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WHEN MANDATES OUTPACE MARKET READINESS: REGULATORY-DRIVEN DOWNSTREAM FRICTION IN INDIA'S E20 TRANSITION

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Abstract
This research examines the nature of disruption that is caused by prescriptive sustainability transitions where changes in regulation occur at a rate that is higher than the markets are prepared for. The manuscript employs a theory elaborating single-case longitudinal design and focuses on India's journey from E10 to E20 for example where a policy push triggered a controversy for vehicle compatibilities, mileage and usability (from the perspective of the downstream actors) and was counterbalanced by a coordinated response from government, car manufacturers and intermediaries. The empirical corpus consists of nine sources that are publicly available and classified into four categories: one regulatory notification, four general news reports, two Reuters wire reports and two industry-press reports, which range from February to July 2026. The content was sequentially ordered and coded at three levels, First Order—evidence terms, Second Order—analytical themes, and Third Order—dimensions aggregated, based on the qualitative case based research, benchmarked to the operations and supply chain management discipline. The analysis points to an intermediate mobilization process with three stages: upstream regulatory injection, downstream friction accumulation and threshold triggered by intermediary mobilization. The study contributes to research on sustainability transitions by providing more clarity on the micro-process that facilitates regime-level interventions to instabilise the user interface, and to research on operations and supply chain by separating disruption due to legitimacy and traditional physical disruption. Furthermore, the results show that the functions of the dealers and the service-oriented intermediaries can be understood as a function that buffers, translates and legitimises on the local level vis-à-vis the disruptive green transitions.

Keywords: *Sustainbility transitions, E10, E20, controversy, Empirical corpus, supply chain, immediate mobilization, dealers, intermediaries*

Vol. 12 Issue 8 August 2026)
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1. Introduction

Sustainability transitions scholarship has shown that there is more to transitioning towards clean socio-technical systems than the substitution of technologies; reconfiguration is needed in regulation, user practices, infrastructures, industrial networks and cultural meaning (Geels, 2002; Geels et al., 2017; Markard et al., 2012). However, policy-imposed transitions often rely on the assumption that the adoption of formal change can be hastened by designing the policy even if the actors downstream are not necessarily equally ready to adopt the change in practice (Rosenbloom et al., 2020; Fesenfeld et al., 2022). This tension is important because transitions can be 'successful' in compliance terms but not in 'use', 'interpretation' and 'legitimacy' terms at the market interface.

The transition of India to Pulsar E20 petrol presents an analytically revealing context to look into the issue. According to public reporting, the 20 per cent ethanol-blended petrol initiative was formally notified and had official environmental and energy-security rationales, but it was also an obvious subject of contention, concerning higher consumption of the fuel, compatibility of the same with vehicles and engines, its impact on the engines, and what it meant for the everyday user. Eventually, when the backlash grew, the issue transitioned from regular implementation to a concerted defense that included government, automakers, and downstream channels as evidenced in the coded evidence base that was provided in the supplementary appendix.

Theoretically, it is a very important episode because the disturbance did not come from a shortage of materials, failure of suppliers or transport bottlenecks. But instability arose at the user interface at the downstream end—the policy-prod-perf-consump interface and the serv-side interface. Previous work studying supply chain disruption has provided valuable insights on disruptions impacting supply chains from natural disasters, operational failures, and uncertainty from upstream supply chain events, but has largely ignored disruptions caused by interpretations of mandates and the legitimacy strains that can occur at the point of use (Bode & Macdonald, 2017; Craighead et al., 2007; Wagner & Bode, 2008).

To fill this gap, the paper theorises the phenomenon of regulatory-driven downstream friction: an interpretive, technical and service-side process of lags, where an upstream sustainability mandate is enacted at policy speed whereas downstream lags are the lag times that occur as interpretive, technical and service-side readiness catch up. In this context legitimacy strain can build up at the local level and lead to stabilizing measures at the network level, even if there is no disruption of the material flow of the focal product. The paper thus asks: What are the sources of operational friction from mandated sustainability transitions, how does this operational friction evolve into a threshold for systemic concern, and how do intermediaries stabilize the transition beyond the threshold?

There are three contributions to the manuscript. Firstly, it adds to the macro-level transition scholarship by distinguishing specific types of friction, namely regulatory-driven friction, as a mechanism of instability in sustainability transitions, alongside user-interface turbulence in the process of transition implementation (Geels, 2002; Markard et al., 2012). Second, it creates a threshold model process that illustrates how local concerns can take a systemic form of problem through 'amplification' and 'legitimacy strain' and establishes a connection with on-going research on 'tipping dynamics' and 'policy feedbacks' in sustainability transitions (Fesenfeld et al., 2022; Stadelmann-Steffen et al., 2021). Third, it proposes that downstream actors, particularly those acting as buffers or translators, such as dealers and service-linked actors, are local actors whose role is largely neglected in transition research and traditional supply chain disruption literature.

Theoretical Background

Sustainability transitions and implementation turbulence

The multi-level perspective approach to the study of sustainability transitions sees them as a dynamic process unfolding through interactions between niche innovations, socio-technical regimes, and landscape pressures, and results in long-run reconfiguration, not technology replacement (Geels, 2002). Since then, a number of studies have confirmed that transitions require the involvement of several actor groups, institutional arrangements, infrastructures, user practices and symbolic meanings (Geels et al., 2017; Markard et al., 2012). The present study is dependent on this literature because the E20 shift in India was not just a fuel substitution decision, but also a one that involved the establishment of vehicle standards, specifications of fuels, consumption habits, creation of public narratives, and coordination among governmental and industrial actors.

Concurrently, transition scholarship has been more attuned to destabilisation of the regime, niche

Vol. 12 Issue 8 August 2026)
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DOI: https://doi.org/10.69980/djy54b51

development, policy mixes, and long-term transformation pathways, than to the operational turbulence that may arise during implementation (Markard et al., 2012; Rosenbloom et al., 2020). Recent studies on policy feedback and political feasibility have demonstrated that the effects of climate and sustainability policies are not only formally defined by the rules, but also by how they are understood and lived by targeted users of the policy (Fesenfeld et al. 2022; Rosenbloom et al. 2019). That opening allows room to look into the implications of green mandates to produce downstream instability even in the presence of policy commitment and material supply.

Supply chain disruption beyond physical interruption

Generally, the study of supply chain disruptions has focused on discrete events, which are rare but very dramatic, e.g., natural disasters, supplier failures, transportation breakdowns and operational accidents. Disruptions are understood to be unplanned, unanticipated events that impact the flow of goods and materials in a supply chain, and typically have a significant impact on performance and recovery (Craighead et al., 2007; Wagner & Bode, 2008). Subsequent research expanded this literature by studying propagation of disruption, network vulnerability, as well as the relationship between risk sources and network structure (Bode & Macdonald, 2017).

However, in spite of this development, the bulk of the disruption scholarship is still based on physical disruptions or fluctuating demands and supplies. Although reputational and regulatory risks are sometimes found in literature, they are more likely to be considered as contextual risk factors and not as mechanisms of downstream disruption. This leaves a gap in cases where there is a continuous flow of material without changes in socio-operational conditions of use. The present study fills this gap and aims to distinguish the legitimacy-mediated disruption from conventional disruptions in the supply.

Intermediaries, governance, and buffering roles

The second underdeveloped aspect is the part of intermediaries downstream. Whereas transition studies tend to focus on states, lead firms, advocacy coalitions and niche actors, operations and supply chain studies tend to focus on the functional role of dealers, distributors, and service channels as actors rather than their interpretive and legitimacy-lending role. Research on governance and risk suggests that actors that are closer to the customer interface tend to take up the ambiguity, filter policy or technical shifts, and smoothen conflict due to uncertainty and misalignment (Shafiq et al., 2017). Here it indicates that intermediaries could potentially have a significant buffering function in cases where the mandates are contested, and need to be explained, reassured and adapted in a local way.

Threshold escalation in contested transitions

Low-level dissatisfaction can sometimes be manageable, sometimes systemically consequential, and a growing area of emerging work on social tipping, policy feedback, and transition politics also help to shed light on this. The studies on social tipping and climate-policy feasibility emphasize amplification processes, social feedbacks, and politically relevant change in support and resistance in addition to formal interventions as drivers of nonlinear change (Fesenfeld et al., 2022; Stadelmann-Steffen et al., 2021). In the present instance this means that the downstream "friction" might remain dormant until there is enough public controversy, burdens of explanation, and erosion of the sense of "legitimate," to make it more expensive to do nothing than to respond in a coordinated way.

Literature Review and Research Gap

Three streams of literature converge in this study, but they have not yet been adequately integrated.

First, sustainability transitions research sheds light on the different aspects of a transition – technological, institutional and behavioral – that unfold in response to a policy shift (Geels, 2002; Geels et al., 2017; Markard et al., 2012). However, it does not provide much analytical detail on the challenges that may arise from implementation at the user interface when implementing a mandate in regular practice. Specifically, there is greater literature that explains long-term pathways of transition as opposed to the microprocesses of downstream turbulence in contested adoption.

Secondly, there are well-developed frameworks that could be applied to study rare events, operational risk, and network vulnerabilities in the context of supply chain disruption and resilience (Craighead et al., 2007; Wagner & Bode, 2008; Bode & Macdonald, 2017). However, this literature has focused on material discontinuities and has paid relatively little attention to legitimacy-mediated, interpretive and policy induced

Vol. 12 Issue 8 August 2026)
ISSN: 2208-2190 Pages- 76-84
DOI: https://doi.org/10.69980/djy54b51

discontinuities. Consequently, this is not very good at articulating how a supply chain can be physically functional and yet be unstable in terms of its value and meaning, and as the customer-facing interaction.
Third, from a governance perspective, research suggests that intermediaries sitting between focusing firms and end-users have the capacity to buffer from uncertainty and to handle adaptation costs, a function which is not necessarily studied explicitly in green transitions (Shafiq et al., 2017). While there are existing studies on public support and socio-political feasibility as well as resistance issues in the transition to low carbon, they do not link resistance issues to the stabilization of supply chains by day-to-day actors that are downstream of the process (Fesenfeld et al., 2022; Biresselioglu et al., 2024).
The resulting gap is thus not only empirical, but also conceptually. The process of what makes regime-level sustainability demands create friction downstream, and how this friction is systemically relevant, and how intermediaries help stabilize the process when controversy reaches the pitch of conflict, are not all completely clear. The present manuscript fills this gap by presenting a theory elaborating longitudinal case of transition to E20 in India.

Methodology

Research design

A longitudinal single child study design with the theory elaborating approach is used in the study. Case research is suitable for the problem of how and why an under-theorized phenomenon comes into being in its natural setting and for purposes of building or developing theory, not estimating prevalence (Voss et al., 2002; Stuart et al., 2002). Qualitative case studies have proven useful in unpacking emergent processes, specifying mechanisms through a grounded construct, and reporting the design, data sources and coding procedures clearly in operations and supply chain research (Barratt et al., 2011).
There are three revelatory reasons why this is the case for India's transition to the E20. First, it has a visible regime level intervention, which is the mandated transition towards sustainable fuels. Second, it caused controversy downstream between consumers, vehicle manufacturers, service providers and communication among government. Third, it is a process that shows a clearly visible transition from implementation to escalation to coordinated stabilization, which is appropriate for process tracing and temporal bracketing.

Empirical boundaries and unit of analysis

The empirical window is from the time of the regulatory notification (February 2026) until the controversy and coordinated response (July 2026). The time span of this boundary is suitable as it encompasses the entire sequence of events required for process theorization: policy trigger, implementation conditions, controversy building and stabilization response. The unit of analysis is the interorganizational process that connects the policy level (regime) with the consequences at the market interface (car users, service networks, dealers, car manufacturers, and fuel providers).

Data sources

The empirical material consisted of eight available sources of public information from four categories: one regulatory notification, two Reuters wire reports, two industry press reports and four general news reports; and spanned the period February-July 2026. The materials were then ordered chronologically, and they were coded at three levels, starting with the terms of the evidence that would be primary constituents of the materials, then the analytical themes that would be secondary constituents of the materials, and finally the three aggregate dimensions upstream regulatory injection, downstream friction accumulation, and threshold-triggered intermediary mobilization. This reporting format is based on benchmark qualitative case reporting guidance which focuses on transparency of data provenance, analytical procedure and abstraction (Voss et al. 2002; Stuart et al. 2002; Barratt et al. 2011).

Vol. 12 Issue 8 August 2026)
ISSN: 2208-2190 Pages- 76-84
DOI: https://doi.org/10.69980/djy54b51

Source category	Number of sources	Sources included	Coding purpose
Government / regulatory text	1	Ministry of Petroleum and Natural Gas notification (17 Feb 2026)	Establish policy trigger, formal mandate, and timing
General news reports	4	The Quint; The Week; Reuters backlash report; India Today clarification report	Reconstruct rollout, controversy, and official rebuttal sequence
Reuters wire reports	2	Reuters backlash report; Reuters coordinated defense report	Capture escalation, cross-actor reaction, and coordinated defense
Industry / automotive press	2	Autocar Professional; Deccan Herald	Corroborate sector-side interpretation and automaker involvement

A fuller source-level table and coding summary are retained in the supplementary coding appendix and should accompany the submission package.

Analytical procedure

There were four steps to the analysis. The first step in the empirical materials was to arrange them chronologically to create an event history of the E20 episode. Second, they were open coded to identify observations of a first order, which appeared repeatedly in the data: that the rollout was required, the concern of compatibility was raised, losses of mileage were mentioned, rumors circulated, a public rebuttal was issued, an automaker clarification was provided, and a service side reassurance was issued. Third, first order observations were aggregated together into second order analytical themes which encompassed more comprehensive processes. Second, the themes were related to each other in a temporal bracketing.Third, the themes were related to each other in an overall process model which comprised three phases.

Data structure

To clearly lay out the coding progression, Table 2 condenses the three levels of analysis observed in the study, from first order evidence terms to second order analytical themes, and then to aggregate dimensions. This is reflective of the reporting requirements described in qualitative case studies in operations from the benchmark (Voss et al., 2002; Stuart et al., 2002; Barratt et al., 2011).

First-order evidence terms			Second-order analytical themes	Aggregate	dimension
Mandatory	E20	rollout;	Policy	Upstream	regulatory
nationwide		supply	injection	injection	
direction;		BIS/RON			
specification					

Vol. 12 Issue 8 August 2026)
ISSN: 2208-2190 Pages- 76-84
DOI: https://doi.org/10.69980/djy54b51

No fuel choice at stations; older vehicle concern; compatibility anxiety	User-side uncertainty	Downstream accumulation	friction
Reduced fuel efficiency; wear-and-tear claims; drivability concern	Performance ambiguity	Downstream accumulation	friction
Viral claims; misinformation rebuttal; "experiment" remark circulation	Amplified contestation	Downstream accumulation	friction
Public dissent; protest planning; policy becoming a flashpoint	Threshold recognition	Threshold-triggered intermediary mobilization	
Government clarification; auto-industry defense; compatibility statements	Coordinated response	Threshold-triggered intermediary mobilization	
Service data citation; vehicle-assurance localized messaging; reassurance needs	Intermediary buffering	Threshold-triggered intermediary mobilization	

Trustworthiness and limitations of evidence

It is a secondary study and rigor is not dependent on access to the backstage deliberation but on transparency and triangulation, and on clear analytical boundaries. The sequence is not based on a single narrative account but was pieced together from multiple, independent and reliable public sources. The goal here is not to resolve all the technical arguments about ethanol blending, but to provide an explanation of how downstream conflicts became a systemic issue, as a result of the process of organizing and establishing an ethanol supply chain.The point is not to provide a resolution to all the technical questions regarding ethanol blending but to explain how policy-induced friction downstream became systemically relevant to the organization and supply chain for ethanol. The design is in line with theory elaborating case logic and in addition suggests the need for further interview-based and comparison studies.

Findings

Phase 1: Upstream regulatory injection

The first phase was characterized by a regime-level policy push that moved faster than downstream adaptation. The coded evidence shows that the E20 transition was formalized through regulatory direction and publicly justified through energy-security and emissions arguments. In transition terms, this was a regime-level intervention intended to accelerate socio-technical reconfiguration. Yet formal compliance at the policy level did not guarantee operational or interpretive stabilization at the user level.

The analytical point is that regulatory implementation created a latent readiness mismatch. While the mandate aligned the formal fuel-supply system around E20, downstream users and parts of the installed vehicle base were left to confront unresolved questions concerning compatibility, performance, and everyday usability. Regulatory-driven downstream friction therefore begins not with failure of supply, but with unresolved use-side tensions embedded in an apparently successful rollout.

Phase 2: Downstream friction accumulation

The second process was the gathering of the uncertainty on the side of the users and the contestation from the public. The coded materials document issues with fuel efficiency, engine issues, vehicle compatibility, and

Vol. 12 Issue 8 August 2026)
ISSN: 2208-2190 Pages- 76-84
DOI: https://doi.org/10.69980/djy54b51

viral claims that need to be addressed. Importantly, however, these concerns were not just technical, they were socio-operational as they affected how the mandate was felt at the point of use.

There are three reinforcing mechanisms indicated by the evidence. The first was that when users were faced with perceived performance trade-offs they had a plausible reason for being displeased. Second, local uncertainty became visible, and thus, controversial, through media and digital amplification. Third, there was an increased burden on organizations at the customer interface for explanation/rebuttal. This phase highlights the difference between this type of disruption and standard disruption stories: material supply was stable, but material use of the stable use conditions of the material became increasingly fragile in terms of interpretation and legitimacy.

Phase 3: Threshold-triggered intermediary mobilization

The third phase started when the total amount of friction exceeded visibility and impact, and thus could be coordinated for stabilization. The materials in the empirical section reveal a transformation from a scattered to a coordinated response from government and auto-industry players as they made a public defense of the mandate, clarified technical details, and attempted to put the economy back on course.

This stage emphasises the involvement of intermediaries in the downstream stages. The automakers and service-channels were the vehicles of reassurance, translation and localized legitimacy repair. In those cases where OEM communication was not as evident as dealer communication on a national level; the market set up the dealers and service networks as the de facto arena where reassurance needed to be performed. The result is a threshold system; in times of low-level concerns, it is possible to respond to them individually, but with amplification and legitimacy pressure, one needs to mobilize intermediaries in a coordinated way.

Emergent process model

Overall, the results validate a process model, where the need to implement the sustainability mandate at the regime-level leads to a downstream reconfiguration cost, which is not directly reflected in compliance parameters. Concerns by local users build up around questions of performance trade-offs, compatibility, and claims in the public sphere, forming a growing zone of interpretative instability. After controversy reaches a certain degree of salience, intermediary actors will be called to restore local trust and continuity in the transition process, but without reversing the mandate.

This process will help clarify the basic mechanism of the friction down stream of the grate. Friction is regulatory-driven since it arises in the formal policy acceleration and is both downstream since it emerges at the user interface and friction because it is a material system that is unstable interpretatively and operationally.

Discussion

The study contributes to the sustainability transitions literature by providing a more explicit consideration of the downstream instability during transitions implementation. Regime change is complex and can involve multiple actors and dimensions (as is the case in the E20), but the E20 case also illustrates a concrete micro-process in which regime acceleration can cause a "turbulence of user practices, interpretations and local service interactions" (Geels, 2002; Geels et al., 2017; Markard et al., 2012). This can help clarify the turbulence that can be experienced in system transitions even when policy commitment and technical rollout are unchanged.

The paper also makes a contribution to operations and supply chain research, as it differentiates between legitimacy mediated disruption and ‘old fashioned' physical disruption. For E20, there was no significant material shortage for the network to become in a disruption state. Otherwise, the disruption arose when the legitimacy of the transition (at the point of use) became fragile, which, in turn, led to coordinated buffering and reassuring activities not adequately represented in traditional notions of supply continuity (Craighead et al., 2007; Bode & Macdonald, 2017).

The third contribution has to do with the role of the intermediaries. The results of the present study suggest that the role of the dealer/service-linked organization is not simply to be transactional end points, but also to be buffers between the contestation of the policy and credible local interaction. This insight adds to the governance approach to sustainability risk and monitoring and provides a pathway for transition scholarship to the "outside front" of implementation (Shafiq et al., 2017).

Theoretical Implications

Vol. 12 Issue 8 August 2026)
ISSN: 2208-2190 Pages- 76-84
DOI: https://doi.org/10.69980/djy54b51

The first novelty in the manuscript is the idea of regulating friction as a new mechanism of instability in sustainability transitions, which occurs downstream. This mechanism is different from the general implementation difficulty as it is created when acceleration at the regime level is outpaced by the interpretive and service-side absorption.
Second, a threshold model of escalation in transition is developed. When the sum of these forms of dissatisfaction is exceeded and reaches a level that is intolerable, the dissatisfaction becomes systemically consequential. This creates a dynamic escalation logic for transition studies, and links transition politics with processes of downstream operation.
Third, in contested transitions (the study concept) the downstream intermediaries are reinterpreted as buffers and translators. They don't just transcribe information and data to and from the official policy world, they do a certain amount of interpretation work to ensure continuity where the policy world is inadequate.

Managerial and Policy Implications
The findings indicate that upstream readiness assessment and communication architecture on the interfaces between the two should be included in the design of the transition, alongside compliance milestones, for policymakers. If service actors and the end users are not adequately prepared, then a mandate can be effective, but not have an impact on user-side interpretation. Therefore, downstream communication and technical assurances should be considered as an implementation capacity and not postpone as a damage control.
For companies, particularly auto manufacturers and dealer chains, the case suggests that it's not enough to simply adapt to mandated transitions if one wants to be resilient. There is a need for sensing systems for initial indicators of interpretive stress and translation systems for effective communication of policy adjustments to customers. Dealers/service networks are seen as strategic buffers instead of passive last-mile distribution channels.Dealers/service networks are viewed as buffers not just as last-mile channels.

Limitations and Future Research
Due to its theory-elaborating single case approach, the study has privileged an analytical depth over an empirical breadth. Evidence comes from public documents and not from interviews or from organizational records that are not public, thus restricting the ability to see into backstage deliberation and local trading practices. The model should be further extended by comparative case studies, process tracing (through interviews) and multi-method designs for other policy-led transitions, including that of electric mobility, clean heating or circular product mandates.
A further drawback has to do with the fact that the action of the intermediary is not always evident. While the argument suggests dealer-level micro-practices as important buffers between public reporting and government and automaker responses, this specific level is not as visible. Further research is therefore warranted on the way thresholds are recognized by downstream service organizations, the way downstream service organizations coordinate their responses to thresholds, and the way thresholds are transformed into viable customer interactions due to competing demands.

Conclusion
This paper addresses the destabilization of a socio-technical system without interrupting material supply by showing how a mandated green transition can lead to destabilization. Downstream market readiness lagged behind the policy push at the regime level in India, leading to some user interface friction and building up until a critical mass has been reached where intermediary-led stabilization sets in. The manuscript combines sustainability transitions theory with operations and supply chain management perspectives on case-study methods to provide a portable explanation for the concept of friction in contested green transitions, from the perspective of regulatory drivers, and for the buffering effect of downstream intermediaries.

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Vol. 12 Issue 8 August 2026)
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