Using evolutionary concepts of socio-technical change to map transition pathways: Analysing public transport regimes in transition in an Indian megacity

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Abstract

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

Keywords

Regime transformation, sustainability transition, quasi-evolutionary model, public transport, urban mobility, megacity

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

Mega-cities around the world are witnessing acute sustainability problems in mobility systems. Transport is one the sectors contributing most to pollution and a major source of social injustice and inequality issues related to citizen mobility (Mullen and Marsden, 2016; Busby and Shidore, 2017). In this article, we will address persistent mobility problems in Kolkata, which is one of the largest megacities in India. Public transportation is by far the dominant system for mobility in Kolkata, as it is in other cities in the developing world where

a majority of the population cannot afford a car. Public transportation system in Kolkata consists of a wide variety of road, rail and water-based systems like metro, trams, trains, buses, ferries, auto-rickshaws, cycle rickshaws etc. The dominant response of actors in Kolkata to these persistent mobility problems is to seek improvements in existing public transportation system. 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 environmental and social justice problems. It is assumed that these problems can only be addressed through regime-shift or a transition (Grin et al., 2010; Elzen et al., 2004).

In this article, we question this assumption and explore the space in between optimisation and transition, which we call transformation. We argue that a sole focus on regime-shifts reflects a Western bias. In the West, mobility transition predominantly means shifting away from the carbon and energy-intensive 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 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 necessary for megacities such as Kolkata as well, however, they will not be sufficient to solve the problems that Kolkata is experiencing every day. Kolkata is a densely populated city where a majority of people rely heavily on public transportation for everyday life. Actors in Kolkata are therefore more concerned about how to expand and improve the existing public transport system of the city.

In the literature, regime actors are often seen as the ‘incumbents’, who are resistant to change, while the niche actors are the real ‘innovators' who drive transitions (Geels, 2002; 2004). There is an increasing recognition in the transition literature that incumbents can also drive regime change (Konrad et al., 2008; Kungl, 2015; Geels, 2017). However, most studies still emphasise niche creation and regime destabilisation as central to transitions (Geels et al., 2017; Roberts, 2017). Geels and Schot (2007) identified four transition pathways next to the regime optimisation pathway. Three of them are indeed mainly niche based: substitution, reconfiguration and de-alignment and re-alignment, but one of them relies on regime actors taking action. The latter is the regime transformation pathway. In this pathway, regime actors identify problems and use their adaptive capacities to reorient development trajectories, at a moment when niche innovations are not yet sufficiently developed. Transformation is thus a change process from within, responding to landscape pressures. To distinguish the regime transformation pathway from others, we refer in this article to regime optimisation, transformation and transition pathways (bringing all niche-based pathways under the umbrella of the third pathway).

Notions of transformation and transition are both used in the sustainability transitions literature, often interchangeably. In a recent overview Holscher et al., (2017) argue that the critical distinction between the two concepts is that transitions explain how change occurs through disruptive technocratic interventions, in individual subsystems, while transformations focus on broader societal change. In developing country context, regime 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). In this article, we argue that difference between optimisation, transformation and transition

can be understood through the nature of the change of the underlying rule-sets in socio-technical regimes which constitute a socio-technical system. In this conceptualisation, regime represents underlying genes or DNA (genotype) which is manifested in the socio-technical system (phenotype) (Schot and Geels, 2007). It is necessary to revisit the evolutionary foundations of sustainability transitions, to understand the relevance and opportunity of rule-based conceptualisation of regime change and to enrich our understanding of various pathways and mechanisms of the socio-technical regime and system change.

Our research question is: how can we conceptualise transition in mobility systems like in Kolkata, using evolutionary concepts of socio-technical change? Addressing this question allows us to contribute towards a better conceptualisation of the notion of regime change through various pathways. As we will show from our literature overview, despite the importance of the regime concept, it has not been operationalised adequately. We develop a framework which will allow us to decide whether a pathway can be considered system optimisation, system transformation or transition. This is important because it will help regime actors to unlock the potential of prevailing public transportation systems and facilitate optimisation, transformation and transition – necessary for addressing the persistent problems in the mobility system of megacities.

In the next section, we review the literature to unpack the history of the evolution of the regime concept and application of the concept in various pathways of socio-technical change. Based on the literature review, in section 3, we introduce our theoretical framework. This includes a precise 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 of changing public transport regimes in Kolkata. We discuss the case study results and the applicability of the framework in section 6. Finally, we conclude.

2. Literature review

2.1 Evolutionary origins of regime concept: trajectories, paradigms and ex-ante selection

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 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, set 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 including the 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), and the multi-level perspective (Geels, 2002) - which informed the development of the four transition pathways by Geels and Schot (2007).

2.3 Socio-technical regime and rules

[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.

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 these routines operate? How do they relate to the agency of actors? This question 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 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; technology; policy; user preferences; social-cultural symbols and legitimation). Both steps together create a matrix as presented by Geels (2004, p. 906). A 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	- *Search heuristics* - *Routines* - *Exemplars* - *Guiding principles* - *Expectations* - Technological *guideposts*	- Companies own *sense of itself* - *authority structures* in technical communities or firms - testing *procedures*

	- Expected capital returns rate for investment - R&D *subsidies*	- Technical *problem agenda* - presumptive *anomalies* - 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 distribution networks	- *construction of markets* through laws and rules - *property rights* - product quality *laws* - liability rules - market subsidies - *tax credits* to users - *competition* rules - safety requirements	- User *practises* - user *preferences* - user *competencies* - *interpretation* of functionalities of technologies - *beliefs* about efficiency of (free) markets - *perceptions* of what 'the market' wants	- Interlocking *roles and relationships* 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 but not comprehensive. This is symptomatic for the

sustainability transitions literature regarding application of the rules and trajectories concepts.

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 can be seen less fundamental than a change in cognitive rules. New regulations and standards may be introduced quickly, however, change in cognitive beliefs of different social groups take more time and effort. 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 change 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 three 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 more than three regime dimensions forming a "bundle of trajectories" aligned with one another. We will call this a 'super-trajectory', which represents a redirection of the socio-technical system; 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 mixture 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.

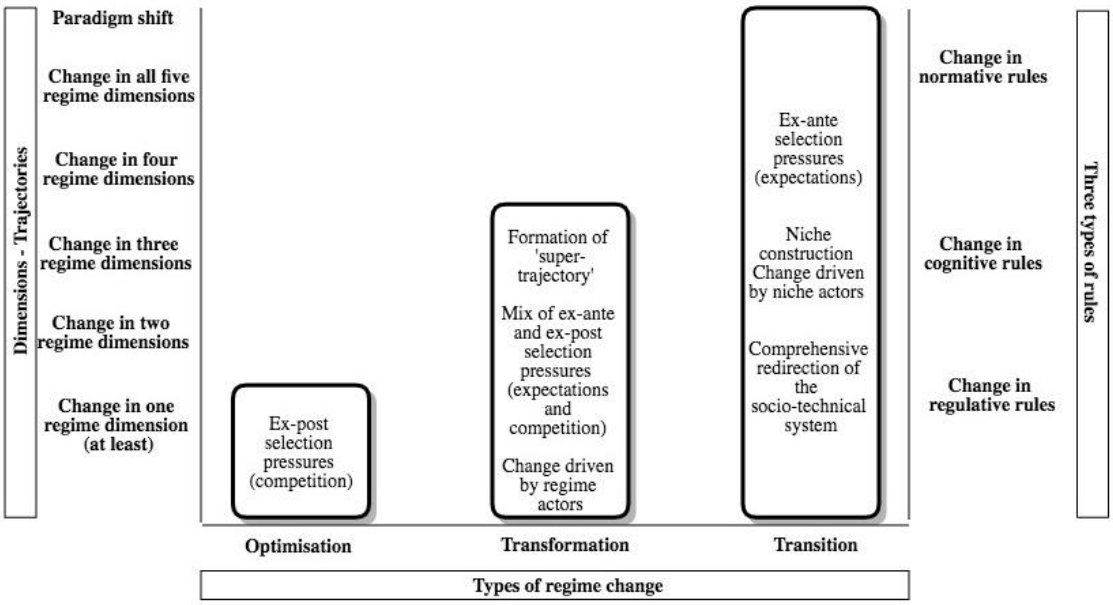

Figure 1. Regime change framework

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

Step 1: Identify trajectories across different regime dimensions

Employing sources like Geels, (2002: 1263; 2004: 906) and Sengers and Raven (2014: 456), we define five regime dimensions:

1. Science and technology – includes design, artefacts, engineering side as well as 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 – taking into account 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 are shared across all dimensions of the regime. Cognitive and regulatory rules are also shared, but they can be more specific for 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. Ex-post selection is 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, along the river Hooghly. 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 its population belong to lower middle-income group – 53.68 percent earning 15,000 - 30,000 Indian rupees ($250-500) per month and they mostly use a combination of public transport such as bus, rail, auto, metro for their daily mobility purposes (Government of West Bengal, 2008). Kolkata has one of the lowest percentage of the population owning a private car among the megacities in India. This suggests that public transport regimes in Kolkata provide the backbone of its mobility system. Each of these modes represents a socio-technical regime since each has a different actor-networks, technologies, knowledge base, market and rule-sets. Together they co-constitute a public transportation system which dictates mobility in the city.

The empirical data for this research is collected through semi-structured interviews, reports, government notices and statistical data accessed during two phases of fieldwork at Kolkata [October 2015-January 2016 and November 2016-January 2017]. The main objective was to explore changes in the different transport regimes in Kolkata in the past 15 years. Twelve transport experts and professionals were interviewed, targeted to gain knowledge about problems faced by the specific regimes; 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 (Appendix I). Each interview lasted an hour on average. The interviews provided knowledge about the changes in the regime rules and trajectories, which was complemented by information obtained 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 sources and reach many interviewees) and citizens (users of transport) during fieldwork. These personal communications were further complemented by and validated through quantitative data and policy documents, including statistical data about routes, passengers in the respective regimes; governmental notifications on route rationalisation, issuance of permit etc; 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. The results were discussed between both authors in several phases of analysis and improved through mutual feedback.

5. Empirical Analysis

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

optimising, transforming and transitioning in the past 15 years. Moreover, the existing cycling regime in Kolkata witnessed major policy intervention in 2012 when Kolkata Police banned cycles, cycle vans, handcarts, pull-carts and bakery vans from major arterial roads. We leave this case out of analysis as this is a case of regime de-stabilisation and outside the scope of this article. We will, however, analyse cycling as a case of regime transition for New Town Kolkata in section 5.3.2.

Below we discuss each of optimising, transforming, and transitioning regimes, by focussing on the rules and trajectories that are changing 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, 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 metro instead of buses as their main 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 a number of passengers, frequent breakdowns and derailment of coaches, stock-out of spare parts, lack of cost recovery, high operational costs, and unticketed 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, [to] make room for faster options"* [Interviewee 4]. Following this belief, CTC discontinued multiple routes and suspended 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. In spite of 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 technology and market 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 tourist-oriented 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

		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 rule 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 while staying 'green' through the 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 and a new cognitive belief about the well-being of actors in the regime.

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 new regulative rule in industry structure and strategy was expected to facilitate easy access to funds for the poor including unemployed members of poor households to be able to own a rickshaw and thereby 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 in 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 would 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 accessible 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 consequence 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 and fleets as well as 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 the industry dimension complemented this change policy trajectory by an organisational restructuration 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 inefficiency in-service 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 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	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 stem from 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 prohibited, and a new auto-rickshaws run on Single mode liquefied petroleum gas (LPG) Auto-rickshaw took over the fleet. These new vehicles mark 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 by new ones within the period of 31.03.2009. In August 2012, RTA offered another window of additional six months for auto-rickshaw 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

[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)

one of the crucial modes of transport in Kolkata, moving away from the perception about autos being noisy, polluting, undisciplined and unregulated paratransit mode. The altered appearance of autos - literally coloured green showcases new 'rule that structured the spread of information' about 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 auto-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 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. On 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 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 autos being a formal mode of public transportation. This evidence suggests that there are new cognitive

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

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 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 part of their 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 users' reliance 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 exceed 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 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 a 'tech-savy' young population willing to shift from driving own cars to using on demand cabs) and socio-cultural meaning (where app-cabs improve 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 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 on 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 aspired to be "smart city" and now aims to be a "Green city" with plans 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 and a new smartphone app. New actors in the industry include Zoomcar, a private company leading in the 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 cycle sharing niche experiment therefore crosses the threshold of transition according to our regime change framework. However, the scope of this transition is limited in the spatial boundaries of New town Kolkata. For cycling to be a case of regime transition, this initiative needs to stabilise and scale up.

Discussion

Our analysis of individual public transport regimes led to some interesting findings which can not only improve the theoretical framework but also help actors to implement changes strategically in the real world. First, we reflect on the framework.

The cases of optimisation, namely metro, tram, ferry and cycle-rickshaw regimes show changes in not more than three dimensions. This confirms the threshold of changing regime dimensions set for optimisation. However, the empirical cases sometimes deviated from the qualitative characterisation of optimisation as being primarily driven by changes in regulatory rules. In multiple 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 also points 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 are closer to transformation than others. This observation led us to re-evaluate whether the boundaries between three pathways of regime change are as firm as theoretically assumed.

The two transforming regimes (State bus and auto-rickshaw) also confirm the rule change threshold since in both cases, there are new rules in more than three dimensions to form super-trajectories. One of the key observations here is the presence of multiple super-trajectories in both regime, indicating ‘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 mobility regimes from Kolkata in the framework. As shown in Figure 2, each of the regimes can be positioned in a scatter plot depending on the evaluation of their pathway of change.

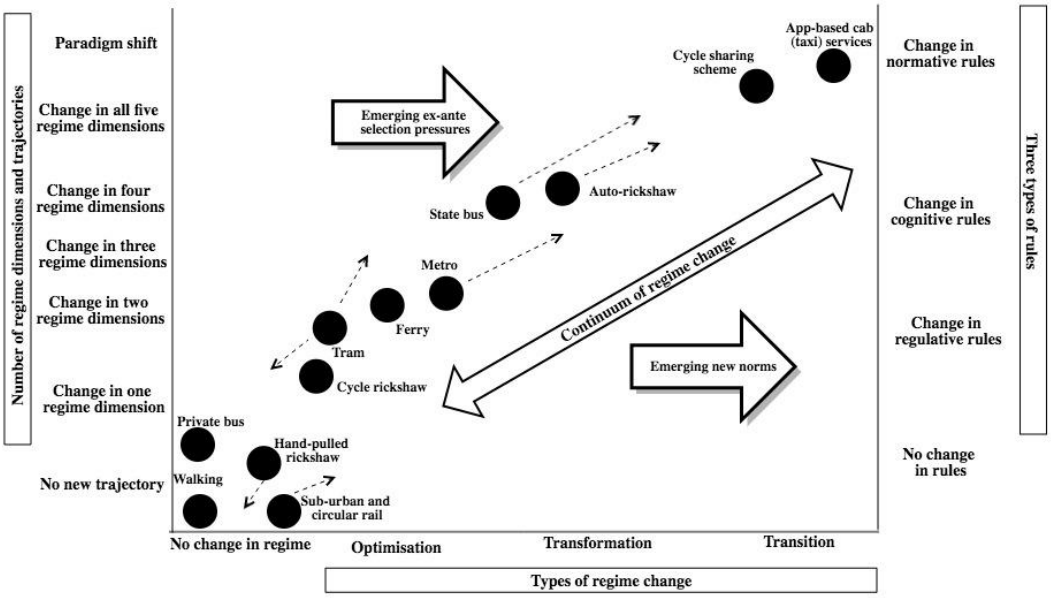

Figure 2. Plotting transport regimes of Kolkata

Here we see that even though regimes stick to the thresholds, they perform unexpectedly on the emergence of cognitive rules, ex-ante selection pressures and normative rules. As a result, we argue that some regimes operate in the 'in-between' space of optimisation-transformation and transformation-transition pathways. These 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 from one to another. The dotted arrows in Figure 2 indicate these possibilities as further change happens. For instance, metro regime shows that it has a potential to transform, as new rules emerge in other regime dimensions once the construction of corridors is completed. The tram regime can either move to transformation space as the new super-trajectories emerge. Alternatively, it may also continue to optimisation until complete destabilisation in the current trajectory. Four regimes that are non-changing, therefore left out of analysis also show movements. While rail regimes are like to optimise along technological and policy trajectories in coming years, hand-pulled rickshaw regime is going to de-stabilise on humanitarian grounds and is likely to be

substituted by battery-driven rickshaws. Other regimes whose movements are not indicated by arrows refer to the fact that their direction of future change is highly unpredictable from the study of past 15 years.

Given these results, we argue that the framework regime change looks promising to explain sustainability transition in contexts where conventional regime destabilisation and niche intervention storyline isn't applicable. However, the ambiguity about boundaries between the pathways proves to be challenge in smooth application of the framework. We believe that an explanation for this fluidity of the pathways could be that all regimes in mobility system in Kolkata are trying to follow three broad rules in the course of change. These are digitalisation, decongestion, and pollution mitigation. Following Schot and Kanger (2018) we call them '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 service, as well as represent niches for both transitioning regimes, namely taxi and cycling regime. The decongestion rule is prominent in metro and tram cases as well as occupies centre stage for both transformation cases. The pollution mitigation rule is manifested in 'going green' initiatives, in fuel efficiency choices, investments in bike sharing and mass transit infrastructure. Presence of these meta-rules partly explains 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 help understanding the overall direction of change in mobility system of Kolkata.

Conclusion

We began this article with the proposition that the focus on niche led transition in the sustainability transitions literature may carry a Western bias. In non-Western cities, the ongoing efforts to improve already dominant public transportation regimes may perhaps be a transition and not just an optimisation insufficient for addressing the persistent sustainability problems. We argue that the conceptual framework that we develop in this paper can capture regime transition (change in genotype) through mapping change in rules, trajectories and selection pressures. The framework allows us to recognise three different pathways of regime change: optimisation, transformation and transition. Applying this framework, we analysed the change in public transport regimes in Kolkata in 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 rapid transition. This escalated pace of change is captured through the new rules and trajectories identified in mobility in Kolkata. Based on the results of the subsequent empirical analysis we argue that all three pathways are significant for urban sustainability transition; they, in fact, work together and in parallel - to co-constitute change in the mobility system (phenotype) of Kolkata.

One contribution of this paper is to illustrate that regime actors deserve considerable credit and exhibit agency in facilitating transition, in spite of several reasons for them to resist change. They 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. This openness is reflected in their investment in innovations that are radical to the context. They introduce new rules and act as front-runners.

This process is almost entirely political and is not free from conflict. We found that different regime actors like transport operators, policymakers, unions, industry actors and users continuously use and negotiate their power and positions as they work with new rules and trajectories. This reflects the inherently political nature of socio-technical change, yet assures that transition is possible right away, instead of relying upon the creation and scaling up of niches.

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 show the regime dimensions and rules that so far have not changed. We suggest that regime actors may think of using such a mapping tool to identify gaps and focus on developing new trajectories in dimensions that are static and neglected, to shape transition. The aim should be to move up in the framework by introducing new rules along existing trajectories and initiate new trajectories along more regime dimensions. Actors may also target to surpass the thresholds for each pathway and move on to the next pathway following the meta-rules. However, forcing all regimes towards transition pathway may not be desirable either. While the meta-rules provide crucial directionality for sustainable transition in all regimes, regime actors in Kolkata must also accept that variability of change processes different regimes can be desirable. They should try to retain the rich diversity of regimes to cater to diverse socio-economic needs. Therefore, a good strategy would be to develop new meta-rules, for instance, ones that will support the poor and disadvantaged citizens to access future mobility systems alongside attracting car users to public transport.

A future research agenda will be to integrate further the concept of meta-rules in the regime change framework, which will better inform findings from the multi-regime analysis. As a next step, it is worth testing the current framework in other socio-technical systems (like electricity, water, sanitation), contexts (other urban regions of the non-western and western world) and over a more extended period (20-30 years). We expect that there will be not only new rules and trajectories but also new routes of change and shifting roles and agencies of regime actors in different contexts and time periods. From a practical point of view, it will be interesting to study regime actors more closely and to involve them in the analysis of their actions and intentions that shape transitions. Such a participatory approach may enlarge the scope for innovative insight and better extend change processes that began in a part of regime to the entire regime.

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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