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Towards a novel regime change framework: Studying mobility transitions in public transport regimes in an Indian megacity

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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.

Highlights

- The focus on niche innovation led transitions reflects a western bias.

- Three pathways of regime change - optimisation, transformation and transition - are proposed.

- A novel regime change framework is developed using rules, trajectories, ex-ante and ex-post selection pressures.

- Socio-technical change in public transportation regimes in Kolkata are used as an empirical case study.

- Regime change pathways are interconnected within a continuum of change, guided by 'meta-rules'.

Keywords

Regime transformation, Sustainability transitions, Regime rules, Public transport, Urban mobility, India

Abbreviations

CSTC - Calcutta State Transport Corporation
CTC – Calcutta Tramways Corporation
JNNURM – Jawaharlal Nehru National Urban Renewal Mission
LPG - Liquefied petroleum gas
MoUD – Ministry of Urban Development, Government of India
NKDA – New Town Kolkata Development Authority
RTA - Regional Transport Authority
WBTC – West Bengal Transport Corporation

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 a 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 later 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 the 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

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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.[1] 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 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

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[1] 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.

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

	Formal/regulative	**Cognitive**	**Normative**
Technology and product	- Technical *standards* - Product *specifications* - Functional *requirements* - Accounting rules to establish profitability for R&D projects - Expected capital returns rate for investment	- *Search heuristics* - *Routines* - *Exemplars* - *Guiding principles* - *Expectations* - Technological *guideposts* - Technical *problem agenda* - presumptive *anomalies*	- Companies own *sense of itself* - *authority structures* in technical communities or firms - testing *procedures*

	- R&D *subsidies*	- problem-solving *strategies* - technical *recipes* - user *presentations* - *interpretative flexibility* and technological frame - *classifications*	
Science	- Formal research programmes - professional boundaries - rules for government subsidies	- *Paradigms* - *Exemplars* - *criteria and methods* of knowledge production	- Review procedures for publication - *norms* for citation - academic *values* and norms
Policy	- Administrative *regulations* and procedures which structure the legislative process - formal regulations of technology - subsidy *programs* - procurement programs	- *Ideas about effectiveness* of instruments - guiding principles - problem agendas	- Policy *goals* - *interaction patterns* between industry and government - *institutional commitments* to existing systems - *role perceptions* of government
Social-cultural	- Rules that structure the *spread of information* - production of cultural symbols	- *Symbolic meanings* of technologies - *ideas about impacts* - *cultural categories*	- Cultural values in society or sectors - *ways* in which users interact with firms
Users, markets and	- *construction of markets* through laws and rules	- User *practices* - user *preferences* - user *competencies*	- Interlocking *roles and relationships*

distribution networks	- *property rights* - product quality *laws* - liability rules - market subsidies - *tax credits* to users - *competition* rules - safety requirements	- *interpretation* of functionalities of technologies - *beliefs* about efficiency of (free) markets - *perceptions* of what 'the market' wants	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. Our framework is built on a mapping tool consisting of a matrix of three types of rules in each of five regime dimensions (introduced below in Step 1 of application of the framework). 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 in any context 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.
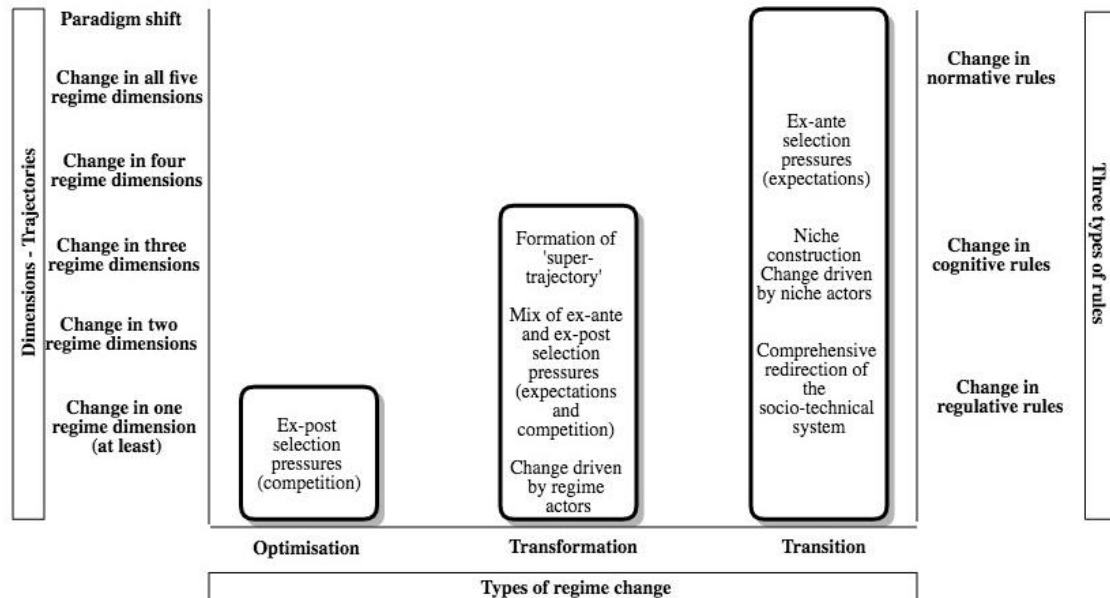
Figure 1. Regime change framework

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. Industry structure and strategy – includes supply-side actors and arrangements, planning for operation, financing, service provision, maintenance and other aspects of day to functioning.

4. Market and users – includes market size, market composition, user preferences, and projected user preferences by producers and policymakers.

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 1. 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 can 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). Majority of this 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 wealthy class population 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' (Elzen et al., 2011) or some of them even as sub-altern regimes (Turnheim et al., 2015) constituting the overarching 'public transport regime' of Kolkata 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

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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 2. 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), 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,

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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 3. 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 4. Ferry regime optimisation

<table>
<tr><td></td><td></td><td colspan="3">Regime rules</td></tr>
<tr><td></td><td></td><td>Regulative</td><td>Cognitive</td><td>Normative</td></tr>
<tr><td rowspan="6">Regime Dimensions</td><td>Science & Technology</td><td>X</td><td>X</td><td rowspan="5">--</td></tr>
<tr><td>Policy & Governance</td><td>X</td><td>--</td></tr>
<tr><td>Industry structure & strategy</td><td>X</td><td>--</td></tr>
<tr><td>Market & users</td><td>--</td><td>--</td></tr>
<tr><td>Socio-cultural meaning</td><td>--</td><td>--</td></tr>
<tr><td>Total</td><td>3</td><td>1</td><td></td></tr>
</table>

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 5. 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 6. State bus regime transformation

		Super-trajectory 1: Modernisation of Bus service			State Bus Super-trajectory 2: Organisational integration and digitalisation		
		Regulative	Cognitive	Normative	Regulative	Cognitive	Normative
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 (Zauba Corp, 2017). 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). 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 7. Auto-rickshaw regime transformation

	Super-trajectory 1: Fuel conversion			Super-trajectory 2: Formalisation		
	Regulative	Cognitive	Normative	Regulative	Cognitive	Normative

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 5000 rupees for replacing the engine in an existing vehicle or 10,000 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-operators[2] 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 autos - coloured green showcases new 'rule that structured the spread of 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 (Bannerjee 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

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[2] 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)

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 [3] ... 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

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[3] Kolkata Municipal Corporation area - representing the core city covering an area of 200.71 square kilometres (kmcgov.in, 2018)

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.

5.3 Transitioning regimes
5.3.1 Taxi

Table 8. 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 9. Transition to cycle sharing

		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. 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 few other neighbourhoods of Kolkata. For 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 This is shown as in Figure 2.
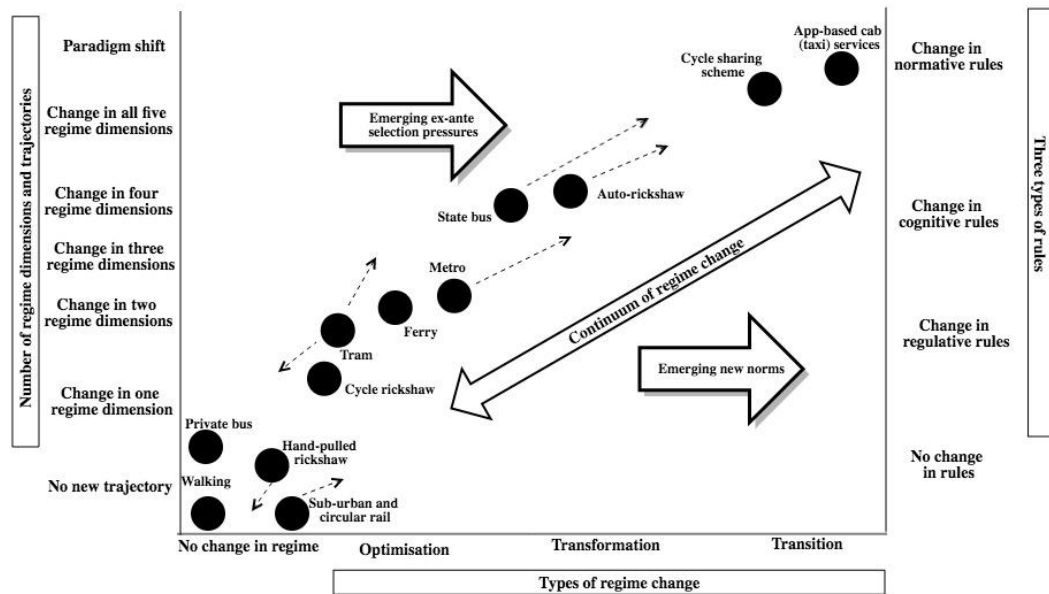
Figure 2. Plotting public transport regimes of Kolkata

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 2 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.

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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.

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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. 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 west and the non-west without implying that specific transition pathways are superior to others.

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Appendix I:

Table 10. List of Interviewees for the case study

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