy consumption for transport	Economically feasible and accessible technologies
	Increase in global trade	Profitability of service provider
	Regional integration	Affordability
	Simplified border crossings	Removal of economic disparity
		Affordability
		Income generation and expansion of market

		Positive impact on national economy
		Minimisation of capital cost
		Minimisation of operation cost
		Minimisation of maintenance cost
		Economic viability
		Complete and robust value chain
		Affordability
		High benefit to cost ratio
		Possibility of Income generation
		Economic feasibility for the government to subsidise
		Affordability
		Possibility of Income generation and job security
		Control over misuse of public resources
Green	Curbing the increase of global temperatures due to GHG emissions	Reduced GHG emission
	Better quality of air and lower noise pollution	Reduced local pollution and minimal health hazard
	Resilience to climate disasters	Use of renewable energy
	Preservation of Ecosystems	Reduced pollution and GHG emission
	Reduction of health costs associated with poor air quality and noise levels	Reduced CO ₂ emission
		CO ₂ mitigation potential
		Natural resources preservation
		No compromise with agricultural land
		Reduced air pollution
		Non-depletion of energy source
		Reduced GHG emission
		Minimal waste
		Reduced local pollution and global emissions
		Minimal fossil fuel energy use
		Minimal and efficient land use

		Easy and efficient waste disposal
		Reduced air pollution
		Reduced noise pollution
		Reduced impact of global climate
		Increased resilience (reduced vulnerability to disaster and environmental hazard etc)
		Reduced per capita GHG emission
		Overall emission reduction
		Reduced GHG emission
		Reduced GHG emission

Chapter 6.

*Smart as politically
transformative?*

*An analysis of a 'smart city' socio-
technical imaginary in an Indian
megacity*

(Paper V)

Bipashyee Ghosh¹, Saurabh Arora¹

¹Science Policy Research Unit, University of Sussex, UK

Abstract

‘Smart cities’ as socio-technical imaginaries have been enthusiastically embraced by urban planners and policy-makers around the world. In 2014, the government of India launched its “Smart Cities Mission” ostensibly to create socially inclusive and sustainable cities. Aspiring to make their cities smart, and following guidelines provided by the national government, local authorities from around India submitted proposals to compete in a ‘Smart City Challenge’. If successful, they would receive financial and technical support from the national government, for carrying out the smart transformations. Focussing on the urban mobility aspects of one such proposal, submitted by New town Kolkata, we assess how politically transformative was the collective process of imagining smart cities in India. A politically transformative process not only imagines the benefits of smart transformations to be widely distributed across different sections of the city, but it is also democratic and articulated. A democratic process affords possibilities to the most marginalised citizens, for raising their diverging and dissenting voices. And an articulated process registers the voices of the most marginalised in the socio-technical imaginary it produces. Our results indicate that while considerable efforts were made to engage with citizens in the making of the imaginary, the process remained highly uneven and concentrated, shaped by the upper and middle classes, leaving behind the voices and needs of poor and marginalised citizens of Kolkata.

Keywords

Smart city, politically transformative, socio-technical imaginary, democratic participation, India

1. Introduction

The ‘smart city’ has been enthusiastically embraced by planners and policy-makers around the world. The smart city vision promises everything from advanced technology to high standards of living for citizens. It has also been criticised as technocratic, and for extending control by large multi-national corporations (Sadowski and Pasquale, 2015; Hollands, 2015). These criticisms, however, seem to have had little influence in government circles, where the

policy enthusiasm for smart cities remains fervent. In India, for instance, the star of the smart city has continued to rise since 2014, when the national government launched its “Smart Cities Mission” aiming to create ‘socially inclusive local development’ and ‘environmentally sustainable’ cities, through a considerable emphasis on technology-led smart ‘solutions’, using the slogan of “Transform-Nation” (MoUD, 2015). Aspiring cities submitted proposals to compete in a ‘Smart City Challenge’, for receiving financial and technical support from the national government. In this paper, we focus on one such proposal, submitted by New town Kolkata (NtK).

As promises of social inclusion with techno-scientific solutions, smart city visions are usefully approached as *socio-technical imaginaries* (Jasanoff and Kim, 2009). Modern science and technology play a constitutive role in human imagination and social life. Imagination is not just the preserve of a few policymakers and politicians with their techno-scientific advisors but rather distributed widely among a nation’s citizens. In fact, without the citizens’ collective imagination and “willingness to invest in their own dreams of shared identity”, a “state may be, or may become, little more than an empty shell, though possibly one with brutal and oppressive instruments at its command” (Jasanoff, 2004: 25-26). In a nation or a region, citizens’ imaginings can be diverse, based on divergent expectations of the future. These imaginings might be in tension, competition, or even in conflict with each other, which in turn give rise to the ‘politics of imagining’. In such politics, powerful actors may attempt to push forward their visions over those of the marginalised actors. State authorities favoured some of these visions and translated into socio-technical imaginaries for (national) development and progress. These imaginaries then work as “active exercises of power in selection of development priorities, allocation of funds, and most importantly acceptance and suppression of political dissent” (Jasanoff & Kim, 2009: 123). Overall, socio-technical imaginaries may be defined as “collectively held, institutionally stabilised and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order, attainable through, and supportive of, advances in science and technology.” (Jasanoff and Kim, 2015: 4).

We analyse the socio-technical imaginaries of the smart city as outlined in the Indian national mission guidelines and the NtK proposal. We ask if NtK’s smart city imaginary can be considered *politically transformative*. The latter has three aspects. First, a politically transformative socio-technical imaginary is *distributed*, in that its envisioned benefits are available to all citizens, irrespective of the social groups they belong to. Second, a transformative imaginary is *democratic*, if the most marginalised citizens are afforded possibilities to raise their

divergent and dissenting voices in its making. Third, a transformative imaginary is *articulated*, if it registers the voices of the most marginalised. To conduct this analysis, we focus on one socio-technical system, namely urban mobility which is central to smart city discourses (Khanna and Khanna, 2015: 40).

We aim to make two contributions. First, we develop a novel conceptual framework to rethink smart city discourses, by analysing whether Kolkata's urban imaginary is distributed, democratic and articulated. Second, we aim to uncover the hidden politics of developing smart city socio-technical imaginaries. This is particularly interesting in the context of the Smart Cities Mission and Challenge in India because of the government's unambiguous promotion of citizen participation and social inclusion in smart city planning. By analysing how participation and inclusion are performed in Kolkata, we offer neither an enthusiasm for the democratising smart city nor a critique of its inherent technocracy. Instead, we examine the actual processes through which democratisation of the smart city imaginaries was attempted and ask how (partially) transformative were those processes.

The paper is structured as follows. In section 2, we review the literature on the politics of smart city designs. In section 3, we outline concepts for rethinking smartness as politically transformative. Our methodology of case selection, data collection and discourse analysis is described in section 4. Section 5 presents our analysis of the NtK proposal in relation to the national mission guidelines. We summarise to draw conclusions in section 6 and offer some directions for future research.

2. Literature review

Smart city visions have been extensively studied, particularly for cities in the Global North (Caragliu et al., 2011; Capdevila et al., 2015). In the Global South, smart city proponents present digital technology as the basis for benchmarking a city, against the best cities around the world (Menon, 2015). Smart cities signify a “digital turn in urban governance”, underpinned by a focus on speed and efficiency (Wiig & Wyly, 2016: 487). The goal is to ‘optimise’ cities using digital technology, which has been criticised as inherently technocratic (Muggah, 2014). With digitisation as the central theme of smart cities, critics argue that ICT firms, computer

programmers and management consultants can easily dominate the process and outcomes of such urbanism (Wiig & Wyly, 2016: 489; Ponting, 2013).

Smart city visions emphasise the benefits of digitisation in multiple socio-technical systems including electricity, mobility, water and sanitation (Nam and Pardo, 2011; Falconer & Mitchell, 2012; Carvalho, 2014). Neirrotti et al. (2014) identify mobility as a crucial ‘application domain’ which is being targeted by aspiring smart cities around the world. The professed aim is to mitigate pollution and congestion in urban areas witnessing fast economic development (Neirrotti et al., 2014: 30). Smart mobility is framed to include local and international accessibility through public transport infrastructure and services, green, non-motorised and shared mobility options “sustainable, innovative and safe transport system” and “availability of ICT infrastructure” (Giffinger and Gudrun, 2010: 15; Irungbam, 2016: 172). Much of the latter relies on Big Data, meant to enable ‘real-time tracking and monitoring’ of public transport facilities as well as transactions through smart cards and mobile phones (Kitchin, 2014). Such data-centric mobility services are often criticised for shifting the focus away from ordinary people’s mobility needs and well-being (Hollands, 2008). Docherty et al., (2017) argue that smart mobility transition is a governance challenge, instead of a technological one, where transparency determines a better quality of life in governance and inclusion of citizens in new mobility planning entailing peer-to-peer sharing, automating and application of ‘internet of things’.

The general technology push of smart cities is tied to an optimistic vision of urban futures facilitated by investments in human capital (Caragliu, et al., 2011; Neirrotti et al., 2014), with the stated aim of delivering a “smart combination of endowments and activities of self-decisive, independent and aware citizens” (Lazaroiu & Roscia, 2012: 328). Yet, critics argue that priority-setting for smart city initiatives is often dominated by municipalities, tech companies and growth coalitions (Luque et al., 2014). And implementation may be organised through public-private partnerships dominated by municipal governments and technology firms charging for service provision (Midgley, 2009). The smart city imaginaries in such cases are technocratic, rather than being representative of citizens’ visions of urban futures. To address this lack of representation, many city and national governments have now adopted the rhetoric of citizen participation in designing smart city visions and plans (Kruks-Wisner, 2018; Bertorelli et al., 2017; Cardullo and Kitchin, 2017). We study one such vision in this paper.

In addition, many studies show how smart cities exclusively target specific groups of people (middle- and higher-income populations), leaving behind and ignoring the needs of poor and marginalised citizens (Bhatkal, 2015; Datta, 2015; Watson, 2014; Vanolo, 2014). Similarly,

Benedikt (2016: 25) argues that smart cities are not designed to accommodate people who are "uneducated in technology, poor or otherwise marginalised". The latter are framed as "'non-forward-thinking' or in other words, non-valuable individuals" (Benedikt, 2016: 25).

To tackle these problems of social exclusion and digital technocracy underpinning smart city imaginaries, some scholars have called for a reorientation from technologies to people (Nam and Pardo, 2011; Vanolo, 2014; Capdevila et al., 2015). Proposals are afoot for "people-centred smart cities" which aim to harness the "collective intelligence" of citizens' voices and skills (Saunders & Baek, 2015: 8, 44). Kundu (2016: 100) argues that "through their individual actions and collective practices, people are central to the processes of place-making as they constantly reconfigure landscapes, things and possibilities". Such agency of people, scholars argue, needs to be recognised and nurtured by broadening the range of actors setting the agenda and driving the implementation of smart cities (Bakıcı et al., 2013). It is proposed that participatory governance is treated as a key 'institutional dimension' of smart cities, or as "inclusive human resource management and transparent governance" (Irungbam, 2016: 164, 167). Smart urbanism would then be able to connect the life on the streets with that in boardrooms and city halls (Townsend, 2013), facilitating transparency, collaboration and social learning through information sharing (see also, Luque et al., 2014; Ferro et al., 2013).

The preceding raises the question: which participatory governance mechanisms allow smart city developers to work pro-actively with marginalised citizens (and empower community initiatives), rather than simply catering to powerful business interests (Capdevila et al., 2015)? In what ways can such democratic decision-making be achieved and any benefits of smart city developments are distributed among the most marginalised citizens? If smart cities are rethought as 'democratic ecologies'³³ (Araya, 2015: 13), would it expand possibilities for empowerment and bottom-up civic engagement, enabling citizens to 'co-produce public systems of governance'?

Emphasising the importance of participation in techno-scientific developments such as smart cities, Jasanoff and Kim (2015: 97) argue for 'grassroots participation', within which "local people need to be listened to, not just 'consulted' or 'educated'." (Jasanoff and Kim, 2015: 97). Empowering engagement with citizens can take the form of delegating decision-making power to citizens (Arnstein, 1969), and letting citizens shape the directions of smart city development

³³ Araya (2015) describes democratic ecologies as urban governance processes that include wide distribution of democratic practices – for instance, commons-driven governance and empowerment of citizens beyond the elite, urban, educated 'creative class' (pp. 8, 13).

(Paquet et al., 2016). To enable the citizen-led transformations, the forums and techniques of participation have to be sensitive and symmetrical toward diverse interests and understandings (Stirling, 2008), helping to enlarge the space for voices of the most marginalised. Examples of participatory forums include citizens' juries (Pimbert and Wakeford, 2002), hybrid forums (Callon et al., 2009), open space technology (Owen, 2008), and deliberative mapping (Davies, 2006). Participatory forums differ in the extent to which they address relations of power, between actors in positions of cognitive or political authority and those occupying more marginalised positions. They also differ in taking a diversity of voices (knowledge and interests) into account, in the process of making decisions, visions and policies (Stirling, 2008). Truly effective democracy requires that the voices of the most marginalised, and dissenting, citizens are taken into account (de Hoop and Arora, 2017).

This begs questions such as: What avenues are offered to the marginalised sections of the city to raise their (dissenting) voices? What effects do their voices have on the (participatory) development of smart city imaginaries? How is knowledge from bottom-up citizens' initiatives linked to smart city developments led by governments, firms and civil society organisations?

3. *Rethinking smart as politically transformative*

To address the foregoing questions, we attempt to rethink 'smart' in cities. We propose that an urban socio-technical imaginary is 'smart' if it is: a) distributed, b) democratic, and c) articulated (Arora, 2016).

A smart city imaginary is *distributed* if it envisions its purported benefits to be available to all citizens, irrespective of their social group (concerning class, caste and gender). Here, we are building on theories of distributive justice of actions (in our case, the imagined smart city interventions), focussing on the distribution of well-being and capabilities (Vallentyne, 2007). By asking whether a smart city imaginary is distributed, we aim to ascertain whose interests and needs the smart city is imagined to serve. In unequal cities, differences between citizens will mean that the needs of the poor and marginalised are distinct from those of the middle- and upper classes. So we ask if these differences are taken into account by the smart city imaginary.

A smart city imaginary is *democratic* if (in the process of its imagining) the most diverse set of citizens, particularly those who are marginalised, are afforded opportunities to raise their voices. By asking whether a smart city imaginary is democratic, we aim to map the forums and techniques used by smart city planners to elicit citizen participation. We question whether the citizen participation methods used in Kolkata arrived at an authoritative and prescriptive imaginary by closing down the decision-making process through a marginalisation of the messy diversity of voices and interests (Stirling, 2008).

A smart city imaginary is *articulated*, if citizens' voices, interests and knowledge, raised through participatory forums and techniques are taken into account by policymakers and other actors with decision-making powers at the city and national levels. Asking whether a smart city imaginary is articulated, directs attention to the matches and mismatches between the expectations/ideas voiced by citizens and the smart solutions proposed by policymakers. The crucial consideration is not whether citizens' voices count or matter in constructing the smart city imaginary, but rather which voices matter and what importance is afforded to them in the imaginary. In particular, how are the (dissenting) voices of the least powerful taken into account by planners and policymakers (de Hoop & Arora, 2017)?

Distributed	<ul style="list-style-type: none"> • For whom is the smart city imaginary in terms of benefits? • Does it take differences between citizens into account?
Democratic	<ul style="list-style-type: none"> • Who was afforded the right to participate? • How/ through what kind of mechanisms do they participate?
Articulated	<ul style="list-style-type: none"> • Whose voices are taken into account in the eventual smart city imaginary? • Are the marginal voices articulated in the imaginary?

Figure 24. Questions emerging out of rethinking smart as distributed, democratic and articulated.

Overall, by asking whether a smart city imaginary is distributed, democratic and articulated, we aim to map if the decision-making process is politically transformative, whether it could *open up* to include a wide diversity of voices and interests, including those of the most marginalised (Stirling, 2008). And by doing this, is the imaginary able to consider and highlight neglected issues, which point to new directions for future socio-technical developments in the city?

4. Documents and interviews

In order to appreciate the smart city imaginaries, produced at national and regional levels in India, we rely on the national mission statement and guidelines (MoUD, 2015), and two versions of New Town Kolkata's (NtK's) proposal submitted to the national smart city challenge (NKDA, 2015 and NKDA, 2016). Each version of the proposal includes annexures containing minutes of official meetings, copies of memoranda of understanding between NKDA and other organisations, as well as details of citizen engagement processes during proposal development (NKDA, 2015: Annexures; NKDA 2016: Annexures). We also consider the feedback provided by the national government officials on the first version of NtK's proposal (MoUD, 2016), responding to which NtK authorities prepared the second version and annexures.

We complement the document analysis with detailed semi-structured interviews conducted by the first author with policymakers and citizens, during two stretches of fieldwork in Kolkata in 2015 and 2016. Interviewees include a senior city government official who played a critical role in envisioning new directions of urban transformations; a senior urban planner who played a significant role in land use planning and design of the city before the inception of smart city plans; and a private consultant who worked closely with the government in drafting smart city plans. Also interviewed were three citizens who actively participated in developing the smart city proposals, representing their residential communities. These interviews were audio-recorded. We also conducted short interviews with around twenty marginalised people including rickshaw pullers, auto-drivers, roadside vendors, fruit and vegetable sellers, cleaners and construction workers, who offered insights into their everyday mobility as well as current problems in the visions for the future.

5. Analysis

NtK is located on the north-eastern fringe of the central district of Kolkata, India. It was primarily a rural area supporting agricultural and pastoral activities until a new township was planned in the early 1990s. The aim was to establish a modern business district, with some residential quarters, for a population of one million (NKDA website, 2016). Private developers invested in the housing and commercial sectors, creating urban living space for “global Indians” belonging to the (upper) middle classes living in Kolkata (Bose, 2014: 392). Around 200 poor households were displaced from their (rural) lands to make way for the new town. According to official reports, they were offered *“a rehabilitation and resettlement package in accordance with norms of Government of India and State government”* (HIDCO, 1999: 8). The stated visions for the early development of NtK in the 1990s were modernity, functional efficiency, aesthetic attractiveness and environmental sustainability (HIDCO, 1999). The overarching ambition was to become a financial hub of West Bengal state and India (Hochadel, 2016).

NtK covers an area of 35.5 sq. Km (8777 acres). Kundu (2016: 93) describes the township to be comprised of residential “gated” housing apartments overlooking agricultural lands adjoining the city. The surrounding rural communities act as “service villages”, supplying “servants, housekeepers, drivers, cleaners, cooks” to the new residents of the housing complexes’ (Kundu, 2016: 96). The focus on attracting Information Technology (IT) companies to set up offices in the city is evident in the land use changes in New Town between 1999 and 2006: the percentage of land available for IT, commercial and institutional purposes increased at the expense of residential and open spaces (see Figure 25). Area for transportation remained nearly the same over this period.

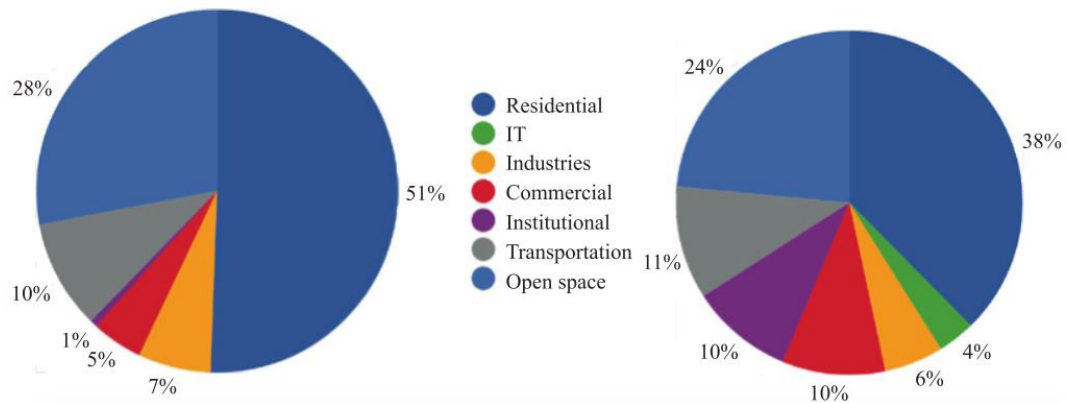


Figure 25. Land use in New Town: 1999 and 2006 comparison

(Sengupta, 2013: 364)

The main administrative body organising local services and amenities is the New town Kolkata Development Authority (NKDA). The central planning agency for the overall development of the city is the Housing Infrastructure Development Corporation (HIDCO). NKDA and HIDCO took the lead in preparing NtK's proposal for the national smart city challenge, taking into account inputs from firms such as IBM, SAP, Oracle, Wipro, Atos, Shapoorji Pallonji, Wabag and Intel (NKDA, 2015: 49). Future Cities Catapult, a UK-based consulting firm assisted in citizen engagement initiatives.

NtK's proposal promises to get the city ready for economic and demographic growth, offering its citizens the "best in class urban living experience" (NKDA, 2015: 16). Other promises include becoming a global services hub by attracting new IT companies, setting up hospitals and higher education institutes, as well as offering citizens opportunities for better work-life balance by hosting entertainment centres, parks and museums. The proposal also upholds the goals to be achieved by NtK, in line with the national smart cities mission guidelines. For instance, in the domain of mobility, NtK's proposal emphasises public transportation through metro rail, monorail, electric buses, e-rickshaws (as para-transit modes), improved walkability and cycle lanes. In developing these elements of the proposal, representatives from West Bengal's state transport department were involved. Other strategies noted in the proposal include IT connectivity, e-governance, and mechanisms for active citizen participation in future decision-making (NKDA, 2015: 16-17).

5.1 A 'distributed' smart city imaginary?

The national smart city mission calls for development that is 'sustainable and inclusive', to improve quality of life, employment opportunities and incomes for everyone, but particularly 'the poor and the disadvantaged' (MOHUA, 2017). By emphasising the flow of any smart city benefits to poor and marginalised people, the mission's guidelines for proposal preparation clearly emphasise inclusion (MoUD, 2015: 34). Yet, the guidelines also assume *citizens* to be a homogenous category by arguing that "applying smart solutions in the transport sector (Intelligent traffic management system) and reducing average commute time or cost to citizens will have positive effects on productivity and quality of life of citizens." (MoUD, 2015: 8). Here the solutions are assumed to benefit all citizens' productivity and quality of life. Differences with respect to gender, caste, age, disability, income class (including vehicle ownership and the motorised or non-motorised vehicle) are not highlighted.

Smart mobility initiatives are imagined as beneficial ostensibly to everyone in the city, marginalising differences of gender, class, caste, age, location and disability differences. When differences are considered, NtK's proposal reduces the definition of transport in a smart city to be "plentiful and attractive to people of all income levels." (NKDA, 2015 Annexure 2:3). This universal framing does not even follow the national guidelines, which suggest the taking into account of the differences between "children, women and elderly" (MoUD, 2015: 9). The erasure of differences and inequalities from the proposal depoliticises NtK's smart city imaginary. By claiming universal benefits (for all residents of the city), the imaginary hides how smart city initiatives may not serve the interests of the poor and marginalised. Through its smart city imaginary, NtK aspires to become a "satellite city", a "service hub" and a luxury home for middle- and high-income groups of IT and corporate professionals, while excluding a wide range of people who are made almost invisible in the imaginary. Many people in NtK earn their living from driving rickshaws, vending fruits and vegetables from pushcarts, labouring on construction sites, working as security guards in flats and offices, cleaning and cooking as domestic 'servants' in the middle- and upper-class homes. Some of these workers live in the city. Others commute from surrounding villages. Nearly all of them use public transport services, roads and other infrastructures on a daily basis. How does the New town Kolkata smart city proposal take their specific needs into account (beyond the framing of universal distribution of benefits)?

NtK proposes to build a “hawkers’ corner” or a community marketplace, that allows small and marginal vendors “to set up shop in an organised manner”, instead of using pushcarts to sell at the buyers’ doorstep (NKDA, 2015: 42, 43). Such initiatives are publicised as attempts to offer ‘safe spaces’ for these vendors, as part of the city’s efforts to be ‘inclusive’ (following the national smart city mission guidelines). However, New town Kolkata Development Authority (NKDA) meetings held in February 2016 reveal an alternate (not-so-inclusive) logic behind this initiative. Responding to the “increasing menace of encroachment of roadside public places by hawkers” who create “nuisance by littering of waste in adjoining roads & footpaths and visual pollution” while “also hampering free flow of traffic in service roads” (NKDA, 2016: Annexure 4: 12), the smart city aimed to seclude them in an enclosed “hawkers’ corner”. As noted by one of our citizen respondents, “it was [considered] essential to remove them from eye-sight in order to present New town as a clean and smart city.” In addition to displacing the small/marginal vendors from their current (mobile) locations, this smart city initiative also dissatisfied many middle-class residents for whom the designated “corner” became a distant and inconvenient location to shop from.

Another specific pro-poor intervention is the proposed introduction of the *Toto* (a battery-operated rickshaw), ostensibly to create new employment opportunities in the smart city. By simplifying the bureaucratic process of acquiring a driver’s license and vehicle registration, the government aims to encourage low-income individuals to own and drive a *Toto* (as a mode of shared/public transport) for a living. However, this ‘inclusive’ intervention at the same time extends the marketisation of public transport in NtK. A city official explicitly stated this during an interview: *“I believe in market mechanisms. Market regulates the price and creates entry and exit barriers. Let us (government) not put additional barriers. If a poor person thinks he can make a living by driving a toto vehicle, let him do that.”* To facilitate this, by bringing the vehicle sellers (private companies) and buyers together, the NKDA even organised an “E-rickshaw Mela” or festival. Here, it appears that when the NtK’s smart city imaginary takes class differences into account and proposes ostensibly pro-poor initiatives, it is done within an overarching goal of promoting deregulation and marketisation (of public transport). Such a marketising approach, geared toward the privatisation of public services, not only overlooks inequality but also actually worsens it (Dutta, 2015; Praharaj et al., 2018).

The same marketisation thrust is brought to the fore in the NtK imaginary’s focus on biking, which is presented as an essential element of the future smart city, but not for all citizens. As noted by a city official: *“We are not advocating that everyone should start bicycling or people*

should bike to work ... cycles will never be popular among elderly citizens, but we are not suggesting one size fits all strategy either. Citizens with different needs and choices will be able to choose what suits him/her most." The role of citizens as makers of choices emerges as a core tenet here, according to which citizens by the act of choosing, become *consumers* of the smart city (Burri, 2015: 244). Everyone is framed as possessing this ability to choose, to become a consumer, irrespective of the (relative) affordability or accessibility of the smart city interventions.

5.2 A 'democratic' smart city imaginary?

The national mission guidelines emphasise citizens' participation as crucial in the creation of smart cities. The mission refers to citizens as 'smart people' who participate in all phases of the making of the smart city, from its definition to "implementing and designing post-project structures" (MoUD, 2015: 18). The mission acknowledges that achieving such broad-based participation is a challenge. To overcome this challenge, the mission's guidelines list ways to identify who needs to be involved on behalf of the 'smart citizens', how they should be consulted, and how their voices should be taken into account. The guidelines state that "The proposal will be citizen-driven from the beginning, achieved through citizen consultations, including active participation of groups of people, such as Residents Welfare Associations, Taxpayers Associations, Senior citizens and Slum Dwellers Associations. During consultations, *issues, needs and priorities of citizens and groups of people will be identified and citizen-driven solutions generated.*" (MoUD, 2015: 22, emphasis added)

The guidelines also emphasise the importance of engaging with "vulnerable sections of society (disabled, children, elderly etc.), ward committees and area *sabha-s* [neighbourhood councils], important citizens groups (associations, organisations and institutions such as local chamber of commerce)." (MoUD, 2015: 35). The suggested mechanisms through which these citizens were expected to be consulted, however, remained rather vague. And digital technologies as tools of citizen participation are emphasised. For example, the guidelines ask the question: "*how much* of social media, community, mobile governance have been used during citizen consultation?" (MoUD, 2015: 35, emphasis added). The technological focus of the national smart city imaginary is therefore maintained in the envisioning of citizen participation,

possibly to promote the contracting of private firms to design and implement the technology-driven participatory forums and mechanisms.

In an attempt to adhere to the national mission guidelines, NtK's proposal focussed on providing numbers of people who 'participated' in defining the smart city, rather than focussing on assessing which (vulnerable) citizens were able to participate. "Leveraging a well-formulated 5 stage citizen communication strategy spread over 50 days, NKDA engaged with around 83% of the residing population (29880 residents) to obtain their feedback on city profile and understand their aspirations, visions and goals. Approximately 21% of respondents (7560 persons) provided inputs for formulating the Smart City Plan through 138 events." (NKDA, 2016: 19)³⁴. The first version of the proposal included a single sentence on which citizens were involved: "all groups of citizens were involved – senior citizens, housewives, students, professionals, housemaids, construction workers/workers in the informal sector, NRIs³⁵, entrepreneurs etc." (NKDA, 2015: 19). In the second version of the proposal, the description had changed to: "Respondents included – senior citizens, housewives, students, professionals including IT employees, informal sector workers, children, non-resident property owners, citizens seeking to relocate to New Town in near future, entrepreneurs, developers, businessmen, city administrators, elected representatives, academicians and other government institutions along with visitors to the city (Refer to Annexure 3.2.1 and 3.2.2 for details)." (NKDA, 2016: 19) The details of the Annexure include a visual representation of the citizens' "focus groups" targeted in the consultation process, which included the poor and vulnerable primarily in the fifth category of those employed in the 'informal sectors' (see figure 26).

³⁴ 7560 of 29880 is in fact 25.30%. However, the statistic is quoted directly from the official smart city proposal document prepared by NKDA. We keep the quotation intact, with the observation noted here.

³⁵ Acronym stands for Non-Resident Indians – "an Indian citizen or person of Indian origin living abroad" (Source: <https://www.collinsdictionary.com/dictionary/english/nri>)



Figure 26. Citizens' groups who were targeted in the consultation process.

Source: NKDA, 2016. Annexure 3.2.1, pp. 3.2.1

Our respondents provided some clarity on the question of 'who participated' in the consultations in the city. One respondent observed that a household comprising 4-5 family members including senior citizens, male and female professionals, children, housemaids, cooks, nannies and pets were generally represented by a single male senior member of the family. Women only attended the meetings, when male members of their family could not attend or because the male members considered the meetings to be 'childish endeavours' that were not worth attending. Another respondent described how a few enthusiastic (often retired) male residents, respected by local government officials due to their professional career, were personally invited to the consultation sessions. Clearly, these influential people are not the marginalised, vulnerable citizens and slum dwellers that the national guidelines referred to.

Each participating residential community, such as the residents' welfare association of a block of flats, selected a representative to attend the NKDA's meetings and workshops. Before these participatory gatherings, some of these representatives collected ideas from other residents, or wrote up their own ideas and validated the same with other residents of the community. Recalling one such meeting, one of our respondents noted, "This was in April or May 2015. Representatives of the residents' welfare associations were asked to participate in a meeting at NKDA office. After an introductory speech by the chairperson of the NKDA, we were showed some video clips (of 'smart cities' around the world). We were then asked to propose any ideas and opinions about making New town a smart city." Through the introductory speech

and by showing a video at the beginning of other smart cities, the participatory meeting was framed by the concerns and goals of NKDA authorities (proponents of the smart city). Such a framing contributes to the closing down of the decision-making process, by marginalising the messy diversity of voices and interests (Stirling, 2008). A powerful audio-visual medium like documentary type videos risks reorienting the citizens' focus away from their local issues and concerns, towards aspirations for meeting 'global' standards (Gerbner, 1987).

In contrast to the paucity of information on 'who participated', NtK's proposal and its annexures are replete with details about 'how citizens participated' in the consultation process. The proposal claims to have adopted a 'five-step methodology' of citizen engagement, to 'envision', 'diagnose', 'co-create', 'refine' and 'share' (NKDA, 2016: Annexure 3.2.1). Figure 27 shows which different techniques were used in each of these steps to engage with citizens. However, missing from the proposal are crucial details on how the different methods were used, reaching which citizens and with what results.



Figure 27. Five-step methodology of citizen engagement.

(Source: NKDA, 2016. Annexure 3.2.1, pp. 3.2.1)

Several other forms and techniques of engaging with citizens are mentioned throughout the proposal and annexures. In Table 19, we document the multiple citizen-engagement methods used in the making of NtK's smart city imaginary, along with the number of citizens reached by each. Once again, the proposal does not provide details on what each of method entailed.

Table 19. Forums and techniques used for citizen engagement.

(Source: Compiled from NKDA (2015), NKDA (2016), Annexures in myGov, (2015))

Mechanism	Outreach
Suggestions about smart initiatives received online	188
Online discussion about smart city vision	396
Online submission about smart city initiatives	577
Citizen's online registrations on MyGov app	20,000
Online votes on smart initiatives through mygov.in	Not mentioned
Essays about a smart city and vision statements received	165
Emails	15000 sent out
SMS	10000 sent out, connecting 9600+ households
Facebook	17,500+ followers; 150+ posts and comments; 2500+ likes
Twitter	200 followers; 100+ tweets and retweets
Youtube	27 videos; 800+ views
Whatsapp social media group	Not mentioned
Dropbox facility	Not mentioned
NKDA website regularly updated	Not mentioned

Focus Group discussion and workshops for visioning and idea exchange camps	4876 people attended
Two-day workshop conducted by Future Cities Catapult, UK and BuroHappold consulting, the UK on 29 th and 30 th September 2015	Not mentioned
Offline polls (surveys with citizens) for smart solutions	1000
Competition among citizens for the best smart city vision	Not mentioned
Smart Fridays organised at NKDA to facilitate discussions on vision/ goals and co-creating innovative solutions	Not mentioned
Offline votes on smart initiatives	55% from AA-I, 17% from AA-II, 4% from AA-III and 24% from other areas
Survey with citizens	5000 distributed, 314 received
Smart city Cyclathon: bicycle rally	1200+ participants – extent of enthusiasm later showcased to emphasise the point that there is an appetite for cycling among citizens if adequate infrastructure is in place.
Smart helpdesks and city-wide kiosks;	7193 offline suggestions received
‘Masti ka Caravan’ (Caravan of fun) – travelling to different residences, commercial areas and offices	Unknown
Sit and draw competition for children who were asked to come up with a vision of their ‘dream city.’	100+ participants
Smart City Stalls during the Durga Puja festival	Unknown
Other events (with smart city kiosks for information dissemination and exchange), during the Durga Puja, Lakshmi Puja and Diwali festivals	138

Publication of an information brochure and citizen involvement procedure	Unknown
Radio shows such as “Innovative Fridays” – a talk show for eliciting innovative ideas from citizens was held in co-operation with a local radio station to seek ideas, suggestions and opinions from citizens.	Not mentioned
Distribution of flyers	“ensuring maximum exposure” (NKDA, 2016: 20)

The table indicates that a variety of mechanisms were used for engaging with citizens. However, a majority of these efforts, such as the distribution of flyers, sending out emails or WhatsApp messages, help desks, bicycle rally, and a regularly-updated website, were geared toward communicating *to* citizens and enthusing them about NtK’s smart city visions, rather than seeking ideas and initiatives from them, or imagining the smart city in collaboration with them. There is also a clear bias towards online media for citizen engagement. Such a focus on online media ends up excluding those (marginalised) citizens who do not own a smartphone or tablet (or a computer) or possess the skills to handle such a device. A few mechanisms did exist for citizens to give feedback such as through the MyGov app and written submissions. A majority of the citizens were heard through face-to-face forums such as focus group discussions and workshops (NKDA 2016, Annexure 3.2.2). However, NtK’s smart city documents do not describe the design or practice of the discussions and workshops. Overall, there is a tendency to showcase the sheer quantity of participation and a lesser emphasis on the content and quality of it. As a result, it is also difficult to ascertain if the (marginalised) citizens attended these gatherings at all and if those who attended were able to raise their voices and get heard.

Without two-way communication for co-production of visions by citizens and city officials, participation is mostly reduced to citizens’ access to information provided by the governance bodies. Citizens were afforded limited opportunities to offer their divergent visions of the city’s futures. As a result, the citizen engagement process in NtK was prone to closing down the imaginary, by marginalising dissenting voices and interests and all their messy diversity. The final proposal was kept largely within the bounds of technocratic smartness as imagined by urban planners/administrators and their partners in technology firms and consultancies. This is apparent in NtK’s proposal and other related smart city government documents, in which the

role of the firms and consultancies is made substantially more prominent, than the role played by thousands of local citizens who were counted as participants (83% of NtK's total population, according to the NKDA 2016: 19). Therefore, while citizen participation was counted as significant in sheer number of people engaged with, the actual impact of these divergent voices appears to have been somewhat limited, as we document in more detail below.

5.3 An '*articulated*' smart city imaginary?

Having an avenue to participate does not necessarily ensure that citizens can *influence* the eventual imaginary articulated in NtK's proposal to the national smart cities mission. Our conversations with NKDA officials revealed that the information gathered from citizens were reviewed, 'cleaned up', and some ideas were cherry-picked out of the received input. Thus, even though a wide range of ideas were received from participating citizens, NtK's policy-makers and planners acted as gatekeepers. They not only framed the design and practice of citizen-engagement mechanisms (as discussed above) but also controlled the flow of ideas. To enact this control, they accepted some ideas as relevant for the proposal, while summarily discarding others. Therefore, only a small selection from all the voices raised by citizens was articulated in/with NtK's smart city proposal.

The national smart city challenge specifies criteria, to emphasise the registration (or articulation) of citizen's voices in smart city proposals. One such criterion asks: "How well does the Vision come out of the needs, aspirations and wishes of the local people to make their city more liveable?" (MoUD, 2015: 33). For this, the national guidelines call for the inclusion of "details of process for co-creating every step (ideas, strategies, implementing mechanism and financial solutions) through an extensive consultation process" (MoUD, 2015: 35). A further evaluation criterion asks: "Do the goals flow from vision identified through citizen consultation?" (MoUD, 2015: 34). The national guidelines also require the cities to respond to whether "best practices [have] been identified and selected in consultation with citizens?" (MoUD, 2015: 35).

The first version of NtK's proposal does not respond to these criteria. It only provides a brief description of different citizen engagement methods (in a 2-page section titled "citizen engagement"). It does nevertheless claim that the smart city vision was collectively imagined, incorporating citizen's inputs. The content of the second revised proposal is more informative in describing the process of articulation of citizens' voices. An example of the latter is shown in Figure 28 below, which details citizen feedback on mobility. It appears that walkability (that includes cycling and enforcement of traffic rules) and transport (including parking facilities) each constituted "10% of the total citizen responses" (NKDA, 2016: 48). Under transport, the citizens' emphasis is overwhelmingly on public transport, both concerning the expansion of options, pan-city connectivity and last mile connectivity. Does this citizens' emphasis align with the smart mobility initiatives and solutions proposed by NtK in its proposal?

The submitted version of the proposal included seven different mobility-related solutions (NKDA, 2016: p. 27):

- "a) 5 smart bus stands and one smart bus terminus;
- b) carpooling programme;
- c) bi-cycling project;
- d) 145 km of pedestrian-friendly pathways and citizen's plaza (2,450 sq. m);
- e) 9 smart parking lots;
- f) App for Autos/ Totos (developed at Pan City level); and
- g) 30 Auto/ Toto stands with charging station, waiting area, water fountains and other amenities."

Besides, eight new metro stations and a "multi-modal transport hub" in each metro station is proposed to "create seamless transport connectivity across the public transport modes" (NKDA, 2016: Annexure 3.7.2). Other options such as monorail, sky trains, bike sharing were also proposed. Many of the mobility initiatives proposed thus appear to be consistent with the citizens' emphasis (depicted in Figure 28).

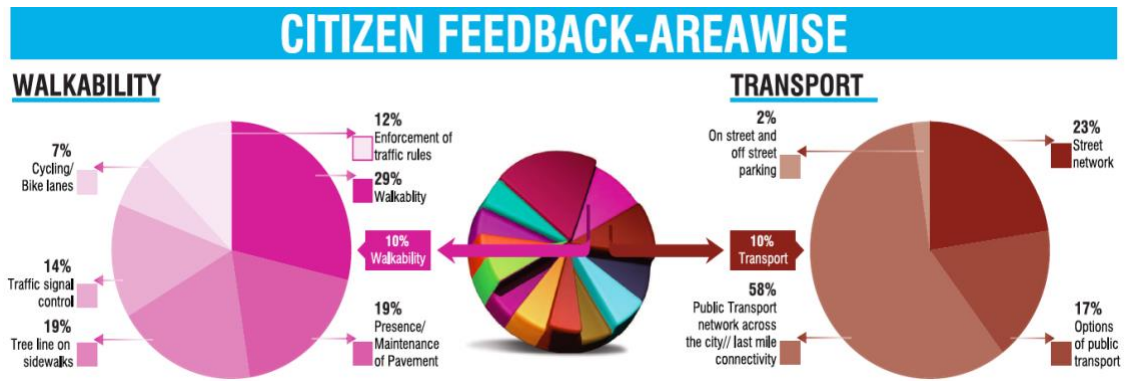


Figure 28. An example of information on citizen input, provided in NtK's smart city proposal.

(Source: NKDA, 2016, Annexure 3.2.2)

In these proposed mobility initiatives, however, ICT is always nearby. Mobility is imagined in terms of technologies such as the 'smart auto-toto app', 'bus locator', 'app for ride pooling', 'fare integration for e-buses' and 'smart bus stands with passenger information system' (NKDA, 2016: Annexure 3.7.2). From the proposal's articulation of citizen feedback (in Figure 28), it is clear that the extensive use of ICT services in mobility was not a citizens' concern. The ICT-based solutions are imagined by urban planners and other experts involved in the defining of the proposal, with no explicit reference to citizens' concerns. NKDA officials took pride in being able to offer the ICT-based smart solutions and admitted that these initiatives were aimed at presenting NtK as a "world-class" city" (Roy, 2011: 259). As one of our respondents says: "if people in New York enjoy certain facilities, why would people in India not have those facilities?" This official adopts a 'global' aspiration to turn NtK into a city such as New York and, rather interestingly, imputes this aspiration to not only the residents of NtK but the whole of India. Clearly, the smart socio-technical imaginary of NtK is then not just local, designed in response to and in collaboration with the city's residents, or even national, in response to smart city mission guidelines. It is also global, inspired by other distant cities and standards. Yet, there is arguably a trade-off between the transformations proposed in response to a notion of globality and those that are responsive to the needs and knowledge of the city's residents (Bose 2014). It appears that, rather than meeting the needs and knowledges of the city's residents, NtK officials reinterpreted the citizens' voices by attaching them to advanced ICT, following 'global' imaginaries with an aim to replicate smart developments in 'richer and more developed' cities such as New York or London (Wiig & Wyly, 2016: 488).

The revised version of the proposal contains a critical annexure titled "Model 'Liveable' Neighbourhood", which attempts to articulate the needs and challenges of living in the city, voiced by three anonymised NtK citizens (NKDA, 2016: Annexure 3.6.5). For this, following the suggestion of the UK-based consultancy, Future Cities Catapult, NtK officials selected one young woman (aged 27, who recently moved back to India after living abroad for some time), one middle-aged man (age 55, working in a private firm) and a senior citizen (male, aged 74, retired, middle class). The woman's concerns focus on the lack of walking and cycling infrastructure, poor air quality and lack of safety in the neighbourhoods. The middle-aged man is concerned about access to doctors, health facilities and the market for food etc., while the senior citizen emphasises the need of last mile connectivity using para-transit modes and of public spaces for community gatherings (NKDA, 2016: Annexure 3.6.5). Transport and mobility are central to all three citizens' concerns. While the articulation of the three citizens' concerns is usefully illustrative of citizen' voices, the proposal does not describe why these citizens were selected and how representative was their articulations of the concerns of poor and vulnerable men and women living in NtK. Instead, this exercise appears to have helped the ticking of a box titled 'model liveable neighbourhoods' in the proposal (NKDA, 2016: 90)

At first sight, it appears that NtK's proposal contains smart solutions that respond to each of the three citizens' needs and challenges. For instance, the proposal promises that "100% streets [will be] having grade-separated bicycle track and unobstructed footpath", in alignment with the young woman's concerns (NKDA, 2016: Annexure 3.6.5). For purposes of understanding the process of articulation in the development NtK's smart city, two observations are essential here. First, the consultation process was focussed on gathering citizens' concerns regarding their perceived needs and challenges of living in NtK, rather than any innovative solutions and initiatives based on their knowledge and experience. The initiatives and solutions are instead imagined by urban planners and policy-makers, advised by hired consultants and tech firms, which are ostensibly based on the concerns voiced by citizens. Second, considering that the three citizens' voices were only articulated in the revised version of the proposal, it is likely that the solutions proposed by the urban planners and policymakers were not responses to citizens' concerns at all. Instead, the latter concerns may have been selected, filtered out of a diversity of citizen inputs (see above), to include in the proposal because they were consistent with the smart solutions that the planners and policymakers had already defined and incorporated into the smart city imaginary.

To map some of the voices that did not get articulated in the proposal, we requested our respondents to narrate their concerns and solutions (focussing on transport and mobility), which they had raised earlier during face-to-face consultations with city officials and their consultants. The citizens' concerns and solutions included general issues such as traffic congestion, improvements to city roads, good public transport and communication. They also added some concrete suggestions such as escalator and lift services in metro stations, safe, well-lit, clean underpasses for walking and crossing the roads, direct bus connectivity to all parts of central Kolkata, as well as higher frequency and more reliable public bus services. These concerns and solutions show that smart urban mobility is not necessarily ICT-driven or even high-tech. Citizens instead emphasise reliability, accessibility and convenience of using public transport.

Our respondents, in this case mostly middle-class citizens, proudly noted that the Chairman of NKDA readily accepted their proposals in the consultation meeting that they attended. Officials at NKDA also claimed that citizens' viewpoints in many cases helped them to reposition their strategies. As one official noted, "normally we wouldn't have given priority to walkability, but citizen's feedback showed us [other] directions to allocate our limited budget." This indicates that the policy-makers and planners were open to at least some alternatives highlighted by upper and middle-class citizens. Other officials clarified that citizens' voices mattered, but only when they 'made sense' from the perspective of financial feasibility and broader social concerns. As observed by a city official: "Often citizens' concern is their immediate neighbourhood; they would hardly ever reflect on an overall aggregate strategic planning. If you listen too much to citizens' views, you go nowhere. You need to take control and do strategic planning." Such disdain toward and localisation of citizens' concerns does not bode well for the articulation of divergent and dissenting voices in the smart city imaginary. It could be due to such disdain that the final version of the proposal included only the three citizens' voices and the data/graphs on citizens' feedback, which were in alignment with the smart solutions and initiatives proposed by NtK.

Ultimately, the citizens whose voices are articulated in NtK's smart city documents belong to the middle- and higher-income groups. They may be employed in (or retired from) prestigious government jobs, own a flat in one of the expensive gated communities and/or possess connections with (international) businesses. Voices of poor and marginalised people are therefore absent in the imaginary. This absence must be viewed as social exclusion of such voices because a participatory focus group consultation did target "informal sectors: maids, construction workers, informal vendors" (NKDA, 2016: Annexures 3.2.1). Unfortunately, the

voices raised in this particular consultation were not included or responded to, in the formulation of solutions based on citizens' feedback. The concerns raised by members of this focus group are therefore not made explicit in the smart city imaginary. Nor is it clear why the marginalised citizens' concerns did not elicit a response from policy-makers and planners, even when the 'informal vendors' were made targets of the smart solution of "organised vending zones for 600 informal vendors" (NKDA, 2016: 43). Clearly, this solution, which might disadvantage the vendors, was not designed through consultations with them.

6. Discussion and conclusions

We have attempted to address if New town Kolkata's smart city imaginary can be considered politically transformative. We consider the latter to be constituted by three aspects: a) distributed, if the imaginary's envisioned benefits are equally available to all citizens; b) democratic, if (in its making) it affords the marginalized citizens possibilities to raise their voices; c) articulated, if it registers the (divergent) voices of the most marginalized and, as a result, modifies the planned initiatives. We conducted a careful discourse analysis of two versions of NtK's smart city proposal, in relation to India's national smart city mission guidelines. We analysed if and how the process of constructing the imaginary *opened up* to include a wide diversity of voices (cf. Stirling 2008) as well as a broader range of possibilities for 'smart' socio-technical developments in the city. In conducting this analysis, we focussed on the mobility socio-technical system.

We find that, following the national guidelines, the city level authorities invested considerable effort in organising forums and techniques for citizens to engage with the construction of the imaginary. However, the process was inadequately democratic because i) the design and practice of the participatory forums/techniques was framed by the officials, in accordance with the technocratic and globalising teleology of the smart city imaginary; ii) many of the forums/techniques were geared toward one-way flow of information from the city administration to the citizens; iii) people who were invited to participate were mostly influential citizens rather than marginalised ones; iv) emphasis was placed on counting the number of people attending rather than on the content of participation; v) when citizen feedback was received, it was focussed on the identification of needs and challenges faced by the citizens rather than on mobilising their knowledge and existing innovative initiatives. Overall, little space

was afforded for actual co-production of the imaginary by citizens and planners/policymakers. Nor were most citizens afforded possibilities to challenge the content of the smart city imaginary.

Having said this, some citizens' voices appear to have been articulated in the proposal, and consistent with these voices, alternate smart solutions and initiatives seem to have been proposed, such as the emphases on walkability and bicycling. However, it is not clear on what basis the articulated voices were selected out of the wide range of citizen inputs that were received. Many concerns of the citizens, as narrated by our respondents during interviews conducted for this study, were not articulated in the eventual imaginary. Interestingly, many concerns and solutions were focussed on mobility and transport but had very little to do with ICT-based technological interventions in the transportation system.

Thus, we can conclude that New town Kolkata's smart city imaginary was geared toward closing down the messy diversity of citizens' voices, despite its emphatic celebration of citizen engagement (possibly in response to the emphasis placed on the latter in the national smart city mission guidelines). To some extent, particularly in the second revised version of the city's proposal, a few citizens' voices were articulated and responded to (through the inclusion of new initiatives in the smart city imaginary). Unfortunately, however, this opening up to different voices was restricted to people belonging to the upper- and middle-classes, and particularly those voices that were largely aligned with the city administration's technology-centric visions. Divergent and dissenting voices, particularly those of poor and marginalised people, were excluded from the imaginary, as were any changes in the direction of smart city developments based on those voices.

The inclusion of voices of the marginalised and their preferred directions of urban development is central to achieving a politically transformative smart city imaginary. Expected benefits from such a transformative imaginary should be distributed across all sections of the city. Such a transformative imaginary would serve the divergent needs of diverse citizens' groups, through a heterogeneous and plural set of socio-technical options for smart city development. Unfortunately, in New town Kolkata, the expected benefits of the ICT-focussed smart city are concentrated among upper- and middle-class residents. Interests of the low-income population of the city, including a wide range of people who live or work as maids, 'informal' vendors and construction workers, remained marginal to the smart city imaginary.

We are not the first ones to emphasise the marginalisation and exclusion of poor people's interests from smart city developments (e.g., see Benedikt, 2016; Bhatkal, 2015; Datta, 2015; Watson, 2014). Nor is ours the first analysis of citizen engagement in the construction of smart city visions (see, for example, Cardullo and Kitchin, 2017; Araya, 2015). The novelty of our analysis lies in: a) its combination of the envisioned distribution of benefits with the democratic articulation of diverse voices in the smart city imaginary; b) its development of a framework that rethinks smart in normative terms, as politically transformative; c) its mapping and assessment of the multiple participatory forums/techniques used in the construction of an ostensibly people-centred and socially inclusive smart imaginary. Crucially, the concepts we have developed in the foregoing – distributed, democratic and articulated – can be used to examine how transformative are visions of any socio-technical imaginaries, including for green and sustainable cities.

Our framework is not without shortcomings, however, which could be addressed in future research on socio-technical imaginaries of the smart city. First, the framework does not adequately account for (marginalised) citizens' agency in imagining smart cities, as politically transformative. Such agency is not only present in citizens' mobilisations (social movements) for the democratisation of urban developments, but it also manifests in citizens' collective initiatives and practices that make urban livelihoods possible (Kundu, 2016; Saunders & Baeck, 2015). Second, our framework does not adequately map how different forms of citizenship, including citizens' subjectivities as individualised consumers or as socially-committed collectives, are constituted of (and shaped by) smart city imaginaries (de Waal and Dignum, 2017; Taylor et al., 2016).

Finally, our framework is useful for appreciating how socio-technical developments towards smartness or sustainability are partial and exclusive, in highly unequal urban worlds. The latter makes it imperative that citizens continue to demand and co-produce politically transformative imaginaries and realities, constituted by equally distributed benefits, democratic participation by a diverse range of citizens and the articulation of the voices of the most marginalised. Now more than ever, marketised urban transformations attempt to imagine and perform citizens as individualised neoliberal consumers (as also documented above for Kolkata). Poor and marginalised citizens do not fit this vision. Nor are their voices often strong enough to challenge public-private partnerships dominated by interests of big corporations pushing their technologies and services. The democratic burden, therefore, is on planners, policymakers, organisations working on participatory engagement, and citizens' social movements to

challenge the partiality and exclusivity of urban socio-technical imaginaries, by making central the voices and interests of the most marginalised citizens, to co-produce imaginaries that are politically transformative.

7. Acknowledgements

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Chapter 7. Epilogue

“Promises are the uniquely human way of ordering the future, making it predictable and reliable to the extent that this is humanly possible.”

- Hannah Arendt

Human beings have always tried to shape their future through purposeful activities and imaginations. Over centuries of our existence, we have numerous successful and unsuccessful attempts to predict, visualise, influence and shape the future. In the last few decades, climate models have predicted that the global temperature will be rising, natural disasters will intensify, and the world will slowly become unsustainable to live on. Challenging such dystopian predictions, people have invested in innovations that embody promises for better futures. However, the gloomy future that scientists predicted in the past appears to have become the present: Humankind is rapidly losing the war against climate change (The Economist, 2018). Problems are even more complex in poverty-stricken, unequal, developing and underdeveloped regions, where environmental issues are coupled with social, political and economic challenges. These regions are predominantly located in the Global South - in Asia, Africa and Latin America. ‘Megacities’ – urban centres with more than 10 million population in these regions are major centres of economic activity, alongside cultivating social inequalities and environmental degradation. The number of megacities in the Global South is increasing, and so are the problems associated with them. This thesis contributes towards developing an understanding of how to tackle these problems through activities that promise sustainable futures in India and Thailand.

I have attempted to justify the focus on megacities in the introduction of this thesis. A key concern is that the number of lives affected by the negative impacts of environmental challenges is bigger in megacities (Hunt, 2012; Folberth et al., 2015). And these big cities are much more difficult and complex to manage than small and middle-sized cities (Kraas et al., 2016). Furthermore, recent trends suggest that with astounding growth of smaller cities and middle-income earning job opportunities, people seeking mid-level income are choosing to migrate into smaller and mid-sized cities and away from megacities (Birkmann et al., 2016). This

trend is feeding into a phenomenon of “the rich get richer and the poor get poorer” in megacities (Huang et al., 2016: 69; Sassen, 2018). At the same time, the inadequacies and insufficiencies of infrastructure, degradation of land and pollution are some of the negative aspects of urbanisation, which are amplified in megacities (Facchini, 2017). The current academic and policy enthusiasm about emerging small and medium cities leaves us with the risk of neglecting the existing and ‘sinking’ megacities, which requires equal or even increased attention. Many of the world's coastal megacities are literally “sinking” under the threat of rising sea level, which will have a catastrophic consequence on millions of human beings if immediate actions are not taken (Kimmelman, 2018). In fact, in light of the problems and prospects that megacities embody, I believe that it would be a mistake to consider them as “sinking cities” and ignore their potential. Last but not the least, megacity is not just a large geographical space but a way of life. It offers a unique identity and “source of pride” to its inhabitants (reflected through terms like Londoner, New Yorker, Delhi-ite, Kolkata-n) (Webster and Burke, 2012). It is essential to find solutions to megacity's sustainability problems in order to ensure sustainable future for these millions of citizens inhabiting world's megacities.

Majority of this thesis focuses on sustainability transformation in one megacity – Kolkata. Looking carefully into this particular city, I learnt about many interesting dynamics such as conflict and coordination between actors, initiatives of regime actors for change from within, and the political process of constructing a collective vision. Several chapters of this thesis present these dynamics and discuss implications for tackling the persistent unsustainabilities faced by the megacity. Ultimately the goal has been to explore ways to transform the mobility socio-technical system to a promising future.

Sustainability transitions in megacities

The recent proliferation of megacities in the Global South can be seen as “a tragic replaying of the worst aspects of the mass urbanisation that occurred previously in the West.” (Kotkin, 2011). Yet, there is hope for the future of these megacities to overcome the tragedy and transform into healthy and sustainable living spaces. In this thesis, discussing on experimentation for and imagination of sustainable urban futures point towards this direction of hope. Urban theorists are mostly concerned with researching specific regions, cities, towns focussing on places or

people (Scott and Storper, 2015). However, in order to fully understand the scale and scope of urban potential to move in sustainable directions, Robinson and Roy (2016) called for a “significant transformations in the mode and style of urban theorization itself.” (p. 185). This thesis – concerning system level change and focussing on solving persistent problems that are encountered across megacities in the Global South and perhaps also the Global North - can be considered as an attempt to respond to this call. Research on systemic change and innovations towards sustainability are still somewhat alien to the research communities dedicated to understanding urbanisation in the Global South (Willis et al., 2014). This thesis hopefully communicates with urban theorists - the usefulness of socio-technical transition perspective to understand urban issues and ongoing changes in Southern megacity context. To this end, I found the term transformation appropriate and useful to refine, in order to analyse socio-technical change in these contexts. The concept of transformation is not new. However, we need a better understanding of the transformative role of different stakeholders in driving sustainability transitions (Facchini, 2017). The way this thesis defines and maps transformation, in the context of long-term socio-technical change – can be useful for navigating change towards sustainable futures in megacities.

The key premise of this thesis is that systems such as mobility in megacities of the Global South are experiencing transformations of many kinds and one needs to be reflexive of the diverse and heterogeneous meanings of sustainability in designing experiments for sustainability - in order to achieve a truly inclusive urban future. In the introduction of this thesis, I have also argued that it is important to look beyond just the experimentation process and analyse changes that are happening within regimes. Experimentation is vital, but it is just the tip of the iceberg. Transforming systems require us to look beyond experiments and invest in changing rules; find a new set of institutional logics that guide regimes, and at the same time pursue a normative understanding of the expected transformation in highly heterogeneous and unequal societies like Southern megacities. This thesis shows that regimes in the Global South are dynamically stable and transforming through changes initiated by regime actors. I believe that a nuanced understanding of different regime dynamics and the underlying processes and politics of regime change, which are different from that studied in the West, is a crucial input towards enriching the socio-technical transitions literature. In this thesis, I have therefore tried to re-define regime transformation as a crucial pathway of transition and laid bare the politics of transformations in an Indian megacity – mapping how rules, sustainability values, institutional logics shift in multiple public transport regimes and how policy-actors and citizens attempt to shape collective imagination of an urban transformation.

Message for scholars and practitioners

“every self-conscious thinker must at all times be aware of — and hence be able to control — the levels of abstraction on which he [/she] is working. The capacity to shuttle between levels of abstraction, with ease and with clarity, is a signal mark of the imaginative and systematic thinker.”

— C. Wright Mills, *The Sociological Imagination*

Keeping the above quote in mind, I offer three key insights about transformation in megacities, that may move between different levels of abstraction while being accessible to non-academic practitioners.

First, *transformation begins with experimentation*. The importance of niche experiments is undeniable for system transitions. However, what is vital for transformation is often not the experiments per se, but the fundamental processes that are often associated with experimentation. One such process is the articulation of expectation. Through mapping socio-technical change, this thesis shows that regime actors' ex-ante expectations are vital for regime transformation. Therefore, while it is not my intention to suggest that sustainability experiments are less important, the key message from regime analysis (Chapter 4) is that visions and expectations about the future - articulated by regime actors are an effective way to drive transformation. Instead of investing in designing new socio-technical experiments that may succeed or fail, actors in the Global South should focus on changing rules – standards, beliefs, norms in multiple regime dimensions (technology, policy, market, industry structure and socio-cultural meanings). In fact, this route of changing regimes rules, without the recourse to niche development can be faster and more effective way of tackling persistent unsustainabilities.

Second, *transformation needs to embrace plurality*. In societies, there are always multiple social interests, sustainability values and technological alternatives. However conventional methods such as cost-benefit analysis for policy decisions, technological assessments conveniently offer a clean and objective picture of a 'best' or 'worst' technological option. Such calculations generally satisfy analysts and policymakers by offering a clean and clear representation of a rather messy and complex reality. By applying multi-criteria mapping methodology, Chapter 2 of this thesis shows that technological options that are perceived highly sustainable in one context or by one social group, may not be perceived sustainable at all in other contexts and/or by other stakeholders. Therefore, in order to drive transformation of

socio-technical systems, actors need to acknowledge and embrace the plurality of options and multiplicity of ways to achieve sustainability. Such plurality of options also ensures that the resilience of systems from unexpected future threats. The multi-criteria mapping also highlights a high degree of uncertainties and ambiguities about what is sustainable, indicating an even greater need for embracing the plurality of means and ends. Policymakers should embrace this type of appraisal instead of top-down decision-making that often neglects existing variabilities and heterogeneities and offers prescriptive pictures of the relative performance of different options based on global trends and hypes. For transformation to sustainable futures, variabilities and heterogeneities need to be appreciated, and decision-making needs to be transparent and bottom-up.

Third, *transformation is a democratic process*. The multi-criteria mapping exercise invites scholars and practitioners to appraise sustainability with “greater democratic accountability and social robustness” (Raven et al., 2017: 595). Scholars and practitioners need to interrogate the process of democratisation of the urban transformation explicitly, as we do in Chapter 6. The chapter shows that a smart city is an elitist vision, dominated by the higher income, privileged social groups. Poor and marginalised citizens do not fit this vision. The inclusion of voices of the marginalised and their preferred directions of urban development is central to achieving a politically transformative smart city imaginary. The democratic burden, therefore, is on planners, policymakers, organisations working on participatory engagement, and citizens' social movements to challenge the partiality and exclusivity of urban socio-technical imaginaries, dominated by interests of big corporations pushing their technologies and services. An empowering transformation requires making the voices and interests of the most marginalised citizens central to the planning and decision-making. Efforts to achieve transformation should, therefore, focus more on the distribution of benefits, democratising the planning processes and registering the voices of marginalised citizens, and less on top-down applications of big data, open data, ICT and artificial intelligence. Data mobilisation is the ongoing trend in the making of smart cities – which under certain conditions may facilitate, but should not be taken for granted as a guaranteed route to, achieving participatory and democratic transformations.

Examples of a democratic nature of transformation are not rare in today's world. In 2018, thousands of students, teenagers protested on the streets of Dhaka (Bangladesh) demanding safety on roads, after school children were killed in a road accident (BBC, 2018). This event which attracted global attention in the past few days serves as an extraordinary example of the power

of citizens' will and voices towards a transformation of the city's mobility system which is safe and sustainable.

Looking forward

"You can find Calcutta anywhere in the world. You only need two eyes to see. Everywhere in the world there are people that are not loved, people that are not wanted nor desired, people that no one will help, people that are pushed away or forgotten. And this is the greatest poverty."

— Mother Teresa

Such a broad definition of poverty applies to the whole of today's urban world and not just in the Global South. I believe that a transformation that is experimental, plural and democratically imagined – can help us navigate through the persistent unsustainabilities that megacities around the world are facing today. Transformative change in megacities will not only save them from 'sinking' but will also make them socially just places to live (Harvey, 2003). In order to achieve such social justice and eradicate poverty, it is essential to give back "the right to the city" to those who are deprived of it (Harvey, 2003). One of my research interests is to understand what transformations in mobility systems would mean for marginalised women of Kolkata. This study did not finally make it to this thesis due to the lack of adequate data, despite gaining adequate insights into the topic through literature reviews and focus group discussions during PhD fieldwork.

There are, in fact, an ocean of topics, ideas, problems that I would like to pick up in the future, based on learning while pursuing this PhD. Furthering the research that made into this thesis, I feel it is worth exploring more carefully the changes in regime rules in closer collaboration with regime actors; understand the politics of empowerment and disempowerment of niche experiments using cases of digitalisation of mobility in Kolkata; explore the emerging rules that guide changes in multiple systems (meta-rules); and examine the implementation of smart city urban imaginaries.

Beyond the themes and topics that this thesis covers, there are also other streams of research which could enrich our understanding of transformation in megacities. For instance, for coastal and climate vulnerable megacities like Kolkata, transformation should also mean building methods of adaptation and resilient systems that can resist climatic disasters. The

concept of resilience was missing in data and discourses around sustainable transformation of mobility systems in Kolkata, in spite of evidence of the lack of resilience in mobility infrastructure. In 2016, a flyover under construction fell apart in Kolkata, taking lives of people. As I am preparing to submit this thesis, there is rescue operation and investigation ongoing for yet another bridge collapse that shocked the citizens of Kolkata in September 2018 (PTI, 2018). The causes and consequences of such incidents demand careful scholarly reflection, through a better understanding of system resilience and associated threats. This could be an important future research agenda, relevant to Kolkata and beyond. Furthermore, the focus on individual systems around public transportation modes fail to highlight the importance of transportation planning, investments in mega-infrastructure in megacities. Notably, in 2015 a newly built flyover in Kolkata inflicted an increased congestion on roads, immediately after inauguration. The vital aspect of mobility planning should be incorporated in the understanding of system-level change by considering whole mobility system transformation in future research. Finally, in the majority of this thesis, the state and various governmental actors are seen to be dominating the process of change in mobility systems. In this regard, the role of public sector innovation, recent momentum in partnerships and co-operation between city level actors can be useful and interesting topics of research, in order to improve our understanding of socio-technical transitions in the Global South.

To conclude, this thesis calls for transformations in socio-technical systems in order to secure sustainable future in megacities (in diverse ways possible). The world needs megacities that are socially just and environmentally sustainable. We need to attend to these cities' persistent problems to make them liveable in the future. It is up to us – humans - to “order the future”, not only through promises, but also appropriate actions.

References

- Acharya, RC., May 20 2016. Kolkata Metro & RVNL: Network set for quantum jump, time for Mamata to remove obstacles. Financial Express. Available at: <http://www.financialexpress.com/opinion/rvnl-poised-to-usher-in-a-new-era-for-kolkata-metro/260465/> (Accessed 11 April 2018).
- Additional Chief Secretary to the Government of West Bengal, 2008. *Notification No. 3692-WT/4M-23/95*, Retrieved from RTA office, 12 December 2016
- Ahlborg, H., 2017. Towards a conceptualization of power in energy transitions. *Environmental Innovation and Societal Transitions*, 25, pp.122-141.
- Ahuja, A., Rai, B., Ghatikar G., Seethapathy, R., Suri R., Pillai, R.K., October 2017. *Implementation plan for electrification of public transportation in Kolkata*. Shakti Foundation. India smart grid forum.
- Araya, D., 2015. Smart Cities and the Network Society: Toward Commons-Driven Governance. In *Smart Cities as Democratic Ecologies*, Palgrave Macmillan, London. pp. 11-22
- Arnstein, S. R., 1969. A ladder of citizen participation. *Journal of the American Institute of planners*, 35(4), 216-224.
- Arora, A., Anand, A., Banerjee-Ghosh, S., Baraya, D., Chakrabarty, J. Chatterjee, M., Das, S., Ghosh, P., Gupta, S., Jain, P., Khatua, S., Matham, A., Mukherjee, S., Mukhopadhyay, P., Naik, M., Roy, S., Sherawat, P., Sidhwani, P., and Taraporevala P., 2016. *Integrating Intermediate Public Transport Within Transport Regulation in a Megacity: A Kolkata Case Study*. Centre for Policy Research, New Delhi.
- Arora, S., 2016. Rethinking 'Smart' in India: The city as an ecology of practices. [Blog]. STEPS Centre, Brighton. Available at: <http://steps-centre.org/2016/blog/rethinking-smart-in-india-the-city-as-an-ecology-of-practices/>. (Accessed 28 August 2016).
- Avelino, F. and Wittmayer, J.M., 2016. Shifting power relations in sustainability transitions: a multi-actor perspective. *Journal of Environmental Policy & Planning*, 18(5), pp.628-649.
- Avelino, F., Wittmayer, J.M., Pel, B., Weaver, P., Dumitru, A., Haxeltine, A., Kemp, R., Jørgensen, M.S., Bauler, T., Ruijsink, S. and O'Riordan, T., 2017. Transformative social innovation and (dis) empowerment. *Technological Forecasting and Social Change*.
- Bai, X., Roberts, B. and Chen, J., 2010. Urban sustainability experiments in Asia: patterns and pathways. *Environmental Science and Policy*, 13, pp. 312–325.
- Bakıcı, T., Almirall, E. and Wareham, J., 2013. A smart city initiative: the case of Barcelona. *Journal of the Knowledge Economy*, 4(2), pp.135-148.
- Bandhan Bank, 2017. About us. <https://www.bandhanbank.com/about-bandhan-bank.aspx> (Accessed 10 February 2018)

- Bandyopadhyay, K., October 11, 2014. First bus-route rejig in four decades. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/First-bus-route-rejig-in-four-decades/articleshow/44778362.cms> (Accessed 16 March 2018)
- Bandyopadhyay, K., November 20, 2017. In a first, Kolkata's app fleet outnumbers yellow cabs. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/in-a-first-citys-app-fleet-outnumbers-yellow-cabs/articleshow/61717648.cms>. (Accessed 16 March 2018)
- Bandyopadhyay, R., 2017. Obstruction: counter-pedestrianism and trajectories of an infrastructure public. *Decision*, 44(2), pp.121-132.
- Bandopadhyay, K., 2018. Auto policy notified, to come into effect from September 1. *The Times of India*. Kolkata. Available at: <http://timesofindia.indiatimes.com/articleshow/65557355.cms?> (Accessed 5 September 2018).
- Bandhyopadhyay, K., 2018. Kolkata is 2nd-most polluted metro, air quality worsening faster than Delhi's. *The Times of India*. Available at: <https://timesofindia.indiatimes.com/city/kolkata/kolkata-is-2nd-most-polluted-metro-air-quality-worsening-faster-than-delhis/articleshow/64007600.cms> (Accessed 20 June 2018)
- Banerjee, A., Sengupta, P.P. and Bandyopadhyay, A., 2012. Pollution as a consequence of public transport: A case study of Kolkata, India. *Journal of Management Research*, 4(1).
- Banerjee, S., 2016. *Memoirs of Roads: Calcutta from Colonial Urbanization to Global Modernization*. Oxford University Press.
- Banister, D., 2005. *Unsustainable transport: city transport in the new century*. Routledge.
- Banister, D., 2011. Cities, mobility and climate change. *Journal of Transport Geography*, 19, pp. 1538–1546.
- Bansal, P., Kockelman, K.M., Schierelbein, W. and Schauer-West, S., 2016. Indian vehicle ownership and travel behaviours: a case study of Bangalore, Delhi and Kolkata. Under review for publication in *Research in Transport Economics*. (Accessed 28 August 2018).
- Barter, P.A., 1999. *An International Comparative Perspective on Urban Transport and Urban Form in Pacific Asia: The Challenge of Rapid Motorisation in Dense Cities*. PhD Dissertation, Murdoch University, Australia.
- Basu, J. 2014. Kolkata revokes earlier order, restricts cycling ban to 62 roads. *Down to Earth*. <http://www.downtoearth.org.in/news/kolkata-revokes-earlier-order-restricts-cycling-ban-to-62-roads-43617>. (Accessed on 21 February 2018)
- Basu, L., 2017. Growth and Development of Autorickshaws in Kolkata: An Enigma to Planners. *Journal of Humanities and Social Science*, 22(7), pp. 19-24.
- Batra, R. and Reio Jr, T.G., 2016. Gender inequality issues in India. *Advances in Developing Human Resources*, 18(1), pp.88-101.

- Bausch, J.C., Bojórquez-Tapia, L. and Eakin, H., 2014. Agro-environmental sustainability assessment using multicriteria decision analysis and system analysis. *Sustainability science*, 9(3), pp. 303-319.
- Bazeley, P. and Jackson, K. eds., 2013. *Qualitative data analysis with NVivo*. Sage Publications Limited.
- BBC, 2018. Bangladesh protests: How a traffic accident stopped a city of 18 million. Available at <https://www.bbc.co.uk/news/world-asia-45080129> (Accessed 20 August 2018)
- Begum, S., and Sen, B., 2004. Unsustainable livelihoods, health shocks and urban chronic poverty: rickshaw pullers as a case study. *Chronic Poverty Research Centre Working Paper*, (46).
- Bell, J., 2014. *Doing Your Research Project: A guide for first-time researchers*. McGraw-Hill Education (UK).
- Benedikt, O., 2016. The valuable citizens of smart cities: The case of Songdo City. *Graduate Journal of Social Science*, 12(1), pp.17-36.
- Bergman, N., 2017. Stories of the future: personal mobility innovation in the United Kingdom. *Energy Research & Social Science*, 31, pp.184-193.
- Berkhout, F., Angel, D. and Wieczorek, A.J. 2009. Asian development and sustainable socio-technical regimes. *Technological Forecasting and Social Change*, 76(2), pp. 218–228
- Berkhout, F., Verbong, G., Wieczorek, A.J., Raven, R., Lebel, L. and Bai, X., 2010. Sustainability experiments in Asia: innovations shaping alternative development pathways?. *Environmental science & policy*, 13(4), pp.261-271.
- Berkhout, F., Smith, A. and Stirling, A., 2004. *Socio-technological regimes and transition contexts. System innovation and the transition to sustainability: theory, evidence and policy*. Edward Elgar, Cheltenham, 44(106), pp.48-75.
- Bertorelli, E., Heller, P., Swaminathan, S. and Varshney, A., 2017. Does Citizenship Abate Class?. *Economic & Political Weekly*, 52(32), p.47.
- Bhatkal, T., Avis, W. and Nicolai, S., 2015. *Towards a better life? A cautionary tale of progress in Ahmedabad*. Development Progress Case Study Report. London: ODI.
- Bijker, W.E., Hughes, T.P. and Pinch, T.J., 1987. *The social construction of technological systems: new directions in the sociology and history of technology* (No. E14 B594). MIT Press.
- Bird, Kelly; Hattel, Kelly; Sasaki, Eiichi; Attapich, Luxmon. 2011. *Poverty, Income Inequality, and Microfinance in Thailand*. Asian Development Bank. Available at: <http://hdl.handle.net/11540/1311>
- Birkmann, J., Welle, T., Solecki, W., Lwasa, S. and Garschagen, M., 2016. Boost resilience of small and mid-sized cities. *Nature News*, 537(7622), p.605.

- Borup, M., Brown, N., Konrad, K. and Van Lente, H., 2006. The sociology of expectations in science and technology. *Technology analysis & strategic management*, 18(3-4), pp.285-298.
- Bose, P.S., 2015. *Urban development in India: Global Indians in the remaking of Kolkata*. Routledge.
- Bose, R. 2016. Mock disaster drill at Kolkata Metro stations. *The Hindu*. Available at: <http://www.thehindu.com/todays-paper/tp-national/Mock-disaster-drill-at-Kolkata-Metro-stations/article15228932.ece> (Accessed 10 April 2018).
- Brown, N. and Michael, M., 2003. A sociology of expectations: retrospecting prospects and prospecting retrospects. *Technology Analysis & Strategic Management*, 15(1), pp. 3-18.
- Bulkeley, H., 2015. *Accomplishing climate governance*. Cambridge University Press.
- Bulkeley, H.A., Castán Broto, V. and Edwards, G., 2015. *An Urban Politics of Climate Change: Experimentation and the Governing of Socio-Technical Transitions*. London: Routledge.
- Burgess, J., Stirling, A., Clark, J., Davies, G., Eames, M., Staley, K. and Williamson, S., 2007. Deliberative mapping: a novel analytic-deliberative methodology to support contested science-policy decisions. *Public Understanding of Science*, 16(3), pp.299-322.
- Burri, R.V., 2015. Imaginaries of science and society: Framing nanotechnology governance in Germany and the United States. In . Jasanoff, S. and Kim, S. (ed.), *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*. pp. 233-253.
- Busby, J.W. and Shidore, S., 2017. When decarbonization meets development: the sectoral feasibility of greenhouse gas mitigation in India. *Energy research & social science*, 23, pp.60-73.
- Byrne, R., Smith, A., Watson, J. and Ockwell, D., 2011. Energy pathways in low-carbon development: From technology transfer to socio-technical transformation. *STEPS Working Paper 46*, Brighton: STEPS Centre
- Calcutta Tramways Corporation. 2014. *Reconnecting Trams and Built Heritage*. <http://calcuttatramways.com/reconnecting-trams-and-built-heritage/>. (Accessed on 18th February 2018).
- Callon, M., 1987. Society in the making: the study of technology as a tool for sociological analysis. *The social construction of technological systems: New directions in the sociology and history of technology*, pp.83-103.
- Callon, M., Lascoumes, P. and Barthe, Y., 2009. *Acting in an uncertain world: An essay on technical democracy*. Cambridge, MA: The MIT Press.
- Campbell, B. and Sallis, P., 2013. Low-carbon yak cheese: transition to biogas in a Himalayan socio-technical niche. *Interface focus*, 3(1), DOI: 10.1098/rsfs.2012.0052
- Capdevila, I. and Zarlenga, M.I., 2015. Smart city or smart citizens? The Barcelona case. *Journal of Strategy and Management*, 8(3), pp.266-282.

- Caragliu, A., Del Bo, C. and Nijkamp, P., 2011. Smart cities in Europe. *Journal of urban technology*, 18(2), pp.65-82.
- Cardullo, P. and Kitchin, R., 2017. Being a 'citizen' in the smart city: Up and down the scaffold of smart citizen participation. *The Programme City Working Paper 30*, Ireland.
- Carvalho, L., 2014. Smart cities from scratch? A socio-technical perspective. *Cambridge Journal of Regions, Economy and Society*, 8(1), pp.43-60.
- Castán Broto, V. and Bulkeley, H. 2013. A survey of urban climate change experiments in 100 cities. *Global Environmental Change*, 23, pp. 92–102
- Chakrabartty, A. and Gupta, S., 2014. Traffic congestion in the Metropolitan City of Kolkata. *Journal of Infrastructure Development*, 6(1), pp.43-59.
- Chakravarty, A., 2014. *Last Mile Chaos*. Available: <http://www.downtoearth.org.in/content/last-mile-chaos> (Accessed 1 December 2014).
- Chapman, L., 2007. Transport and climate change: a review. *Journal of transport geography*, 15(5), pp.354-367.
- Chappin, E.J. and Ligtoet, A., 2014. Transition and transformation: A bibliometric analysis of two scientific networks researching socio-technical change. *Renewable and sustainable energy reviews*, 30, pp.715-723.
- Chatterjee, P. and Ghosal, A. 2015. Landmark Study Lies Buried: How Delhi's Poisonous Air Is Damaging Its Children for Life. *The Indian Express*. Available at: <http://indianexpress.com/article/india/india-others/landmark-study-lies-buried-how-delhis-poisonous-air-is-damaging-its-children-for-life/> (Accessed 21 August 2018)
- Cheyne, C. and Imran, M., 2016. Shared transport: Reducing energy demand and enhancing transport options for residents of small towns. *Energy Research & Social Science*, 18, pp.139-150.
- Chiapello, E. and Fairclough, N., 2002. Understanding the new management ideology: a transdisciplinary contribution from critical discourse analysis and new sociology of capitalism. *Discourse & society*, 13(2), pp.185-208.
- Chin, V., Jaafar, M., Subudhi, S., Shelomentsev, N., Do, D. and Prawiradinata, I., 2018. *Unlocking Cities: The impact of ridesharing across India*. The Boston Consulting Group.
- Chow, F.C., Paul, T., Vähäaho, I.T., Sellberg, B. and Lemos, L.J.L., 2002, March. Hidden aspects of urban planning: utilisation of underground space. In *Proc. 2nd Int. Conference on Soil Structure Interaction in Urban Civil Engineering*.
- Clark, D., 1998. Interdependent urbanization in an urban world: an historical overview. *Geographical Journal*, 164(1), pp.85-95.
- CMERI. 2010. *Soleckshaw (Solar-Electric Rickshaw): A CSIR-CMERI Technology*. Central Mechanical Engineering Research Institute. (Accessed 29 July 2015).

- Coates, N., 2016. *Tramjatra: The story of the Melbourne conductor who helped save Kolkata's trams*. <http://www.abc.net.au/news/2016-10-06/tramjatra-melbourne-and-kolkata-linked-by-tram-history/7904626> (Accessed 12 March 2018)
- Coburn J, Stirling A., 2016. *Multicriteria mapping manual: version 2.0 (No. 2016-21)*. SPRU- Science and Technology Policy Research, University of Sussex
- Cochran, F.V., Brunsell, N.A., Cabalzar, A., van der Veld, P.J., Azevedo, E., Azevedo, R.A., Pedrosa, R.A. and Winegar, L.J., 2016. Indigenous ecological calendars define scales for climate change and sustainability assessments. *Sustainability Science*, 11(1), pp.69-89.
- Cohen, M.J., 2009. Sustainable mobility transitions and the challenge of countervailing trends: the case of personal aeromobility. *Technology Analysis & Strategic Management*, 21(2), pp. 249-265.
- Datta, A., 2015. New urban utopias of postcolonial India: 'Entrepreneurial urbanization in Dholera smart city, Gujarat. *Dialogues in Human Geography*, 5(1), pp.3-22.
- Davies, G., 2006. Mapping deliberation: Calculation, articulation and intervention in the politics of organ transplantation, *Economy and Society* 35(2), pp. 232-258.
- de Hoop, E. and Arora, S., 2017. Policy democracy: Social and material participation in biodiesel policy-making processes in India. *SPRU Working Paper Series 2017-02*, Brighton.
- de Waal, M., and Dignum, M., 2017. The citizen in the smart city: How the smart city could transform citizenship. *Information Technology* 59(6), pp. 263-273.
- Delhi High Court. 2014. *Judgement in matter of writ petition: Shanawaz Khan vs. New Delhi Municipal Corporation*, New Delhi: Delhi High Court.
- Denzin, N.K. and Lincoln, Y.S., 1994. *Handbook of qualitative research*. Sage publications, inc.
- DiMaggio, P. & Powell, W.W., 1983. The iron cage revisited: Collective rationality and institutional isomorphism in organizational fields. *American sociological review*, 48(2), pp.147-160.
- DiMaggio, P.J. and Powell, W.W. eds., 1991. *The new institutionalism in organizational analysis* (Vol. 17, pp. 1-38). Chicago, IL: University of Chicago Press.
- Dimitriou, H.T. and Gakenheimer, R. eds., 2011. *Urban transport in the developing world: A handbook of policy and practice*. Edward Elgar Publishing.
- Dobbs, R., Remes, J., Manyika, J., Roxburgh, C., Smit, S., and Schaer F., 2011. *Urban world: Cities and the rise of the consuming class*. Available at: <https://www.mckinsey.com/featured-insights/urbanization/urban-world-cities-and-the-rise-of-the-consuming-class> (Accessed 8 August 2018).
- Docherty, I., Marsden, G. and Anable, J., 2018. The governance of smart mobility. *Transportation Research Part A: Policy and Practice*, 115, pp.114-125.

- Dosi, G., 1982. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research policy*, 11(3), pp.147-162.
- Eames, M. and McDowall, W., 2010. Sustainability, foresight and contested futures: exploring visions and pathways in the transition to a hydrogen economy. *Technology Analysis & Strategic Management*, 22(6), pp.671-692.
- Elzen, B., Geels, F.W. and Green, K. eds., 2004. *System innovation and the transition to sustainability: theory, evidence and policy*. Edward Elgar Publishing.
- Elzen, B., Geels, F.W., Leeuwis, C. and Van Mierlo, B., 2011. Normative contestation in transitions 'in the making': Animal welfare concerns and system innovation in pig husbandry. *Research Policy*, 40(2), pp.263-275.
- Evans, J. and Karvonen, A., 2011. Living laboratories for sustainability: exploring the politics and epistemology of urban transition. *Cities and low carbon transitions*, pp.126-141.
- Evans, J., Karvonen, A. and Raven, R., 2016. The experimental city: New modes and prospects of urban transformation. In *The experimental city* (pp. 1-12). Routledge.
- Facchini, A., 2017. 'The road to sustainability for megacities' [PowerPoint]. Available at: https://icspconference.files.wordpress.com/2016/12/21_facchini.pdf (Accessed 8 August 2018).
- Farrelly, M. and Brown, R., 2011. Rethinking urban water management: Experimentation as a way forward?. *Global Environmental Change*, 21(2), pp.721-732.
- Feola, G., 2015. Societal transformation in response to global environmental change: a review of emerging concepts. *Ambio*, 44(5), pp.376-390.
- Ferro, E., Caroleo, B., Leo, M., Osella, M. and Pautasso, E., 2013. The role of ICT in smart cities governance. In *Proceedings of 13th international conference for E-democracy and open government*. Donau-Universität Krems (pp. 133-145).
- Flick, U., 2004. *Triangulation in qualitative research. A companion to qualitative research*, 3, pp.178-183.
- Folberth, G.A., Butler, T.M., Collins, W.J. and Rumbold, S.T., 2015. Megacities and climate change—A brief overview. *Environmental Pollution*, 203, pp.235-242.
- Frantzeskaki, N., Broto, V.C., Coenen, L. and Loorbach, D. eds., 2017. *Urban sustainability transitions*. Vol. 5. Taylor & Francis.
- Frey, W.H. and Zimmer, Z., 2001. Defining the city. *Handbook of urban studies*, 1, pp.14-35.
- Friedland, R. and Alford, R.R., 1991. Bringing society back in: Symbols, practices and institutional contradictions. Powell, W., and Dimaggio, P., (eds) *The New Institutionalism in Organizational Analysis*, pp. 232-263.

- Fuenfschilling, L. and Truffer, B., 2014. The structuration of socio-technical regimes— Conceptual foundations from institutional theory. *Research Policy*, 43(4), pp.772-791.
- Furlong, K., 2010. Small technologies, big change: Rethinking infrastructure through STS and geography. *Progress in Human Geography*, 35, pp. 460–482.
- Furlong, K., 2014. STS beyond the “modern infrastructure ideal”: Extending theory by engaging with infrastructure challenges in the South. *Technology in Society*, 38, pp.139-147.
- Gakenheimer, R., 1999. Urban mobility in the developing world. *Transportation Research Part A: Policy and Practice*, 33, pp. 671–689.
- GEA., 2012. *Global Energy Assessment – Towards a Sustainable Future*. Cambridge/Laxenburg, Austria: Cambridge University Press/The International Institute for Applied Systems and Analysis (IIASA).
- Geels, F. and Raven, R., 2006. Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). *Technology Analysis & Strategic Management*, 18(3-4), pp.375-392.
- Geels, F., Kemp, R., Dudley, G. and Lyons, G., 2011. *Automobility in transition?: A socio-technical analysis of sustainable transport*. Routledge.
- Geels, F.W. and Kemp, R., 2007. Dynamics in socio-technical systems: Typology of change processes and contrasting case studies. *Technology in society*, 29(4), pp.441-455.
- Geels, F.W. and Schot, J., 2007. Typology of sociotechnical transition pathways. *Research policy*, 36(3), pp.399-417.
- Geels, F.W. and Smit, W.A., 2000. Lessons from failed technology futures: potholes in the road to the future. *Contested Futures A sociology prospective techno-science*. Aldershot Burlington USA Singapore Sydney: Ashgate, pp.129-156.
- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy*, 31(8-9), pp.1257-1274.
- Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research policy*, 33(6-7), pp.897-920.
- Geels, F.W., 2005. *Technological transitions and system innovations: a co-evolutionary and socio-technical analysis*. Edward Elgar Publishing.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental innovation and Societal Transitions*, 1(1), pp.24-40.
- Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of transport geography*, 24, pp.471-482.

- Geels, F.W., 2013. The impact of the financial–economic crisis on sustainability transitions: Financial investment, governance and public discourse. *Environmental Innovation and Societal Transitions*, 6, pp.67-95.
- Geels, F.W., 2014. Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective. *Theory, Culture & Society*, 31(5), pp.21-40.
- Geels, F.W., 2017. Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective. *Energy Research & Social Science*, 37, pp. 224-231
- Geels, F.W., 2018. Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). *Energy Research & Social Science*, 46, pp.86-102.
- Geels, F.W., Sovacool, B.K., Schwanen, T. and Sorrell, S., 2017. Sociotechnical transitions for deep decarbonization. *Science*, 357(6357), pp.1242-1244.
- Gerbner, G., 1987. Science on television: How it affects public conceptions. *Issues in Science and Technology*, 3(3), pp.109-115.
- Ghosh, B., 2014. *Sustainability appraisal of emerging trajectories in solar photovoltaic and urban mobility systems in India and Thailand* (MSc thesis. Eindhoven University of Technology). Available at: <https://pure.tue.nl/ws/files/46971147/780502-1.pdf>
- Ghosh, B. and Schot, J., 2018. Mapping socio-technical change in mobility regimes: The case of Kolkata. *SPRU Working Paper Series (SWPS)*. 2018-16: 1-45. ISSN 2057-6668. Available at: <http://www.sussex.ac.uk/spru/research/swps>
- Ghosh, D., 2016. Autorickshaw union leaders extorting drivers now a common phenomenon. *The Times of India*. Kolkata. Available at: <http://timesofindia.indiatimes.com/articleshow/54033270.cms?> (Accessed 5 September 2018).
- Ghosh, D., Roy, J., Raven, R. and Saha, S., 2013. Motorization of cycle rickshaws (vans) in India: analysis of a few experiments. *GCP-JU Working Paper: GCP-JU/WOTRO/05/01*.
- Ghosh, D., Sengers, F., Wieczorek, A.J., Ghosh, B., Roy, J. and Raven, R., 2016. Urban mobility experiments in India and Thailand. *The experimental city*. Routledge, Oxon, pp.122-136.
- Gibson, R.B., 2006. Beyond the pillars: sustainability assessment as a framework for effective integration of social, economic and ecological considerations in significant decision-making. *Journal of Environmental Assessment Policy and Management*, 8(03), pp.259-280.
- Giddens, A., 1984. *The constitution of society: Outline of the theory of structuration*. University of California Press.
- Giffinger, R. and Gudrun, H., 2010. Smart cities ranking: an effective instrument for the positioning of the cities?. *ACE: architecture, city and environment*, 4(12), pp.7-26.

- González-Mejía AM, Eason TN, Cabezas H, Suidan MT., 2014. Social and economic sustainability of urban systems: comparative analysis of metropolitan statistical areas in Ohio, USA. *Sustainability Science*, 9(2):217–228
- Goodrick, E. and Reay, T., 2011. Constellations of institutional logics: Changes in the professional work of pharmacists. *Work and Occupations*, 38(3), pp.372-416.
- Gopalakrishnan, K., 2010. JNNURM brings much needed relief to Kolkata's public transport. *Motorindia*. <http://www.motorindiaonline.in/buses/jnnurm-brings-much-needed-relief-to-kolkatas-public-transport/> Accessed 23rd February 2018
- Goswami, U., 2012. UN Climate Change Negotiations 2012: Ahmedabad's Bus Rapid Transit System to be showcased by United Nations. *The Economic Times*, 15 November 2012.
- Government of West Bengal, 2008. Comprehensive Mobility Plan – Back to Basics. Kolkata Metropolitan Area. Available at: <http://wricitieshub.org/sites/default/files/Comprehensive%20Mobility%20Plan%20for%20Kolkata%20Metropolitan%20Area.pdf> (Accessed 20 July 2018).
- Gowen, A., 2013. City of Kolkata bans bikes to reduce traffic, but India's environmentalists, workers protest. *The Washington Post*. Available at: https://www.washingtonpost.com/world/city-of-kolkata-bans-bikes-to-reduce-traffic-but-indias-environmentalists-workers-protest/2013/10/15/f07ac840-3189-11e3-ad00-ec4c6b31cbcd_story.html (Accessed 23 August 2018).
- Graham, S. and Marvin, S., 2001. *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. London: Routledge.
- Greenberg, M., 2000. Branding cities: A social history of the urban lifestyle magazine. *Urban affairs review*, 36(2), pp.228-263.
- Greenwood, R. and Hinings, C.R., 1996. Understanding radical organizational change: Bringing together the old and the new institutionalism. *Academy of management review*, 21(4), pp.1022-1054.
- Greenwood, R., Díaz, A.M., Li, S.X. and Lorente, J.C., 2010. The multiplicity of institutional logics and the heterogeneity of organizational responses. *Organization Science*, 21(2), pp.521-539.
- Greve, H.R. and Man Zhang, C., 2017. Institutional logics and power sources: Merger and acquisition decisions. *Academy of Management Journal*, 60(2), pp.671-694.
- Grin, J., Rotmans, J. and Schot, J., 2010. *Transitions to sustainable development: new directions in the study of long-term transformative change*. Routledge.
- Grunwald, A., 2017. A transdisciplinary approach to the process of socio-technical transformation: The case of German Energiewende. In *Transdisciplinary Research and Sustainability*, pp. 35-52. Routledge.
- Gwilliam, K. W., 2002. *Cities on the Move: A World Bank Urban Transport Strategy Review*. Washington, DC: The World Bank.

- Hansen, T. and Coenen, L., 2015. The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environmental innovation and Societal Transitions*, 17, pp.92-109.
- Hara K, Uwasu M, Yabar H, Zhang H., 2009. Sustainability assessment with time-series scores: a case study of Chinese provinces. *Sustainability Science*, 4(1), pp. 81–97
- Harding, S.E., Badami, M.G., Reynolds, C.C. and Kandlikar, M., 2016. Auto-rickshaws in Indian cities: Public perceptions and operational realities. *Transport policy*, 52, pp.143-152.
- Harvey, D., 2003. The right to the city. *International journal of urban and regional research*, 27(4), pp.939-941.
- HIDCO, 1999. *New town Calcutta project report for AA-I*, HIDCO New Town Kolkata. (Accessed 17 December 2016).
- Hildebrand, M., Kanaley, T. and Roberts, B., 2013. *Strategy Paper: Sustainable and Inclusive Urbanization in Asia Pacific*, New York: United Nations Development Programme.
- Hochadel, A., 2016. *India's 100 Smart Cities - What Will Success Look Like?*. [Blog], Future Cities Catapult. London. UK. URL: <http://futurecities.catapult.org.uk/2016/01/28/blog-indias-100-smart-cities-what-will-success-look-like/> (Accessed 10 March 2018).
- Hodson, M. and Marvin, S., 2010. Can cities shape socio-technical transitions and how would we know if they were?. *Research policy*, 39(4), pp.477-485.
- Hodson, M. and Marvin, S., 2012. Mediating low-carbon urban transitions? Forms of organization, knowledge and action. *European Planning Studies*, 20(3), pp.421-439.
- Hoffman, J., 2013. Theorizing power in transition studies: the role of creativity and novel practices in structural change. *Policy Sciences*, 46(3), pp.257-275.
- Hoffman, M.J., 2011. *Climate governance at the crossroads: experimenting with a global response after Kyoto*. Oxford University Press: Oxford
- Hollands, R.G., 2008. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?. *City*, 12(3), pp.303-320.
- Hölscher, K., Wittmayer, J.M. and Loorbach, D., 2018. Transition versus transformation: What's the difference?. *Environmental innovation and Societal Transitions*, 27(1), pp.1-3.
- Hoogma, R., Kemp, R., Schot, J. and Truffer, B., 2005. *Experimenting for sustainable transport: the approach of strategic niche management*. Routledge.
- Hopkins, D. and Schwanen, T., 2018. Automated Mobility Transitions: Governing Processes in the UK. *Sustainability*, 10(4), p.956.
- Huang, L., Yan, L. and Wu, J., 2016. Assessing urban sustainability of Chinese megacities: 35 years after the economic reform and open-door policy. *Landscape and Urban Planning*, 145, pp.57-70.

- Hugé J, Waas T, Dahdouh-Guebas F, Koedam N, Block T., 2013. A discourse-analytical perspective on sustainability assessment: interpreting sustainable development in practice. *Sustainability Science*, 8(2):187–198
- Hunt, J., 2012. Megacities Face Mega Problems. Opinion. *The Moscow Times*. Available at: <https://themoscowtimes.com/articles/megacities-face-mega-problems-15773/> (Accessed 20 August 2018).
- Hyrapiet, S. and Greiner, A.L., 2012. Calcutta's Hand–Pulled Rickshaws: Cultural Politics and Place Making in a Globalizing City. *Geographical Review*, 102(4), pp.407-426.
- IAC. 2018., *About us*. Indian Auto LPG coalition. <https://www.iac.org.in/about-us>. Accessed on February 2018
- IBP, 2013. *Thailand Transportation Policy and Regulations Handbook Volume I: Strategic and Practical Information*. Washington, DC: International Business Publications.
- Ingram, J., Maye, D., Kirwan, J., Curry, N. and Kubinakova, K., 2015. Interactions between niche and regime: an analysis of learning and innovation networks for sustainable agriculture across Europe. *The Journal of Agricultural Education and Extension*, 21(1), pp.55-71.
- IPCC, 2012. Summary for policymakers. In Managing the risks of extreme events and disasters to advance climate change adaptation, eds. Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, et al. *A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Cambridge, UK, and New York, NY, USA: Cambridge University Press, pp. 3–21.
- IPCC, 2014. Mitigation of Climate Change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Irungbam, R.S., 2016. The Model of Smart Cities in Theory and in Practice. *Journal for Studies in Management and Planning*, 2(4), pp.156-187.
- ITDP, 2013. *The BRT Standard*. New York: Institute for Transportation and Development Policy.
- Jacobsson, S. and Bergek, A., 2011. Innovation system analyses and sustainability transitions: Contributions and suggestions for research. *Environmental Innovation and Societal Transitions*, 1(1), pp.41-57.
- Jasanoff, S., 2015. Future imperfect: Science, technology, and the imaginations of modernity. *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*, pp.1-47.
- Jittrapirom, P., Caiati, V., Feneri, A.M., Ebrahimigharehbaghi, S., Alonso González, M.J. and Narayan, J., 2017. Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges. *Urban Planning*, 2, pp.13-25.
- Johnstone, P. and Newell, P., 2018. Sustainability transitions and the state. *Environmental innovation and Societal Transitions*, 27, pp.72-82.

- Joint Secretary to the Government of West Bengal. *Notification No. 1276-WT/4AM-23/95 Pt.-I*. Transport Department, Kolkata. Available at: <http://transport.wb.gov.in/>. (Accessed 17 February 2018).
- Jolly S., 2016. *Collective institutional entrepreneurship for fostering sustainable energy transitions in India*. PhD thesis. Eindhoven University of Technology
- Jones, N. and Sumner, A., 2009. Does mixed methods research matter to understanding childhood well-being?. *Social Indicators Research*, 90(1), pp.33-50.
- Joshi, R. and Joseph, Y., 2015. Invisible cyclists and disappearing cycles: the challenges of cycling policies in Indian cities. *Transfers*, 5(3), pp.23-40.
- Julka, H., & Shrivastava, A. Jan 15, 2015. Oh Kolkata! Uber, Ola get legitimacy in West Bengal. *The Economic Times*. New Delhi. <https://economictimes.indiatimes.com/news/politics-and-nation/oh-kolkata-uber-ola-get-legitimacy-in-west-bengal/articleshow/45896071.cms> (Accessed on 15 March 2018).
- Kabiraj, I., 2017. Rent Cycles @ Rs 2 For An Hour, Pick & Drop Them At Your Convenience – PEDL Cycle Rental is Bringing The Green Revolution in Kolkata !. *The Beacon Kolkata*. Available at: <http://www.thebeaconkolkata.co.in/pedl-cycle-rental/> (Accessed 23 June 2018).
- Kabiraj, I., 2018. City To Witness More Women Behind The Wheels – Pink Autos In Kolkata Are Soon To Be A Reality!. *The Beacon Kolkata*. Available at: <http://www.thebeaconkolkata.co.in/pink-autos-in-kolkata/> (Accessed 5 September 2018).
- Karvonen, A. and van Heur, B., 2014. Urban laboratories: experiments in reworking cities. *International Journal of Urban and Regional Research*, 38: 379–392.
- Kemp, R., Loorbach, D. and Rotmans, J., 2007. Transition management as a model for managing processes of co-evolution towards sustainable development. *The International Journal of Sustainable Development & World Ecology*, 14(1), pp.78-91.
- Kemp, R., Schot, J. and Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology analysis & strategic management*, 10(2), pp.175-198.
- Kenworthy, J.R., 2003. *Transport energy use and greenhouse gases in urban passenger transport systems: a study of 84 global cities*.
- Kern F., 2010. *The politics of governing 'system innovations' towards sustainable electricity systems*. PhD thesis. SPRU
- Khan, J., Hassan, T. and Shamsad, S., 2012. Socio-economic profile of cycle rickshaw pullers: a case study. *European Scientific Journal*, 8, pp. 310–330.
- Khanna, A. and Khanna, P., 2015. Generative Cities: Innovative, Sustainable, Inclusive. In *Smart Cities as Democratic Ecologies*, Palgrave Macmillan, London. pp. 35-42.

- Kimmelman, M., 5 July 2018. The world's sinking megacities. *ABC Conversations*. Available at: <http://www.abc.net.au/radio/programs/conversations/conversations-michael-kimmelman/9921902> (Accessed 28 August 2018).
- Kitchin, R., 2014. The real-time city? Big data and smart urbanism. *GeoJournal*, 79(1), pp.1-14.
- Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system-level transitions. *Research policy*, 43(8), pp.1370-1380.
- Kivimaa, P., Hildén, M., Huitema, D., Jordan, A. and Newig, J., 2017. Experiments in climate governance—a systematic review of research on energy and built environment transitions. *Journal of Cleaner Production*, 169, pp.17-29.
- KMCGov.in. 2018. *Incorporation of erstwhile Joka-I & Joka-II Gram Panchayats under the jurisdiction of Kolkata Municipal Corporation*. Available at: https://www.kmcgov.in/KMCPortal/outside_jsp/Incorporation_erstwhile_Joka.jsp (Accessed on 15 March 2018).
- Koehler, J., Geels, F.W., Onsongo, E., Wieczorek, A.J. and Kern, F., 2017. A research agenda for the Sustainability Transitions Research Network, *STRN Working Group*. Available at: <https://transitionsnetwork.org/>
- Koehler, J., Whitmarsh, L., Nykvist, B., Schilperoord, M., Bergman, N. and Haxeltine, A., 2009. A transitions model for sustainable mobility. *Ecological economics*, 68(12), pp.2985-2995.
- Kohli, D., 2015. How Smart Cities Will Force The Poor Out. Youth Ki Awaaz. Available at: <https://www.youthkiawaaz.com/2015/07/smart-cities-keep-the-poor-out/> (Accessed 17 May 2018).
- Kolkata Metro Rail Corporation, 2018. *The Grand Design*. <http://www.kmrc.in/technology.php> <http://www.kmrc.in/technology.php> (Accessed on 30th January 2018).
- Kolkata Metro Rail Corporation. 2016. *Safety first.. and last along with comfort*. Available at: http://www.kmrc.in/safety_comfort.php (Accessed 20 November 2017).
- Kolkata Traffic Police. 2015. *Annual review: Road to safety*, Accessed from Kolkata traffic police guard during fieldwork December 2016.
- Konrad, K., Truffer, B. and Voß, J.P., 2008. Multi-regime dynamics in the analysis of sectoral transformation potentials: evidence from German utility sectors. *Journal of Cleaner Production*, 16(11), pp.1190-1202.
- Kothari, E. 2013. Cycle Satyagraha: An appeal against the ban in Kolkata. *SwitchOn*. <http://switchon.org.in/cyclesatyagraha.pdf>. Accessed on 23rd February 2018
- Kotkin, J., 2011. The Problem with Megacities. *Forbes*. Available at: <https://www.forbes.com/sites/megacities/2011/04/04/the-problem-with-megacities/> (Accessed 17 May 2018)
- Kraas, F., Leggewie, C., Lemke, P., Matthies, E., Messner, D., Nakicenovic, N., Schellnhuber, H.J., Schlacke, S., Schneidewind, U., Brandi, C. and Butsch, C., 2016. *Humanity on the*

move: Unlocking the transformative power of cities. WBGU-German Advisory Council on Global Change.

Kruks-Wisner, G., 2018. The Pursuit Of Social Welfare: Citizen Claim-Making in Rural India. *World Politics*, 70(1), pp.122-163.

Kumar, A., 2011. Understanding the Emerging Role of Motorcycles in African cities: A Political Economy Perspective. *Sub-Saharan Africa Transport Policy Program (SSATP)*. Discussion Paper.

Kundu, R., 2016. Making Sense of Place in Rajarhat New Town. *Economic & Political Weekly*, 51(17), p.93.

Kungl, G., 2015. Stewards or sticklers for change? Incumbent energy providers and the politics of the German energy transition. *Energy Research & Social Science*, 8, pp.13-23.

Kuzdas C, Warner BP, Wiek A, Vignola R, Yglesias M, Childers DL., 2016. Sustainability assessment of water governance alternatives: the case of Guanacaste Costa Rica. *Sustainability Science*, 11(2), pp. 231–247

Lazaroiu, G.C. and Roscia, M., 2012. Definition methodology for the smart cities model. *Energy*, 47(1), pp.326-332.

Leach M, Scoones I, Stirling A., 2010. *Dynamic sustainabilities: technology, environment, social justice*. Routledge, London

Lohia, S.K., 2013. Preface. *Urban Bus Specifications II*. Available at: <http://cstc.org.in/doc/Urban-Bus-Specifications-II.pdf> (Accessed on February 2018).

Loorbach, D. and Wijsman, K., 2013. Business transition management: exploring a new role for business in sustainability transitions. *Journal of cleaner production*, 45, pp.20-28.

Loorbach, D., 2010. Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance*, 23(1), pp.161-183.

Lund, C., 2006. Twilight institutions: public authority and local politics in Africa. *Development and change*, 37(4), pp.685-705.

Luque-Ayala, A., Bulkeley, H. and Marvin, S., 2018. Rethinking urban transitions: an analytical framework. *Rethinking Urban Transitions*, Routledge, pp. 31-54.

Luque, A., McFarlane, C. and Marvin, S., 2014. Smart urbanism: Cities, grids and alternatives. Hodson, M. and Marvin, S. (eds). *After sustainable cities*. Routledge. pp.74-89.

Mahadevia, D., Joshi, R. and Datey, A., 2013. *Low-Carbon Mobility in India and the Challenges of Social Inclusion: Bus Rapid Transit (BRT) Case Studies in India, Denmark*, UNEP Risø Centre on Energy, Climate and Sustainable Development.

Maitra, S., 2017. Soon, rent a cycle at New Town. The Times of India. Available at: <http://timesofindia.indiatimes.com/articleshow/61775923.cms?> (Accessed 20 August 2018).

- Maji, P. K., Banerjee, P. S., Banerjee, A. J. and Maity, S., 2010. Electric motor-assisted pedal driven tricycle. *International Journal of Electric and Hybrid Vehicles*, 2, pp. 202–210.
- Managing Director, CSTC. *Request for proposal for implementation & Operation of Intelligent Transport Management System (ITS): 2nd Call. No: 002/260*. Calcutta State Transport Corporation; Accessed from CSTC office in December 2015.
- Markard, J., 2011. Transformation of infrastructures: sector characteristics and implications for fundamental change. *Journal of Infrastructure Systems*, 17(3), pp.107-117.
- Markard, J., Raven, R. and Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. *Research policy*, 41(6), pp.955-967.
- Marler, N.W., 1982. *The Performance of High-flow Bus Lanes in Bangkok*, Crowthorne, UK: Transport and Road Research Laboratory.
- Marletto, G., 2014. Car and the city: Socio-technical transition pathways to 2030. *Technological Forecasting and Social Change*, 87, pp.164-178.
- Mateo-Babiano, I., Kumar, S. and Mejia, A., 2017. Bicycle sharing in Asia: a stakeholder perception and possible futures. *Transportation research procedia*, 25, pp.4966-4978.
- Mattioli, G., 2016. Transport needs in a climate-constrained world. A novel framework to reconcile social and environmental sustainability in transport. *Energy Research & Social Science*, 18, pp.118-128.
- McCormick, K., Anderberg, S., Coenen, L. and Neij, L., 2013. Advancing sustainable urban transformation. *Journal of Cleaner Production*, 50, pp.1-11.
- McDowall W, Eames M., 2007. Towards a sustainable hydrogen economy: a multi-criteria sustainability appraisal of competing hydrogen futures. *International Journal of Hydrogen Energy*, 32(18), pp. 4611–4626
- McLarty D, Davis N, Gellers J, Nasrollahi N, Altenbernd E., 2014. Sisters in sustainability: municipal partnerships for social, environmental, and economic growth. *Sustainability Science*, 9(3), pp. 277–292
- McMichael, A.J., 2000. The urban environment and health in a world of increasing globalization: issues for developing countries. *Bulleting of the World Health Organization*, 78, pp. 1117–1126.
- Meadowcroft, J., 2007. Who is in charge here? Governance for sustainable development in a complex world. *Journal of Environmental Policy & Planning*, 9(3-4), pp.299-314.
- Meadowcroft, J., 2011. Engaging with the politics of sustainability transitions. *Environmental Innovation and Societal Transitions*, 1(1), pp.70-75.
- Menon, A., 2015. URBAN PLANNING - Smart Cities are the way ahead for us. *The Times of India*. Available at: <http://epaperbeta.timesofindia.com/Article.aspx?eid=31804&articlexml=URBAN-PLANNING-Smart-Cities-are-the-way-ahead-26012015014030> (Accessed on 29 June 2018).

- Metro Railway Kolkata, 2016. *New Metro Projects*. Available at: http://www.mtp.indianrailways.gov.in/view_section.jsp?lang=0&id=0,1,397. (Accessed on 30th January 2018).
- Metro Railway Kolkata. 2016. Passenger amenities in Metro Railway, Kolkata. *Indian Railways portal*. (Accessed 10th April 2018).
- Metropolitan Transport Project, 1972. *Calcutta Mass Transit Study 1970-71 Dum-Dum to Tollygunj Vol-I*. Metro Railway, Kolkata (Accessed 10 November 2015).
- Midgley, P., 2009. The role of smart bike-sharing systems in urban mobility. *Journeys*, 2(1), pp.23-31.
- Millennium Post, 2018. City to get pink autos with women on wheels City to get pink autos with women on wheels. Kolkata. <http://www.millenniumpost.in/kolkata/city-to-get-pink-autos-with-women-on-wheels-28351> [Accessed on 12th February 2018].
- Miller, T.R., Wiek, A., Sarewitz, D., Robinson, J., Olsson, L., Kriebel, D. and Loorbach, D., 2014. The future of sustainability science: a solutions-oriented research agenda. *Sustainability science*, 9(2), pp.239-246.
- Minh, T.T., Friederichsen, R., Neef, A. and Hoffmann, V., 2014. Niche action and system harmonization for institutional change: Prospects for demand-driven agricultural extension in Vietnam. *Journal of Rural Studies*, 36, pp.273-284.
- Moeller, C., Sauerborn, J., de Voil, P., Manschadi, A.M., Pala, M. and Meinke, H., 2014. Assessing the sustainability of wheat-based cropping systems using simulation modelling: sustainability= 42?. *Sustainability science*, 9(1), pp.1-16.
- MOHUA, 2017. Metro Rail Policy. Ministry of Housing and Urban Affairs, Government of India. Available at: <http://mohua.gov.in/> (Accessed 12 April 2018)
- MOHUA, 2017. Smart Cities. Ministry of Housing and Urban Affairs. The Government of India. URL: <http://mohua.gov.in/cms/smart-cities.php> (Accessed 8 March 2018)
- Moradi, A. and Vagnoni, E., 2018. A multi-level perspective analysis of urban mobility system dynamics: What are the future transition pathways?. *Technological Forecasting and Social Change*, 126, pp.231-243.
- Moriarty, P. and Honnery, D., 2008. Low-mobility: the future of transport. *Futures*, 40: 865–872.
- Morichi, S. and Acharya, S.R. eds., 2012. *Transport development in Asian megacities: A new perspective*. Springer Science & Business Media.
- MoUD, 2005. *Guidelines for projects of Jawaharlal Nehru National Urban Renewal Mission on urban infrastructure & Governance*, Ministry of Urban Development, Government of India. New Delhi.

- MPost, 2016. New transport corporation will provide better services. *Millennium post*. Kolkata. Available at: <http://www.millenniumpost.in/new-transport-corporation-will-provide-better-services-suvendu-160907> (Accessed 21 January 2018).
- Mullen, C. and Marsden, G., 2016. Mobility justice in low carbon energy transitions. *Energy Research & Social Science*, 18, pp.109-117.
- Næss, P. and Vogel, N., 2012. Sustainable urban development and the multi-level transition perspective. *Environmental Innovation and Societal Transitions*, 4, pp.36-50.
- Nam, T. and Pardo, T.A., 2011, June. Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291). ACM.
- Neirotti, P., De Marco, A., Cagliano, A.C., Mangano, G. and Scorrano, F., 2014. Current trends in Smart City initiatives: Some stylised facts. *Cities*, 38, pp.25-36.
- Nelson, R. and Winter, S., 1982. *An evolutionary theory of technical change*. Cambridge, MA, The Bknap Press. Harvard.
- Nelson, R.R. and Winter, S.G., 1977. In search of a useful theory of innovation. In *Innovation, economic change and technology policies* (pp. 215-245). Birkhäuser, Basel.
- Nevens, F., Frantzeskaki, N., Gorissen, L. and Loorbach, D., 2013. Urban Transition Labs: co-creating transformative action for sustainable cities. *Journal of Cleaner Production*, 50, pp.111-122.
- Newig J, Voss J-P, Monstadt M., 2007. Governance for sustainable development in the face of ambiguity, uncertainty and distributed power: an introduction. *Journal of Environmental Policy & Planning*, 9, pp. 185–192
- Nicholls, R.J., 1995. Coastal megacities and climate change. *GeoJournal*, 37(3), pp.369-379.
- Nilsson, M. and Nykvist, B., 2016. Governing the electric vehicle transition–Near term interventions to support a green energy economy. *Applied energy*, 179, pp.1360-1371.
- Niyogii, S. April 9, 2009. AC buses prove a hit on city roads. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/AC-buses-prove-a-hit-on-city-roads/articleshow/4377253.cms> (Accessed 26th February 2018)
- NKDA website. 2016. *Webpage of New Town Kolkata Development Authority. Background*. Available at <https://www.nkdamar.org/Pages/Background.aspx> (Accessed 8 March 2018)
- NKDA, 2015. Smart city proposal. Annexures. Smart city challenge Stage 2. *India Smart city Mission*.
- NKDA, 2015. Smart city proposal. Smart city challenge Stage 2. *India Smart city Mission*.
- NKDA, 2016. Smart city proposal (upgraded). Annexures. Smart city challenge Stage 2. *India Smart city Mission*.

- NKDA, 2016. Smart city proposal (upgraded). Smart city challenge Stage 2. *India Smart city Mission*.
- Nykvist, B. and Whitmarsh, L., 2008. A multi-level analysis of sustainable mobility transitions: Niche development in the UK and Sweden. *Technological forecasting and social change*, 75(9), pp.1373-1387.
- O'Brien, K., 2012. Global environmental change II: from adaptation to deliberate transformation. *Progress in Human Geography*, 36(5), pp.667-676.
- O'Neill, J., 2001. Representing people, representing nature, representing the world. *Environment and Planning C: Government and Policy*, 19(4), pp.483-500.
- Oliveira, R. 2015. How to improve life lived in the megacity. *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2015/01/how-to-improve-life-lived-in-the-megacity/> (Accessed 8 August 2018).
- Olsson, P., Galaz, V. and Boonstra, W.J., 2014. Sustainability transformations: a resilience perspective. *Ecology and Society*, 19(4).
- Oltra, V. and Jean, M.S., 2005. The dynamics of environmental innovations: three stylised trajectories of clean technology. *Economics of Innovation and New Technology*, 14(3), pp.189-212.
- Owen, H., 2008, *Open space technology: A user's guide* (3rd edition). San Francisco: Berrett-Koehler Publishers.
- Pagel, H., Ranke, K., Hempel, F. and Köhler, J., 2014. *The use of the concept "Global South" in Social Science & Humanities*. Univ. Calif. Berkeley, 125, pp.13-9.
- Panebianco, S. and Pahl-Wostl, C., 2006. Modelling socio-technical transformations in wastewater treatment—a methodological proposal. *Technovation*, 26(9), pp.1090-1100.
- Paquet, J., Vikhornova, A., & Wright, N., 2016. *Sharing cities: D2.1C Report on Engagement Methods*. Future Cities Catapult. London: Horizon 2020 research and innovation programme.
- Patterson, J., Schulz, K., Vervoort, J., Van Der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M. and Barau, A., 2017. Exploring the governance and politics of transformations towards sustainability. *Environmental Innovation and Societal Transitions*, 24, pp.1-16.
- Patton, M.Q., 1990. *Qualitative evaluation and research methods*. SAGE Publications, inc.
- Pel, B. and Bauler, T., 2014. The institutionalization of social innovation: between transformation and capture. *TRANSIT working paper*, 2.
- Pelling, M. and Blackburn, S. eds., 2014. *Megacities and the coast: risk, resilience and transformation*. Routledge.

- Petty, N.J., Thomson, O.P. and Stew, G., 2012. Ready for a paradigm shift? Part 2: Introducing qualitative research methodologies and methods. *Manual therapy*, 17(5), pp.378-384.
- Pimbert M.P. and Wakeford T., 2002. *Prajateerpu: A Citizens Jury/Scenario Workshop on Food and Farming Futures for Andhra Pradesh, India*. IIED, London and IDS, Sussex.
- Pinch, T.J. and Bijker, W.E., 1984. The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social studies of science*, 14(3), pp.399-441.
- Pradhan, C.K., Thakur, S., Mukherjee, A.K. and Roychowdhury, A., 2008. Energy expenditure of cycle rickshaw pullers in different places in India. *Ergonomics*, 51(9), pp.1407-1417.
- Praharaj, S., Han, J.H. and Hawken, S., 2018. Urban innovation through policy integration: Critical perspectives from 100 smart cities mission in India. *City, culture and society*, 12, pp.35-43.
- Prasad, R. 2015. Design, Standard, Planning and Implementation of Joka-Majerhat Metro Section in view of the requirement of MRTS in Kolkata. *Rail Vikas Nigam Limited*. Retrieved from Department of Transport, Government of West Bengal on December 2016.
- Press Trust of India. April 14, 2017. Kolkata's yellow cabs to roar on TYGR app. *Business Standard*. Kolkata. Available at: <https://www.thehindubusinessline.com/economy/logistics/kolkatas-yellow-cabs-to-roar-on-tygr-app/article9640379.ece> (Accessed 18 February 2018)
- PTI, 2006. Hand-pulled rickshaws in Kolkata to pass into history. *DNA India*. Kolkata. Available at: <http://www.dnaindia.com/india/report-hand-pulled-rickshaws-in-kolkata-to-pass-into-history-1067726> (Accessed 12th February 2018).
- PTI. 2014. Kolkata: Police taking fines from us illegally, say cyclists. *First Post*. Available at: <https://www.firstpost.com/india/kolkata-police-taking-fines-from-us-illegally-say-cyclists-1321891.html> (Accessed 24th August 2018).
- PTI. 2018. Kolkata bridge collapse: Toll rises to three. *The Times of India*. Available at <http://timesofindia.indiatimes.com/articleshow/65710688.cms?> (Accessed 8 September 2018)
- Pucher, J. and Buehler, R., 2010. Walking and cycling for healthy cities. *Built Environment*, 36(4), pp.391-414.
- Purushothaman S, Patil S, Francis I., 2013. Assessing the impact of policy-driven agricultural practices in Karnataka, India. *Sustainability Science*, 8(2), pp.173–185
- Rahul, T.M. and Verma, A., 2013. Economic impact of non-motorized transportation in Indian cities. *Research in transportation economics*, 38(1), pp.22-34.
- Railway Board, 2018. *Indian Railways Annual report and accounts 2016-17*. Ministry of Railways, Government of India. Available at: <http://www.indianrailways.gov.in/> (Accessed 10 April 2018).

- Rajvanshi, A.K., 2002. Electric and improved cycle rickshaw as a sustainable transport system for India. *Current Science*, 83(6), pp.703-707.
- Ratti, C. and Townsend, A., 2011. The social nexus. *Scientific American*, 305(3), pp.42-49.
- Raven, R. and Verbong, G., 2007. Multi-regime interactions in the Dutch energy sector: the case of combined heat and power technologies in the Netherlands 1970–2000. *Technology Analysis & Strategic Management*, 19(4), pp.491-507.
- Raven, R., 2008. *Strategic niche management for biomass: a comparative study on the experimental introduction of bioenergy technologies in the Netherlands and Denmark*. PhD thesis. VDM Publishing.
- Raven, R., Ghosh, B., Wieczorek, A., Stirling, A., Ghosh, D., Jolly, S., Karjangtimapron, E., Prabudhanitisarn, S., Roy, J., Sangawongse, S. and Sengers, F., 2017. Unpacking sustainabilities in diverse transition contexts: solar photovoltaic and urban mobility experiments in India and Thailand. *Sustainability Science*, 12(4), pp.579-596.
- Raven, R., Kern, F., Smith, A., Jacobsson, S. and Verhees, B., 2016. The politics of innovation spaces for low-carbon energy: introduction to the special issue. *Environmental Innovation and Societal Transitions*, 18, pp.101-110.
- Raven, R., Schot, J. and Berkhout, F., 2012. Space and scale in socio-technical transitions. *Environmental Innovation and Societal Transitions*, 4, pp.63-78.
- Raven, R., Van den Bosch, S. and Weterings, R., 2010. Transitions and strategic niche management: towards a competence kit for practitioners. *International Journal of Technology Management*, 51(1), pp.57-74.
- Raven, R.P., 2006. Towards alternative trajectories? Reconfigurations in the Dutch electricity regime. *Research Policy*, 35(4), pp.581-595.
- Reay, T. and Hinings, C.R., 2009. Managing the rivalry of competing institutional logics. *Organization studies*, 30(6), pp.629-652.
- Reddy, B.S. and Balachandra, P., 2012. Urban mobility: A comparative analysis of megacities of India. *Transport Policy*, 21, pp.152-164.
- Rigg, J., 2007. *An everyday geography of the global south*. Routledge.
- Rip A, Kemp R., 1998. Technological change. In: Rayner S, Malone L (eds) *Human choice and climate change*, Resources and technology. Vol 2. Batelle Press, Washington, pp 327–399
- Rip, A., 1992. A quasi-evolutionary model of technological development and a cognitive approach to technology policy. *RISSEST-Rivista di studi epistemologici e sociali sulla scienza e la tecnologia*, 1992(2), pp.69-102.
- RTES, 2014. *Detailed Project Report for New metro corridors in Kolkata*. Retrieved from Metro Railway, Kolkata office in December 2015.

- Roberts, J.C.D., 2017. Discursive destabilisation of socio-technical regimes: Negative storylines and the discursive vulnerability of historical American railroads. *Energy Research & Social Science*, 31, pp.86-99.
- Robinson, J. and Roy, A., 2016. Debate on global urbanisms and the nature of urban theory. *International Journal of Urban and Regional Research*, 40(1), pp.181-186.
- Rock, M., Murphy, J.T., Rasiah, R., van Seters, P. and Managi, S., 2009. A hard slog, not a leap frog: Globalization and sustainability transitions in developing Asia. *Technological Forecasting and Social Change*, 76(2), pp.241-254.
- Rogers, D.S., Duraiappah, A.K., Antons, D.C., Munoz, P., Bai, X., Fragkias, M. and Gutscher, H., 2012. A vision for human well-being: transition to social sustainability. *Current Opinion in Environmental Sustainability*, 4(1), pp.61-73.
- Rotmans, J. and Loorbach, D., 2009. Complexity and transition management. *Journal of Industrial Ecology*, 13(2), pp.184-196.
- Roy, R., Chan, N.W. and Rainis, R., 2014. Rice farming sustainability assessment in Bangladesh. *Sustainability science*, 9(1), pp.31-44.
- Roy, A., 2011. The Blockade of the World-Class City: Dialectical Images of Indian Urbanism. In Ananya Roy and Aihwa Ong (ed). *Worlding Cities: Asian Experiments and the Art of Being Global*, First Edition. Blackwell Publishing Ltd.
- Sadhukhan, S., Banerjee, U.K. and Maitra, B., 2017. Preference heterogeneity towards the importance of transfer facility attributes at metro stations in Kolkata. *Travel Behaviour and Society*. DOI: <http://dx.doi.org/10.1016/j.tbs.2017.05.001>
- Sarkar, P.K. and Tagore, P., 2011. An approach to the development of sustainable urban transport system in Kolkata. *Current Science*, pp.1349-1361.
- Sassen, S., 2018. *Cities in a world economy*. Sage Publications.
- Satterthwaite, D. and Mitlin, D., 2012. *Urban poverty in the global south: scale and nature*. Routledge.
- Saunders, T. and Baeck, P., 2015. *Rethinking smart cities from the ground up*. London: Nesta.
- Schot J., Boni, A., Ramirez M., Steward, F., 2018. Addressing SDGs through Transformative Innovation Policy, *TIPC Research Briefing 2018-01*. Available at: http://tipconsortium.net/wp-content/uploads/2018/06/4198_TIPC_research_brief_web-FINAL.pdf (Accessed 10 August 2018)
- Schot J., Daniels, C., Torrens, J., Bloomfield G., 2018. Developing a Shared Understanding of Transformative Innovation Policy. *TIPC Research Briefing 2017-01*. Available at: http://tipconsortium.net/wp-content/uploads/2018/04/TIPC-Research-Brief.-Developing-a-Shared-Understanding-of-Transformative-Innovation-Policy-FINAL_.pdf (Accessed 20 June 2018)

- Schot, J. and Geels, F.W., 2007. Niches in evolutionary theories of technical change. *Journal of Evolutionary Economics*, 17(5), pp.605-622.
- Schot, J. and Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology analysis & strategic management*, 20(5), pp.537-554.
- Schot, J. and Kanger, L., 2018. Deep transitions: Emergence, acceleration, stabilization and directionality. *Research Policy*, 47(6), pp.1045-1059.
- Schot, J. and Steinmueller, E., 2016. *Framing innovation policy for transformative change: Innovation policy 3.0*. SPRU Science Policy Research Unit, University of Sussex: Brighton, UK. Available at: <http://tipconsortium.net/> (Accessed 11 June 2018)
- Schot, J. and Steinmueller, W.E., 2018. Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, 47(9), pp. 1554-1567.
- Schot, J., 1992. The policy relevance of the quasi-evolutionary model. The case of stimulating clean technologies. Coombs, R.; Saviotti, P.; Walsh, V. *Technological Change and Company Strategies*, pp.185-200.
- Schot, J., 1998. The usefulness of evolutionary models for explaining innovation. The case of the Netherlands in the nineteenth century. *History and Technology, an International Journal*, 14(3), pp.173-200.
- Schot, J., Hoogma, R. and Elzen, B., 1994. Strategies for shifting technological systems: the case of the automobile system. *Futures*, 26(10), pp.1060-1076.
- Scoones, I., Leach, M. and Newell, P. eds., 2015. *The politics of green transformations*. Routledge.
- Scott, A.J. and Storper, M., 2015. The nature of cities: the scope and limits of urban theory. *International journal of urban and regional research*, 39(1), pp.1-15
- Scott, W.R., 1995. Institutions and organizations. Foundations for organizational science. *London: A Sage Publication Series*.
- Scrase, I. and Smith, A., 2009. The (non-) politics of managing low carbon socio-technical transitions. *Environmental Politics*, 18(5), pp.707-726.
- Seawright, J. and Gerring, J., 2008. Case selection techniques in case study research: A menu of qualitative and quantitative options. *Political Research Quarterly*, 61(2), pp.294-308.
- Secretary to the Government of West Bengal, 2012. *Notification No. 2941-WT/3M-60/12*. Dated 22.08.2012. Transport Department, Kolkata. Retrieved from RTA office on December 2016.
- Sen, 2016. *Green city New town* [powerpoint slides], Retrieved from NKDA office during fieldwork in December 2016
- Sengers, F. and Raven, R., 2014. Metering motorbike mobility: informal transport in transition? *Technology Analysis and Strategic Management*, 6, pp. 453–468.

- Sengers, F. and Raven, R., 2014. Metering motorbike mobility: informal transport in transition?. *Technology Analysis & Strategic Management*, 26(4), pp.453-468.
- Sengers, F. and Raven, R., 2015. Toward a spatial perspective on niche development: the case of Bus Rapid Transit. *Environmental Innovation and Societal Transitions*, 17, pp. 166–182.
- Sengers, F., 2016. *Transforming transport in Thailand: experimenting for transitions in sustainable urban mobility*, Doctoral dissertation, Technische Universiteit Eindhoven.
- Sengers, F., Berkhout, F., Wieczorek, A. and Raven, R.P.J.M., 2016. Experimenting in the city: Unpacking notions of experimentation for sustainability. James Evans, Andrew Karvonen and Rob Raven (eds), *The Experimental City*, Abingdon: Routledge, pp.15-31.
- Sengers, F., Wieczorek, A.J. and Raven, R., 2016. Experimenting for sustainability transitions: A systematic literature review. *Technological Forecasting and Social Change*. DOI: <https://doi.org/10.1016/j.techfore.2016.08.031>
- Sengupta, U., 2013. Inclusive development? A state-led land development model in New Town, Kolkata. 31(2), pp.357-376.
- Seyfang, G. and Haxeltine, A., 2012. Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions. *Environment and Planning C: Government and Policy*, 30(3), pp.381-400.
- Sheller, M., 2012. The emergence of new cultures of mobility: stability, openings and prospects. In Geels, F., Kemp, R., Dudley, G. and Lyons, G. (eds), *Automobility in Transition? A Socio-technical Analysis of Sustainable Transport*. New York: Routledge, 180–202.
- Shove E, Walker G., 2007. CAUTION! Transitions ahead: politics, practice, and sustainable transition management. *Environment and Planning A*, 39, pp. 763–770
- Simon, H.A., 1982. *Models of bounded rationality*. Cambridge, Massachusetts. MIT Press.
- Simon, H.A., 1991. Bounded rationality and organizational learning. *Organization science*, 2(1), pp.125-134.
- Smink, M., Negro, S.O., Niesten, E. and Hekkert, M.P., 2015. How mismatching institutional logics hinder niche–regime interaction and how boundary spanners intervene. *Technological Forecasting and Social Change*, 100, pp.225-237.
- Smith, A. and Stirling, A., 2007. Moving outside or inside? Objectification and reflexivity in the governance of socio-technical systems. *Journal of Environmental Policy & Planning*, 9(3-4), pp.351-373.
- Smith, A., 2007. Translating sustainabilities between green niches and socio-technical regimes. *Technology analysis & strategic management*, 19(4), pp.427-450.
- Smith, A. and Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Research policy*, 41(6), pp.1025-1036.

- Smith, A. and Stirling, A., 2010. The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society*, 15(1).
- Smith, A., Stirling, A. and Berkhout, F., 2005. The governance of sustainable socio-technical transitions. *Research policy*, 34(10), pp.1491-1510.
- Smith, A., Voß, J.P. and Grin, J., 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research policy*, 39(4), pp.435-448.
- SMV Wheels Pvt. Limited., 2011. Dasra Social Impact: Converting Poor to Power. Available at: <http://www.dasra.org/n/forwebsite/dasra/Reports/SMV%20Wheels.pdf> (Accessed 28 November 2014).
- Sorensen, A. and Okata, J. eds., 2010. *Megacities: urban form, governance, and sustainability* (Vol. 10). Springer Science & Business Media.
- Sovacool, B.K., 2017. Experts, theories, and electric mobility transitions: toward an integrated conceptual framework for the adoption of electric vehicles. *Energy research & social science*, 27, pp.78-95.
- Sprei, F., 2017. Disrupting mobility. *Energy Research & Social Science*, 37, pp. 238-242
- Staff Reporter, 2016. New Town tax bill passed. *The Telegraph*. Calcutta. https://www.telegraphindia.com/1161208/jsp/calcutta/story_123569.jsp#.WLkFfTt97IU (Accessed 10 March 2018)
- Starkey, P., 2000. *Local Transport Solutions: People, Paradoxes and Progress – Lessons Arising from the Spread of Intermediate Means of Transport*, SSATP Working Paper No. 56. Sub-Saharan Africa Transport Policy Program (SSATP), Africa Region, The World Bank.
- Steffen, W., Rockström, J., Richardson, K., Lenton, T.M., Folke, C., Liverman, D., Summerhayes, C.P., Barnosky, A.D., Cornell, S.E., Crucifix, M. and Donges, J.F., 2018. Trajectories of the Earth System in the Anthropocene. *Proceedings of the National Academy of Sciences of the United States of America*, 115(33), pp.8252-8259. DOI: 10.1073/pnas.1810141115.
- Steg, L. and Gifford, R., 2005. Sustainable transportation and quality of life. *Journal of transport geography*, 13(1), pp.59-69.
- Stirling, A., Lobstein, T., Millstone, E. and PorGrow Research Team, 2007. Methodology for obtaining stakeholder assessments of obesity policy options in the PorGrow project. *Obesity Reviews*, 8, pp.17-27.
- Stirling, A. and Mayer, S., 2000. Precautionary approaches to the appraisal of risk: a case study of a genetically modified crop. *International Journal of Occupational and Environmental Health*, 6(4), pp.296-311.
- Stirling, A. and Mayer, S., 2001. A novel approach to the appraisal of technological risk: a multicriteria mapping study of a genetically modified crop. *Environment and Planning C: Government and Policy*, 19(4), pp.529-555.

- Stirling, A., 1999. The appraisal of sustainability: some problems and possible responses. *Local Environment*, 4(2), pp.111-135.
- Stirling A., 2006. Analysis, participation and power: justification and closure in participatory multi-criteria analysis. *Land Use Policy*, 23, pp. 95–107
- Stirling, A., 2008. “Opening up” and “closing down” power, participation, and pluralism in the social appraisal of technology. *Science, Technology, & Human Values*, 33(2), pp.262-294.
- Stirling, A., 2009. Direction, Distribution and Diversity! Pluralising Progress in Innovation, Sustainability and Development, *STEPS Working Paper 32*, Brighton: STEPS Centre
- Stirling, A., 2010. Multicriteria Diversity Analysis: a novel heuristic framework for appraising energy portfolios. *Energy Policy*, 38, pp. 1622–1634.
- Stirling, A., 2011. Pluralising progress: From integrative transitions to transformative diversity. *Environmental Innovation and Societal Transitions*, 1(1), pp.82-88.
- Stirling, A., 2014. Emancipating Transformations: From Controlling ‘The Transition’ to Culturing Plural Radical Progress, *STEPS Working Paper 64*. STEPS Centre, Brighton, UK
- Subramanian, A. 2017 Kolkata Launches New Uber-Like App to Get Real-Time Info on Local Buses to Help Commuters. *The Better India*. Available at: <https://www.thebetterindia.com/91823/kolkata-app-local-buses/> (Accessed on 30th January 2018).
- Sur, M., 2017. In Kolkata, citizens defy police attempts to squeeze bicycles off the road. *Scroll.in*. Available at: <https://scroll.in/article/828176/in-kolkata-citizens-resist-police-attempts-to-squeeze-bicycles-off-the-road>. (Accessed 15 March 2018).
- Sustainable Mobility for All. 2017. *Global Mobility Report 2017: Tracking Sector Performance*. Washington DC
- Swilling M, Anneck E., 2012. *Just transitions: explorations of sustainability in an unfair world*. UNU books, Tokyo
- Switchon, 2013. *Cycle Satyagraha – An appeal against the ban in Kolkata*. [Powerpoint slides] Available at: <http://switchon.org.in/cyclesatyagraha.pdf> (Accessed 20 August 2018).
- Tanaboriboon, Y., 1992. An overview and future direction of transport demand management in Asian metropolises. *Regional Development Dialogue*, 13, pp. 46–70.
- Tashakkori, A. and Teddlie, C., 1998. *Mixed methodology: Combining qualitative and quantitative approaches*, Vol. 46. Sage.
- Taylor, L., Richter, C., Jameson, S. and Perez del Pulgar, C., 2016. Customers, users or citizens? Inclusion, spatial data and governance in the smart city. *Maps4Society Final Project Report*, Available at SSRN: <http://ssrn.com/abstract=2792565>

- The Economist. 2018. The world is losing the war against climate change. Available at: <https://www.economist.com/leaders/2018/08/02/the-world-is-losing-the-war-against-climate-change> (Accessed 3 August 2018).
- The Government of West Bengal Transport Department, June 27th, 2017. *Jaladhara Scheme guidelines. Notification No. 2926 -WT/3W-13/2017*. Kolkata. <http://transport.wb.gov.in/jaladhara-scheme/> (Accessed 24 January 2018)
- The Guardian. 2016. How can Kolkata's chaotic transport system be untangled? Available at: <https://www.theguardian.com/global-development-professionals-network/2016/oct/10/how-can-kolkatas-chaotic-transport-system-be-untangled> (Accessed 20 June 2018).
- The Guardian. 2017. Delhi doctors declare pollution emergency as smog chokes city. Available at: <https://www.theguardian.com/world/2017/nov/07/delhi-india-declares-pollution-emergency-as-smog-chokes-city> (Accessed 20 June 2018).
- The Indian Express. 2018. Full text: PM Narendra Modi's keynote speech at plenary session of WEF in Davos. New Delhi. Available at: <https://indianexpress.com/article/india/full-text-pm-modis-keynote-speech-at-plenary-session-of-davos-wef-5036533/> (Accessed 10 August 2018).
- The Wall Street Journal, 2014. The Energy Buzzwords People Misuse and Misunderstand. The Experts. Available at: <https://blogs.wsj.com/briefly/2014/12/29/the-energy-buzzwords-people-misuse-and-misunderstand/> (Accessed 10 August 2018).
- Thorns, D.C., 2017. *The transformation of cities: urban theory and urban life*. Macmillan International Higher Education.
- Thornton, P. H., & Ocasio, W., 2008. Institutional logics. In R. Greenwood, C. Oliver, R. Suddaby & K. Sahlin (Eds.), *The SAGE handbook of organizational institutionalism*, pp. 99-129, London, UK: SAGE
- Thornton, P.H. and Ocasio, W., 1999. Institutional logics and the historical contingency of power in organizations: Executive succession in the higher education publishing industry, 1958–1990. *American journal of Sociology*, 105(3), pp.801-843.
- Thornton, P.H., Jones, C. and Kury, K., 2005. Institutional logics and institutional change in organizations: Transformation in accounting, architecture, and publishing. In *Transformation in cultural industries*, pp. 125-170. Emerald Group Publishing Limited.
- Thornton, P.H., Ocasio, W. and Lounsbury, M., 2012. *The institutional logics perspective: A new approach to culture, structure, and process*. Oxford University Press.
- Tiwari, G. and Jain, H., 2008. Bicycles in urban India. *Bicycling in Asia*, pp.9-25.
- TNN, April 26, 2012. Low mileage of JNNURM buses brings old ones back on road. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/Low-mileage-of-JNNURM-buses-brings-old-ones-back-on-road/articleshow/12874102.cms> (Accessed 25 January 2018)

- TNN, December 16, 2014. Hand-pulled rickshaws get e-push. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/Hand-pulled-rickshaws-get-e-push/articleshow/45527961.cms> (Accessed 10 January 2018)
- TNN, November 6, 2011. Soleckshaw, the new vehicle in Kolkata. *The Times of India*. Kolkata. Available at: <https://timesofindia.indiatimes.com/city/kolkata/Soleckshaw-the-new-vehicle-in-Kolkata/articleshow/10626506.cms> (Accessed 19th February 2018)
- TNN, 2016. Auto policy unveiled, union won't stand by offenders The Times of India. Available at: <https://timesofindia.indiatimes.com/city/kolkata/Auto-policy-unveiled-union-wont-stand-by-offenders/articleshow/54687163.cms> (Accessed 10 January 2018)
- TOI, 2014. Experts welcome e-rickshaw guidelines, New Delhi: *The Times of India*, Available at: <https://timesofindia.indiatimes.com/city/delhi/Experts-welcome-e-rickshaws-guidelines/articleshow/40028536.cms> (Accessed on 11 August 2014).
- Townsend, A.M., 2013. *Smart cities: Big data, civic hackers, and the quest for a new utopia*. WW Norton & Company.
- Truffer, B., Voß, J.P. and Konrad, K., 2008. Mapping expectations for system transformations: Lessons from Sustainability Foresight in German utility sectors. *Technological Forecasting and Social Change*, 75(9), pp.1360-1372.
- Truffer, B., 2003. User-led innovation processes: the development of professional car sharing by environmentally concerned citizens. *Innovation: The European Journal of Social Science Research*, 16(2), pp.139-154.
- Turnheim, B., Kivimaa, P. and Berkhout, F. eds., 2018. *Innovating climate governance: moving beyond experiments*. Cambridge University Press.
- Tyfield, D., 2014. Putting the power in 'Socio-Technical Regimes' – e-mobility transition in China as political process. *Mobilities*, 9, pp. 585–603.
- UN-DESA. 2016. *The World's Cities in 2016 – Data Booklet (ST/ESA/SER.A/392)*. Department of Economic and Social Affairs, Population Division, United Nations
- UN-DESA. 2018. *World Urbanization Prospects: The 2018 Revision: Key facts*. United Nations, Department of Economic and Social Affairs, Population Division. Available at: <https://esa.un.org/unpd/wup/Publications/Files/WUP2018-KeyFacts.pdf> (Accessed 10 August 2018).
- UN. 2015. *Transforming our world: The 2030 agenda for sustainable development*, A/RES/70/1.
- UNDP, 2015. Helen Clark, Director, *Speech: 'Transforming Societies: People, Planet and Prosperity; the New Global Sustainable Development Agenda at The Global Transformation Forum'*, United Nations. Available at: <http://www.undp.org/content/undp/en/home/presscenter/speeches/2015/10/21/helen-clark-speech-on-transforming-societies-people-planet-and-prosperity-at-the-global-transformation-forum.html> (Accessed 10 August 2018).

- UNESCO. 2013. *The World Social Science Report 2013: Changing Global Environments*. United Nations Educational, Scientific and Cultural Organization (UNESCO) Publishing. Available at: <http://unesdoc.unesco.org/images/0022/002246/224677e.pdf> (Accessed 20 August 2018).
- United Nations, 2014. *World Urbanization Prospects: The 2014 Revision*, New York: United Nations, Department of Economic and Social Affairs, Population Division.
- United Nations. 2018. *Sustainable Development Goals report*. United Nations. New York. Available at <https://unstats.un.org/sdgs/files/report/2018/TheSustainableDevelopmentGoalsReport2018-EN.pdf>
- UNRISD - United Nations Research Institute For Social Development. 2016. *Policy Innovations For Transformative Change. Implementing the 2030 Agenda for Sustainable Development*, Available at: [http://www.unrisd.org/80256B42004CCC77/\(httpInfoFiles\)/2D9B6E61A43A7E87C125804F003285F5/\\$file/Flagship2016_FullReport.pdf](http://www.unrisd.org/80256B42004CCC77/(httpInfoFiles)/2D9B6E61A43A7E87C125804F003285F5/$file/Flagship2016_FullReport.pdf) (Accessed 10 August 2018).
- Urry, J., 2016. *What is the Future?*. John Wiley & Sons.
- Valderrama, A. and Vogel, N., 2014. Transitioning to a low carbon society? The case of personal transportation and urban form in Copenhagen: 1947 to the present. *Transfers*, 4, pp. 4–22.
- Vallentyne, P., 2007. Distributive justice. R. E. Goodin, P. Petit and T. Pogge. (ed.) *A Companion to Contemporary Political Philosophy*. Malden, MA, Blackwell. pp. 548-562. Available at: <http://hdl.handle.net/10355/10157>
- Van den Belt, H. and Rip, A., 1987. The Nelson-Winter-Dosi model and synthetic dye chemistry. The social construction of technological systems. *New directions in the sociology and history of technology*, pp.135-158.
- Van den Bergh, J.C., Truffer, B. and Kallis, G., 2011. Environmental innovation and Societal Transitions: Introduction and overview. *Environmental innovation and Societal Transitions*, 1(1), pp.1-23.
- Van Driel, H. and Schot, J., 2005. Radical innovation as a multilevel process: introducing floating grain elevators in the port of Rotterdam. *Technology and Culture*, 46(1), pp.51-76.
- Van Lente, H. 1993. *Promising technology. The dynamics of expectations in technological developments*, Delft: Eburon. PhD thesis (University of Twente)
- Van Lente, H., 2012. Navigating foresight in a sea of expectations: lessons from the sociology of expectations. *Technology Analysis & Strategic Management*, 24(8), pp.769-782.
- van Mossel, A., van Rijnsoever, F.J. and Hekkert, M.P., 2018. Navigators through the storm: A review of organization theories and the behavior of incumbent firms during transitions. *Environmental innovation and Societal Transitions*, 26, pp.44-63.

- van Welie, M.J. and Romijn, H.A., 2018. NGOs fostering transitions towards sustainable urban sanitation in low-income countries: Insights from Transition Management and Development Studies. *Environmental Science & Policy*, 84, pp.250-260.
- van Welie, M.J., Cherunya, P.C., Truffer, B. and Murphy, J.T., 2018. Analysing transition pathways in developing cities: The case of Nairobi's splintered sanitation regime. *Technological Forecasting and Social Change*.
- Vanolo, A. 2013. Smartmentality: The smart city as disciplinary strategy. *Urban Studies*, 51(5), pp. 883–898.
- Veisi H, Liaghati H, Vaninee HS., 2014. Participatory assessment of the sustainability of livelihoods in the agroecosystem of Abesard, Iran. *Sustainability Science*, 9(3), pp. 347–359
- Velayanikal. M., 2017. Ola, Uber growth in India screeches to a halt in 2017. *Business Standard*. Available at: http://www.business-standard.com/article/companies/ola-uber-growth-in-india-screeches-to-a-halt-in-2017-with-fall-in-rides-117050200255_1.html. (Accessed 1st March 2018)
- Verbong, G. and Geels, F., 2007. The ongoing energy transition: lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy policy*, 35(2), pp.1025-1037.
- Verbong, G., Christiaens, W., Raven, R. and Balkema, A., 2010. Strategic Niche Management in an unstable regime: Biomass gasification in India. *Environmental Science & Policy*, 13(4), pp.272-281.
- Verbong, G., Geels, F. and Raven, R., 2008. Multi-niche analysis of dynamics and policies in Dutch renewable energy innovation journeys (1970–2006): hype-cycles, closed networks and technology-focused learning. *Technology Analysis and Strategic Management*, 20, pp. 555–573.
- Voss J, Bauknecht D, Kemp R., 2006. *Reflexive governance for sustainable development*. Edward Elgar, Cheltenham
- Voß, J.P., Newig, J., Kastens, B., Monstadt, J. and Nölting, B., 2007. Steering for sustainable development: a typology of problems and strategies with respect to ambivalence, uncertainty and distributed power. *Journal of Environmental Policy & Planning*, 9(3-4), pp.193-212.
- Walker, B., Holling, C.S., Carpenter, S. and Kinzig, A., 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and society*, 9(2).
- Walker, G. and Shove, E., 2007. Ambivalence, sustainability and the governance of socio-technical transitions. *Journal of Environmental Policy & Planning*, 9(3-4), pp.213-225.
- Watson V. 2014. African urban fantasies: dreams or nightmares? *Environment and Urbanization*, 26, pp. 215–231.
- Weber, K.M. and Rohracher, H., 2012. Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-

- level perspective in a comprehensive 'failures' framework. *Research Policy*, 41(6), pp.1037-1047.
- Webster, P. and Burke, J., 2012. How the rise of the megacity is changing the way we live. *The Guardian*. Available at: <https://www.theguardian.com/society/2012/jan/21/rise-megacity-live> (Accessed 8 August 2018).
- White, R. and Stirling, A., 2013. Sustaining trajectories towards Sustainability: Dynamics and diversity in UK communal growing activities. *Global environmental change*, 23(5), pp. 838-846.
- Wieczorek AJ, Raven R, Berkhout F., 2015. Transnational linkages in sustainability experiments: a typology and the case of solar PV in India. *Environmental Innovation and Societal Transitions*, 17, pp. 149–165
- Wieczorek, A.J. and Hekkert, M.P., 2012. Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, 39(1), pp.74-87.
- Wieczorek, A.J., 2018. Sustainability transitions in developing countries: Major insights and their implications for research and policy. *Environmental Science & Policy*, 84, pp.204-216.
- Williams, J.J., 2000. South Africa: urban transformation. *Cities*, 17(3), pp.167-183.
- Willis, K., Williams, G. and Meth, P., 2014. *Geographies of developing areas: The Global South in a changing world*. Routledge.
- Wirth, S., Markard, J., Truffer, B. and Rohrer, H., 2013. Informal institutions matter: Professional culture and the development of biogas technology. *Environmental Innovation and Societal Transitions*, 8, pp.20-41.
- Woodside-Jiron, H., 2004. Language, power, and participation: Using critical discourse analysis to make sense of public policy. In *An introduction to critical discourse analysis in education*. pp. 203-236. Routledge.
- World Population Review, 2017. Kolkata Population. Available at: <http://worldpopulationreview.com/world-cities/kolkata-population/> (Accessed 11 April 2018)
- Yin, R.K., 1994. *Case Study Research: Design and Methods* (Applied Social Research Methods, Vol 5. Sage Publications
- Yin, R.K., 2015. *Qualitative research from start to finish*. Guilford Publications.
- Zhao, P., 2010. Sustainable urban expansion and transportation in a growing megacity: Consequences of urban sprawl for mobility on the urban fringe of Beijing. *Habitat International*, 34(2), pp.236-243.
- Zoomcar, 2017. *PEDL by Zoomcar*. Kolkata. Available at: <https://pedl.zoomcar.com/> (Accessed 18 February 2018).