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Purposive transition governance for road freight decarbonization

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ABSTRACT

Road freight decarbonization, like other complex system transitions, presents a formidable political, social and organizational as well as technical and economic challenge. While technical and economic aspects have received considerable research focus, there is much less research on political, social and organizational aspects. Purposive road freight decarbonization furthermore needs an effective governance framework to coordinate system-level decision-making that reflects all these important system dimensions. Findings from literature regarding governance requirements for purposive system transitions are synthesized to form a novel framework organized around the three pillars of governance processes, effectiveness and legitimacy. This framework is validated and further developed via thirteen semi-structured interviews and a workshop with transport authorities and industry associations. Conclusions are drawn regarding maintaining system functions and managing asymmetric power relations during transitions; key governance enablers; and the importance of achieving input, throughput and output legitimacy. Governance connections are identified, and the implications of these for transition wickedness discussed.

1. Introduction

Globally, heavy and medium duty road freight transport accounted for 1830 million tonnes in 2022 (IEA, 2024), or 5 % of a total 36,800 million tonnes (IEA, 2023) of CO_2 emissions. In the United Kingdom (UK) in 2023, heavy goods vehicles over 3.5 tonnes represented 21 million tonnes or 5 % of a total 426 million tonnes of CO_2 emissions (DfT, 2023b).

Road freight, particularly long-haul freight, is often cited as a hard to abate sector (Shell / Deloitte, 2021). However, its abatement must be achieved if we are to reach net zero. Given the urgency of the climate crisis, the transition must be rapid and radical, yet to date it remains slow and incremental. In this paper, we propose that the lack of effective transition governance is a key contributor to this.

Zero emission trucks are entering the market and the UK government is providing financial stimulus to encourage operators to acquire these (GOV.UK, 2023). Other road freight decarbonization opportunities exist (Greening et al., 2019). Some opportunities, such as improving vehicle aerodynamics or reducing rolling resistance, result in incremental decarbonization. Changing the vehicle energy source or shifting mode to rail or water can deliver radical decarbonization, however these actions have major energy system, infrastructure and vehicle supply dependencies. They also have substantial operational and service implications for fleet operators and customers, and require operators to engage with new partners and service providers. Radical road freight decarbonization can therefore be considered a wicked problem, which is defined as being *"ill-defined, ambiguous, and contested, and featuring multilayered interdependencies and complex social dynamics"* (Termeer et al., 2017).

Purposive transition is core to the framing of this study and assumes that, due to system dependencies, rapid and radical road freight decarbonization will only occur if it is made to do so purposively, meaning it is deliberate, structured, planned, and organized. Smith et al. (2005) identify that a purposive transition is necessary when high coordination between actors is needed, and there are resources required to execute the transition that are external to the established regime. Radical road freight decarbonization actions fulfil both these criteria.

Patterson et al. (2017) define governance as *"the structures, processes, rules and traditions that determine how people in societies make decisions and share power, exercise responsibility and ensure accountability"*. Competing actor values, beliefs and vested interests make transitions deeply political, and conflict is inevitable (Steurer and Bonilla, 2016; Downie, 2017;

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Churchman et al., 2023). Transition governance must therefore include effective mechanisms for managing conflict in addition to making and enforcing transition decisions. Politics, conflict resolution, decision-making and decision enforcement are however under-analyzed in transitions governance literature (Voβ et al., 2009; Patterson et al., 2017; de Geus et al., 2022).

Aligned with these conclusions, Churchman et al. (2025) identify that rapid and radical road freight decarbonization requires: 1) techno-economically feasible solutions; 2) a shared understanding of the design choices that need to be codesigned; and 3) a politically and socio-technically feasible codesign framework to make these design choices. This paper specifically addresses the third requirement and considers the research question: "What are the governance requirements for rapid and radical road freight decarbonization?". As political and socio-technical factors vary substantially by geography, the research question is considered specifically within a UK context. The findings are presented in the form of a governance framework that provides a heuristic and checklist for authorities and actors seeking to purposively enact this transition. The opportunity to apply the framework in other countries and for other sustainability transitions is explored in the conclusions section. This reflects the observations that many of the insights identified are relevant beyond UK road freight decarbonization; and purposive transition governance is understudied for sustainability transitions in general.

The remainder of the paper is organized as follows: section 2 describes the methodological approach used; section 3 proposes the governance framework developed from literature; section 4 presents the validation and further development of this framework via thirteen interviews and a workshop with transport authorities and industry associations; and section 5 concludes with reflections on the research question; governance connections; application to other transitions; research limitations; original contribution; and opportunities for further research.

2. Methodological approach

2.1. Theoretical basis

The methods used in this paper apply a combination of abduction and retroduction, which are methodological alternatives to induction, which is commonly used in subjectivist and qualitative research; and deduction, which is commonly used in objectivist and quantitative research. Please see Appendix A for a theoretical overview of abduction and retroduction.

2.2. Literature review

The first research phase was a literature review to identity relevant insights and frameworks. This was carried out in three steps. The first step identified relevant established governance frameworks in literature. The conclusion that none of these provide a complete solution for the governance of purposive system transitions led to the decision to identify specific relevant insights from literature as the basis of a new framework. In the resulting second step, Scopus was used to identify papers containing keywords that indicate a focus on both complex system transition and coordinated decision making. Following a sequential filtering of papers based on source title, title, abstract and full paper text, thirteen papers remained selected. These were qualitatively coded using grounded theory methods and the three governance pillars of processes, effectiveness and legitimacy were identified, each containing three themes. For the third step, targeted searches were conducted using Google Scholar and Scopus for additional literature considering these themes. This resulted in 11 further papers being identified. More detail on these steps is presented in section 3.

2.3. Interviews and workshop

Thirteen semi-structured interviews and a review workshop were held with transport policymakers and industry associations to validate and further develop the governance framework developed from literature within the specific context of UK road freight decarbonization. All interviews were with one participant except one transport authority interview that had two participants. The workshop had five participants, bringing the total number of participants to 19 representing nine national, regional and local transport authorities, and four transport industry associations. Authority representatives are transport officers with responsibilities that include freight transport. Industry association participant responsibilities include policy, strategy and stakeholder engagement. Appendix B presents the specific questions asked in interviews.

Each interview began with an introduction to the framework developed from literature. The opportunity was provided for participants to ask clarifying questions. This meant that, when the questions in Appendix B were subsequently discussed, participants understood the pillars and themes, and why they had been identified as relevant for road freight decarbonization.

Interview recordings were transcribed and qualitatively coded to identify more specific governance themes under each of the three pillars. Themes that did not align to a pillar were grouped under a fourth "governance enablers" pillar. The further developed pillars and themes were then reviewed in the workshop with five transport authority representatives. Weightings were assigned to themes by workshop participants and additional commentary regarding the themes was captured.

3. Framework development

3.1. Literature review

3.1.1. Step 1: existing frameworks for the governance of sustainability transitions

Several governance frameworks for sustainability transitions are proposed in literature. Three prominent approaches are Earth System Governance (ESG); Adaptive Management (AM); and Transition Management (TM). These frameworks are relevant as all consider collaborative path-setting and decision-making by stakeholders in the sustainable management and/or transition of socio-environmental systems. All also recognize the political context of systems. However, each adopts a different view of the purpose of governance and the nature of the challenges that governance must address.

ESG is a product of the Earth System Science Partnership, created to develop strategies for Earth System Management (ESM) (Biermann et al., 2010). ESG considers governance architecture; state and non-state agency; adaptiveness of mechanisms and processes; accountability and legitimacy; and questions of just allocation and access. Four cross-cutting themes identified are power, knowledge, norms, and scale.

AM was developed in the context of socio-ecological systems (Olsson et al., 2004). While the focus of AM is on local community governance, it recognizes that this needs to be founded on vision, leadership and trust; be supported by necessary legislation creating a social space for co-management; and be enabled by appropriate knowledge and information flows.

TM was developed by Loorbach (2010) building on socio-technical systems and innovation theory (Geels, 2004), which in turn is founded on science and technology studies (STS) (Jasanoff, 1996). TM considers the strategic, tactical, operational and reflexive management activities required to develop long-range transition visions. Hyysalo et al. (2019b) further develop the role of TM to define mid-range pathways that provide transition steering and coordination.

Foxon et al. (2009) compare TM and AM and propose that combining the iterative learning from AM with the longer-term transition perspective of TM could lead to a more resilient governance framework.

Patterson et al. (2017) critically assess approaches to understanding transitions and make three overarching observations: the deeply political nature of transitions; the challenges of thinking about transformations ex-ante; and the tensions between steering change and recognizing its open-ended and emergent nature.

Whilst ESG, TM and AM all offer valuable insights and heuristics, none provide a complete answer for transition governance (Foxon et al., 2009; Bosman and Rotmans, 2016). More recent work has proposed how these methods could be operationalized to support transition decision-making (Halbe et al., 2020), but the emphasis remains on long-range visioning and nurturing bottom-up innovation rather than purposive system-level steering of transitions by actors.

3.1.2. Step 2: systematic literature review[1]

To identify literature that provides insights into how to purposively govern transitions, a Scopus search was conducted for paper titles containing words associated with complex system transition: "wicked", "transition", "transformation*" or "complex" in combination with words associated with purposive transitions and coordinated decision-making: "governance", "management", "stakeholder*", "collabor*" or "codesign". After filtering for reviews and articles in the relevant subject areas of social sciences, environmental science and energy, 3204 papers were identified.

The 3204 papers were published in 1575 journals. As a first filter, papers were deselected that were in non-relevant journals or journals with titles that are not in English. Journal relevance was first assessed by identifying journal titles containing words that clearly suggest non-relevance (e.g. "Education" or "Medicine") or that have a specific focus on developing economies. Following this, titles were reviewed individually and any that were judged to be very unlikely to be relevant were excluded. After this process, 248 journals containing 988 papers remained selected.

As a second filter, papers with non-relevant titles were deselected. The same selection approach was applied as for journal titles. In addition, papers with a solely methodological or technical focus, or a focus on specific topics such as COVID with past rather than forward-looking relevance were deselected. Following this, 89 papers remained selected.

As a third filter, paper abstracts were reviewed using the same criteria as title filtering. Papers were then positively selected that met the two selection criteria of considering complex system transitions and providing insights regarding purposive transitions and coordinated decision-making. Following this process, 31 papers remained selected.

As a final filter, full paper content was reviewed and the same positive selection criteria as for abstract filtering were applied. After this, 13 papers remained selected.

The full content of the 13 selected papers was qualitatively coded in NVivo using open, axial and selective coding (Williams and Moser, 2019). Nine themes grouped under three pillars were identified and are presented in Fig. 1.

3.1.3. Step 3: targeted non-systematic literature review

Following the identification of the governance themes in the previous step, targeted searches were conducted for each of the identified themes using Google Scholar and Scopus. This was achieved by using different combinations of the theme words with the words "governance", "purposive", "transition" or "sustainability". Relevance of papers was assessed using the same approach as step 2. This resulted in a further six relevant papers being identified. In addition, five relevant papers identified from previous literature reviews were included, bringing the total to 24. Please see Appendix C for the alignment of the 24 papers to the pillars and themes in Fig. 1.

The additional eleven papers did not appear in the results of the step 2 search as they do not contain the required search words in the paper title. This is because either the title contains the theme words developed in step 2 rather than the search words; or the search or theme words are in the abstract or paper content rather than the title. Extending the original Scopus search to include incidences of the search words in abstracts and keywords resulted in an unmanageably large number of over 140,000 papers being identified.

Fig. 2 summarizes the review and coding conducted in steps 2 and 3.

The remainder of this section summarizes the identified governance themes based on insights from the 24 selected papers.

3.2. Governance pillars

3.2.1. Governance processes

Dentoni et al. (2018) identify a systems and network governance approach as essential to "harness wickedness". They consider three governance processes of deliberation, decision-making and enforcement:

3.2.1.1. Deliberation. While multi-Stakeholder Partnerships (MSPs) bring together actors from different backgrounds, there are often power imbalances between actors. If governance is framed within a deliberative democratic ideal, power imbalances must be neutralized for deliberation to be effective:

> *"Deliberative democracy incorporates the requirements that deliberation take place in contexts of equal recognition, respect, reciprocity, and sufficiently equal power for communicative influence to function"* (Bächtiger et al., 2018, p.1).

Bächtiger et al. (2018) identify four critiques of deliberative democracy as a governance mechanism, but argue that these have been at least partially addressed in "second generation" deliberative democracy:

- It is too idealistic and ignores power and politics
- It mistakenly aims at consensus
- It misunderstands human motivations and the limits to the cognitive capacities of ordinary citizens
- Deliberation is too rational, and excludes the informal social and speaking styles typical of many marginalized groups

Deliberative democracy is a large subject and a full exposition is beyond the scope of this paper. However, the central tenets of equal recognition, respect, reciprocity, and sufficiently equal power are core. Set against this, Dentoni et al. (2018) highlight that many studies find that affirmative efforts to neutralize power imbalance do not compensate for the dominance of certain participants, power plays and coalitions. If power imbalances cannot be fully neutralized, they argue that it is nevertheless important to ensure that all relevant voices are heard and considered at the deliberation stage. This requires different sources of knowledge to be considered; the facilitation of authentic deliberation between stakeholders with conflicting values; and continual reappraisal of the issues considered and the stakeholders included in deliberation.

3.2.1.2. Decision-making. As with deliberation, an idealized decision-making process would be based on equal representation and influence of all interested parties. In practice, this is rarely if ever the case. Measures need to be taken to manage asymmetric power relations to the extent possible, to ensure that potentially vulnerable and marginalized groups are represented and that private economic interests to not overwhelm environmental and social objectives. However, some degree of compromise and appeasement of private interests is likely to be necessary, and the decision-making process must accommodate this. Recognizing that both formal and informal decision-making processes exist, clear decision-making structures, roles and rules nevertheless need to be defined.

[1] A spreadsheet with a full audit trail of the filtering conducted in the systematic literature review is provided as a supplementary data object.

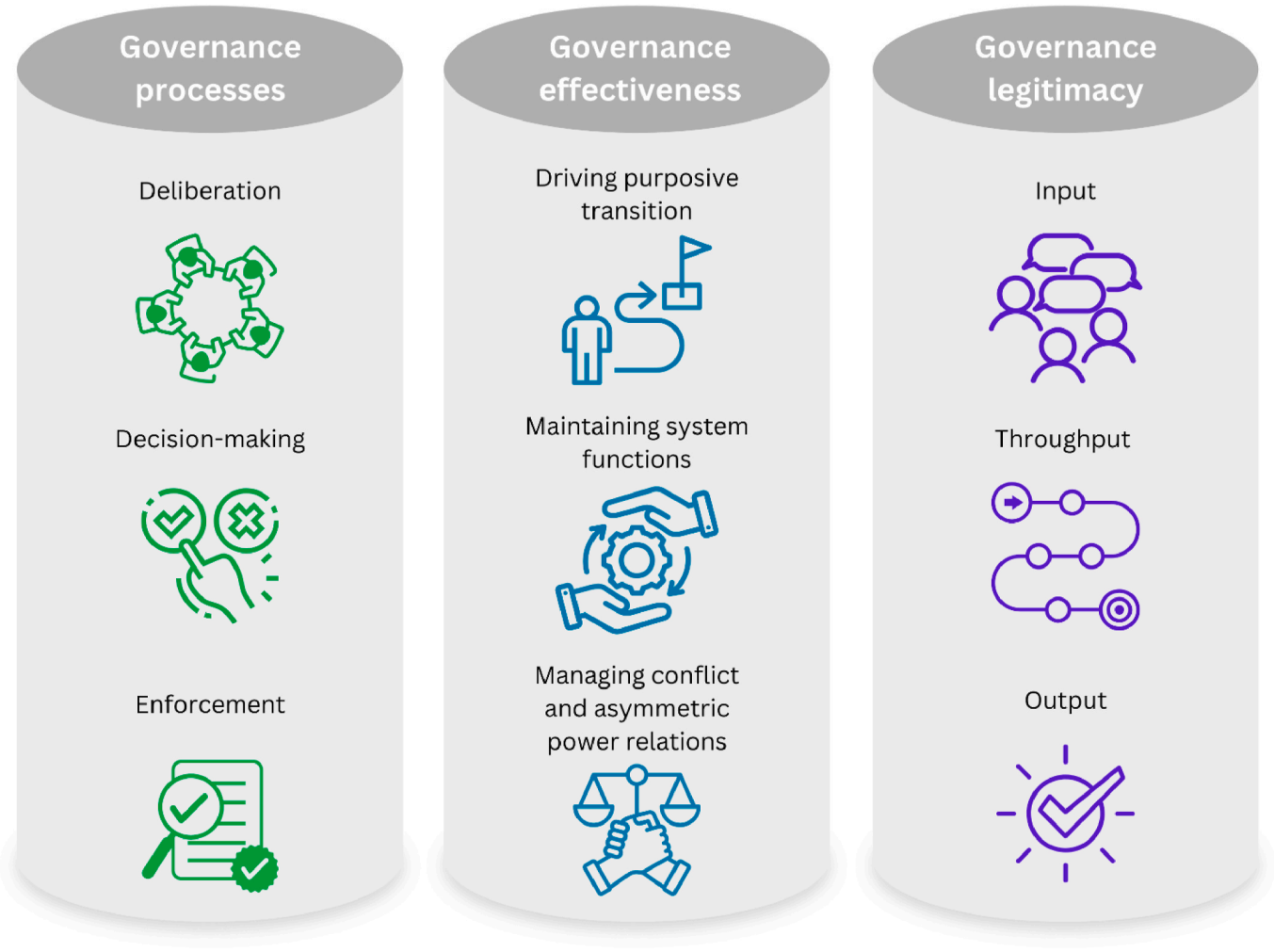

Fig. 1. Governance pillars and themes synthesized from literature.

3.2.1.3. Enforcement. The extent to which decisions are advisory or compulsory has strong implications for legitimacy and the nature of enforcement. Churchman et al. (2023) find a dichotomy between actors who believe that key road freight decarbonization decisions should be made centrally, and those who believe that all options should be left on the table so that operators and shippers can select solutions that work best for them. The nature of enforcement therefore also has significant political implications. Irrespective of the form of enforcement, decisions need to be expressed in a form that allows delivery against these to be monitored and reported.

3.2.2. Governance effectiveness

3.2.2.1. Drive purposive transition. Despite the urgency of the climate crisis, purposive transition governance is understudied. Termeer et al. (2017) contribute one of the few works to engage deeply on this topic and challenge the concept that incremental change is necessarily slow. They propose continuous transformational change with a focus on enabling and accelerating "small in-depth change" to reconcile the needs of incrementality and speed. To achieve this, they suggest three intervention strategies:

(1) Provide basic conditions for enabling small in-depth wins
(2) Amplify small wins through sensemaking, coupling, and integrating
(3) Unblock stagnations by confronting social and cognitive fixations with counterintuitive interventions

3.2.2.2. Maintain system functions. In general, transitions literature emphasizes the destabilization of incumbent actors and system functions to make space for new actors and functions. However, since we depend for our health, security and wellbeing on critical systems such as energy, transport and food, system functions must be maintained through the transition. Little literature has been found that considers this important aspect of system transition, apart from the observation by Foxon et al. (2009) that AM gives greater emphasis to the maintenance of system functions than TM.

To maintain system functions, we propose it is first necessary to identify concretely what these are and define the parameters that represent good system functioning. Once these parameters are defined, transition design can then incorporate ex-ante analysis to assess whether transition pathways will maintain system functions within required thresholds. Processes can be established to monitor system functions during the transition so action can be taken if thresholds are or appear likely to be breached. Approaches such as adaptive mid-range planning (Hyysalo et al., 2019a) can then be implemented to enable these course adjustments.

3.2.2.3. Manage conflict and asymmetric power relations. Due to competing vested interests and complex system interdependencies, conflict is unavoidable in system transitions (Downie, 2017; Normann,

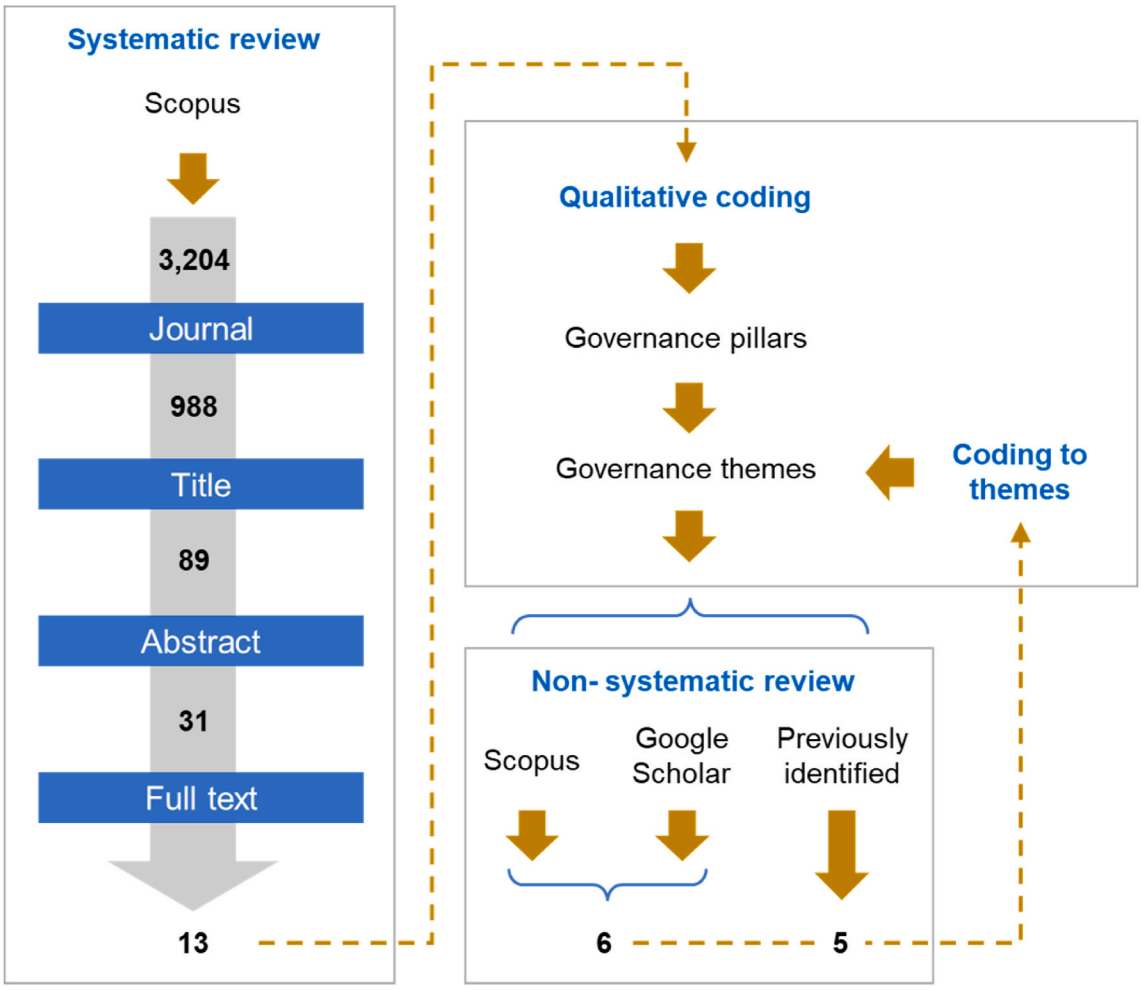

Fig. 2. Summary of literature review and coding.

2017). This means that governance must include mechanisms for managing conflict and for decision-making in the likely absence of full consensus. Negotiation between actor groups is a necessary element of this (Steurer and Bonilla, 2016). This challenging requirement is further complicated by power differences between actors.

Ansell and Gash (2008) identify that the success of collaborative governance depends on prior history of conflict or cooperation, incentives for stakeholders to participate, power and resource imbalances, leadership, and institutional design. While examples of effective collaborative governance are identified, other examples highlight where powerful stakeholders manipulate the process, public agencies lack commitment to collaboration, and distrust becomes a barrier to good faith negotiation. Their evidence suggests that strongly interdependent actors can work together to achieve rapid change, even in high conflict and low trust situations. However, without such interdependence, trust and time become necessary to negotiate decisions.

Voβ and Bornemann (2011) find that conflict, asymmetric power relations and politics are often neglected in the reflexive governance approaches of AM and TM. They suggest two requirements to address this: (1) detailed rules and procedures to avoid domination and capture by powerful political interests, and (2) alignment of governance with actual political practices and existing patterns of governing.

3.2.3. *Governance legitimacy*

The importance of legitimacy within liberal democracies emerges clearly from literature; and recent history also demonstrates its significance. The *gilets jaunes* and farmers protests in France (Goury-Laffont, 2024; Yildiz, 2024); the anti-nuclear movement in Germany (Jahn and Korolczuk, 2012); and the backlash against pro-environmental and road safety policies in England and Wales (DfT, 2023a) are all examples of where social legitimacy has directly influenced policy formulation and outcomes.

While several concepts of legitimacy exist, three widely referenced legitimacy concepts have been selected from literature: input, throughput and output (Schmidt and Wood, 2019). Input legitimacy relates to the diversity and representativeness of societal perspectives engaged in the decision-making process. Throughput legitimacy reflects the quality of decision-making processes and rules. Output legitimacy concerns the extent to which the results of decision-making are perceived as addressing collective problems.

While it is helpful to consider input, throughput and output legitimacy, we suggest these cannot be entirely separated. For example, for climate change deniers, pro-climate policies could be seen as failing on output legitimacy. However, climate change denial rhetoric associates climate action with the making of decisions based on the interests of "elites" (input legitimacy) and the mechanisms and regulations of the state and supra-state (throughput legitimacy). This makes it impossible to analyze the politics of climate change action without considering all three forms of legitimacy.

Please see Appendix D for a further consideration of the challenges of reconciling the multiple requirements of legitimacy.

4. Framework validation and enhancement

The recordings from the 13 interviews were transcribed and then qualitatively coded in NVivo, initially to the pillars and themes identified from the literature review, and then via an iterative process of open, axial and selective coding (Williams and Moser, 2019) to more detailed themes. Important governance themes emerged that did not fall under one of the three pillars in Fig. 1, so a fourth "governance enablers" pillar was created. Fig. 3 shows the themes identified from interviews aligned to the four pillars. All governance process and effectiveness themes identified from interviews align to one of the highlighted themes and are shown as nested under these. Two new legitimacy themes were identified that did not fall within the themes of input, throughput and output legitimacy, and are therefore shown at the same level as these.

In the concluding workshop, the pillars and themes developed from literature and interviews were shared with participants, and they were asked to qualitatively comment on each theme and to review theme weightings. The commentary from the workshop was transcribed and coded to themes following the same approach as for interviews. Workshop participants were also asked if any themes should be added or removed, but they confirmed that the identified themes appeared valid and comprehensive.

The following summarizes the points raised by interview and workshop participants for each theme. Selected quotes illustrating these points are provided in Appendix E and are referenced by quote number.

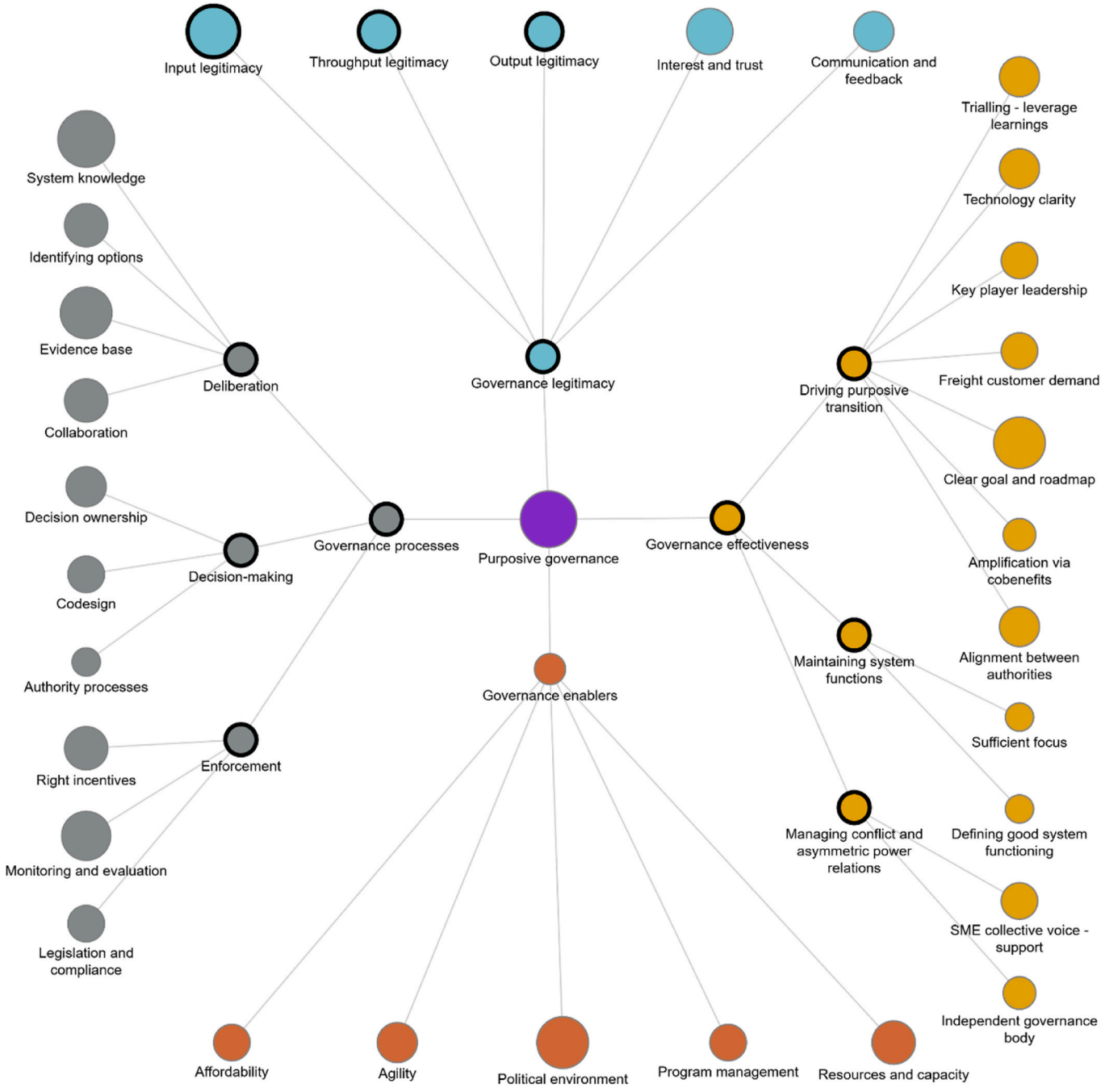

Fig. 3. Governance themes from interviews: Size of circle reflects weight assigned to theme in workshop (Theme categories not weighted; themes/theme categories from literature highlighted with black border).

4.1. Governance processes

4.1.1. Deliberation

4.1.1.1. System knowledge. There was a shared view that current decision making is hampered by different parties operating in silos, each with only partial information (quote 1). Both transport authority and industry association representatives highlighted that decision making would not be effective if decision makers did not have a good understanding of current freight activities and why these are done the way they are (quote 2).

A lack of freight expertise in transport authorities was identified as a gap, and as a result freight experts were seen being needed to facilitate deliberation and decision making (quote 3). System knowledge was also seen as variable within operators with, for example, transport managers potentially having a different view to board members. However, it was noted that, given uncertainty and the complexity and scope of the multiple systems involved, there would never be perfect system knowledge.

4.1.1.2. Identifying options. Having a robust and transparent process for identifying and assessing options was highlighted as key. It was seen as important to initially identify the range of options, and to then conduct a multi-criteria analysis of these (quote 4). The need to make options understandable to all stakeholders was also identified, meaning it may be necessary to "dumb down" option descriptions and analyses. Early elimination of options that are unlikely to be feasible or politically acceptable was seen as helpful (quote 5). It was also noted that the list of available options was not static as new options become available and existing options are demonstrated to be non-viable.

4.1.1.3. Evidence base. Establishing a robust evidence base to support deliberation was identified as necessary, but also challenging. Reluctance to share data was seen as an obstacle (quote 6). Available data was highlighted as not being in the right form or sufficiently detailed to support transition planning by authorities. The short timeframes in which data had to be obtained was highlighted as a further challenge. While it was proposed that policy needs to be supported by the best available evidence, it was at the same time noted that it is impossible to have perfect information, and that decisions need to be made despite this (quote 7).

4.1.1.4. Collaboration. The need for better collaboration between the public and private sectors on freight and logistics was highlighted. Collaboration was also identified as being required between operators, energy providers, government and vehicle manufacturers to establish shared charging/fueling infrastructure (quote 8). A further form of collaboration mentioned was collaborative purchasing of vehicles. It was noted that collaboration was required across sectors that were not accustomed to working together, and these sectors often spoke "very different languages".

4.1.2. Decision-making

4.1.2.1. Codesign. It was proposed that neither a fully top-down nor bottom-up process would be effective, and that it was necessary to combine elements of both. Getting the right people around the table and then keeping them there for the duration of the decision-making process was seen as challenging. In addition to engaging operators and authorities, it was proposed that codesign participants should include energy providers and those responsible for enforcing decisions. Having a design board with voting and non-voting members was suggested as a way of achieving the required breadth of input and engagement while ensuring effective decision-making (quote 9).

4.1.2.2. Authority processes. Transport authority representatives highlighted the need to align with authority assurance and appraisal processes (quote 10). The nature of these processes was identified as being different depending on whether decisions were national, regional or local, with more people needing to be involved the wider the impact of the decision. Aligned with this, one participant said that the complexity of decisions and impacts meant that the decision process "is always going to be painfully slow". However, failure to follow consultation and engagement processes was seen as very likely to cause problems later. When decisions include a commitment to spend, these typically need to be supported by a cost benefit analysis, which was flagged as being challenging for decarbonization actions that could result in costs increasing (quote 11).

4.1.2.3. Decision ownership. Clear ownership of decisions was seen as necessary. An industry association representative expressed the view that, although they expected to be consulted, executive decisions are necessary, and this requires clear decision ownership and responsibility (quote 12). A transport authority representative said that clarity of decision ownership was also important when working across multiple levels of government. However, they didn't see anyone being ready to take responsibility for key decisions such as technology choices (quote 13).

It was noted that, even when decision-ownership is clear, there is in some cases a reluctance to make decisions due to uncertainty and dependence on other decisions. Regarding technology selection decisions, it was proposed that, while government would determine what was defined as a zero-emission vehicle, individual operators would still need to make their own choices from the options available based on the technology that would work for them.

4.1.3. Enforcement

4.1.3.1. Monitoring and evaluation. Industry association representatives proposed that both quantitative and qualitative measures are required, and that funding and resources for monitoring and evaluation need to be identified at the deliberation stage. It was highlighted that operators are concerned that there may be a need for more vehicles due to loss of payload and charging times, and that there needs to be monitoring to capture this (quote 14). Transport authority representatives expressed the view that monitoring and evaluation had historically been an area of weakness, although it was also suggested that this had received significant focus in Ultra Low Emission Zones (ULEZs).

4.1.3.2. Right incentives. A transport authority representative suggested that there are fewer levers available to policymakers to decarbonize road freight than public transport (quote 15). Another argued that, while authorities can influence the choices operators make, if operators are not able to move goods they will find a way around incentives. Negative unforeseen consequences of vehicle manufacturer quotas from the point of view of operators were identified, with operators being told by manufacturers they can only buy diesel vehicles if they also buy battery electric vehicles, even if the latter do not meet operational needs.

4.1.3.3. Legislation and compliance. Expecting operators to make low carbon choices without legislation was seen as unlikely to be successful. However, it was also argued that regulation was "pointless" without enforcement (quote 16). It was noted that the extent of regulation required would vary depending on the requirement. It was suggested that road freight is already very "compliance heavy" and that compliance was potentially a better term to use than enforcement.

4.2. Governance effectiveness

4.2.1. Driving purposive transition

4.2.1.1. Clear goal and roadmap. The need for a clear goal and roadmap was identified in ten of thirteen interviews. "Goal" was expressed variously as mission, vision, narrative, end objective, north star, direction, scope or "what good looks like". In all cases, it was seen as being necessary to provide a common understanding of the aiming point of the transition (quote 17). There were differing views on how prescriptive the goal should be with regards to the specification of decarbonization solutions, but there was agreement on the requirement to decarbonize needing to be unambiguous. A shared view was expressed that expecting the industry to transition in one step was unrealistic for reasons including fleet replacement cycles; differing operational requirements and constraints; and different operator profiles. A phased roadmap, potentially incorporating the concept of small in-depth change in which earlier phases lay the foundations for later ones, was seen as necessary.

4.2.1.2. Technology clarity. While some participants said that government should not be prescriptive regarding technology choices, other participants likened current technology uncertainty to a "Betamax vs VHS situation" and "a Mexican standoff" (quote 18). Although the sales ban of internal combustion engine (ICE) vehicles was seen as helpful, clarity on the specific technologies that would be deployed at scale was argued to be necessary for infrastructure planning, as no government has sufficient funds to deploy infrastructure to support all technologies. Technology uncertainty was seen as a particular barrier for SME operators, as buying an incorrect truck could bankrupt their company (quote 19). At the same time, operators were seen as being resistant to having electric technology options imposed on them. However, while technology choices remain open, engaging with shippers on how duty cycles could be adapted to be compatible with battery electric vehicles was identified as difficult.

4.2.1.3. Alignment across authorities. The requirement for alignment across authorities was identified in six interviews, with a shared view being expressed that relevant policymaking is siloed and split across multiple levels of government. It was highlighted that local and national policy were often at odds on planning and infrastructure matters (quote 20). Different local authorities were also identified as placing different and incompatible requirements on operators. Lack of trust and data sharing across authorities were seen as challenges.

4.2.1.4. Freight customer demand. Freight customers were identified as having an essential role to play as operators have no choice but to align to their requirements, and these requirements therefore need to be compatible with decarbonization (quote 21). Current freight procurement was seen as still being primarily driven by cost and service delivery rather than environmental impact.

4.2.1.5. Key player leadership. Large operators and shippers were identified as having a key transition leadership role to play (quote 22). Firstly, they were seen as having the resources required to trial new technologies and vehicles, and to accommodate this within their operations. Secondly, it was considered necessary for these actors to be at the table for key decisions. Thirdly, these organizations were perceived as being able to take decarbonization action more independently, without the same need for public sector coordination as smaller operators. Finally, early investment by key players was viewed as important for establishing the public infrastructure that smaller players could then benefit from.

4.2.1.6. Trialing - leverage learnings. Technology trials were seen as helpful to ensure solutions deliver anticipated outcomes; to provide a necessary evidence base; and to help build the case for large scale adoption (quote 23). One perceived risk was that, if only larger operators participate in trials, solutions may be developed that do not work for smaller operators. Communication of the outcome of trials was also seen as being patchy, particularly if a trial is unsuccessful. It was considered that there are as many lessons to be learned from unsuccessful trials as successful ones.

4.2.1.7. Amplification via co-benefits. Emphasizing benefits in addition to decarbonization was seen as helpful to building support for the transition. An example mentioned is the fact that drivers tend to like battery electric vehicles (quote 24). Reduction in particulate emissions was also seen as an important co-benefit for local stakeholders.

4.2.2. Maintaining system functions

4.2.2.1. Defining good system functioning. It was identified as being important not to focus only on vehicles, but on wider logistics systems and supply chains. Some degree of disruption was seen as unavoidable with a transition of this scale and complexity, but the need to manage disruption so that priority flows are maintained was highlighted (quote 25).

4.2.2.2. Sufficient focus. Participants identified that transition projects can give insufficient focus to maintaining system functions and that, while this is important, achieving this can be difficult (quote 26).

4.2.3. Managing conflict and asymmetric power relations

4.2.3.1. SME Collective voice – support. Transport authorities identified that engaging with SME operators was challenging due to the large number of these and their limited capacity to participate in consultation forums (quote 27). It was nevertheless seen as important to get input from SMEs during the deliberation and decision-making process rather than just at the end. It was also noted that may SMEs do not buy new vehicles and are therefore reliant on vehicles that are available in the second-hand market (quote 28). An industry association representative highlighted that decision-makers need to consider the impact of decisions on SMEs. For this, they argued that a collective voice is required. It was also proposed that an independent monitoring role was needed to ensure that transition decisions did not result in SMEs being priced out of the market.

4.2.3.2. Independent governance body. Linked to the above point, an independent governance body was seen as required by industry association representatives to ensure that the impact on smaller operators was considered in decision making and that SMEs were not unfairly disadvantaged, for example by technology selection decisions (quote 29). It was also proposed that an independent body is required to coordinate decision-making across multiple authorities and that this body needs to "have teeth".

4.3. Governance legitimacy

4.3.1. Input legitimacy

Most participants identified input legitimacy as being fundamental, as it is the foundation on which the other elements of legitimacy are based. Representation, equality and accessibility were seen to be key elements of this, with two participants noting that policymaking was generally dominated by white males (quote 30). Soft skills were identified as important to ensure that stakeholders felt safe to express their true views. It was suggested that, while public bodies tend to gather stakeholder input, the focus was often on meeting legal requirements rather than genuine consultation (quote 31). It was acknowledged that it was unlikely that all stakeholders would agree with decisions, but if they

had been consulted and they could see their views had been properly considered, they would be more likely to accept the outcome.

4.3.2. Throughput legitimacy

It was suggested that when authorities had in the past received pushback on measures that had been taken, it was often because the decision-making process had not been seen as good enough, or stakeholders had not been sufficiently engaged. Even if stakeholders provide input, if they cannot see how that input has been used, it was proposed that they will still not trust the process (quote 32).

4.3.3. Output legitimacy

Making decisions relevant to stakeholders by communicating how these would impact them directly in addition to broader societal benefits was identified as a key element of achieving output legitimacy. Another proposed aspect was that funding allocated to support a decision demonstrated policy commitment (quote 33).

4.3.4. Communication and feedback

Across all aspects of legitimacy, stakeholder communication and feedback were identified as critical. This was seen as needing to include regular progress updates and communications of project deliveries and metrics demonstrating positive impacts (quote 34). The importance of ensuring that the language used in communications is appropriate for the audience was also highlighted, as was the importance of communicating proposals to politicians in a way that makes clear their relevance to the political agenda.

4.3.5. Interest and trust

Lack of interest and trust amongst stakeholders was identified as a significant challenge to road freight decarbonization. While stakeholders were seen in general as being supportive of climate change action, they were also viewed as being subject to more direct near-term challenges that often took priority (quote 35). Politicians and public authorities were considered as giving less focus to road freight than passenger transport, as the public were perceived as not caring about freight except when it directly impacted on their lives.

Regarding trust, industry associations proposed that past policy experience had reduced operator confidence that policymakers understood or took into consideration their needs. The changing of goalposts, for example end of sale dates for diesel cars, was seen as having reinforced a lack of operator confidence that policies were well thought through and would remain in place (quote 36). Examples were provided of industry representatives voicing skepticism that decarbonization targets could be achieved and of a major retailer challenging local sustainable transport policy where this added time and cost to last-mile deliveries.

4.4. Governance enablers

4.4.1. Political environment

The frequency of change of ministers and the resulting changes in policy were identified as particularly disruptive when a policy needs to be enacted over multiple election cycles. In addition, it was observed that, while politicians may support strategic policy objectives, they may either not understand or not support the practical actions required to achieve these. Furthermore, due to the nature of the UK electoral system, gaining support for any policy that provides overall benefits but has negative local impacts was seen as extremely difficult (quote 37). The need for a rigorous evidence trail of policy discussions and decisions was highlighted as required. The support of a policy by a prominent politician, for example a city mayor, was also seen as being extremely helpful.

4.4.2. Resources and capacity

Lack of resources and capacity was seen as a significant challenge for both authorities and operators (quote 38). Local and regional authorities were identified as often relying on only one or two individuals for freight expertise, if this expertise was available at all. Only the largest operators were seen as having the dedicated expertise and capacity required to engage with decarbonization opportunities. As a result, decarbonization and sustainability forums were perceived as often drawing on the same small pool of individuals from a limited number of organizations. One proposed way of addressing resource constraints was to use trusted partners to facilitate consultation and decision-making (quote 39).

4.4.3. Program management

Four program management themes were identified:

- A transition timetable that is well understood and is stuck to
- A program management office that tracks transition activity
- Clarity of activity ownership and responsibilities
- Ensuring governance processes are clearly communicated and followed

The term “program” rather than “project” management is used. While project management is primarily concerned with actions, milestones and resources, program management also encompasses stakeholder engagement, communication and governance.

4.4.4. Agility

The need for agility and adaptability was highlighted by six participants (quote 40). A principal theme was that major unforeseen events such as pandemics and geopolitical threats change priorities and requirements. Current strategic transport planning, which typically runs on a ten-year cycle, was seen as insufficiently responsive. It was also suggested that there will be things that we don’t get right first time, and that it is necessary to be able to recognize this and adjust.

4.4.5. Affordability

The need for option assessment and decision making to consider affordability in relation to public and private expenditure was identified (quote 41). It was noted that this is particularly important for road freight operators given the low margins in the sector (quote 42).

4.5. Areas of differing opinion

In many areas, there was a good level of alignment between the views expressed by participants. However, there were some areas where differing views were expressed. These are included with supporting quotes in Appendix F.

5. Conclusions

5.1. Reflections on research question

The work has provided substantial insights regarding the research question: “What are the governance requirements for rapid and radical road freight decarbonization?” in a UK context. The need for a purposive transition is crystallized by the identification of pillars for governance processes, effectiveness and legitimacy. A fourth pillar of “governance enablers” was also identified from interviews, highlighting additional important requirements that span the political environment, resources and capacity, program management, agility and affordability. The social and political challenge of reconciling purposive transition steering with the management of conflict and asymmetric power relations is considered. We believe that this challenge can only be met if transition governance is itself purposively codesigned by transition actors and stakeholders.

5.2. Governance connections

There are several connections within the governance framework that

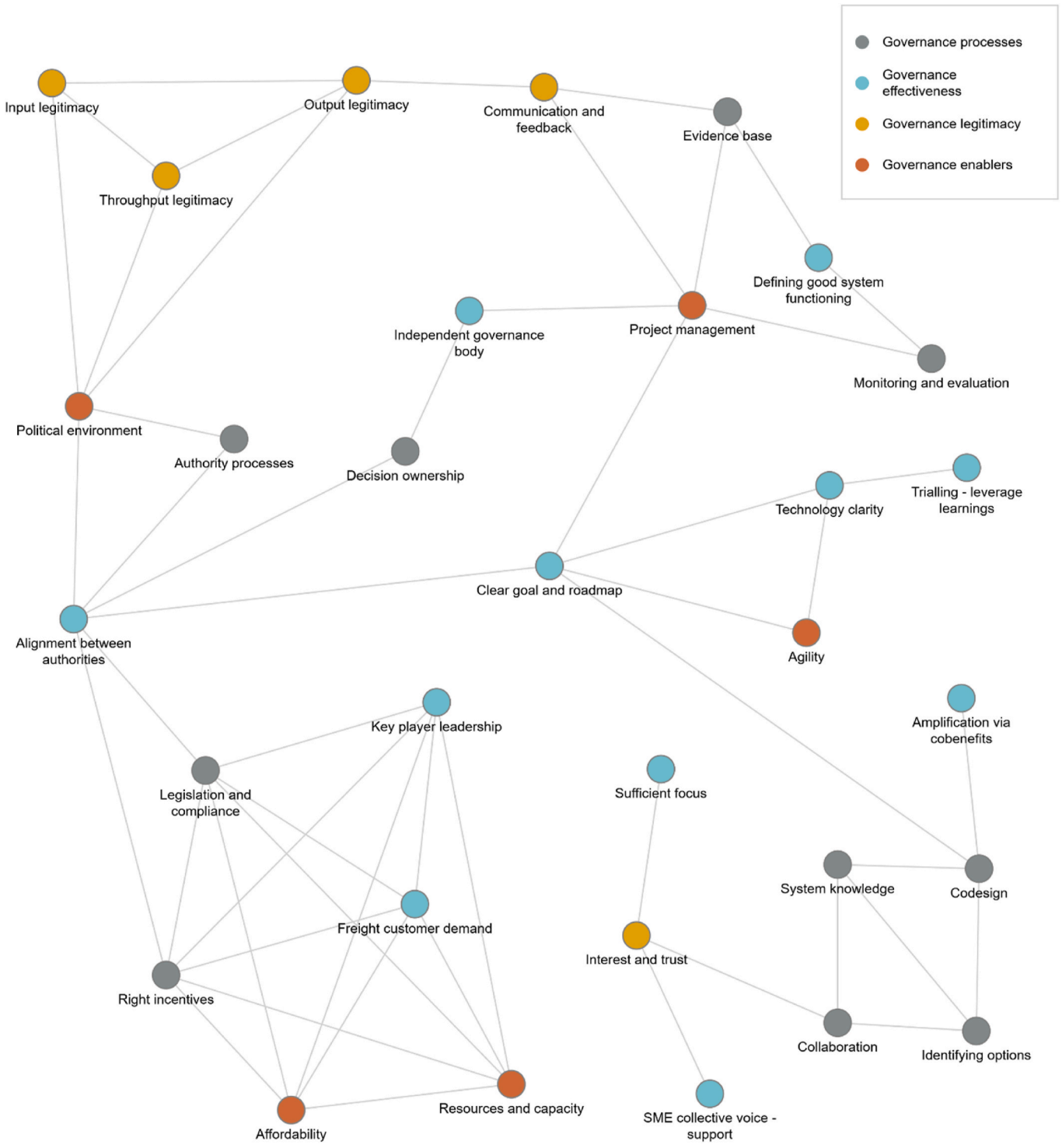

Fig. 4. Subjective identification of governance connections.

represent trade-offs and coordination requirements. Fig. 4 highlights those that we have identified subjectively. Further work is required to develop and validate these. Nevertheless, the connections reinforce the wicked nature of rapid and radical road freight decarbonization. Given the urgency of decarbonization, we believe that it is not sufficient to simply identify it as a wicked problem, and approaches to overcome wickedness need to be defined. A potential starting point for this is to systematically and purposively acknowledge, engage with and find ways of managing governance connections.

5.3. Application to other transitions

During the literature review, interviews and workshop, UK road freight decarbonization provided the framing for the type of system transition that needs to be governed, being characterized by political and socio-technical as well as techno-economic system dimensions; a complex network of system actors and actor groups; substantial system and path dependencies that constrain the ability of individual actors to take radical transition action alone; and as a result a need for purposive system codesign. These characteristics are not unique to road freight

decarbonization, and none of the papers selected specifically focus on this transition or on the UK.

We believe that the four pillars of governance processes, effectiveness, legitimacy and enablers are important for any purposively governed transition. We also believe that the high-level governance themes in Fig. 1 are relevant for any transition that cannot be delivered solely by top down or bottom up governance, meaning that codesign of key transition choices by system actors and stakeholders is necessary. Several of the more detailed governance requirements in Fig. 3 that emerged from the interviews also have general applicability, although their relative importance may vary depending on the nature of the transition and the political and social context within which the transition will be delivered. Some of the requirements under the governance effectiveness pillar such as "freight customer demand" and "SME collective voice – support" are specific to road freight decarbonization and it is likely that other effectiveness themes would need to be identified for other transitions.

We therefore suggest that the framework could be applied to other transitions by considering the following hierarchy of questions:

1. Does the transition need to be purposively executed and governed? If yes, the four pillars are applicable.
2. Is codesign of key decisions by transition actors and stakeholders required? If yes, the high-level governance themes identified from literature in Fig. 1 can be applied.
3. Considering the nature of the transition and the political and social context, what is the relative importance of the specific requirements under the governance process, legitimacy and enabler pillars in Fig. 3? Are there any requirements that need to be added?
4. What are specific governance effectiveness requirements for the transition, considering the three needs of driving purposive transition, maintaining system functions and managing conflict and asymmetric power relations?
5. Are there any further governance requirements that have not already been identified?

5.4. Research limitations

The principal limitations of the research are the consideration of the specific case of UK road freight decarbonization and the focus on incumbent actors in interviews and workshops. These represented research choices to consider a defined transition and political and socio-technical context; and prioritize system knowledge over an opportunity to gather wider perspectives and out-of-the-box ideas. An example consequence of the second choice is that no participant suggested that a pathway to freight decarbonization could be, for example, radical consumer-led degrowth, radical localization of food and goods production, or de-industrialization. An implicit assumption is therefore that the transition would be delivered within the current political and economic order without a major reconfiguring of societal expectations or how societal needs are provisioned.

In addition, the decision to focus interview and workshop research on transport authorities and industry associations was a deliberate choice to engage participants with a good level of literacy and interest in political and social dimensions of transitions, and in transition governance. While this led to insightful discussions and rich outputs, it also means that further work with a wider range of stakeholders is required to validate and operationalize findings.

5.5. Original contribution

To our knowledge, no other research has considered the specific governance requirements of purposive road freight decarbonization. Furthermore, while there is research on the governance required to deliver major system change, this has tended to be somewhat theoretical and focused on bottom-up innovation rather than system-level steering (Avelino and Grin, 2017; Rosenbloom, 2017; Halbe and Pahl-Wostl, 2019). However, recent work is starting to address this gap e.g. (Lovell et al., 2022; Churchman et al., 2023; Lähteenoja et al., 2023; Pineda et al., 2024). We believe that this study makes a material contribution to this effort by synthesizing important governance insights from literature, and by validating and developing these with public and private sector representatives in the context of road freight decarbonization. In addition, the developed governance framework has the potential to be adapted and applied to other sustainability transitions, recognizing that purposive governance is not only understudied for road freight decarbonization, but for sustainability transitions in general.

A further novelty is the application of an abductive approach to develop a strawperson framework from literature, followed by the retroductive validation and further development of this with actors and stakeholders. We believe that this is an effective and underused approach for synthesizing insights from literature and testing and developing these with policymakers, private sector decision-makers and other relevant parties.

5.6. Opportunities for further research

5.6.1. Delivering road freight decarbonization in the UK

While we believe the developed framework provides a good conceptual foundation for the governance of road freight decarbonization in the UK, further work with authorities and a wider range of actors is required to validate and operationalize this including the definition of:

- Detailed governance roles and responsibilities
- Governance processes and rules of engagement
- Monitoring and escalation mechanisms to address roadblocks and other exceptions

These detailed elements will need to be codesigned by and/or negotiated with a full range of key stakeholders including freight operators, customers, infrastructure and energy providers, and vehicle manufacturers. There is an important role for research to facilitate this process. Investigating the governance connections discussed in section 5.2 may provide a fruitful framing for this research.

5.6.2. Application to road freight decarbonization in other countries

The focus of this study has been on road freight decarbonization in the UK. We believe the approach is likely to also be applicable in other national contexts where neither top-down nor bottom-up governance can, on their own, achieve transition outcomes, meaning a codesign approach to system decision making is required.

5.6.3. Application to other sustainability transitions

As discussed in section 5.3, we believe that the purposive governance framework could, with adaptation, also be applicable to other sustainability transitions.

CRediT authorship contribution statement

Phil Churchman: Writing – review & editing, Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kate Pangbourne:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Thijs Dekker:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Vasco Sanchez Rodrigues:** Writing – review & editing, Validation.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX A. THEORETICAL OVERVIEW

Abduction and retroduction

Abduction is where probable theories are developed from incomplete information (Meyer and Lunnay, 2013; Fletcher, 2017). A detective forming theories based on evidence from a crime scene is a form of abduction. Reichertz (2009) proposes that abduction is central to grounded theory, and Charmaz (2008, p.157) suggests, "*Grounded theory starts with an inductive logic but moves into abductive reasoning as the researcher seeks to understand emergent empirical findings*". While induction infers generalized conclusions based on observations of particular instances, abduction develops probable theories by connecting two or more premises based on available evidence. For example, if it is observed that a household dog barks every morning around 10am, and it is known that the postman/woman comes around that time, a theory could be abductively proposed that the dog is barking at the postman/woman.

Retroduction is where the researcher considers a predefined theory and assesses the conditions under which this theory would be true (Danermark et al., 2019). It builds well on abduction, as abduction acknowledges that proposed theories are based on incomplete knowledge and therefore require critical scrutiny and development (Land, 2024). The "retro" in retroduction implies a form of backcasting in which the conditions that would need to be true for a theory to be valid are assessed. Retroduction allows an ontologically realist view of the future to be taken while at the same time recognizing that complex and emergent causal mechanisms of systems are very hard to "prove" deductively (Bhaskar, 2013).

The initial framework development, presented in section 3, is abductive. A grounded theory approach is used to synthesize relevant governance themes from literature into the framework presented in Fig. 1. This represents what was judged to be a "most likely" theory of transition governance based on the identified evidence from literature. The subsequent testing and development of the theory with interview and workshop participants presented in section 4 is retroductive. In this, the abductively developed framework was proposed to participants and exploratory questions were asked to identify the governance aspects that, in their view, would need to be true to successfully deliver road freight decarbonization. This resulted in specific requirements being identified for each of the three proposed pillars, and further "governance enabler" requirements being identified that did not fall under any of these pillars.

The abductive/retroductive approach is, we propose, better able to accommodate situations where evidence and knowledge are incomplete than more classical deductive approaches. As a result, we believe it is more appropriate for developing theories of change for societal systems that are complex, emergent, uncertain and stratified, particularly when there is no precedent for the change, as is the case for radical road freight decarbonization.

Critical realism

Considering the governance of digital innovations, Pel (2024) highlights the paradox of treating innovation as simultaneously emergent and spontaneous, and directed and purposive. Proposed consequences of this are a confusing representation of steering capacity; inconsistent representations of the role of technology; a loss of strategic value when innovation refers simultaneously to 'landscape developments', 'regime reproduction' and radical 'niche' innovation; and a disorienting shifting of scope and focus. Alternative views of transitions adopted by different disciplines are presented by Rotmans (2005) as transition typologies that are either targeted or emergent, and subject to a greater or lesser degree of coordination.

The philosophical standpoint adopted in this study is that purposive codesign requires a broadly realist ontological position, as otherwise there is no possibility of reaching a common view of the problem or options available to address it, which is required for reasoned collective choices to be made. However, it is also necessary to recognize that the emergent, stratified, uncertain and contested nature of socio-technical and political systems means that full system understanding or control may never be possible. We propose that critical realism (Bhaskar, 2013), combined with abductive and retroductive methods, provides a practically helpful foundation for purposive transition governance and for navigating the contradictions and challenges that Pel (2024) and Rotmans (2005) raise.

APPENDIX B. INTERVIEW QUESTIONS

Table 1
Semi-structured interview questions

Section	Questions
Governance processes[a]	• For each of the three governance processes, what are the key requirements for successful road freight decarbonization? • Are there any governance requirements not covered by the three processes? What are these and why are they important?
Governance effectiveness[a]	• For each of the three governance effectiveness requirements, what are the key requirements for successful road freight decarbonization? • Are there any important governance effectiveness requirements not covered by the three mentioned? What are these and why are they important?
Governance legitimacy[a]	• In what priority order would you place the three types of legitimacy, and why? • For each type of legitimacy, what are the key requirements for successful road freight decarbonization?
Other	• Are there other governance requirements not covered by the framework? What are these and why are they important?

[a] Governance pillars identified from literature review.

APPENDIX C. GOVERNANCE THEMES ALIGNED TO 24 SOURCE PAPERS

Table 2
Governance themes aligned to 24 source papers

Governance pillar	Governance theme	Sources
Overall transition governance		(Patterson et al., 2017; Wannags and Gold, 2020; Grewatsch et al., 2023)
Processes	Deliberation	Dentoni et al. (2018)
	Decision-making	Dentoni et al. (2018)
	Enforcement	Dentoni et al. (2018)
Effectiveness	Driving purposive transition	(Beer and Nohria, 2000; Marsden and Bonsall, 2006; Laes et al., 2014; Bosman and Rotmans, 2016; Avelino and Grin, 2017; Termeer et al., 2017; Hyysalo et al., 2019a, 2019b; Keating and Katina, 2019)
	Maintaining system functions	(Foxon et al., 2009; Hyysalo et al., 2019a, 2019b)
	Managing conflict and asymmetric power relations	(Ansell and Gash, 2008; Voβ and Bornemann, 2011; Bosman and Rotmans, 2016; Steurer and Bonilla, 2016; Downie, 2017; Normann, 2017)
Legitimacy	Input	(Mena and Palazzo, 2012; de Geus et al., 2022)
	Throughput	(Iusmen and Boswell, 2017; Schmidt and Wood, 2019; Steffek, 2019; de Geus et al., 2022)
	Output	(Mena and Palazzo, 2012; de Geus et al., 2022)

APPENDIX D. RECONCILING LEGITIMACY REQUIREMENTS

Some writers who oppose centralized governance criticize throughput legitimacy, as it is seen as an attempt to give authority to technocratic bodies (Iusmen and Boswell, 2017; Steffek, 2019). However, this study is founded on the assumption that the transition of complex socio-technical systems needs to be purposively codesigned by actors and policymakers, implying the need for at least some degree of centralized governance and technical understanding of the system being changed. If such "technocratic" governance is necessary, we propose that a consideration of throughput legitimacy is required to ensure that governance processes remain aligned with societal needs and expectations.

Within an interpretivist paradigm, diverse governance participation (input legitimacy) is often associated axiomatically with good governance. However, de Geus et al. (2022) find that, in the five case studies they consider, while inclusion and participation were emphasized in each case, the way these principles were applied was opaque and the process for closing down options and making final decisions was a black box. This suggests that assuming input legitimacy naturally leads to throughput and output legitimacy may be flawed.

In addition to the identification of input, throughput and output legitimacy in the selected papers, other legitimacy categories are proposed in wider literature. Pragmatic legitimacy (perceived as realistic and useful), normative legitimacy (perceived as socially and morally correct) and regulatory legitimacy (conforming to accepted rules) are identified as dimensions of individual views of legitimacy (Alexiou and Wiggins, 2019; Cheah and Low, 2022). Procedural legitimacy considers the application of administrative law to the functioning of supra-national organizations (Esty, 2006). Substantive and symbolic legitimacy are presented as contrasting motivations for enterprises engaging with and reporting on sustainability initiatives (Quintás and Martínez-Senra, 2024). Cognitive legitimacy is identified as a threshold that must be achieved by emerging organizations and practices if they are to succeed (Shi and Wang, 2023). These legitimacy dimensions provide further insight into what different stakeholders may assess to constitute legitimacy, but all also fall within the scope of input, throughput and output legitimacy. This reinforces the choice of the latter as a helpful high level framing.

A Scopus search for recent (2020 or later) literature including the words "legitimacy", "transport" and "transition*" in the title, abstract or keywords identified seven papers that consider legitimacy in the context of the sustainable transition of land transportation. Relevant themes from these papers include the need for social inclusion; the challenge of populist politics reinforcing automobility; and the roles of local, national and regional authorities in transitions. These themes further reinforce the need to consider input, throughput and output legitimacy; the need for alignment across authorities; and the importance of mechanisms to manage conflict and asymmetric power relations.

APPENDIX E. SELECTED INTERVIEW AND WORKSHOP QUOTES

1. "Half the time you're dealing with half-truths or half-baked sets of information that doesn't really allow you to [identify] the most optimum solution and bring all the different [stakeholders] with you." (Transport Authority 3)
2. "When it comes to road freight and commercial vehicles, there aren't many people that really fully understand the nuances of the industry." (Industry Association 2)
3. "Having everyone at a baseline level of knowledge to be able to have that conversation could be quite challenging, because we don't have [many] freight experts in local government." (Transport Authority 8)
4. "You'd have to look at all the options rather than just pluck one idea out of thin air. And then you'd go through a process, you'd do a multi criteria analysis." (Transport Authority 8)
5. "If ministers … take a view on a certain technology … then it's quite important to understand the scope that the options are being developed in." (Transport Authority 11)
6. "In all the engagement stuff I've done … you find that there's a conversation, but nobody will share any actual facts and figures." (Industry Association 1)
7. "You will never have the perfect evidence base. But as civil servants, we always strive to have as much evidence as we can to inform policy decisions." (Transport Authority 11)
8. "There is a significant need for the public and private sector to collaborate more on freight and logistics." (Transport Authority 3)
9. "We have voting members on the board and then we have non-voting members … everyone gets to skill up and teach in, but when it comes to voting, it's different." (Transport Authority 9)

10. “If the approval and assurance process has not been fully followed, if we’ve not explained, consulted and engaged multiple times with multiple stakeholders at multiple levels … things break down.” (Transport Authority 2)
11. “Our conventional tools for cost benefit analysis don’t help us … because decarbonizing is often more expensive than business as usual in the short term. It probably needs new approaches.” (Transport Authority 8)
12. “We’re not a democracy. I don’t expect … to vote and that vote somehow has some meaning. Because at the end of the day, someone has to make an executive decision.” (Industry Association 3)
13. “You need to know who leads what and who’s responsible for what when it comes to deliberation and decision making. You need to have a good understanding of accountability.” (Transport Authority 5)
14. “Operators are concerned you may need more vehicles because the payload is compromised or you need to stop to charge. There is going to need to be a way to understand how we measure and monitor that impact.” (Industry Association 4)
15. “On public transport, we’ve got more levers to pull. But for freight it is pretty limited.” (Transport Authority 8)
16. “Putting in regulations without enforcing them … is pointless regulation.” (Industry Association 1)
17. “I think you need a clear narrative of what it is beginning to end. Is it a vision, mission, something that’s ties it together. Otherwise … it starts to drift apart. “ (Industry Association 1)
18. “At the moment, the government has been fuel and technology agnostic and [have said] they’ll let the market decide. From everything I’ve seen, that leads to uncertainty - I refer to it as a Mexican standoff.” (Transport Authority 3)
19. “We’re driven by SMEs. So, if they have one or two HGVs and have to purchase another one, it’s a massive undertaking. If they buy the wrong truck, it bankrupts their company. How are they going to make a decision? That’s the number one question facing the industry.” (Transport Authority 4)
20. “There are pockets of good practice and there are people out there saying we need to sort this out, but it’s like swimming uphill when you haven’t got the policy leaders and the policy positions aligned at the right levels.” (Transport Authority 3)
21. “You need buy-in from customers, because while customers are saying we need to reduce our [scope 3] emissions, they’re not necessarily prepared to pay for it.” (Industry Association 4)
22. “The other one that jumped out for me was key player leadership, [for example] DHL and Amazon, because early investment will ensure the public infrastructure will be in place that others can then piggyback off for their own transition.” (Transport Authority 11)
23. “[Trials are] also very useful to build the case for things, both externally and internally … when it comes to planning the change and making sure that everyone’s on board with it.” (Transport Authority 5)
24. “When operators have transitioned to battery electric, they say they’re quieter, they’re cleaner and the drivers really love them. It’s selling the positives for the organization.” (Industry Association 4)
25. “If you’re carrying out quite radical change, there will be some disruption. It’s about understanding and managing disruption so that your priority freight flows are always maintained.” (Transport Authority 9)
26. “Maintaining system functions is more important than most people would think. People do understand it, but it’s how to bridge that. It’s not an easy one to do.” (Transport Authority 2)
27. “But if you’re talking to smaller operators at a regional level, just making the time for those kinds of meetings might be a challenge [for them]." (Transport Authority 8)
28. “The history of [SME] fleets is they don’t buy brand new vehicles. They buy secondhand refurbished HGVs which have been used by larger companies. The trouble is that when you decarbonize, there isn’t a secondhand market you can go to.” (Transport Authority 4)
29. “To manage conflicts and asymmetric power relations, some independent body is required. [This needs to] ensure that once you’ve set the course, you’ve got to get to zero, but by incentivizing reduction in carbon from the fleet in such a way that those vehicles can be cost-competitive to diesel.” (Industry Association 2)
30. “Taking input [legitimacy], I do think decision making is not very representative. Elected representatives probably more so, but in terms of officers and civil servants, it’s not great.” (Transport Authority 8)
31. “Too often, there’s a feeling that the consultation process is about submission rather than outreach and engagement.” (Industry Association 2)
32. “Did you tell the person who [gave the input] that you did something with it? If they don’t see you’ve done something with it, they will still not trust the process.” (Transport Authority 7)
33. “They’ve got the legitimacy of being given the money to do it. People have bought into the fact that it’s an essential part of the mix.” (Industry Association 2)
34. “You can’t say six months after a big upheaval [that it has worked]. People want more than that. [For example] they want to know that 20 mile per hour zones have led to a fall in accidents and greater road safety.” (Transport Authority 1)
35. “A city or regional authority is a challenging world to get action on freight, because there’s always higher priorities.” (Transport Authority 8)
36. “Having confidence in what government is saying and the goal posts won’t change. With the phase out date for cars and vans, we had the 2035 date which was stretching, that was moved to 2030 and then moved back, and now the new government may be moving it back again.” (Industry Association 4)
37. “If there’s anything that is seen as potentially unpopular with local people, it really is like pushing treacle up hill.” (Transport Authority 6)
38. “Sometimes you’ll have capital funding to do something but lack the revenue funding to have the people to implement these things, or for ongoing implementation if it is something that requires ongoing revenue funding.” (Transport Authority 8)
39. “You need an external person … who you can say …, “these are the options, what is your feedback?“" (Transport Authority 5)
40. “If we go back 100 years, we were transitioning from horse drawn vehicles to using trains [and then] lorries … lots of petrol stations had to be put in place, not by government but by the private sector. That took decades. The problem we’ve got is we can’t wait 30–40 years because of the climate emergency. So, what happened in the past is not an example that we can say will happen again.” (Transport Authority 4)
41. “Subsidies aren’t available. The number of vehicles we are talking about (is huge)." (Transport Authority 4)
42. “Especially given the make-up of the UK freight industry where profit margins are so small and cost of hardware is so high.” (Transport Authority 10)

APPENDIX F. AREAS OF DIFFERING OPINION

Governance processes - Collaboration

Differing perspectives were given on the effectiveness of collaboration in Zero Emission HGV and Infrastructure Demonstrations (ZEHIDs):
"Sharing of data is problematic, either from a company competitive point of view, or just for SME's having the resources and understanding how to do it." (Industry Association 4)
versus
"The collaboration part of that is really positive and the different consortia … are sharing a lot of information between themselves and also publishing it." (Transport Authority 11)

Governance processes – Right incentives

There were differing views on the need for stick as well as carrot incentives:
"Diesel becomes more expensive and therefore battery electric starts to become and more cost competitive. Increased tax on road diesel. The market can't decide because it doesn't have enough information to make the right decision, and the market at the moment is skewed in favor of carbon-based fuels." (Industry Association 2)
versus
"[Operators] would absolutely support in a safety perspective that you need that regulation and level playing field. In this space, [they] prefer the carrot approach." (Industry Association 4)

Governance effectiveness – Clear goal and roadmap

The role of a goal and roadmap from government was also contended:
"Industry can do this through market innovation. And what we need the politicians to do is to have an overall framework that allows that phasing in and phasing out to happen, but equally then not interfere, just let the market do its work." (Industry Association 3)
versus
"And it feels like our government and other governments do really need to just say, right, we're going to go down this route, and legislate for that." (Transport Authority 3)

Governance legitimacy – Output legitimacy

Different views were expressed regarding whether popular support is a required attribute of legitimacy:
"Legitimacy for me does not equal popularity. Just because a policy or an action is not popular at the moment does not mean it's not legitimate, if it's supported by objective evidence." (Transport Authority 1)
versus
"Something's gone wrong in the legitimacy of that process that has meant that people aren't buying into it, they're not particularly engaged in it and they really don't think it's going to be possible." (Industry Association 2)

Appendix G. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tranpol.2025.103771.

Data availability

The data that has been used is confidential.

References

Alexiou, K., Wiggins, J., 2019. Measuring individual legitimacy perceptions: scale development and validation. Strateg. Organ. 17 (4), 470–496. https://doi.org/10.1177/1476127018772862.

Ansell, C., Gash, A., 2008. Collaborative governance in theory and practice. J. Publ. Adm. Res. Theor. 18 (4), 543–571. https://doi.org/10.1093/jopart/mum032.

Avelino, F., Grin, J., 2017. Beyond deconstruction. a reconstructive perspective on sustainability transition governance. Environ. Innov. Soc. Transit. 22, 15–25. https://doi.org/10.1016/j.eist.2016.07.003.

Bächtiger, A., Dryzek, J.S., Mansbridge, J., Warren, M., 2018. 1Deliberative Democracy: an Introduction, *the Oxford Handbook of Deliberative Democracy*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198747369.013.50, 0.

Beer, M., Nohria, N., 2000. Breaking the Code of Change. Harvard business school press, Boston, MA.

Bhaskar, R., 2013. A Realist Theory of Science. https://doi.org/10.4324/9780203090732.

Biermann, F., Betsill, M.M., Gupta, J., Kanie, N., Lebel, L., Liverman, D., Schroeder, H., Siebenhüner, B., Zondervan, R., 2010. Earth system governance: a research framework. Int. Environ. Agreements Polit. Law Econ. 10 (4), 277–298. https://doi.org/10.1007/s10784-010-9137-3.

Bosman, R., Rotmans, J., 2016. Transition governance towards a bioeconomy: a comparison of Finland and the Netherlands. Sustainability 8 (10). https://doi.org/10.3390/su8101017.

Charmaz, K., 2008. Grounded theory as an emergent method. Handbook of emergent methods 155, 172.

Cheah, S.K.A., Low, B., 2022. The impact of public policy marketing, institutional narratives and discourses on renewable energy consumption in a developing economy. Asia Pac. J. Mark. Logist. 34 (5), 944–962. https://doi.org/10.1108/APJML-11-2020-0835.

Churchman, P., Dekker, T., Anable, J., 2025. Decarbonising road freight by operationalising transition theory: a systematic literature review. Manuscript Under Review.

Churchman, P., Dekker, T., Pangbourne, K., 2023. Transition codesign for purposive road freight decarbonization. Transport. Res. Transport Environ. 125. https://doi.org/10.1016/j.trd.2023.103980.

Danermark, B., Ekström, M., Karlsson, J.C., 2019. Explaining Society: Critical Realism in the Social Sciences. https://doi.org/10.4324/9781351017831.

de Geus, T., Wittmayer, J.M., Vogelzang, F., 2022. Biting the bullet: addressing the democratic legitimacy of transition management. Environ. Innov. Soc. Transit. 42, 201–218. https://doi.org/10.1016/j.eist.2021.12.008.

Dentoni, D., Bitzer, V., Schouten, G., 2018. Harnessing wicked problems in multi-stakeholder partnerships. J. Bus. Ethics 150 (2), 333–356. https://doi.org/10.1007/s10551-018-3858-6.

DfT, 2023a. Policy Paper: the plan for drivers. https://www.gov.uk/government/publications/plan-for-drivers/the-plan-for-drivers. (Accessed 11 October 2024).
DfT, 2023b. Transport and environment statistics: 2023. https://www.gov.uk/government/statistics/transport-and-environment-statistics-2023/transport-and-environment-statistics-2023. (Accessed 28 November 2024).
Downie, C., 2017. Business actors, political resistance, and strategies for policymakers. Energy Policy 108, 583–592. https://doi.org/10.1016/j.enpol.2017.06.018.
Esty, D.C., 2006. Good governance at the supranational scale: globalizing administrative law. Yale Law J. 115 (7), 1490–1562. https://doi.org/10.2307/20455663.
Fletcher, A.J., 2017. Applying critical realism in qualitative research: methodology meets method. Int. J. Soc. Res. Methodol. 20 (2), 181–194. https://doi.org/10.1080/13645579.2016.1144401.
Foxon, T.J., Reed, M.S., Stringer, L.C., 2009. Governing long-term social-ecological change: what can the adaptive management and transition management approaches learn from each other? Environ. Pol. Govern. 19 (1), 3–20. https://doi.org/10.1002/eet.496.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res. Pol. 33 (6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015.
Goury-Laffont, V., 2024. Farmers' protests sweep France, seizing agenda before EU elections. https://www.politico.eu/article/farmers-protests-france-unofficially-kicks-off-eu-elections-macron/. (Accessed 10 November 2024).
GOV.UK, 2023. Government invests £200 million to drive innovation and get more zero emission trucks on our roads. https://www.gov.uk/government/news/government-invests-200-million-to-drive-innovation-and-get-more-zero-emission-trucks-on-our-roads. (Accessed 11 April 2024).
Greening, P., Piecyk, M., A, P., Dadhich, P., 2019. Decarbonising road freight. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780895/decarbonising_road_freight.pdf. (Accessed 10 July 2021).
Grewatsch, S., Kennedy, S., Bansal, P., 2023. Tackling wicked problems in strategic management with systems thinking. Strateg. Organ. 21 (3), 721–732. https://doi.org/10.1177/14761270211038635.
Halbe, J., Holtz, G., Ruutu, S., 2020. Participatory modeling for transition governance: linking methods to process phases. Environ. Innov. Soc. Transit. 35, 60–76. https://doi.org/10.1016/j.eist.2020.01.008.
Halbe, J., Pahl-Wostl, C., 2019. A methodological framework to initiate and design transition governance processes. Sustainability 11 (3), 844.
Hyysalo, S., Lukkarinen, J., Kivimaa, P., Lovio, R., Temmes, A., Hildén, M., Marttila, T., Auvinen, K., Perikangas, S., Pyhälammi, A., Peljo, J., Savolainen, K., Hakkarainen, L., Rask, M., Matschoss, K., Huomo, T., Berg, A., Pantsar, M., 2019a. Developing policy pathways: redesigning transition arenas for mid-range planning. Sustainability 11 (3). https://doi.org/10.3390/su11030603.
Hyysalo, S., Marttila, T., Perikangas, S., Auvinen, K., 2019b. Codesign for transitions governance: a mid-range pathway creation toolset for accelerating sociotechnical change. Des. Stud. 63, 181–203. https://doi.org/10.1016/j.destud.2019.05.002.
IEA, 2023. CO2 emissions in 2022. https://www.iea.org/reports/co2-emissions-in-2022. (Accessed 1 April 2024).
IEA, 2024. Trucks and buses. https://www.iea.org/energy-system/transport/trucks-and-buses#tracking. (Accessed 17 April 2024).
Iusmen, I., Boswell, J., 2017. The dilemmas of pursuing 'throughput legitimacy' through participatory mechanisms. West Eur. Polit. 40 (2), 459–478. https://doi.org/10.1080/01402382.2016.1206380.
Jahn, D., Korolczuk, S., 2012. German exceptionalism: the end of nuclear energy in Germany. Environ. Polit. 21 (1), 159–164.
Jasanoff, S., 1996. Is science socially constructed - and can it still inform public policy? Sci. Eng. Ethics 2 (3), 263–276. https://doi.org/10.1007/BF02583913.
Keating, C.B., Katina, P.F., 2019. Complex system governance: concept, utility, and challenges. Syst. Res. Behav. Sci. 36 (5), 687–705. https://doi.org/10.1002/sres.2621.
Laes, E., Gorissen, L., Nevens, F., 2014. A comparison of energy transition governance in Germany, the Netherlands and the United Kingdom. Sustainability 6 (3), 1129–1152. https://doi.org/10.3390/su6031129.
Lähteenoja, S., Marttila, T., Gaziulusoy, İ., Hyysalo, S., 2023. Transition co-design dynamics in high level policy processes. Des. Stud. 88. https://doi.org/10.1016/j.destud.2023.101207.
Land, J., 2024. Producing locally causal explanations in qualitative research by using a realist phenomenological methodology. Int. J. Qual. Methods 23, 16094069241234806. https://doi.org/10.1177/16094069241234806.
Loorbach, D., 2010. Transition management for sustainable development: a prescriptive, complexity-based governance framework. Governance 23 (1), 161–183. https://doi.org/10.1111/j.1468-0491.2009.01471.x.
Lovell, K., Watson, J., Hiteva, R., 2022. Infrastructure decision-making: opening up governance futures within techno-economic modelling. Technol. Forecast. Soc. Change 174. https://doi.org/10.1016/j.techfore.2021.121208.
Marsden, G., Bonsall, P., 2006. Performance targets in transport policy. Transp. Policy 13 (3), 191–203. https://doi.org/10.1016/j.tranpol.2005.09.001.
Mena, S., Palazzo, G., 2012. Input and output legitimacy of multi-stakeholder initiatives. Bus. Ethics Q. 22 (3), 527–556. https://doi.org/10.5840/beq201222333.
Meyer, S.B., Lunnay, B., 2013. The application of abductive and retroductive inference for the design and analysis of theory-driven sociological research. Sociol. Res. Online 18 (1), 86–96. https://doi.org/10.5153/sro.2819.
Normann, H.E., 2017. Policy networks in energy transitions: the cases of carbon capture and storage and offshore wind in Norway. Technol. Forecast. Soc. Change 118, 80–93. https://doi.org/10.1016/j.techfore.2017.02.004.
Olsson, P., Folke, C., Berkes, F., 2004. Adaptive comanagement for building resilience in social-ecological systems. Environ. Manag. 34 (1), 75–90. https://doi.org/10.1007/s00267-003-0101-7.
Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., Barau, A., 2017. Exploring the governance and politics of transformations towards sustainability. Environ. Innov. Soc. Transit. 24, 1–16. https://doi.org/10.1016/j.eist.2016.09.001.
Pel, B., 2024. Is 'digital transition' a syntax error? Purpose, emergence and directionality in a contemporary governance discourse. J. Resp. Inno. 11 (1), 2390707. https://doi.org/10.1080/23299460.2024.2390707.
Pineda, A.F.V., Elle, M., Iuel-Jensen, J., 2024. The role of design in sustainable transitions: the case of mobility in greater copenhagen. Environ. Innov. Soc. Transit. 50. https://doi.org/10.1016/j.eist.2023.100807.
Quintás, M.A., Martínez-Senra, A.I., 2024. Are small and medium enterprises defining their business models to reach a symbolic or substantive environmental legitimacy? J. Environ. Plann. Manag. 67 (4), 742–765. https://doi.org/10.1080/09640568.2022.2132476.
Reichertz, J., 2009. Abduction: the logic of discovery of grounded theory. Forum Qualit. Sozialfor. 11 (1).
Rosenbloom, D., 2017. Pathways: an emerging concept for the theory and governance of low-carbon transitions. Glob. Environ. Change 43, 37–50. https://doi.org/10.1016/j.gloenvcha.2016.12.011.
Rotmans, J., 2005. Societal innovation: between dream and reality lies complexity. SSRN Electron. J. https://doi.org/10.2139/ssrn.878564.
Schmidt, V., Wood, M., 2019. Conceptualizing throughput legitimacy: procedural mechanisms of accountability, transparency, inclusiveness and openness in EU governance. Public Adm. 97 (4), 727–740. https://doi.org/10.1111/padm.12615.
Shell/Deloitte, 2021. Decarbonising road freight: getting into gear. https://www.shell.com/energy-and-innovation/the-energy-future/decarbonising-road-freight.html#iframe=L2Zvcm1zL2VuX2diX2VucXVpcnlfZm9ybQ. (Accessed 1 May 2022).
Shi, F., Wang, C.C., 2023. Cognitive legitimacy and ownership heterogeneity: impact of local incumbent firms on new private firm formation in China's manufacturing sector. Reg. Stud. 57 (2), 344–355. https://doi.org/10.1080/00343404.2022.2094906.
Smith, A., Stirling, A., Berkhout, F., 2005. The governance of sustainable socio-technical transitions. Res. Pol. 34 (10), 1491–1510. https://doi.org/10.1016/j.respol.2005.07.005.
Steffek, J., 2019. The limits of proceduralism: critical remarks on the rise of 'throughput legitimacy'. Public Adm. 97 (4), 784–796. https://doi.org/10.1111/padm.12565.
Steurer, N., Bonilla, D., 2016. Building sustainable transport futures for the Mexico City metropolitan area. Transp. Policy 52, 121–133. https://doi.org/10.1016/j.tranpol.2016.06.002.
Termeer, C.J.A.M., Dewulf, A., Biesbroek, G.R., 2017. Transformational change: governance interventions for climate change adaptation from a continuous change perspective. J. Environ. Plann. Manag. 60 (4), 558–576. https://doi.org/10.1080/09640568.2016.1168288.
Voß, J.P., Bornemann, B., 2011. The politics of reflexive governance: challenges for designing adaptive management and transition management. Ecol. Soc. 16 (2). https://doi.org/10.5751/ES-04051-160209.
Voß, J.P., Smith, A., Grin, J., 2009. Designing long-term policy: rethinking transition management. Policy Sci. 42 (4), 275–302. https://doi.org/10.1007/s11077-009-9103-5.
Wannags, L.L., Gold, S., 2020. Assessing tensions in corporate sustainability transition: from a review of the literature towards an actor-oriented management approach. J. Clean. Prod. 264. https://doi.org/10.1016/j.jclepro.2020.121662.
Williams, M., Moser, T., 2019. The art of coding and thematic exploration in qualitative research. Int. Manag. Rev. 15 (1), 45–55.
Yildiz, A., 2024. From Streets to Policies: the Impact of Yellow Vests Movement on French Public Policy. SSRN 4765783.

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