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Tactics of infrastructures in transitions: exploring the space between decarbonization strategies and operational practices in Dutch infrastructure organizations

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ABSTRACT

Infrastructure systems are critical to advancing decarbonization goals, yet translating strategic ambitions into practice remains challenging. While prior research has explored high-level visions and operational experiments, the tactical level—where mid-level actors coordinate between strategy and operations—has received limited attention. This study investigates how tactical-level functions shape sustainability strategy implementation across three Dutch infrastructure providers: a national mobility agency, a regional drinking water utility, and a regional electricity distribution operator. Based on 34 semi-structured interviews and document review, it identifies four tactical functions: translating strategic goals into operational roles, processes, and requirements; taking advantage of emerging interdependencies and collaboration opportunities; trade-off navigating between conflicting priorities; and transferring lessons from operations back to strategy. These functions are shaped by sector-specific constraints and institutional contexts but reveal shared interdependencies, particularly in capacity planning. The findings underscore tactical actors' crucial role in aligning sustainability ambitions with operational realities across interdependent infrastructure systems.

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Infrastructure; decarbonization; sustainability transitions; tactical level; energy-water-mobility

1. Introduction

Effective infrastructure planning is indispensable for ensuring economic development and societal needs. Yet accelerating resource depletion, environmental degradation, and systemic uncertainties require infrastructure providers to rethink how systems are governed, designed, and managed while maintaining resilient and future-proof services (Ahmadi, Shirkhani, & Lounis, 2025).

Long-range planning and strategic management scholarship have long recognized the gap between strategic intent and actual practice – often attributed to individual motivations, organizational culture, and behavioral inertia (Gratton, 1996; Mintzberg, 1994). Although the content and language of strategy have evolved over the past decades, the gap between strategy and operations continues to be framed as a longstanding organizational challenge (Friesl, Stensaker, & Colman, 2021). The accomplishment of sustainability strategies present a unique context around this gap: they often involve ambiguous or conflicting goals (Engert & Baumgartner, 2016), temporal misalignments between long-term ambitions and short-term demands (Slawinski & Bansal, 2015), and tensions with existing organizational logics and legitimacy (Hengst et al., 2020).

Sustainability transitions are defined by long-term, fundamental shifts in socio-technical systems towards more sustainable modes of production and consumption (Köhler et al., 2019), whereas infrastructure planning and management have traditionally emphasized incremental improvements in efficiency and resilience (Faber et al., 2020), rooted in established practices and routines (Bojórquez-Tapia et al., 2022). Such transitions are especially challenging because infrastructure assets, such as bridges, grids, and pipelines, are long-lived and capital-intensive that decisions made

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in the past may result in institutional and behavioural lock-ins that are difficult to reverse (Ersoy, Bryson, & Van Bueren, 2020), and encouraging risk-averse decisions in operations (Buhl & Markolf, 2023). Moreover, as infrastructure assets are an important part of public services, infrastructure providers need to respond to long-term transition ambitions while simultaneously responding to external pressures and shocks and dealing with existing assets and the operational responsibility of providing reliability and accessibility to the public. This creates a constant tension between the future ambitions, past commitments, and present operational demands. These demands are further shaped by the high interdependencies between infrastructure systems, where changes in one system can affect both strategies and operations of others (Hall et al., 2016). This makes infrastructure an important context for investigating how actors work between strategy and operations under transition pressures.

This brings into focus the tactical level of infrastructure – the organizational interface where strategic objectives are translated into actionable plans through prioritization, resource allocation, and mediation between strategic ambitions and operational realities (Mantere, 2008; Mintzberg, 1994; PMI, 2017). The tactical level is distinct from the operational level where plans are executed as discrete tasks and projects, as well as the strategic level that sets the long-term direction. As such, the strategy-to-operations gap becomes particularly visible at this tactical interface, which is both critical yet underexplored in sustainable infrastructure transitions (Kaya et al., 2025).

In the infrastructure context, recent literature has acknowledged the tactical level and the challenge of aligning strategy with operations. Though not as the main focus of inquiry, Xu et al. (2022) describe the tactical level as the interface between project activities and operational preparation for mega-infra projects, while Zani, Denicol, and Broyd (2024) position it as the mediating layer between strategic managers and operational actors, coordinating resources and 'gate-keeping' top-down and bottom-up processes. Other studies identify project portfolios and infrastructure programmes as tools for aligning projects with strategic direction (Eikelenboom et al., 2025; Roberts & Hamilton Edwards, 2023) or emphasize the neglected meso-scale of implementing circularity and sustainability in infrastructure projects (Liu, Dijk, & Colombo, 2024) and industry (Meath et al., 2022). Together, these studies echo broader calls for greater attention to middle-management roles in public organizations (Brorström & Willems, 2021).

However, these studies primarily examine projects, programmes, or governance arrangements rather than infrastructure organizations themselves as the unit of analysis. This is also reflected in the sustainability transitions literature, where organizations have often been approached as relatively monolithic actors responding to environmental change (Ohlendorf, Löhr, & Markard, 2023; Patala et al., 2019), while there is growing interest in unpacking organizations from inside-out to understand the struggles to align internal structures, interests, and demands when adapting to sustainability (Schupfer & Soppe, 2025). Following this direction, this study takes the tactical level inside those organizations itself as the object of inquiry, examining which actors operate at this level, how tactical functions – defined here as the mediating practices linking strategy and operations – are enacted, and what challenges and enabling practices emerge. In doing so, the study brings the underexamined tactical organizational space in sustainability transitions into focus.

Additionally, this strategy-to-operations gap is not only intra-organizational, as most existing studies have examined, but also inter-organizational, because sustainability transitions require coordination of resources and institutional arrangements across interdependent infrastructure systems such as energy, water, and transport (Monstadt et al., 2022). Yet infrastructure research has largely examined this gap from an intra-organizational perspective, with tactical work primarily explored within individual organizations. Consequently, little is known about how tactical work unfolds between infrastructure organizations, where cross-sectoral tensions are negotiated, and long-term sustainability ambitions are translated into coordinated operational action (Kaya et al., 2025). This study addresses this gap by examining tactical functions within and between infrastructure organizations, asking:

RQ: What tactical functions emerge in and between infrastructure organizations pursuing sustainability transitions, and how do they address the gap between sustainability strategy and operations?

Drawing on qualitative data from three Dutch infrastructure organizations responsible for national mobility, drinking water, and electricity distribution, this study investigates how tactical functions shape sustainability transitions across interdependent infrastructure systems. It contributes to the infrastructure sustainability transitions literature by conceptualizing the tactical level through an empirically grounded typology of four tactical functions and revealing sector-specific differences and opportunities for cross-sectoral coordination. Section 2 presents the theoretical background conceptualizing the tactical level, followed by the methodology and case descriptions in Section 3. Section 4 presents the findings by identifying tactical actors and tactical functions across the infrastructure agencies (Sections 4.1–4.3), followed by cross-case comparison (Section 4.4) and their inter-agency interfaces (Sections 4.5). Finally, Section 5 discusses the challenges and prospects behind the revealed tactical functions, together with theoretical and practical implications.

2. Theoretical background

2.1. Understanding tactical level in management literature

Management literature has traditionally distinguished organizational functions into three interconnected levels: strategic, tactical, and operational. In general management, Mintzberg (1994) conceptualizes the tactical level as the intermediary layer where strategic goals are translated into actionable medium-term plans. Following Parnell (2008), strategic planning defines where the organization wants to go in long-term, operational planning specifies how work is executed, while tactical planning occupies the space between them by setting the boundary conditions through which strategic ambitions are translated into coordinated operational action. Accordingly, we conceptualize tactical work through three interrelated dimensions: **people, processes, and prioritization** (Figure 1). Together, these dimensions explain **who** interprets and aligns strategy with operations, **how** strategic ambitions and operational experiences are continuously mediated between organizational levels, and **how** competing organizational values and resources are prioritized and balanced.

People: Tactical work has often been associated with middle managers, described as *strategy translators* who interpret strategic visions and align strategic ambitions with operational realities (Balogun & Johnson, 2004; Mantere, 2008). Beyond implementing deliberate strategy, these actors also influence strategy formation by communicating operational experiences upwards through synthesizing information (Wooldridge, Schmid, & Floyd, 2008). Similarly, program and portfolio managers coordinate strategic intent across multiple projects (Pellegrinelli, 2002). In the public sector, middle managers champion alternatives, synthesize information, implement policy and span organizational

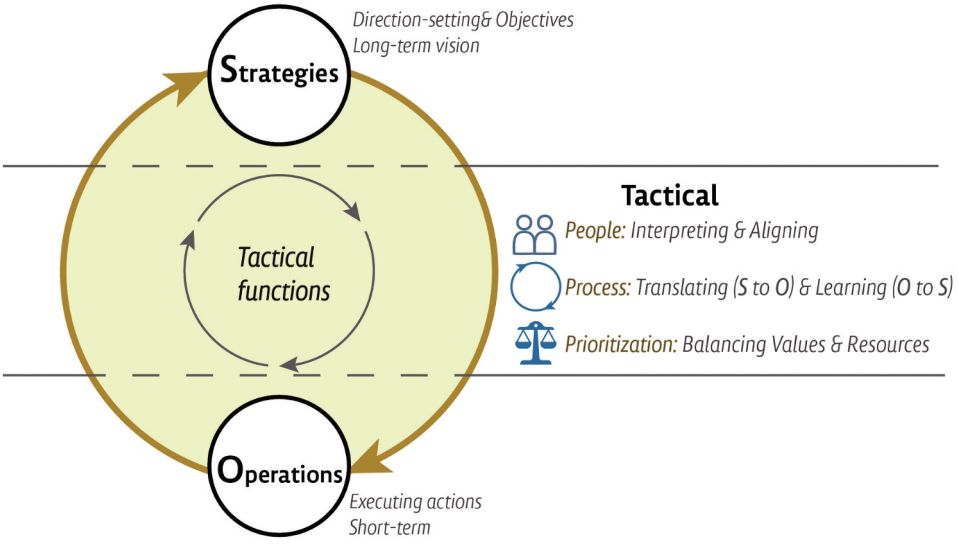

Figure 1. Conceptualization of tactical level (inspired by the above literature, drawn by authors).

boundaries (Chen, Berman, & Wang, 2017). Occupying this intermediary position requires them to continuously navigate relationships in both upward and downward directions (Gjerde & Alvesson, 2020). Consequently, organizations increasingly depend on empowering these actors to respond effectively to uncertainty (Mamburu, de Metz, & Davis, 2024).

Process. Tactical work involves processes through which activities are organized and connected across the strategy–operations divide. While management studies have predominantly examined tactical processes from a top-down, strategy-to-operations perspective, Mintzberg's concept of emergent strategy argues that strategy also develops through operational learning, whereby middle managers communicate operational experiences upward and shape strategic adaptation (Mintzberg & Waters, 1985). Later, strategy-as-practice perspective provides a contrasting position to understanding strategy as a thing to be implemented, in order to bring into focus the process of making a strategy, often involving middle managers (De Metz, Jansen van Rensburg, & Davis, 2023; Van Rensburg, Davis, & Venter, 2014; Whittington, 2006). Recent public project organization research similarly highlights that strategic change depends on practices connecting organizational ambitions with implementation, including knowledge transfer across projects (Eikelenboom & van Marrewijk, 2024). Likewise, public management scholars argue that learning from implementation experiences enables the continuous adaptation of strategy and public value creation (Moore, 2021). Thus, the process dimension captures the ways in which activities are connected across levels, as from strategy-to-operations and operations-back to strategy. (Figure 1)

Prioritization. Tactical work is characterized by the continuous balancing of competing organizational values, objectives, and resource constraints. Rather than implementing strategy mechanically, tactical actors reconcile long-term ambitions with short-term operational realities by allocating resources, coordinating interdependencies, and negotiating competing stakeholder interests (PMI, 2017). Similarly, project portfolio management positions the tactical level as responsible for aligning resource allocation with strategic objectives and realizing synergies across projects (Gemünden & Kock, 2025). Within public organizations, prioritization extends beyond individual organizational objectives to balancing shared resources, activities, and capabilities across organizations in pursuit of public value and accountability (Bryson, Crosby, & Stone, 2006)

Accordingly, we conceptualize the tactical level as a dynamic organizational space constituted by people, processes, and prioritization. Together, these dimensions shape tactical functions – the recurring mediating practices through which sustainability ambitions are interpreted, prioritized, coordinated, and translated into organizational action. Rather than referring to a single activity, process, or formal organizational position, the term *tactical functions*[1] is used as an umbrella term that comprises multiple activities, processes, and roles that jointly connect strategy and operations.

2.2. Understanding the tactical level in infrastructure sustainability transitions

This practice-oriented understanding is particularly relevant for infrastructure organizations pursuing sustainability transitions. Transition scholarship has primarily examined implementation from two perspectives. Strategic studies focus on long-term transition pathways and policy visions, such as decentralized water infrastructures (Särkilahti et al., 2017) and infrastructure lock-ins in energy transitions (Mühlemeier, 2019). Operational studies examine experimental pilot projects (Li et al., 2022; Tongur & Engwall, 2017), asset management (Alegre et al., 2016), and resource-efficient practices (Roelich et al., 2015). Between these perspectives, the tactical level has received comparatively limited attention, typically appearing as the space connecting strategy and operations rather than the primary object of inquiry. Existing infrastructure research refers to this space through organizational and integration capacities, organizational and regime barriers such as engineering culture (Birch, 2016; Coenen et al., 2022), yet without explicitly examining tactical practices for infrastructure organizations-in-sustainability transitions (Kaya et al., 2025).

Following Borrás et al. (2024), we view the transformative capacity of public organizations as emerging from the interaction between organizational roles, resources, and capabilities. Building on this perspective and Figure 1, we conceptualize these capacities as being enacted through tactical functions, whereby people, processes, and prioritization translate strategy into operations, integrate operational learning into strategy, and balance competing organizational demands. In infrastructure transitions, however, these functions extend beyond individual organizations because infrastructure systems are inherently interdependent.

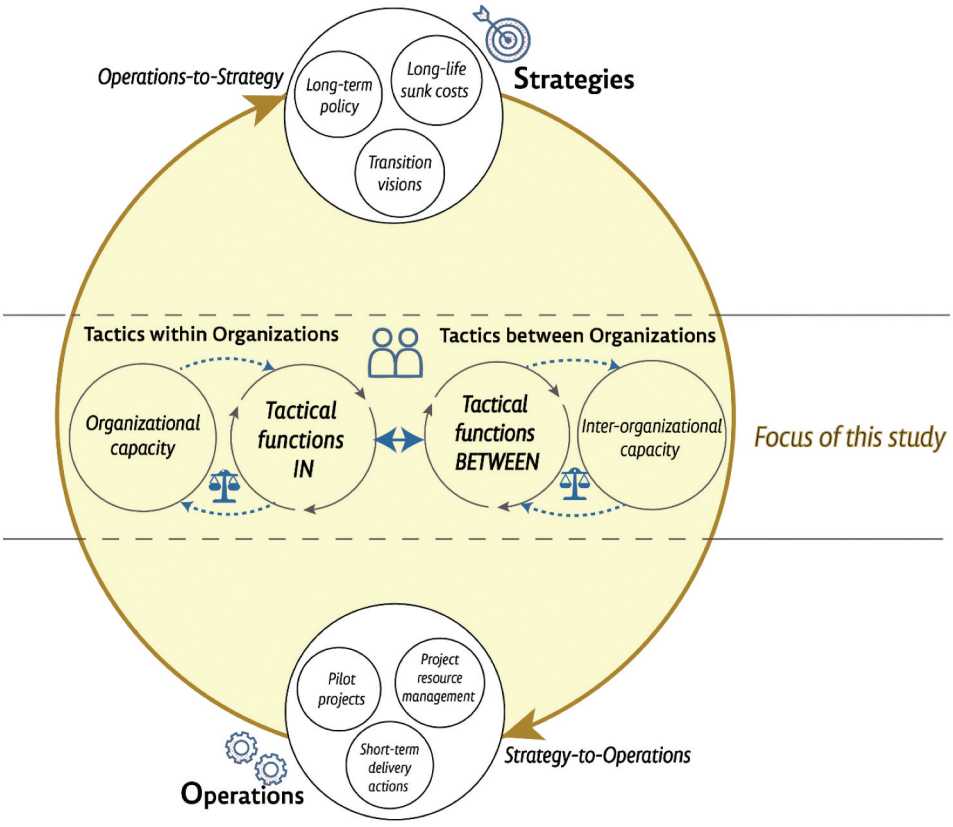

Figure 2. Conceptualization of tactical level in infrastructure-in-sustainability transitions (inspired by the below literature, drawn by authors).

Consistent with this view, Transition Management conceptualizes the tactical level as the domain of 'actors and processes responsible for agenda-building, negotiation, and coalition-building within and between organizations' (Loorbach, 2010). Yet, while Loorbach recognizes that the tactical level operates across organizations, no attention has been paid to how tactical functions emerge across interdependent infrastructure systems such as energy, water, and transport (Kaya et al., 2025).

Accordingly, Figure 2 extends the conceptualization introduced in Figure 1 by positioning tactical functions as recurring mediating activities operating both within and between infrastructure organizations. Within organizations, tactical functions address organizational capacity challenges, whereas between organizations, they coordinate shared infrastructure interdependencies, resources, and long-term transition ambitions.

3. Research methods

3.1. Case selection, characteristics and boundaries

Dutch infrastructure provides a compelling context for analyzing tactical-level dynamics in sustainability transitions, given the country's pioneering role in sustainability and climate governance (Frantzeskaki, Jhagroe, & Howlett, 2016). Since the late 2000 s, most infrastructure policies and projects have incorporated elements of sustainable development, with this orientation becoming especially explicit by 2008 (Wetenschappelijke Raad voor het Reg, 2008). Yet beyond these ambitions, Dutch infrastructure systems face a critical challenge: territorial space scarcity and the cumulative societal and environmental pressures it creates (Priemus, Flyvbjerg, & Wee, 2008). As such, Dutch infrastructure lies at the core of a tactical dilemma – how to translate ambitious sustainability goals into action within constrained operational capacities.

This research focuses on publicly owned infrastructure providers responsible for national mobility infrastructure, electricity distribution, and drinking water provision in The Netherlands. The study examines how these organizations translate sustainability strategies into tactical and operational practices, with particular attention to circular infrastructure management, climate adaptation, and the energy transition, respectively. While their institutional forms vary, from central government agencies to regional public utilities, all serve key societal functions with public ownership as the largest utility companies and national infra agency, and operating across overlapping geographic regions. The selected organizations reflect the cross-sectoral nature sustainability transitions of infrastructure network and were engaged through collaboration with an infrastructure consortium that supports this research.

3.1.1. National mobility and water infrastructure manager: organization A

The first case examines the national agency responsible for large-scale mobility and water infrastructure – including highways, waterways, bridges, tunnels, dams, and sluices – and for their planning, maintenance, and renovation. Traditionally, the organization operated under a hierarchical model in which the Ministry of Infrastructure and Water Management defined strategic objectives and budgets, while the agency managed the planning, tendering, and delivery of national infrastructure projects. This structure has gradually evolved toward asset management, revealing the need for improved coordination across strategic, tactical, and operational processes (Volker et al., 2013) and reflecting a broader transition toward a more networked, society-responsive governance model (van den Brink, 2020). The organization aims to be climate-neutral and fully circular by 2030 across its entire asset portfolio and direct operations. This ambition involves reducing carbon emissions by 612 kton CO_2 eq. by 2030 alongside maximizing material reuse (e.g., CO_2 performance cost indicator for tendering and circular asphalt initiatives) (Ministry of Infrastructure and Water Management, 2020). According to a recent study, the agency's tactical focus is shaped by the dual challenge of renewing its aging infrastructure while meeting climate-neutral and circularity targets, particularly by aligning circular strategic ambitions with renovation operations (van Dongen, 2025).

3.1.2. Regional drinking water utility: organization B

The second case covers a public drinking water utility serving the central and eastern provinces of The Netherlands, including Gelderland, Overijssel, Utrecht, and Flevoland. Within the Dutch water management system, Organization A manages national water infrastructure and ensures freshwater availability and flood protection, while Organization B is responsible for the sustainable extraction, treatment, and distribution of drinking water. Drinking water infrastructure is designed to ensure long-term availability, quality, and accessibility, with strategies shaped by environmental conditions. Recent challenges, particularly the prolonged droughts between 2018 and 2020, have intensified pressure on water resources and underscored the need for adaptive responses (van der Wiel, Batelaan, & Wanders, 2023). The utility relies predominantly on groundwater extraction and, under its *Every Drop Sustainable* strategy, aims to minimize ecological impacts, reduce energy consumption, and embed circular principles – including reuse, material efficiency, and flexible water systems – thereby contributing to national climate-neutral and circularity goals. Within this context, the tactical focus of this case lies in how sustainability strategies are operationalized in drinking water infrastructure planning and project implementation.

3.1.3. Regional electricity infrastructure operator: organization C

The third case examines a regional electricity distribution system operator (DSO) responsible for managing low- and medium-voltage grids across several Dutch provinces, including Gelderland, Noord-Holland, Friesland, and parts of the Randstad. As The Netherlands accelerates its transition towards decentralized renewable energy, increasing electrification of transport, heating, and industry is placing growing pressure on grid infrastructure, risking delays in the energy transition without major upgrades (PBL Netherlands Environmental Assessment Agency, 2023). Operating in densely populated and industrialized regions, the organization faces acute grid congestion, reinforced by the rise of prosumers and the growing integration of decentralized energy resources, making distribution system operators increasingly critical to the energy transition (Nederland, 2024). Unlike Organization B, which operates in a fully public, non-liberalized sector, Organization C – though also publicly owned and heavily regulated – operates within a liberalized

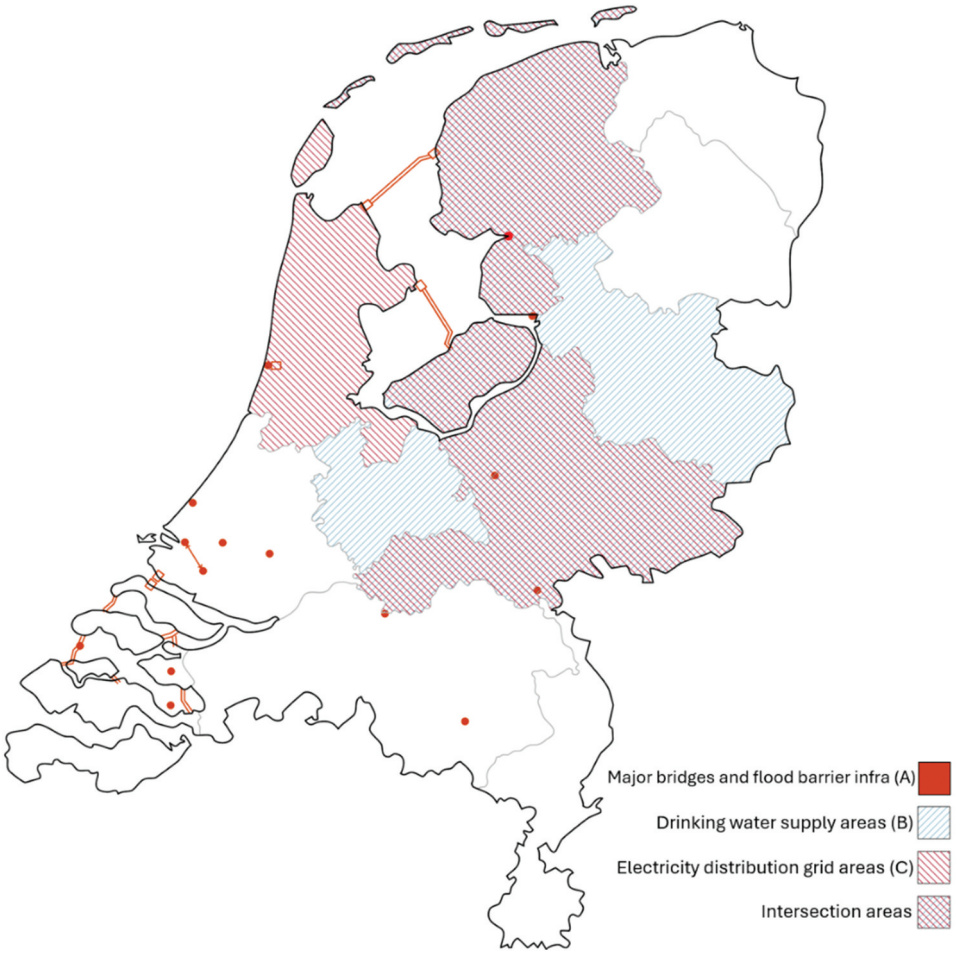

Figure 3. Map of case organizations.

energy market, where production and supply are unbundled from grid operation under the Electricity Act (1998). Accordingly, the tactical focus of this case lies in managing operational constraints and capacity bottlenecks while aligning with national decarbonization goals. This requires moving from simply 'laying cables' to efficient and flexible use of the existing grid to accommodate renewables and future demand (Kaya et al., 2026).

This regional electricity distributor is operationally interdependent with the other both cases, as both rely on the operated electricity distribution network to power critical infrastructure – such as pumping stations, water treatment facilities, and flood control systems, bridge mechanisms – while also coordinating on underground works and spatial planning. As shown in the map of the case organizations, in Figure 3, their overlapping service areas further underscore this operational linkage. These three cases represent distinct yet interdependent infrastructure systems that face parallel pressures to implement decarbonization strategies. Their selection allows the study to examine how tactical-level functions are enacted both within and across organizations – driven by shared sustainability ambitions and a mutual dependency on the same external environment.

3.2. Data collection

To explore how tactical functions mediate sustainability transitions in infrastructure organizations, we employed a multi-step qualitative case study approach. Data collection began with desk research to map sectoral decarbonization ambitions and transition contexts of the case organizations. We reviewed 11 documents (Supplementary Data), including national policy frameworks (e.g., the Dutch Climate Agreement), sectoral strategies for water, energy, and climate-neutral infrastructure,

and organizational documents such as strategic plans, innovation portfolios, and annual capacity report. These documents were reviewed to set the background of the sustainability transition commitments and key operational challenges of each organization. Therefore, the set of documents involved not only the organizations' own strategy documents, but also broader institutional agreements and sector-specific legal/regulatory frameworks, such as national climate and sectoral agreements. The documents were not formally coded as part of Gioia methodology but were used to provide contextual and background information on the sustainability ambitions of the case organizations. This review helped identifying sector-specific sustainability goals and informed the selection of initial strategic-level interviewees, consistent with case study approaches using multiple data sources to strengthen construct validity and contextual understanding (Yin, 2018). These interviewees helped validate the desk-research insights and identify actors involved in connecting long-term ambitions with operational realities.

Rather than being selected according to formal organizational positions, participants working at the tactical level were identified through the mediating functions they perform between strategy and operations (following Figure 1), established through document analysis and snowball sampling based on their involvement in work such as translating strategy, learning from operations, coordination or prioritization. This identification also drew on how interviewees described their own roles as 'tactical' and/or referred to colleagues performing these functions in between long-term strategic-direction setting and daily operations level. Consequently, an interviewee's formal position could be predominantly strategic or operational while still encompassing tactical functions they carried out or recognized as necessary – meaning tactical actors were defined by the boundary-spanning work they performed rather than by job title or hierarchical level. To do so, first initial interviews (Table 1), including program managers, sustainability advisors, and corporate social responsibility directors, revealed key tensions between sustainability ambitions and available capacity. We subsequently applied purposive sampling (Campbell et al., 2020) to deliberately select actors working around the main operational challenges in relation to long-term ambitions in each case, such as who involved in capacity planning, asset management, and cross-departmental coordination, operating between strategic direction and operational implementation. For example, in Organization A, we focused on how the renovation backlog in national infrastructure (TNO, 2021) affects the pursuit of climate-neutral ambitions. In Organization C, we focused on how grid congestion, with more than 10,000 parties on waiting lists for new connections and waiting times of up to 10 years (De Telegraaf, 2024), affects the energy transition. These focal areas shaped subsequent interviews. To achieve data saturation, we applied snowball sampling, whereby interviewees recommended additional participants based on thematic relevance (Atkinson & Flint, 2001). Respondents were selected across organizational layers, including those responsible for sustainability strategy, those engaged in operational innovation trials or projects, and those bridging these domains, to capture the dynamics of the tactical level. It is important to note that this study focuses on internal tactical functions within infrastructure providers. External stakeholders (e.g., ministries, regional governments, contractors, or end-users such as households and road users) were not included in the interview sample, despite their relevance to broader sustainability transitions. The focus remains on how infrastructure organizations coordinate, interpret, and act upon sustainability mandates within and across sectors.

A total of 34 interviews were conducted across the three infrastructure organizations, as presented in Table 1. Participants were purposefully selected based on their involvement in sustainability transition activities and the main operational challenges of each case. Building on the sampling approach described above snowball sampling were used to identify additional relevant participants. Data collection continued until recurring patterns in these tactical functions were observed across the three cases and additional interviews yielded no substantially new themes, indicating data saturation (Moser & Korstjens, 2018).

Interviews with the electricity distribution operator were conducted between December 2023 and March 2024, with the national infrastructure agency between November 2024 and June 2025, and with the drinking water provider between June 2024 and July 2025. Each interview lasted approximately 45–60 minutes. The 18-month data collection period enabled us to capture evolving tactical challenges amid changing political, social, and organizational conditions. Interviews with the electricity and water organizations (Organizations B and C) were conducted in English. Most interviews with the national infrastructure agency (Organization A) were conducted in Dutch, except for three interviews (Int. 4, Int. 6, and Int. 10) held in English; Dutch transcripts were

Table 1. Interview list.

Organization	No.	Interviewee Type	Function in Transitions	1st Round	2nd Round
Organization A: National Mobility and Water Infrastructure Manager	Int.1	Director of Major Projects & Maintenance	Large-scale renovation and maintenance planning-guiding strategic direction		X
	Int.2	Program Secretary Climate Neutral and Circular Infrastructure Projects	Updating long-term transition strategy and mid-term action plans (to 2027)		X
	Int.3	Innovation Advisor (in GPO*)	Advising circular innovation for projects		X
	Int.4	Director of Replacement &Renovation	Sustainability themes for renovation and replacement projects		X
	Int.5	Program Director for Vital Infrastructure/ Market transition	Connecting the bigger strategy with national programming of projects		X
	Int.6	Program Manager- Climate-neutral& Circular Infra	Developing strategies for decarbonization	X	X
	Int.7	Senior Portfolio Advisor (Locks)	Improving the quality of renewal tasks (locks, sluices)		X
	Int.8	Portfolio Manager/Technical Client (Bridges)	Procurement strategy shifts, engagement with contractors		X
	Int.9	Head Innovation Management Program (in WVL**)	Setting the innovation agenda, internal innovation process		X
	Int.10	Senior Consultant in Circular Infra (Bridges, Viaducts)	Developing a roadmap for the transition of bridges		X
Organization B: Regional Drinking Water Utility	Int.1	Policy Advisor/ Asset Manager	Long-term targets for asset management planning	X	X
	Int.2	Program Manager/Stakeholder Manager	Program for reducing the daily water demand		X
	Int.3	Strategist	Defining the internal sustainability agenda		X
	Int.4	Legal Advisor	Navigating legal uncertainties around water scarcity, environmental measures and financing		X
	Int.5	Marketing Advisor	Internal and external communication with drinking water consumers		X
	Int.6	Portfolio Manager	Balancing the investment and resources for the portfolio		X
	Int.7	Policy Advisor/Strategist	Advising strategic board on transition path		X
	Int.8	Program Manager- Sustainability	Monitoring sustainability performance and including sustainability in decisions		X
	Int.9	Asset Manager/ Stakeholder Manager	Standardize stakeholder management practices, long-term and short-term projects in the Province of Gelderland		X
	Int.10	Program Manager/ Asset Manager	Long-term and short-term drinking water projects in Province Overijssel		X
	Int.11	Policy Advisor	Advising policy to the strategic board		X
	Int.12	Strategic Advisor	Scanning the external changes to inform top management		X
	Int.13	Business Development Manager	Innovation agenda and developing new sustainable solutions		X
Organization C: Regional Electricity Infrastructure Operator	Int.1	Corporate Social Responsibility Director	Shaping ESG strategy, prosperity ethics agenda	X	X
	Int.2	Regional Manager (North Holland)	Overseeing Grid expansion and congestion management	X	X
	Int.3	Lead Research Advisor- Digital Monitoring	Monitoring energy network, exploring AI-driven solutions		X
	Int.4	Program Manager- Congestion Management and Market Innovation	Platform design for congestion management and customer connection		X
	Int.5	Senior Policy Advisor	Risk-based investment strategies		X
	Int.6	Consultant in Energy Transition	Local energy transition consultant aligning with the grid		X
	Int.7	Innovation Development Lead	Tariff systems for congestion relief		X
	Int.8	Team Leader in Grid Strategy	Political and societal shifts to strategic ambitions		X
	Int.9	Technical Project Lead-Sustainable Grid Integration	Product design for new decentralized energy demands		X
	Int.10	Innovation Consultant	Redesign internal products and rules for energy transition		X
	Int.11	Team Manager in Grid Operations	Operational control room for the future grid-customers on waiting lists		X

*GPO stands for "groete projecten en onderhoud", translated as major projects and maintenance.
**WVL stands for "water, verkeer, leefomgeving", translated as water, traffic and living environment.

translated by Dutch-speaking members of the research team. All interviews were conducted online, complemented by in-person roadmap sessions and workshops, such as on grid congestion and sustainable bridge renovation, which further validated the findings.

3.3. Data analysis

Data analysis was conducted concurrently with data collection, allowing emerging themes to inform subsequent interviews and the assessment of thematic saturation, which ultimately determined the final number of interviews. Interviews were transcribed and anonymized by the first author, resulting in approximately 15,900 transcript lines (208,000 words).

Data were analyzed in Atlas.ti following the four-round Gioia coding method – a structured approach to qualitative coding that enhances the rigor of case study research (Gioia, Corley, & Hamilton, 2012): (1) open coding, (2) first-order coding, (3) second-order coding, and (4) aggregate coding through thematic synthesis (Figure 4). In the first round, we conducted open coding on six randomly selected interviews across the three organizations to familiarize ourselves with the data, breaking down and comparing segments for patterns (Strauss & Corbin, 1998). We considered interviewees' organizational positioning – strategic, operational, or intermediate – and how information flowed between sustainability ambitions and everyday practice, guided by questions such as how strategic goals are translated into action, what misalignments exist between long-term visions and operational needs, and who bridges this gap and how. Quotes reflected translating strategy into operations (e.g., *'to align that with the strategy, what do we expect from each renewal project'*), transferring operational insights back to strategy (e.g., *'project teams will learn from this asset and transfer it to the next'*), and balancing competing tactics rather than either directional flow. Together, these observations pointed to three initial tactical spheres: from strategies to operations, balancing competing tactics, and from operations to strategies. This first analysis reflected the three dimensions introduced in Section 2.1: interviewees' positioning related to *people*, while the emerging tactical spheres reflected *processes and prioritization*. The codes themselves, however, were developed inductively from the interviews. This reflects an abductive approach, whereby existing theoretical dimensions sensitized the early coding, while the tactical spheres and aggregate functions emerged through iterative engagement between theory and empirical data (Rahmani & Leifels, 2018).

In the second step, conceptually similar codes were grouped into first-order codes through axial coding, reducing complexity while retaining respondents' language (Corbin & Strauss, 2014). For instance, statements like 'defining concrete measures for projects' and 'setting frontrunner KPIs for portfolios' were grouped under 'requirements,' within the from strategies to operations sphere (Figure 4); issues around unclear responsibilities and departmental silos were grouped into 'roles'; and processes like communication or standardization were labeled 'processes.' In the third step, these first-order codes were synthesized through selective coding into more abstract second-order codes: requirements, roles, and processes were integrated into translating to requirements, translating to roles, and translating to processes. Similar iterations across the remaining tactical spheres generated second-order codes, such as aligning priorities, tactical reframing, and learning from success. At this stage, we distinguished these activities and processes from the broader tactical functions. Activities refer to specific actions described by respondents (e.g., defining KPIs for tunnel installations), while processes refer to recurring ways of organizing or connecting such actions (e.g., standardization, communication from strategy to operations). The term *tactical function*[1] instead captures a pattern of tactical work that brings together multiple activities, processes, and roles to mediate between strategy and operations, aligned with revealed analytical codes in Gioia analysis. In the fourth step, the second-order codes were iteratively compared across the three organizations and synthesized through thematic analysis into four aggregate tactical functions: (i) translating, (ii) trade-off navigating (iii) taking advantage, (iv) transferring, as shown in Figure 4.

Building on this within-organization coding, we conducted an additional review to identify how the four tactical functions extended beyond individual organizations. We reviewed first- and second-order codes where respondents referenced other case organizations, shared infrastructure interdependencies, or cross-sectoral coordination, and re-clustered these segments using the same aggregate functions (translating, transferring, trade-off navigating, taking advantage). This yielded seven recurring inter-agency tactical connections (Section 4.5), allowing us to examine whether and how tactical functions occur between organizations.

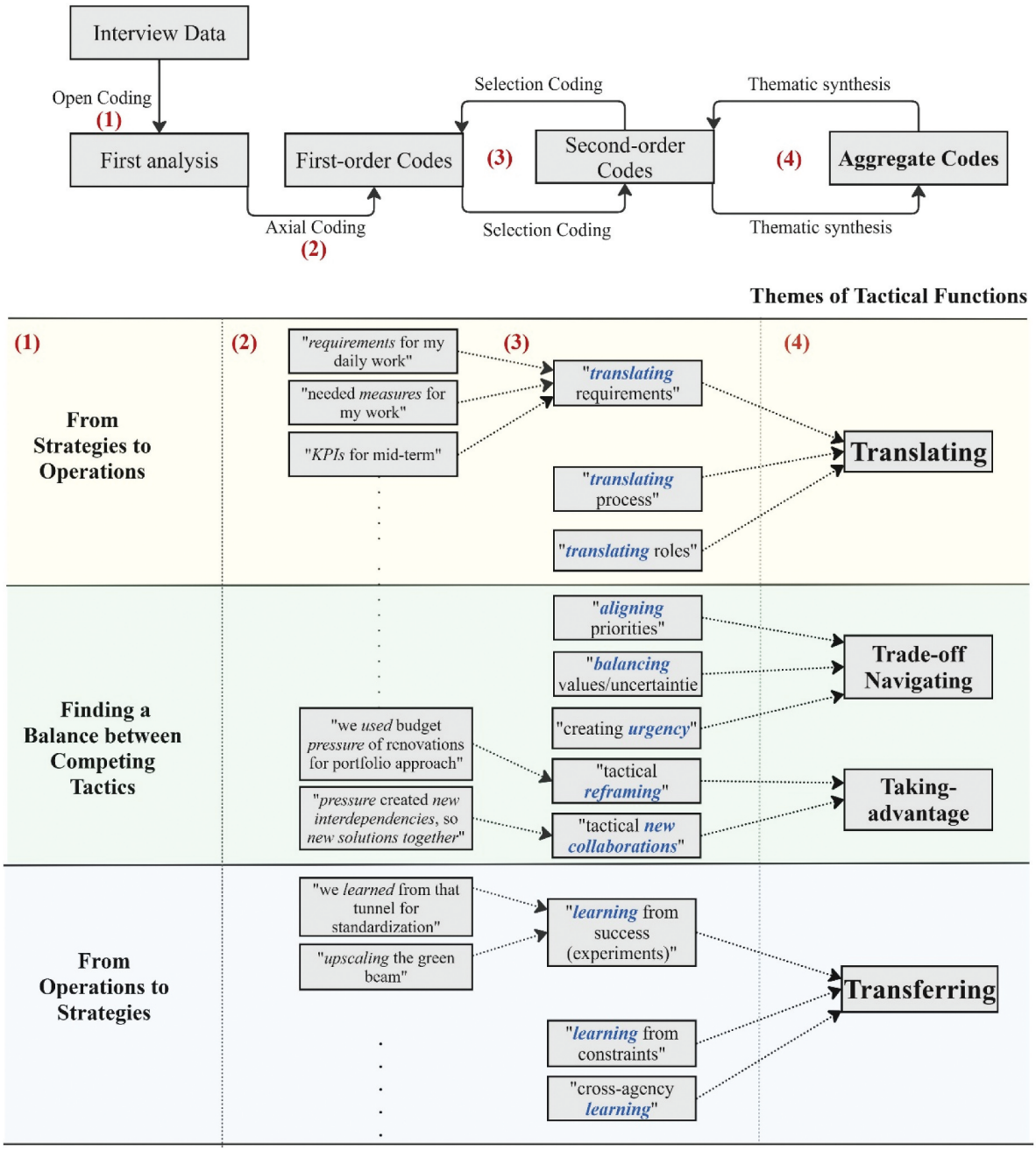

Figure 4. Data analysis and structure.

Table 2. Linking theoretical dimensions to tactical functions.

Theory	Findings
People *(Section 2.1)*	**Tactical actors** identified across infrastructure organizations *(Section 4.1)*
Processes *(Section 2.1)*	**From Strategy to Operations** *(Translating) (Section 4.1)* **& From Operations to Strategy** *(Transferring) (Section 4.3)*
Prioritization *(Section 2.1)*	**Finding a Balance between Competing Tactics** *(Trade-off Navigating & Taking Advantage) (Section 4.2)*
Tactics between Organizations *(Section 2.2)*	**Tactical functions between Three Cases** *(Section 4.4)*

Table 2 maps this coding structure onto the theoretical dimensions from Section 2: people, processes, and prioritization (Section 2.1) correspond to the within-organization functions of translating, transferring, and trade-off navigating/taking advantage (Sections 4.1–4.3), while the inter-organizational extension introduced in Section 2.2 corresponds to the cross-case and inter-agency findings (Sections 4.4–4.5).

4. Findings

The findings are structured around the four tactical functions identified in the data analysis, showing how each function is enacted across the three case organizations while highlighting cross-case similarities and differences. The selected organizations are interdependent public infrastructure providers operating within similar regional sustainability transitions, while representing different governance arrangements, institutional responsibilities, and market structures that shape their tactical work. Sections 4.1–4.3 present the within-organization findings, Section 4.4 provides a cross-case comparison, and Section 4.5 examines tactical functions across the interdependent organizations.

Besides differences in interpreting sustainability transitions organizationally, the three cases also represent distinct governance arrangements. Organization A is hierarchically dependent on the Ministry, which provides policy and financial direction, translating circular ambitions into increasing renovation demand – often described as the need to shift from a project delivery organization to an 'asset management organization.' Organization B is a publicly owned utility within a non-liberalized, monopolistic water system, with its tactical position shaped by dependencies on provinces, water boards, and the national infrastructure manager (Organization A), who determine groundwater levels and regulations. Organization C is a publicly owned, regulated regional electricity operator within a liberalized energy market, heavily dependent on the production and supply sides of the energy transition.

Accordingly, the findings are presented through three tactical spheres: (i) from strategy to operations (translating), (ii) balancing competing priorities (trade-off navigating and taking advantage), and (iii) from operations to strategy (transferring). For each sphere, we compare how these functions emerged across the organizations given their differing sustainability interpretations and challenges. The first sphere also explains who is referred to as the tactical actors in each organization.

4.1. From strategy to operation: translating function

Across the three cases, translating emerged as the primary tactical function through which long-term sustainability ambitions were operationalized within everyday organizational practice. Although the content of what was translated reflected each organization's governance context and transition challenges, tactical actors consistently performed three interrelated functions: translating strategic ambitions into operational requirements, organizational processes, and roles and responsibilities.

4.1.1. Translating to requirements

For Organization A, although the strategy of becoming circular is clearly established, translating this ambition into concrete project requirements remains challenging. 'Peloton' measures establish minimum sustainability standards through initiatives such as the Circular Infrastructure Program, developing roadmaps for requirements including circular concrete. However, these measures were often described as operating mainly at the strategic-to-tactical level, raising questions about how effectively they reach daily project practice. As one circularity consultant noted, *'Project managers are under huge pressure already; we need to make those sustainable requirements for bridges or viaducts clearer. It needs testing. Safety is the major concern.'* Participants emphasized sustainability requirements should be incorporated from the very beginning, particularly during tendering. As the director of major projects put it, *'It's essential to incorporate those at the beginning of the project – not in the middle. That complicates everything – financially, in scheduling, and in capacity.'*

Beyond minimum requirements, the organization promotes 'frontrunner' measures in around 25–30% of its portfolio, encouraging the use of tools such as the Environmental Cost Indicator (ECI). However, participants described a continuing dilemma: while responsibility for sustainability is increasingly placed on

contractors, the market still waits for clearer direction from the client. As one program director noted, *'The market knows sustainability is necessary and is waiting for a clear request from the client. If the organization said, "this is the plan," the market would follow. But there's frustration about constant changes and lack of clear direction.'* Shifting government priorities and uncertain circularity requirements create inconsistent project direction. Although some projects receive additional funding for sustainable measures, organization-wide CO_2 budgets and reduction targets remain absent.

Similarly, Organization B faced the challenge of translating broad sustainability ambitions into concrete, measurable operational requirements. Unlike Organization A, where sustainability requirements are increasingly institutionalized through the Ministry's strategic direction and implemented through procurement, sustainability within Organization B is more dependent on demand-side developments, considering future drinking water availability and external conditions such as permits and regional stakeholder expectations. Consequently, tactical translation focused on mid-term operational requirements, including assessing asset condition, anticipating future demand, and developing demand-reduction programmes. Many participants described sustainability as abstract and inconsistently interpreted across departments, reflecting limited strategic clarity and organizational alignment.

The organization's historically operational focus, centered on water supply, reinforces a preference for existing methods, even when sustainable alternatives have a strong business case. This is partly due to uncertainty: although the environmental impact of water extraction is acknowledged, clear performance indicators for circularity, biodiversity, and emissions are still missing. As one portfolio manager noted, *'Without those, it's hard for my team to steer actions.'* Uncertainty about the actual life-time condition of existing assets also makes it difficult to align maintenance needs with strategic goals and for justifying investment proposals. This also applies to demand-side data, where limited up-to-date information on specific user groups complicates demand management. As one marketing advisor explained, *'Hospitals, hotels, families with gardens – we need to understand their water use to influence demand effectively.'* Although water awareness has grown, tactical insight into broader environmental impacts remains fragmented, with limited understanding of where nature is most affected or how emissions can be quantified and reduced. Defining operational KPIs for these challenges, therefore, requires stronger input from departments such as asset management, identified as the organization's core tactical hub.

For Organization C, translating sustainability primarily involved redefining operational requirements from reliability towards flexibility, now considering efficient use of the existing grid equally important as expansion. Meeting this challenge requires better insight into future electricity demand and its implications for grid capacity. To address short-term constraints, the organization introduced non-firm connections, where capacity cannot always be guaranteed. As one innovation team member explained, *'We have congestion on the high-voltage grid, but we can't reliably predict when spare capacity is available.'* Similar to Organization B, limited data and insufficient customer-side information constrain operational decision-making, highlighting the growing need for demand data and closer interaction with users.

4.1.2. Translating to processes and roles

The case studies revealed beyond translating requirements, translation from strategy to operation also involves shaping processes and defining roles for aligning strategies with operations.

For Organization A, a key tactical process has been the shift towards standardization through a portfolio approach, bundling similar assets, such as bridges, into the market as a portfolio to enable partial reuse, improve maintenance, and support circularity. As the Director of Renovation and Replacement explained, *'If all bridges use the same beams, it simplifies maintenance, supports reuse, and benefits sustainability.'* Because many structures share similar designs, understanding the failure mechanism of one can help identify smarter ways to extend the lifespan of others. As noted by renovation director, *'If we treat each project separately, no knowledge is built. But with an asset management approach and standardization, we create consistency.'* However, operational staff emphasized the need to remain adaptive, as *'all structures often turn out to be different in practice.'*

Several participants also described an ongoing process towards national programming, moving from regionally organized work towards prioritizing renovation tasks from a national perspective. As one programme manager explained, *'We are looking from more of a national perspective to see what needs to be done and what should come first when there isn't enough funding for everything.'* Programme managers

and portfolio managers were most frequently referred to as the tactical actors responsible for translating sustainability ambitions into projects. However, participants repeatedly highlighted ambiguity around accountability and ownership, *'if a portfolio manager personally values sustainability, it's included; if not, no one holds them accountable.'* This became particularly visible in the shift towards national programming, as participants explained that regional and national groups often develop different priority lists that must later be aligned, while regional managers continue to prioritize their own areas because they remain accountable for regional funding and societal backlash: *'if something goes wrong, that region's leader has to explain it to the newspaper.'* This creates ongoing tensions in translating national sustainability ambitions into regional implementation.

Unlike Organization A, where translating process focuses on standardization and consistency, Organization B's key translating process involved embedding flexibility for climate adaptation as adapting water extraction, designing pipeline redundancies, and flexible use of multi-sources, described as *'how we operationalize flexibility at the tactical level.'* As one strategist explained, *'We used to replace one-to-one. Now we need an organization that can find new water sources, manage multiple projects simultaneously, and still maintain the old system for 20 years.'* Similar to Organization A's shift towards national programming, this translation required a more centralized, system-wide coordination process. However, the legacy of more than 100 locally developed networks, a result of municipalities historically being individually responsible for drinking water provision, was not designed for climate adaptation or broader soil-water dynamics. As one policy advisor explained, *'We need to start extracting water from the most optimal locations and transport it where it's needed, but that requires a more system-wide approach,'* making communication with project managers and field technicians a key process. In terms of roles, team managers and asset managers were most frequently identified as the tactical actors. However, similar to Organization A, participants highlighted ambiguity around ownership and responsibilities. A system-wide asset management process required stronger coordination across organizational silos, yet the historical merger of more than 60 providers into 10 regional monopolies reinforced a regionally oriented mindset and fragmented responsibilities. As one sustainability programme manager noted, *'The challenge is adapting our structure to new strategic goals, very different from those we've had for 100 years. Without leadership, ownership, and translation into technical terms, progress won't happen.'*

For Organization C, participants likewise described embedding flexibility as the central translating process. However, unlike Organization B, flexibility was primarily achieved through new forms of interaction with electricity users. Instead of one-way customer requests for connections, the organization increasingly engages in two-way dialogue to jointly explore flexible solutions. Congestion managers and regional managers were identified as the emerging tactical actors leading this transition, together with newly established departments focusing on smart solutions, and stakeholder coordination. Nevertheless, participants also described these roles as reactive and still evolving, reflecting the continuing challenge of translating rapidly changing energy transition ambitions into stable organizational responsibilities.

The comparison shows that translating is shaped by each organization's governance, planning logic, and capacity challenges. Organization A centred on standardization through portfolio management and national programming under ministerial direction. By contrast, Organizations B and C emphasized flexibility – Organization B to address climate uncertainty and future water availability, and Organization C to manage rapidly changing electricity demand and persistent grid congestion. These priorities were reflected in the tactical actors involved – from programme and portfolio managers in Organization A, to asset and team managers in Organization B, and congestion and regional managers in Organization C. Rather than residing at a single organizational level, translating emerged as a distributed practice, leaving ownership of sustainability implementation ambiguous.

4.2. Finding a balance between competing tactics: trade-off navigating & taking-advantage functions

Across the three organizations, tactical actors continuously balanced competing economic, environmental, and societal priorities under increasing uncertainty. Although the trade-offs reflected different sectoral challenges, participants consistently described tensions between immediate operational pressures and long-

term sustainability ambitions. All three organizations also demonstrated a taking advantage function by using emerging pressures and external shocks to accelerate organizational change.

For Organization A, trade-offs primarily emerged around aligning circular ambitions with ongoing renovation programmes. Each renovation requires project-specific safety assessments, forcing actors to balance reuse with safety demands, work pressure, and costs. As one director explained, *'If a bridge were to be reused, you'll need to consider the time and financial costs of organizing reuse, compared to the cost of manufacturing new steel bridge parts.'* Similarly, although the agency aims to be a pioneer for other infrastructure clients and the market, sustainable procurement is constrained by the need to justify spending 'taxpayer money,' requiring continuous balancing of price, quality, safety, and environmental impact. Similar tensions emerged between short- and long-term priorities. Traffic disruption and media attention frequently encouraged short-term decisions over standardized, modular solutions with greater long-term value. As the head of innovation programme explained, *'We can act quickly now, and do 3,000 bridges one-by-one, avoid disruptions, and redo it in 20 years, or accept more disruption and do it right for the next 50 to 100 years.'* Participants therefore described a lack of perceived urgency around sustainability and no clear framework to weigh long-term benefits.

Participants also described several examples of taking advantage. Renovation pressure itself was referred to as a *'trojan horse'*, creating space for tactical reframing. Limited labour and funding encouraged bundling similar projects and combining contracts, giving the market more room to innovate for climate impact. As one participant explained, referring himself as tactical actor, *'Connecting different units, for example transport with data engineering, opened up new opportunities. My bonus then depended not just on my unit, but also on the business generated through collaboration, it was a tactical synergy.'* (Portfolio advisor). As renovation became a priority for other infrastructure clients, it stimulated collaboration by sharing design guidelines to extend asset lifespans and knowledge exchange on product-based asset management. Rising material prices also pushed contractors to take climate-neutral and circular approaches more seriously. Yet, these tactical opportunities still require clearer mandates and cross-organizational learning.

In Organization **B**, trade-offs primarily centred on balancing affordable drinking water provision with long-term water security under climate change, with a stronger demand-side focus. Tactical actors continuously navigated what to invest in and how to justify these choices to ministries and regulators, particularly regarding tariffs. However, participants noted that decisions often defaulted to financial considerations, sidelining longer-term environmental values. As one participant explained, *'Under pressure to invest in maintenance, we fall back into the old mindset, just supply water. Sustainability gets scraped off as a luxury, but that's a misconception. It doesn't always need extra money.'* Another important trade-off concerned declining water availability. Participants described growing pressure to say no to customers, raising difficult questions about balancing uncertainty and societal value. As one legal expert noted, the current drinking water law provides little guidance when water supply becomes insufficient, leaving the organization to prioritize between societal users, such as large-scale industry, agriculture, and residential areas. Tactical actors therefore sought to create urgency around the shared risks of scarcity and the long-term value of circular solutions and smart meters. However, the politicization of drinking water further complicates these trade-offs. Participants referred to growing pressure to accommodate agricultural water demands following the rise of the farmers' party, alongside increasing competition for physical space between housing, defense, and water infrastructure, often prolonging permitting processes. As one business development manager noted, *'The provinces are our shareholders and permit authorities, but act more like third parties, telling us to solve problems while they watch. That slows things down'*. Climate-related pressures also created opportunities to reframe priorities and encourage behavioral and organizational change. The 2018 drought became a *'trojan horse'* that increased awareness that water supply is not infinite and legitimized demand reduction programmes and circular water solutions. Still, as one participant observed, *'People are all used to open the tap and have the infinite drinking water,'* making it difficult to influence consumption, even within the organization, as supply continues to be seen as the core responsibility. The combined scarcity of water, labor, and space also stimulated new collaborations with other water companies, government bodies, and infrastructure agencies, demonstrating how climate urgency could be tactically used to support resilience at the tactical level.

Compared to the other two organizations, Organization C faced more immediate operational trade-offs driven by grid congestion and regulatory constraints. Participants balanced contracted electricity capacity

and customer expectations with the physical limits of the network, *'load growth from heat pumps, EVs, and solar panels is exponential, while our grid expansion is linear.'* As congestion shifts towards low-voltage grids serving households, tactical actors increasingly question the societal value of electricity and how to prioritize scarce capacity – for example, whether it is more valuable to serve thousands of small companies or a few large ones like data centers. Participants also described navigating uncertainty within rigid regulatory rules become a key tactical function, as one interviewee noted, *'We pay them to connect and pay again when they cause problems . . . it's not just our responsibility, it's a collective one.'* Moreover, efficiency-oriented regulation reinforced short-term thinking by making substantial future investments difficult to justify. As one participant stated, *'We have a system where network operators are incentivized for efficiency. It was difficult to justify substantial future investments because the structure discouraged major upgrades in the short term.'* However, growing grid congestion itself became a *'trojan horse'* that legitimized long-term investment and accelerated organizational change. As one policy advisor explained, *'It can't be that we put everyone on a waiting list and only then start investing . . . from a societal perspective, it's the worst approach. So, we're seeing a shift – from reactive to proactive investment strategies.'*.Tactical responses increasingly included prioritizing investments based on urgency rather than financial logic, alongside collaboration with regional governments on spatial planning, customer engagement through peak shaving and smart charging, and coordination with other grid operators.

The trade-offs reflected the institutional pressures each organization faced. Organization A negotiated between circular ambitions, public accountability, and renovation; Organization B balanced long-term water security with affordability and competing societal claims over scarce resources; and Organization C reconciled electrification ambitions with network capacity and regulatory obligations. Across all three organizations, renovation pressure, water scarcity, and grid congestion became catalysts for tactical innovation, legitimizing longer-term sustainability investments and new collaborations.

4.3. From operations to strategy: transferring function

The fourth tactical function involved transferring operational lessons back into strategy. Across the three organizations, participants described learning both from operational constraints and experimental successes, as well as learning from each other.

For Organization A, learning centred on transferring lessons from frontrunner projects, both from constraints and successes, into broader organizational practice. In terms of constraints, participants explained that renovation projects often turn out differently on-site, requiring a more hands-on *'with the market'* approach in the technical design phase, where risks are shared and solutions are developed jointly with contractors. This shift was described by a tactical actor (portfolio manager for bridges) as a learning-based transition approach. Innovation advisors and programme managers also played an important role in transferring lessons from *'frontrunner'* pilot projects back into strategy. For example, the green beam initiative explores harvesting and reusing bridge beams to understand how circular practices can be scaled. As one innovation advisor noted, *'It sounds so easy, but we need tactical-level frameworks for upscaling innovations.'* Participants emphasized that transferring lessons beyond individual projects remains difficult. One barrier is public procurement law, which limits long-term innovation partnerships. As the head of innovation for bridges explained, *'we're now tendering 12 bridges, hoping to award them to a few contractors so they improve with each one; the more they build, the more efficient the process becomes.'* Participants also highlighted growing cross-sectoral learning with other infrastructure clients, provinces, and municipalities to share innovations, build on each other's experiences, and provide clearer direction to the market.

For Organization B, learning from operations to strategy was mainly linked to successful experiments, such as testing new water sources based on surface water, although scaling these pilots remained a key challenge. Learning from constraints was driven by anticipating future uncertainties, including drinking water availability and groundwater reserve policies. Participants also described cross-sectoral learning as an important mechanism, transferring expertise on water quality and health to rainwater and greywater reuse in housing, while adopting innovations from other sectors, such as smart meters inspired by the energy sector. Nevertheless, operational learning remained constrained by a conventional asset-oriented mindset, where regional project teams had limited incentives to pursue integrated water management or circular solutions.

Compared to the previous two organizations, Organization C described learning as emerging directly from operational experimentation under grid congestion. Capacity constraints created room for learning-by-doing and fostered what participants described as a start-up-like culture. Teams experimented with grid steering and customer engagement, and these experiences gradually became embedded in routine practices, informing strategic decisions about which flexibility solutions proved effective. Rather than applying one-size-fits-all solutions, participants increasingly recognized the need for region-specific approaches, transferring lessons from local experiments across regions.

4.4. Comparing tactical functions across cases

To synthesize the case findings, this section compares how the three organizations enact the tactical functions of translating, trade-off navigating, taking advantage, and transferring, highlighting both shared patterns and sector-specific differences. Figures 5–7 summarize the relative distribution of these tactical functions within each organization, while Tables 3–5 compare the underlying mechanisms, tactical actors and challenges. Together, they show that although all four tactical functions are present across the three organizations, their relative emphasis differs according to the organizations' institutional responsibilities and market environments.

In national infrastructure executing agency, as Figure 5 shows the most balanced distribution of tactical functions among the three organizations. Translation is comparatively well-institutionalized through peloton standards, portfolio approach, and tendering tools, but progress still relies on intrinsic motivation and navigating between ministry expectations and market demands. Its innovation pathway is market-driven, drawing on contractors' knowledge and long-term partnerships to transfer lessons. Yet this creates dependency on the market and leaves the agency caught between ministry and industry calls for clarity.

The drinking water utility, by contrast, must confront droughts and aging, decentralized infrastructure. Here, translation is less about fixed requirements and more about embedding resilience and flexibility, though hindered by unclear KPIs, fragmented responsibilities, and a conservative engineering focus. In the

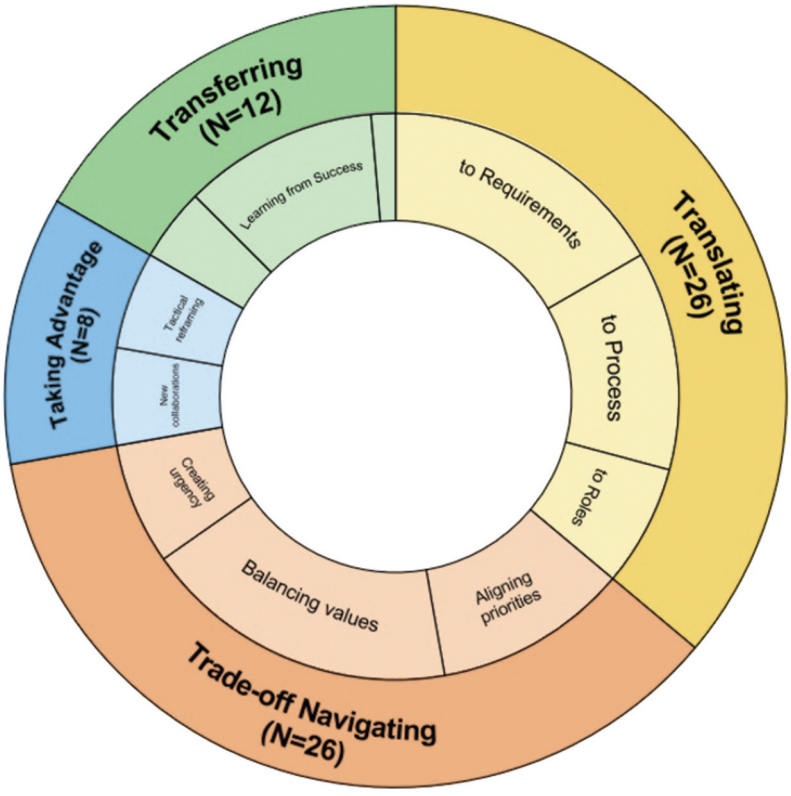

Figure 5. Organization A: national mobility infrastructure: distribution of tactical functions.

Table 3. Summary table of translating strategy to operations.

Tactical Function	Organization A: National Infrastructure Agency	Organization B: Drinking Water Utility	Organization C: Electricity Grid Operator	Related Literature
Translation from Strategy to Operations	**Well-institutionalized measures** (peloton standards, ECI in tendering) **How?**:Standardization/ portfolio approaches (bundling similar assets) **Who?**: Consultants/program managers formalize sustainability	**Less-embedded translation**; asset condition data (pipe maintenance/lifecycle) and demand-side measures weakly integrated. **How?**:Centralized/system-wide coordination in the drinking water system **Who?**: Asset managers act as tactical hub.	**Least-embedded translation**; future electricity demand uncertain, fragmented info in liberalized market, low user data/automation. **How?**: Flexible use of existing grid; Customer communication **Who?**: New roles (congestion managers) emerging.	Resilience–sustainability in urban water (Bocchini et al., 2014; Elmqvist et al., 2019); electricity shifting from reliability to legitimacy and flexibility (Geels et al., 2017; Sovacool, 2016)
	Key Challenges: Including measures at early project stage Lack of clear market direction Weak ownership/ responsibility; reliance on intrinsic motivation	***Key Challenges:*** Unclear KPIs and environmental impacts Legacy decentralized water infra, fragmented roles, weak team manager responsibility •Conservative/engineering focus	***Key Challenges:*** Lack of standardized grid flexibility process Roles reactive and unclear Lack of institutional power in liberalized market	

electricity case, translation emerges mainly under system stress: congestion has triggered new departments and KPIs, yet requirements remain reactive and uncertain in a liberalized market with fragmented information and fluctuating demand. Of the three, the electricity grid shows the least developed translation function, operating largely in a 'learning under pressure' mode. The comparison across cases detailed in Table 3.

Compared with national infrastructure agency, Figures 6 and 7 reveal a gradual shift away from translating towards balancing competing priorities for drinking water and electricity utility agencies. In Organization A, trade-offs can be partially embedded through formal instruments and are primarily negotiated internally between cost, safety, and circularity. In Organizations B and C, by contrast, scarcity

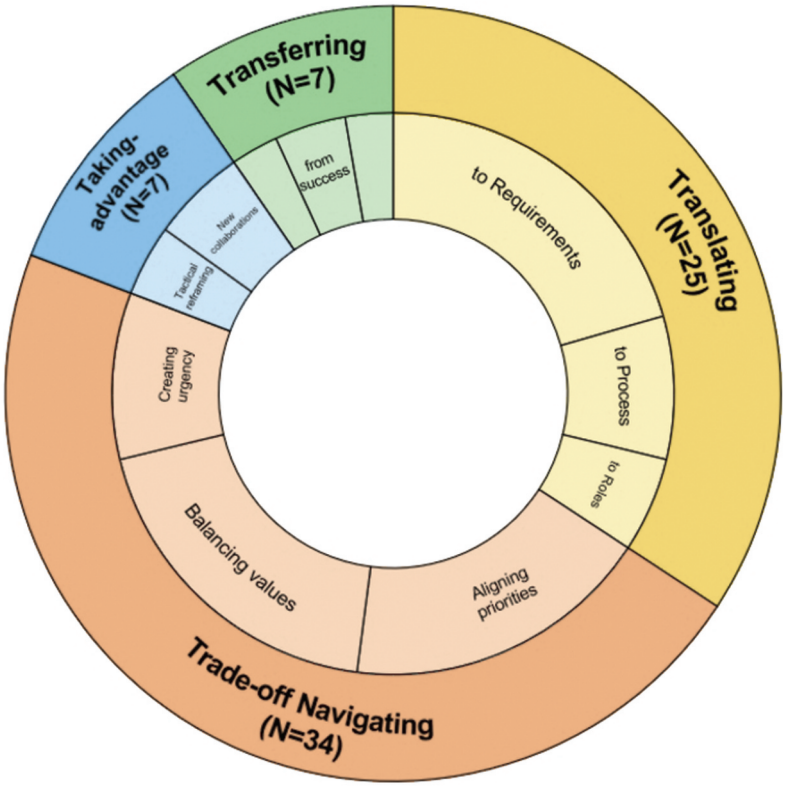

Figure 6. Organization B: distribution of tactical functions.

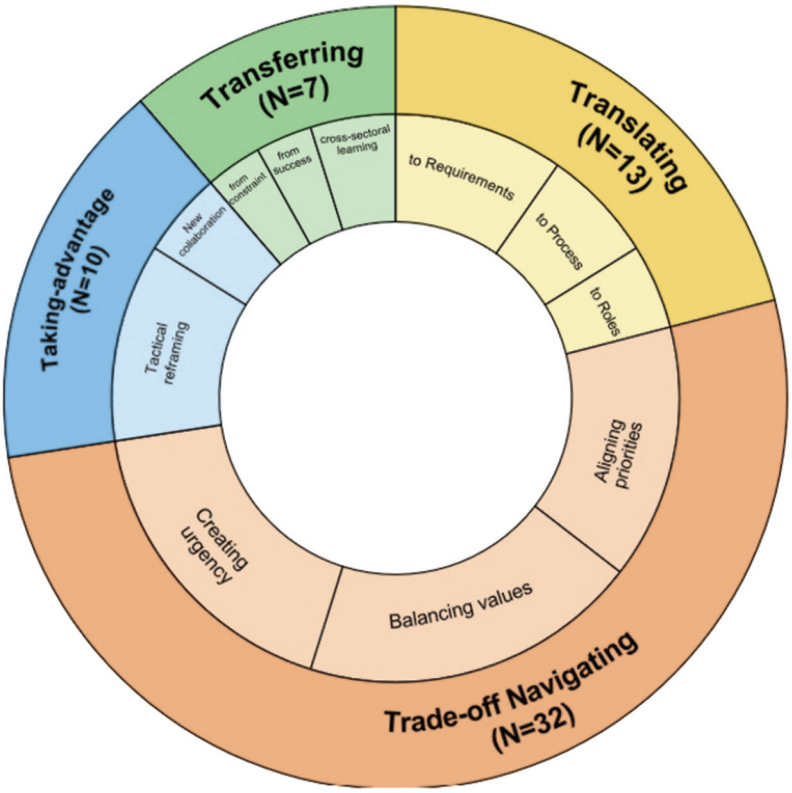

Figure 7. Organization C: distribution of tactical functions.

Table 4. Summary table of balancing competing tactics.

Balancing competing Tactics	Tactical Function	Organization A: National Infrastructure Agency	Organization B: Drinking Water Utility	Organization C: Electricity Grid Operator	Related Literature
	Trade-off Navigating	Cost, quality, risk vs. circularity Legitimizing choices to society: quick fixes vs. modular/circular paths ***Key Challenges:*** Lack of perceived urgency on sustainability No clear framework to assess long-term impact Limited power vis-à-vis ministry & society	Affordability vs. sustainability Scarcity forces prioritization (factories vs. households) Politicization (farmers' party, permits) ***Key Challenges:*** Lack of social value framing Maintenance pressure reinforces economic focus	Electricity capacity vs. user expectations Large industries vs. SMEs/ households Financial vs. societal/ sustainability values ***Key Challenges:*** Efficiency incentives discourage proactive investment 'Copper plate' principle	Difficulty in accountability for decentralized utilizes Brisbois (2019)
	Taking advantage (Trojan horses)	Renovation pressure reframed as opportunity (standardization/bundling projects) Material price increase for circular solutions ***Key Challenge:*** Limited by disruptions and safety concerns	Droughts create urgency to long-term planning Space/labor constraints push cross-sector partnerships ***Key Challenge:*** Infinite-supply mindset (societal and organizational)	Grid congestions fostered collaboration with governments/customers Material/labor scarcity accelerates flexibility ***Key Challenge:*** Reliance on congestion urgency	

Table 5. Summary table of transferring from operations to strategy.

Tactical Function	Organization A: National Infrastructure Agency	Organization B: Drinking Water Utility	Organization C: Electricity Grid Operator	Related Literature
Transferring from Operations to Strategy	Learning 'with the market' Learning from frontrunner projects (e.g., green beam) ***Key Challenges:*** Lack of frameworks for upscaling innovations Procurement law limits long-term partnerships	Learning from pilots (e.g., surface water use, smart meters) Lobbying to align drinking water planning with national groundwater reserves ***Key Challenges:*** Scaling experimental pilots into strategy Overcoming conservative, asset-based mindset	Congestion fostered 'learning-by-doing' / startup culture From one-size-fits-all to case-by-case learning ***Key Challenges:*** Regional pilots not systematically integrated Learning remains reactive, congestion-driven	Project-based knowledge transfer from public-private infra development (Aerts, Dooms, & Haezendonck, 2017)

of water, electricity capacity, labour, and physical space forces continuous prioritization between competing users, short-term operational needs, and long-term resilience, reflecting their stronger dependence on external environmental and societal conditions. The comparison between trade-off functions detailed in Table 4.

While Figures 5–7 show that transferring and taking advantage are less dominant than translating and trade-off navigating across the three organizations, Table 5 highlights differences in how operational learning is generated and embedded. Organization A follows a market-driven approach, using pilots and frontrunner projects to formalize contractor knowledge into organizational routines, although scaling remains constrained by procurement rules. In contrast, Organizations B and C are more society-driven, with learning emerging from user practices, demand patterns, and external pressures such as droughts and grid congestion. Across all three agencies, however, lessons from projects and pilots remain largely siloed, pointing to the need for tactical mechanisms that better connect operational experimentation with strategic and cross-sectoral learning.

4.5. Tactics in inter-agency context

As sustainability transitions grow in complexity, infrastructure agencies increasingly rely on tactical collaboration to mediate between strategic ambitions and operational realities. Drawing insights from the three case organizations, we've observed seven interagency tactical connections (illustrated as nodes in Figure 8) through which the tactical functions identified in the previous sections extend beyond organizational boundaries. Building on the mentioned inter-organizational tactical functions, these nodes illustrate how translating, transferring, and balancing are jointly enacted between infrastructure organizations through cross-sectoral coordination, knowledge transfer, and the management of shared interdependencies. Nodes 1–3 represent inter-agency translating tactics, node 4 illustrates cross-sectoral transferring, while nodes 5–7 capture balancing tactics where organizations jointly negotiate shared resources and competing priorities.

First case organization, as a national infrastructure agency, has emphasized the importance of requesting sustainability in a standardized way among other infrastructure clients. One official explained: *'It would really help if clients worked together to request sustainability in a standardized way. There's so much we do that other governments could adopt – and vice versa.'* This is part of a growing attempt to *translate ambitions into common procurement processes* (, and it gains traction through concrete collaborations like joint design codes for asset renovation with national railway infrastructure provider (**node 1&2 : translating- common standards with other clients**). Similarly, cross-sectoral translation occurs between two of the case organizations, between national infrastructure agency and electricity grid, where more mature alignment has taken root, as of the first one learning from the other about the standardization: *'For example, how do energy infra providers do asset management? We learn from them and are also working on standardization … now building the product platform for locks and going to build one for bridges too.'* (**node 3: translating- cross-sectoral asset management**) These initiatives exemplify translation, from strategy towards the operations,

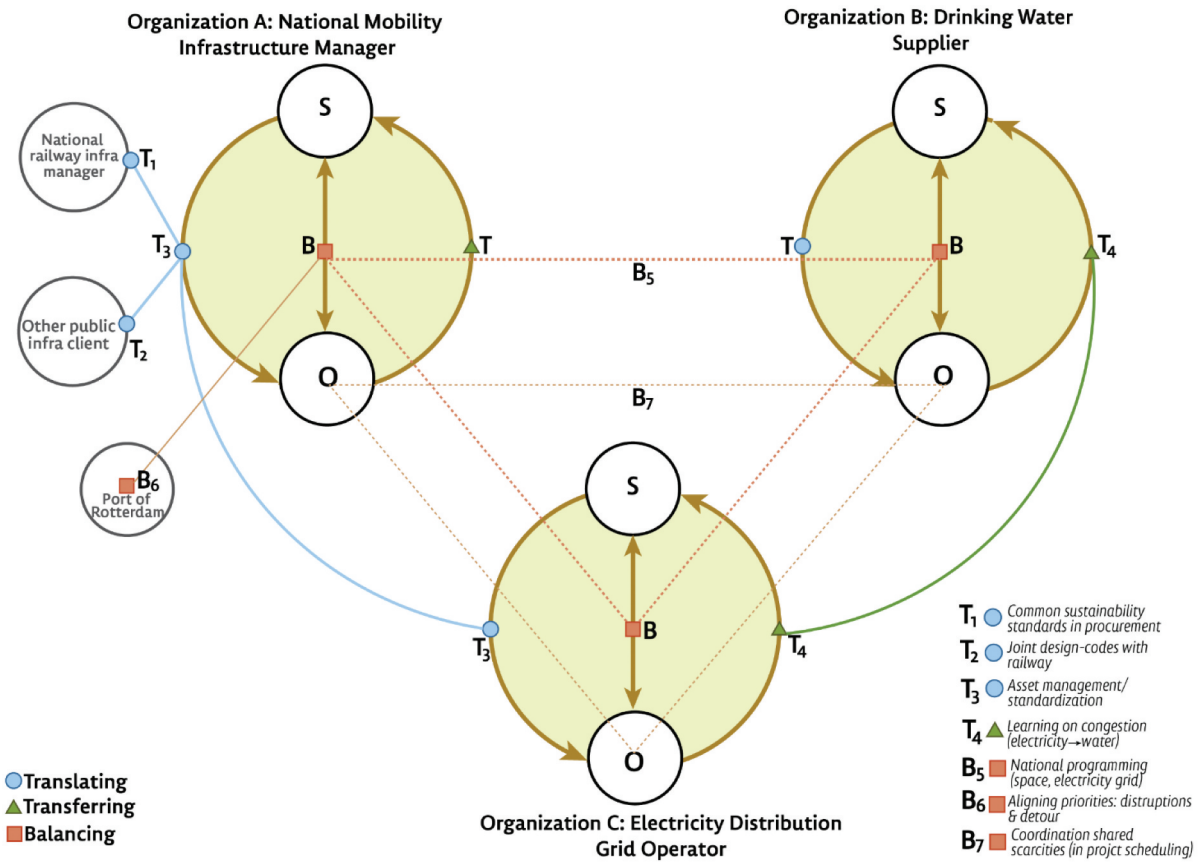

Figure 8. Tactical connections between agencies.

not only of technical requirements but also of organizational routines, showing how certain inter-agency collaborations (like between organization A and C) have institutionalized tactical learning into structured practices.

Other linkages remain more tentative. Transfer of innovations and cross-sectoral learning between drinking water supplier and electricity distribution grid, for example, is emerging but not yet systematic (**node 4: transferring- operational learning from contraints**). They are engaged in forms of tactical learning that involve reinterpreting each other's experiences, as can be called through implicit coordination. For example, the drinking water supplier reflected on the energy sector's experience with grid congestion: *'They had data on congestion for years, but it only recently reached the strategic agenda. We need to get it on the agenda sooner.'* Similarly, energy's experience with capacity prioritization is influencing water suppliers' own decision-making: *'We began using criteria to be more selective about which companies we serve . . . in a way, we're just following their lead.'* At the same time, water organizations offer lessons to the electricity sector, particularly on social prioritization. As one interviewee explained, *'If a data center needs cooling water, we say no. But for a new hospital needing drinking water, that's a yes.'* This illustrates how both sectors are learning to balance competing societal values under conditions of scarcity.

Cross-sectoral learning from innovation remains limited, though some examples highlight early efforts to transfer successful practices. One such instance involves the adoption of smart meters in the drinking water sector, drawing lessons from the electricity grid: *'We're starting to install smart meters, but data use needs regulation. The energy sector has a code of conduct – we're now developing one for drinking water meters with the whole sector.'* However, such tactical-level information exchange is mentioned far less frequently than other forms of collaboration, suggesting that operational best practices are not yet systematically informing cross-sector strategies. Tactical actors recognize the systemic barriers to scaling innovations across sectors. As one participant from a national infrastructure agency noted, *'People like to keep their information to themselves . . . open*

information sharing is important in an ideal world.' While mechanisms like innovation partnerships exist, actual efforts to share experimental insights across agency boundaries remain constrained by institutional silos and competitive dynamics. Even when learning occurs, it tends to stay within sectoral boundaries.

Perhaps the most fragile – but increasingly urgent – tactical role lies in *navigating trade-offs* through national programming (**node 5: balancing- national programming**). Shared resources such as space, permits, and grid capacity demand coordinated prioritization, but current approaches remain fragmented. As one drinking water expert observed, *'We are collaborating in some smaller projects … but not prioritizing as a country, among our resources, our sustainability ambitions.'* Another described how overlapping goals can unintentionally obstruct one another: *'If we want to electrify construction machinery and make buildings zero-emission, we need electricity on-site, but even building that electricity infrastructure causes emissions … it's a dilemma.'* Electricity grid congestion further amplifies interdependencies for finding a balance between the infrastructure for competing tactics. A drinking water respondent explained: *'We use a lot of energy, so new water plants require a large grid connection … but it's not always available, it's a serious issue.'* Similar tensions were echoed by a national infrastructure agency, referencing the Port of Rotterdam: *'If we limit infrastructure for heavy trucks, that affects Rotterdam, they'd have to adjust their ship types or road transfers.'* **(node 6: balancing – aligning priorities)** These examples underscore the delicate position of tactical actors who must weigh local operational needs against broader systemic alignment, a role still constrained by institutional silos.

The most frequently mentioned interdependency – and a shared tactical challenge across all agencies – is labor scarcity, which increasingly demands new forms of coordination (**node 7: balancing- coordinating shared scarcities**). As one national infrastructure expert noted, *'We're all competing for the same people, fishing in the same pond – drinking water, electricity, municipalities, provinces.'* Workforce, machinery, and contractor shortages increasingly shape tactical decisions, requiring agencies to align project timelines alongside their sustainability ambitions. Yet such coordination remains limited. As one interviewee put it, *'It would really help to know what other agencies are planning, so we could spot overlaps. Right now, that rarely happens.'* As a result, workforce shortages and scheduling conflicts can undermine sustainability ambitions.

Together, these seven inter-agency tactical connections illustrate how translating, transferring, and balancing extend across organizational boundaries. While certain links, such as efforts to standardize asset practices between infrastructure providers, are becoming more institutionalized, others – like national prioritization and open innovation sharing – remain emergent. Unlike the within-organizational findings, taking advantage – using disruptions or shocks as leverage for organizational change – did not emerge at the inter-agency level, suggesting that agencies currently exploit these pressures individually rather than jointly across sectors. These findings highlight both the growing importance of cross-sectoral tactical coordination and the remaining opportunities for strengthening infrastructure governance in sustainability transitions.

5. Discussion

Addressing the gap between strategy and operations, this research starts from the assumption that tactical functions exist within infrastructure providers, reflecting tensions between decarbonization strategies and infrastructure management operations. Building on the conceptualization introduced in the theoretical background – tactical work as constituted by people, processes, and prioritization – our cross-case comparison shows that these dimensions manifest differently across the three agencies, shaped by sectoral contexts, institutional histories, and transition pressures. While the four functions – translating, transferring, taking advantage, and trade-off navigating – emerge in all cases, their emphasis shows contrasts and similarities across different organizations. Below, we discuss why these functions emerge as they do, situate them within the existing literature to articulate the study's theoretical implications following the same three dimensions, and then present the practical implications for infrastructure organizations undergoing sustainability transitions.

5.1. Theoretical implications

5.1.1. People: locating tactical roles and boundary spanning

The first observation across all three organizations was the difficulty of identifying who the actual 'tactical people' are. We began with the assumption that they would be those bridging strategy and operations. Yet, it became clear that tactical people cannot easily be located within the organizations; instead, they appeared closer either to strategy formation or to day-to-day operations. Rather than holding distinct tactical roles in sustainability transition efforts, they performed tactical functions with different shades along the spectrum between strategy and operations, often avoiding the label of 'tactical actor' because they did not see themselves as responsible for the translation. Nevertheless, participants repeatedly stressed that translating sustainability ambitions into practice depends on these so-called 'tactical people' – portfolio advisors, asset managers, and team managers – who interpret strategic information and translate it into project and asset decisions. Yet, these actors are rarely involved in strategy formulation, limiting their awareness of broader sustainability goals and weakening communication across organizational levels (Obembe, Al Mansour, & Kolade, 2021). This finding should also be read in relation to our interview sample. While fewer respondents held purely task-executing operational roles, our sampling focused on actors involved in the main operational challenges and their connection to longer-term sustainability ambitions, rather than on proportionally representing formal organizational levels. Therefore, the difficulty of locating tactical people may partly reflect our sample, but it also reflects how participants described tactical work as spread across different positions between strategy and operations.

Recent work argues that middle managers should be integrated more closely into strategy development, as mediators shaping the context in which strategy is pursued (Mamburu, de Metz, & Davis, 2024). Our findings support this closer integration but suggest that the middle layer of infrastructure organizations is shaped by characteristics that existing organizational literature has paid limited attention to. Public infrastructure organizations combine public legitimacy with project management functions increasingly tendered to the market, meaning tactical actors cannot only be brought closer to strategy but must remain equally connected to operations, as setting the boundary conditions of sustainability ambitions for assets. Accordingly, we argue that tactical actors are defined less by a fixed organizational position than by a boundary-spanning function connecting strategy and operations in both directions. This is consistent with calls to recognize boundary spanners as central to infrastructure project performance and innovation (Satheesh et al., 2024), but extends this literature in two ways. Existing studies primarily conceptualize boundary spanning around the relationship between public clients and market contractors within individual projects, whereas our findings shift the focus to organizational practices connecting strategy and operations, showing that tactical boundary spanning is essential for translating long-term sustainability ambitions into project and asset decisions. Furthermore, as sustainability transitions intensify socio-technical interdependencies across infrastructure systems, tactical boundary spanning increasingly extends beyond organizational boundaries, requiring coordination and knowledge exchange between infrastructure organizations to align transition ambitions with available capacities. Defining and supporting such boundary-spanning roles is therefore not only an internal management issue but also a question of political legitimacy, as public infrastructure agencies depend on ministerial and regional funding, making the distribution of responsibility for sustainability part of a broader governance struggle (Nasiritousi & Grimm, 2022). Strengthening knowledge exchange and collaboration among tactical actors across infrastructure organizations may therefore also reinforce the legitimacy needed to integrate long-term sustainability values into public decision-making.

5.1.2. Process: translating and transferring between strategy and operations

Management literature has traditionally emphasized tactical processes as translating strategic ambitions into operations through planning and programme management (Mintzberg, 1994; PMI, 2017), while strategy-as-practice scholarship shows strategy is also performed through everyday practices (Whittington, 2006) and emerges from operational learning (Wooldridge, Schmid, & Floyd, 2008). Our findings support this bidirectional view but extend it to infrastructure sustainability transitions.

Across all three organizations, translating ambitions into concrete requirements – through procurement criteria, asset management standards, and performance indicators – emerged as the key tactical process, albeit shaped by institutional context: the mobility agency showed the most mature translation, built on established procurement standards and an environmental cost indicator under ministerial steering, while both utilities struggled to shift KPIs from reliability to flexibility, requiring closer alignment between strategy and operational asset condition and demand data. Translation often depended on individual motivation rather than formal accountability structures, even as procurement, portfolio coordination, and asset management increasingly functioned as key mechanisms for sustainability implementation. These findings reinforce Eriksson's (2017) argument that procurement represents a critical leverage point for sustainability innovation and show how standardized procurement instruments and portfolio approaches can progressively institutionalize tactical translation beyond individual projects. We extend this work by demonstrating that translating into procurement requirements and standard approaches must also reach other infrastructure clients to steer the contractor market, indicating that translation occurs not only within but also between organizations. While prior work focuses on translation within projects (Brunet & Aubry, 2018) or single organizations (Paulsson, 2018), we conceptualize tactical translation as an inter-organizational process shaping how sustainability ambitions travel across clients and markets.

In terms of transferring operational learning back to strategy, literature has largely conceptualized transferring as learning from successful pilots and frontrunner projects, confined within individual organizations or projects (Aerts, Dooms, & Haezendonck, 2017). Our findings extend this view in three ways. First, transferring is triggered not only by success but by constraints themselves: operational scarcity and disruption – grid congestion, droughts – generate lessons that feed back into strategy just as pilots do, suggesting learning-from-constraints deserves recognition as a tactical function in its own right. Second, the transferring function differs by institutional context: the national infrastructure agency relies on formal innovation units and portfolio approaches to scale learning from pilots on green beams, material reuse, and low-carbon construction, whereas the drinking water and electricity utilities learn more through responding directly to operational pressures such as scarcity and congestion, given their high dependency on consumer behaviour and other regional actors.

Third, transferring increasingly extends beyond organizational boundaries. Vosman et al. (2023) argue that scaling sustainable innovation requires an ecosystem perspective beyond procurement rules and project boundaries, and our findings specify the tactical dimension of this perspective by showing how shared capacity challenges begin to generate cross-sectoral learning, even if such exchanges remain largely informal and implicit. Transferring is thus better conceptualized not only as an intra-organizational process linking operations and strategy, but as an inter-organizational process requiring mechanisms for cross-sectoral knowledge exchange, pointing to a broader ecosystem of sustainable infrastructure transitions as an avenue for future research.

5.1.3. Prioritization: balancing trade-offs within and across boundaries

Tactical balancing emerges as the most pressing challenge for infrastructure agencies, both within organizations and across sectoral boundaries. Case studies indicate a shift toward multi-scalar coordination, particularly through national programming where priorities are set centrally to allocate scarce resources such as labor and funding across regions, aligning internal balancing with broader societal prioritization and long-term transition goals. This resonates with debates on cross-sectoral coordination, where decarbonizing interdependent systems increasingly requires a system-of-systems perspective (Markolf et al., 2018). While prior work has emphasized cross-sectoral resource balancing through nexus approaches such as energy–water (Liu et al., 2017) and energy–mobility (van Baal & Finger, 2020), these remain largely confined to quantitative modeling and offer limited insight into how interdependent infrastructures engage with decarbonization transitions in practice.

Our findings also challenge fixed temporal conceptualizations of tactical work. Whereas literature situates tactical decision-making within defined time horizons – ranging from one to two years (Khalifa, 2021) to five to fifteen years (Loorbach, 2010) – we show that tactical work is better understood as continuous navigation between long-term strategic commitments and short-term shocks. Within this, creating urgency – bringing long-term sustainability values into present-day

decisions – emerges as a distinct tactical function, particularly where such values conflict with efficiency-oriented project logics.

This dynamic becomes especially visible in the role of shocks and scarcity as windows of opportunity. Grid congestion, droughts, and renovation pressures not only pose risks but also enable the reframing of priorities, acceleration of investments, and formation of new collaborations, as seen most clearly in the electricity operator facing widespread congestion. While existing literature shows that shocks can trigger rethinking of socio-technical systems, foster social learning (Broto et al., 2014), reduce demand (Kanda & Kivimaa, 2020), and challenge consumption norms, it largely treats these dynamics as intra-organizational. Our findings extend this view by showing that taking advantage of shocks remains predominantly internal to individual organizations, with limited coordination across sectors facing similar pressures. This points to inter-agency 'taking advantage' of shocks as an underdeveloped tactical capability and a key theoretical implication for understanding infrastructure transitions.

5.2. Practical implications

This research set out to address a central question: how infrastructure organizations can plan for the long term while acting in the present. Engagement with practitioners across critical infrastructure providers – from strategic (policy) to operational (project) levels – consistently pointed to the tactical level as the locus of this challenge. Our findings indicate that tactical actors currently operate without a clear formal mandate. Their influence over strategy remains constrained by public legitimacy and policy frameworks, while operations are predominantly shaped by project management logics and short-term cost-efficiency. In response, this study identifies empirically grounded role typologies and associated functions – translating, transferring, navigating trade-offs, and taking advantage – that can be more explicitly recognized and supported in practice, rather than remaining dependent on individual initiative. The findings further highlight that learning processes extend beyond individual organizations to interconnected infrastructure networks, underscoring the growing importance of horizontal collaboration. This distinguishes the tactical level in infrastructure systems from that in private-sector contexts. Strengthening inter-organizational transfer of lessons may also enhance the legitimacy required for tactical actors to align long-term sustainability ambitions with short-term operational pressures, particularly in the absence of formal authority. Finally, the study points to the need for a more proactive role of tactical actors in engaging with shocks and resource scarcities. Rather than responding reactively, tactical actors can play a key role in taking advantage of such disruptions to enable innovation, thereby contributing to more sustainable and resilient infrastructure systems.

6. Limitations and future research

First, the qualitative data analysis and coding of tactical functions relied on the interpretive judgment of the participants. The dataset spans more than thirty interviews, and aimed to include actors from different levels in the organization, but fewer respondents held purely operational roles, partly also due to the much of the task-executing work carried out by external contractors. Although, the tactical function was acknowledged as a significant aspect in our infrastructure organizations, while the nature of the tactical function has been ill-defined. Therefore, a limitation of this study lies in the interpretive flexibility afforded to the interviewees. Nevertheless, the analysis here has provided rich insights into the variety of ways in which the tactical function can manifest. Future research can extend to other actors both inside the organization but also from the external environment who also responsible from the transitions. Specifically, because this study focuses on infrastructure-provider (client) organizations and the tactical functions within and between them, future research could look at how people more directly involved in task-executing operational work perceive and carry out these functions. Such research could also reveal additional, perhaps context-specific challenges (from infrastructure projects and designs) for tactical decision-making.A follow-up step – sharing the framework of tactical functions with participants for feedback could strengthen confidence in their applicability across contexts. Second, the extended data collection period and the researchers' engagement with the organizations not only through interviews but also through consortium meetings may have shaped how challenges and practices were interpreted. While this engagement offered

rich contextual insights, it may also have influenced our reflections on tactical dynamics. Moreover, the study remains bounded to the Dutch institutional setting. The Netherlands provides a particularly dense and interdependent infrastructure environment, with strong national commitments to sustainability, but this context may differ from countries where infrastructure is more fragmented, privatized, or subject to weaker sustainability mandates. Future research should therefore examine how tactical functions manifest in other governance settings in other countries.

Finally, while the study highlighted cross-sectoral interdependencies and emerging tactical functions across the infrastructure agencies, the data were collected primarily through separate interviews within each organization. This provides a static view of tactical practices. Future research could adopt more dynamic approaches – for example, by engaging tactical actors from different agencies in joint workshops or scenario exercises to observe how tactical functions unfold in real-time coordination across sectors. Such approaches could deepen understanding of how translation, transfer, and trade-off navigation operate not just within but between infrastructure systems.

7. Conclusions

This paper has examined how the tactical level shapes the alignment between decarbonization strategies and infrastructure operations. By studying three Dutch infrastructure providers, we identified four tactical functions, translating, balancing, transferring, that reveal both the opportunities and tensions of embedding sustainability day-to-day management of infrastructure. The cross-case comparison showed how these functions are shaped by sectoral contexts, institutional legacies, and transition pressures, while also pointing to the gaps where ownership and learning for decarbonization remain unclear. For practice, the findings underline that tactical work is essential yet often vaguely defined. Translation still depends heavily on individual initiative, trade-offs are shaped by scarcities, and lessons from pilots or constraints rarely scale beyond project boundaries. Strengthening tactical roles, making them more explicit, and providing clearer frameworks for cross-project and cross-sectoral learning will be crucial for embedding long-term sustainability goals into everyday operations. For research, the study adds to the growing body of work on sustainable infrastructure transitions by drawing attention to the 'in-between' space where ambitions meet practice. It highlights the need to further explore tactical dynamics not only within organizations but also across sectors, as interdependencies in space, labor, and capacity become increasingly pressing.

Note

1. The term *tactical functions* is also consistent with practitioners' terminology in infrastructure organizations, where it is used to refer to sectoral functions. It is also used by Dutch practitioners in the study frequently referring to '*tactische functies*' in Dutch.

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Author contributions

CRediT: **Hazal Deniz Kaya:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft; **Paul W. Chan:** Conceptualization, Supervision, Validation, Writing – review & editing; **Daan Schraven:** Project administration, Supervision, Writing – review & editing; **Martijn Leijten:** Supervision, Validation, Writing – review & editing.

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References

Wetenschappelijke Raad voor het Reg. (2008, June 11). *Infrastructures: Time to invest*. Wetenschappelijke Raad voor het Reg. https://www.wrr.nl/documenten/2008/06/11/infrastructures-time-to-invest

Aerts, G., Dooms, M., & Haezendonck, E. (2017). Knowledge transfers and project-based learning in large scale infrastructure development projects: An exploratory and comparative ex-post analysis. *International Journal of Project Management*, *35*(3), 224–240. https://doi.org/10.1016/j.ijproman.2016.10.010

Ahmadi, L., Shirkhani, H., & Lounis, Z. (2025). An integrated framework to sustainable and resilient infrastructure design and management in a changing climate. *Sustainable and Resilient Infrastructure*, *10*(5), 489–511. https://doi.org/10.1080/23789689.2025.2496053

Alegre, H., Coelho, S. T., Vitorino, D., & Covas, D. (2016). Infrastructure asset management – the trust approach and professional tools. *Water Supply*, *16*(4), 1122–1131. https://doi.org/10.2166/ws.2016.033

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social Research Update*, *33*, 1–4. http://sru.soc.surrey.ac.uk/SRU33.html

Balogun, J., & Johnson, G. (2004). Organizational restructuring and middle Manager sensemaking. *Academy of Management Journal*, *47*(4), 523–549. https://doi.org/10.2307/20159600

Birch, K. (2016). Materiality and sustainability transitions: Integrating climate change in transport infrastructure in Ontario, Canada. *Prometheus*, *34*(3–4). https://doi.org/10.1080/08109028.2017.1331612

Bocchini, P., Frangopol, D. M., Ummenhofer, T., & Zinke, T. (2014). Resilience and sustainability of civil infrastructure: Toward a unified approach. *Journal of Infrastructure Systems*, *20*(2). https://doi.org/10.1061/(asce)is.1943-555x.0000177

Bojórquez-Tapia, L. A., Eakin, H., Reed, P. M., Miquelajauregui, Y., Grave, I., Merino-Benítez, T., & Molina-Pérez, E. (2022). Unveiling uncertainties to enhance sustainability transformations in infrastructure decision-making. *Current Opinion in Environmental Sustainability*, *55*, 101172. https://doi.org/10.1016/j.cosust.2022.101172

Borrás, S., Haakonsson, S., Hendriksen, C., Gerli, F., Poulsen, R. T., Pallesen, T., Larsen, H., Kugelberg, S., & Larsen, H. (2024). The transformative capacity of public sector organizations in sustainability transitions. *Environmental Innovation and Societal Transitions*, *53*, 100904. https://doi.org/10.1016/j.eist.2024.100904

Brisbois, M. C. (2019). Powershifts: A framework for assessing the growing impact of decentralized ownership of energy transitions on political decision-making. *Energy Research and Social Science*, *50*, 151–161. https://doi.org/10.1016/j.erss.2018.12.003

Brorström, S., & Willems, J. (2021). Getting integrative urban regeneration strategies done: Insights from Antwerp and Gothenburg. *International Review of Administrative Sciences*, *89*(2), 346–362. https://doi.org/10.1177/00208523211029122

Broto, V. C., Glendinning, S., Dewberry, E., Walsh, C., & Powell, M. (2014). What can we learn about transitions for sustainability from infrastructure shocks? *Technological Forecasting and Social Change*, *84*, 186–196. https://doi.org/10.1016/j.techfore.2013.08.002

Brunet, M., & Aubry, M. (2018). The governance of major public infrastructure projects: The process of translation. *International Journal of Managing Projects in Business*, *11*(1), 80–103. https://doi.org/10.1108/IJMPB-08-2017-0095

Bryson, J. M., Crosby, B. C., & Stone, M. M. (2006). The design and implementation of cross-sector collaborations: Propositions from the literature. *Public Administration Review*, *66*(s1), 44–55. https://doi.org/10.1111/j.1540-6210.2006.00665.x

Buhl, M., & Markolf, S. (2023). A review of emerging strategies for incorporating climate change considerations into infrastructure planning, design, and decision making. *Sustainable and Resilient Infrastructure*, *8*(sup1), 157–169. https://doi.org/10.1080/23789689.2022.2134646

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, *25*(8), 652–661. https://doi.org/10.1177/1744987120927206

Chen, C. A., Berman, E. M., & Wang, C. Y. (2017). Middle managers' upward roles in the public sector. *Administration & Society*, *49*(5), 700–729. https://doi.org/10.1177/0095399714546326

Coenen, T. B., Visscher, K., & Volker, L. (2022). A systemic perspective on transition barriers to a circular infrastructure sector. *Construction Management and Economics*, *41*(1), 22–43. https://doi.org/10.1080/01446193.2022.2151024

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th ed.). Sage.

De Metz, N., Jansen van Rensburg, M., & Davis, A. (2023). Acting strategically during change: A process and dwelling world-view approach. *Journal of Change Management*, *23*(3), 250–268. https://doi.org/10.1080/14697017.2023.2238744

De Telegraaf. (2024, March 3). *Alliander: 'Nog zeker tien jaar file op stroomnet, duizenden technici uit buitenland nodig'*. De Telegraaf. https://www.telegraaf.nl/financieel/939560999/alliander-nog-zeker-tien-jaar-file-op-stroomnet-duizenden-technici-uit-buitenland-nodig.

Eikelenboom, M., & van Marrewijk, A. (2024). Tied islands: The role of organizational members in knowledge transfer across strategic projects. *International Journal of Project Management*, *42*(3), 102590. https://doi.org/10.1016/j.ijproman.2024.102590

Eikelenboom, M., Van Uden, M., Coenen, T. B. J., & Vosman, L. (2025). Strategic programmes for circular construction: Lessons from three public clients. *Construction Management and Economics*, *43*(11), 901–921. https://doi.org/10.1080/01446193.2025.2539129

Elmqvist, T., Andersson, E., Frantzeskaki, N., McPhearson, T., Olsson, P., Gaffney, O., Takeuchi, K., & Folke, C. (2019). Sustainability and resilience for transformation in the urban century. *Nature Sustainability*, *2*(4), 267–273. https://doi.org/10.1038/s41893-019-0250-1

Engert, S., & Baumgartner, R. J. (2016). Corporate sustainability strategy - bridging the gap between formulation and implementation. *Journal of Cleaner Production*, *113*, 822–834. https://doi.org/10.1016/j.jclepro.2015.11.094

Eriksson, P. E. (2017). Procurement strategies for enhancing exploration and exploitation in construction projects. *Journal of Financial Management of Property and Construction*, *22*(2), 211–230. https://doi.org/10.1108/JFMPC-05-2016-0018

Ersoy, A., Bryson, J., & Van Bueren, E. (2020). Unlocking values through infrastructure interdependencies. *Infrastructure Asset Management*, *7*(2), 134–143. https://doi.org/10.1680/jinam.18.00029

Faber, M. H., Miraglia, S., Qin, J., & Stewart, M. G. (2020). Bridging resilience and sustainability-decision analysis for design and management of infrastructure systems. *Sustainable and Resilient Infrastructure*, *5*(1–2), 102–124. https://doi.org/10.1080/23789689.2017.1417348

Frantzeskaki, N., Jhagroe, S., & Howlett, M. (2016). Greening the state? The framing of sustainability in Dutch infrastructure governance. *Environmental Science and Policy*, *58*, 123–130. https://doi.org/10.1016/j.envsci.2016.01.011

Friesl, M., Stensaker, I., & Colman, H. L. (2021). Strategy implementation: Taking stock and moving forward. *Long Range Planning*, *54*(4), 102064. https://doi.org/10.1016/j.lrp.2020.102064

Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). The socio-technical dynamics of low-carbon transitions. *Joule*, *1*(3), 463–479. https://doi.org/10.1016/j.joule.2017.09.018

Gemünden, H. G., & Kock, A. (2025). A system of management principles to improve the performance of innovative project portfolios. *Project Management Journal*, *56*(3), 411–425. https://doi.org/10.1177/87569728251336734

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2012). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Gjerde, S., & Alvesson, M. (2020). Sandwiched: Exploring role and identity of middle managers in the genuine middle. *Human Relations*, *73*(1), 124–151. https://doi.org/10.1177/0018726718823243

Gratton, L. (1996). Implementing a strategic vision-key factors for success. *Long Range Planning*, *29*(3), 290–303. https://doi.org/10.1016/0024-6301(96)00019-2

Hall, J. W., Otto, A., Hickford, A. J., Nicholls, R. J., & Tran, M. (2016). A framework for analysing the long-term performance of interdependent infrastructure systems. *The Future of National Infrastructure: A System-Of-Systems Approach*, 12–28. https://doi.org/10.1017/CBO9781107588745.003

Hammingh, P., Volkers, C., van Hout, M., Koutstaal, P., van Sebille, M., & Menkveld, M. (2023). *Climate and Energy Outlook of the Netherlands 2023 (KEV 2023)*. PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/en/publications/climate-and-energy-outlook-of-the-netherlands-2023

Hengst, I.-A., Jarzabkowski, P., Hoegl, M., & Muethel, M. (2020). Toward a process theory of making sustainability strategies legitimate in action. *Academy of Management Journal*, *63*(1), 246–271. https://doi.org/10.5465/amj.2016.0960

Kanda, W., & Kivimaa, P. (2020). What opportunities could the COVID-19 outbreak offer for sustainability transitions research on electricity and mobility? *Energy Research and Social Science*, *68*, 101666. https://doi.org/10.1016/j.erss.2020.101666

Kaya, H. D., Chan, P. W., Schraven, D., & Leijten, M. (2025). Infrastructure in transitions: A systematic review of how infrastructure influences and is influenced by sustainability transitions. *Environmental Innovation and Societal Transitions*, *57*, 101034. https://doi.org/10.1016/j.eist.2025.101034

Kaya, H. D., Leijten, M., Schraven, D., & Chan, P. W. (2026). Navigating lock-ins for adaptation: A case study of grid capacity planning in the Dutch energy transition. *Sustainability Science*, *21*(3), 1–25. https://doi.org/10.1007/s11625-025-01793-6

Khalifa, A. S. (2021). Strategy and what it means to be strategic: Redefining strategic, operational, and tactical decisions. *Journal of Strategy and Management*, *14*(4), 381–396. https://doi.org/10.1108/jsma-12-2020-0357

Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M. S, & Welch, D. (2019). An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions*, *31*, 1–32. https://doi.org/10.1016/j.eist.2019.01.004

Li, H., Jiang, T., Mao, P., Zheng, J., Fang, Y., Skitmore, M., & Wu, D. (2022). Stakeholder perceptions of sustainable infrastructure project delivery: A comparative analysis between Guangdong, Hong Kong, and Macao. *Journal of Environmental and Public Health*, *2022*(1), 1–16. https://doi.org/10.1155/2022/5398706

Liu, X., Dijk, M., & Colombo, C. (2024). Improving multilevel policy mixes for sustainable urban mobility transition. *Environmental Innovation and Societal Transitions*, *50*, 100808. https://doi.org/10.1016/j.eist.2023.100808

Liu, Y., Wang, S., & Chen, B. (2017). Regional water–energy–food nexus in China based on multiregional input–output analysis. *Energy Procedia*, *142*, 3108–3114. https://doi.org/10.1016/j.egypro.2017.12.452

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

Mamburu, M. E., de Metz, N., & Davis, A. (2024). Exploring middle manager's identity as strategists within a public sector organization: A multi-level perspective. *Journal of Strategy and Management*, *17*(4), 744–762. https://doi.org/10.1108/JSMA-08-2023-0205

Mantere, S. (2008). Role expectations and middle Manager strategic agency. *Journal of Management Studies*, *45*(2), 294–316. https://doi.org/10.1111/j.1467-6486.2007.00744.x

Markolf, S. A., Chester, M. V., Eisenberg, D. A., Iwaniec, D. M., Davidson, C. I., Zimmerman, R., Chang, H., Ruddell, B. L., & Chang, H. (2018). Interdependent infrastructure as linked social, ecological, and technological systems (SETSs) to address lock-in and enhance resilience. *Earth's Future*, *6*(12), 1638–1659. https://doi.org/10.1029/2018EF000926

Meath, C., Karlovšek, J., Navarrete, C., Eales, M., & Hastings, P. (2022). Co-designing a multi-level platform for industry level transition to circular economy principles: A case study of the infrastructure colab. *Journal of Cleaner Production*, *347*, 131080. https://doi.org/10.1016/j.jclepro.2022.131080

Ministry of Infrastructure and Water Management. (2020). *Toward climate neutral and circular infrastructure projects*. Toward climate neutral and circular infrastructure projects. https://circulairebouweconomie.nl/wp-content/uploads/2022/01/Towards-a-climate-neutral-and-circular-infrastructure.pdf

Mintzberg, H. (1994). Rethinking strategic planning part I: Pitfalls and fallacies. *Long Range Planning*, *27*(3), 12–21. https://doi.org/10.1016/0024-6301(94)90185-6

Mintzberg, H., & Waters, J. A. (1985). Of strategies, deliberate and emergent. *Strategic Management Journal*, *6*(3), 257–272. https://doi.org/10.1002/smj.4250060306

Monstadt, J., Colen Ladeia Torrens, J., Jain, M., Macrorie, R. M., & Smith, S. R. (2022). Rethinking the governance of urban infrastructural transformations: A synthesis of emerging approaches. *Current Opinion in Environmental Sustainability*, *55*, 101157. https://doi.org/10.1016/j.cosust.2022.101157

Moore, M. H. (2021). Creating public value: The core idea of strategic management in government. *International Journal of Professional Business Review*, *6*(1). https://doi.org/10.26668/businessreview/2021.v6i1.219

Moser, A., & Korstjens, I. (2018). Series: Practical guidance to qualitative research. Part, 3: Sampling, data collection and analysis. *The European Journal of General Practice*, *24*(1), 9–18. https://doi.org/10.1080/13814788.2017.1375091

Mühlemeier, S. (2019). Dinosaurs in transition? A conceptual exploration of local incumbents in the Swiss and German energy transition. *Environmental Innovation and Societal Transitions*, *31*, 126–143. https://doi.org/10.1016/j.eist.2018.12.003

Nasiritousi, N., & Grimm, J. (2022). Governing toward decarbonization: The legitimacy of national orchestration. *Environmental Policy & Governance*, *32*(5), 411–425. https://doi.org/10.1002/eet.1979

Nederland, N. (2024). Capaciteitskaart invoeding elektriciteitsnet. Capaciteitskaart elektriciteitsnet. https://capaciteitskaart.netbeheernederland.nl/

Obembe, D., Al Mansour, J., & Kolade, O. (2021). Strategy communication and transition dynamics amongst managers: A public sector organization perspective. *Management Decision*, *59*(8), 1954–1971. https://doi.org/10.1108/MD-11-2019-1589

Ohlendorf, N., Löhr, M., & Markard, J. (2023). Actors in multi-sector transitions-discourse analysis on hydrogen in Germany. *Environmental Innovation and Societal Transitions*, *47*, 100692. https://doi.org/10.1016/j.eist.2023.100692
Parnell, J. A. (2008). Assessing theory and practice in competitive strategy: Challenges and future directions (September 1, 2008). *Journal of CENTRUM Cathedra*, *1*(2), 12–27. https://doi.org/10.7835/jcc-berj-2008-0010
Patala, S., Korpivaara, I., Jalkala, A., Kuitunen, A., & Soppe, B. (2019). Legitimacy under institutional change: How incumbents appropriate clean rhetoric for dirty technologies. *Organization Studies*, *40*(3), 395–419. https://doi.org/10.1177/0170840617736938
Paulsson, A. (2018). Making the sustainable more sustainable: Public transport and the collaborative spaces of policy translation. *Journal of Environmental Policy & Planning*, *20*(4), 419–433. https://doi.org/10.1080/1523908X.2018.1432345
PBL Netherlands Environmental Assessment Agency. (2023). *Climate and energy outlook of the Netherlands 2023*. https://www.pbl.nl/en/publications/climate-and-energy-outlook-of-the-netherlands-2023
Pellegrinelli, S. (2002). Shaping context: The role and challenge for programmes. *International Journal of Project Management*, *20*(3), 229–233. https://doi.org/10.1016/S0263-7863(01)00073-4
PMI. (2017). *A guide to the project management body of knowledge (PMBOK Guide)* (6th ed.). Project Management Institute, Inc. Newtown Square. – References – Scientific Research Publishing. https://www.scirp.org/reference/referencespapers?referenceid=3400843
Priemus, H., Flyvbjerg, B., & Wee, B. V. (2008). *Decision-making on mega-projects: Cost-benefit analysis, planning and innovation*. Edward Elgar Publishing.
Rahmani, F., & Leifels, K. (2018). Abductive grounded theory: A worked example of a study in construction management. *Construction Management and Economics*, *36*(10), 565–583. https://doi.org/10.1080/01446193.2018.1449954
Roberts, P., & Hamilton Edwards, L. (2023). Portfolio management: A new direction in public sector strategic management research and practice. *Public Administration Review*, *83*(4), 947–959. https://doi.org/10.1111/puar.13633
Roelich, K., Knoeri, C., Steinberger, J. K., Varga, L., Blythe, P. T., Butler, D., Gupta, R., Harrison, G. P., Martin, C., & Purnell, P. (2015). Towards resource-efficient and service-oriented integrated infrastructure operation. *Technological Forecasting and Social Change*, *92*, 40–52. https://doi.org/10.1016/j.techfore.2014.11.008
Särkilahti, M., Kinnunen, V., Kettunen, R., Jokinen, A., & Rintala, J. (2017). Replacing centralised waste and sanitation infrastructure with local treatment and nutrient recycling: Expert opinions in the context of urban planning. *Technological Forecasting and Social Change*, *118*, 195–204. https://doi.org/10.1016/j.techfore.2017.02.020
Satheesh, S. A., van Meerkerk, I., Verweij, S., Busscher, T., & Arts, J. (2023). Enabling boundary spanners in public–private collaboration: The impact of support and role autonomy on reducing role stress. *Public Administration*, *102*(2), 405–424. https://doi.org/10.1111/padm.12927
Schupfer, H., & Soppe, B. (2025). Greening from within: The role of organisational purpose shift in building internal legitimacy for fossil fuel incumbents' green innovation. *Industry and Innovation*, *32*(1), 84–107. https://doi.org/10.1080/13662716.2024.2379995
Slawinski, N., & Bansal, P. (2015). Short on time: Intertemporal tensions in business sustainability. *Organization Science*, *26*(2), 531–549. https://doi.org/10.1287/orsc.2014.0960
Sovacool, B. K. (2016). How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Research and Social Science*, *13*, 202–215. https://doi.org/10.1016/j.erss.2015.12.020
Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Sage.
TNO. (2021). *Vernieuwingsopgave infrastructuur: Analyse en oplossingsrichtingen [Infrastructure renovation challenge: Analysis and solutions]*. TNO Netherlands Organization for Applied Scientific Research. https://www.tno.nl/en/newsroom/2021/11/renovation-task-infrastructure/
Tongur, S., & Engwall, M. (2017). Exploring window of opportunity dynamics in infrastructure transformation. *Environmental Innovation and Societal Transitions*, *25*, 82–93. https://doi.org/10.1016/j.eist.2016.12.003
van Baal, P. A., & Finger, M. (2020). The energy-mobility system in transition: The case of the Swiss federal railways. *Competition and Regulation in Network Industries*, *21*(4), 367–379. https://doi.org/10.1177/1783591720954118
van den Brink, M. (2020). Rijkswaterstaat: Guardian of the Dutch delta. *Guardians of Public Value*, 237–261. https://doi.org/10.1007/978-3-030-51701-4_10
van der Wiel, K., Batelaan, T. J., & Wanders, N. (2023). Large increases of multi-year droughts in north-western Europe in a warmer climate. *Climate Dynamics*, *60*(5–6), 1781–1800. https://doi.org/10.1007/s00382-022-06373-3
van Dongen, E. (2025). Double trouble': Navigating sustainability transitions in infrastructure renewal.
Van Rensburg, M. J., Davis, A., & Venter, P. (2014). Making strategy work: The role of the middle manager. *Journal of Management and Organization*, *20*(2), 165–186. https://doi.org/10.1017/jmo.2014.33
Volker, L., Ligtvoet, A., Boomen, M. V. D., Wessels, L. P., Velde, J. V. D., Lei, T. E. V. D., & Herder, P. M. (2013). Asset management maturity in public infrastructure: The case of Rijkswaterstaat. *International Journal of Strategic Engineering Asset Management*, *1*(4), 439. https://doi.org/10.1504/IJSEAM.2013.060469

Vosman, L., Coenen, T. B., Volker, L., & Visscher, K. (2023). Collaboration and innovation beyond project boundaries: Exploring the potential of an ecosystem perspective in the infrastructure sector. *Construction Management and Economics*, *41*(6), 457–474. https://doi.org/10.1080/01446193.2023.2165695

Whittington, R. (2006). Completing the practice turn in strategy research. *Organization Studies*, *27*(5), 613–634. https://doi.org/10.1177/0170840606064101

Wooldridge, B., Schmid, T., & Floyd, S. W. (2008). The middle management perspective on strategy process: Contributions, synthesis, and future research. *Journal of Management*, *34*(6), 1190–1221. https://doi.org/10.1177/0149206308324326

Xu, Q., Jia, G., Wang, X., & Chen, Y. (2022). Governing value creation in a major infrastructure project client Organization: The case of Beijing daxing international airport. *Sustainability*, *14*(5), 3001. https://doi.org/10.3390/su14053001

Yin, R. K. (2018). *Case study research and applications* (Vol. 6). Sage.

Zani, C. M., Denicol, J., & Broyd, T. (2024). The four coordination roles of clients when designing megaproject organizations. *Project Management Journal*, *55*(5), 558–579. https://doi.org/10.1177/87569728241248033

Appendix

Appendix: interview analysis summary for case organizations

Table A1. National mobility infrastructure tactical analysis.

Aggregate Code	*Second-order codes*	Example Raw Data
Translating	***Translating to Requirements***	'We define the minimum—like a green sticker for locks—and what projects must do to meet it at the beginning. If we're too late, it leads to costly re-engineering and contractor issues.' **(Int.7)** 'Projects get additional budgets for sustainable measures, allowing more sustainable execution. But we don't assign a CO_2 budget or require specific reductions, so we can't measure if targets are met.' **(Int.6)**
	Translation to Process	"Standardization is less of an issue in new construction, but much harder in replacement and renovation—all structures often turn out to be different in practice **(Int.1)** "Most major bridges were designed by the same few engineers—so understanding one helps with many. If we treat each project separately, no knowledge is built Asset management builds consistency and avoids one-off debates like 'this bridge must be iconic." **(Int.4)**
	Translation to Roles	"It's clear what activities are needed but who's responsible from them. once you can monitor the commitments, you can hold people accountable too "**(Int.2)** ' . . . often depends on individual motivation. If someone values sustainability, it's included—if not, no one holds them accountable. And once it costs more, it becomes a tough conversation.' **(Int.5)**
Trade-off Navigating	***Aligning priorities between actors***	'When motivation is low, time, budget, and pressure dominate. Reuse may be better, but if it's costlier or slower, it's rarely prioritized without a push. That's the tension—we need renewal, but it must be safe.' **(Int.3)** 'That's problem. we're executing body of the ministry. We can propose certain approaches, but we are not the only client. It would help if we could agree on the same things with provinces and municipalities.' **(Int.5)**
	Balancing values/ uncertainties	'One challenge is pricing—private parties want to recover sustainable innovation costs, which raises operational costs and the question is: who pays? There's also risk—if new concrete fails, it's not just repair costs but highway disruption, leading to caution around adopting innovations too quickly.' **(Int.6)** "' . . . since it's taxpayer money, we must justify our decisions' **(Int.1)**
	Creating Urgency	'Short-term, there's disruption—traffic, delays. Long-term, not acting means higher climate costs, flooding, biodiversity loss. Mitigation now is more cost-effective. We may need a better decision-making model—maybe even a "future at the table" approach.' **(Int.6)** 'We manage around 3,000 bridges. Replacing them one by one avoids disruption and media attention, but often isn't sustainable choice. We can act quickly and redo it in 20 years, or face more disruption now and do it right for the next 50 to 100.' **(Int.9)**
Taking-advantage	***Tactical Reframing***	'Limited capacity and funding led us to bundle similar projects—like multiple bridges in one contract. It reduces tendering and gives the market room to innovate for climate impact.' **(Int.5)**
	Tactical new collaborations	'Contractors are becoming more aware . . . many want to work more climate-neutral and circular, especially with rising material costs.' **(Int.6)** 'Renovation is now a priority . . . so we're working with rail infra provider on a new design code for those projects.' **(Int.7)**
Transferring	***Learning from Constraints***	'Especially with renewals, it often turns out differently on-site than we expected. Now we sit down with the contractor to solve it together, as technician more in the background.' **(Int.8)**
	Learning from Experiments	'. . . projects as a sequence to build a learning curve. In the A16 tunnel, lessons from an earlier municipal one helped cut energy use. Many elements repeat—we just need better knowledge transfer.' **(Int.4)** 'We now bundle similar bridges or locks into one portfolio. This gives contractors continuity, helps them invest in innovation, and supports more sustainable solutions.' **(Int.1)**
	Cross-agency Learning	'It would help if clients jointly requested sustainability in a standard way. There's much we can learn from each other—and it encourages the sector to invest.' **(Int.2)**

Table A2. Drinking water agency tactical analysis.

Aggregate Code	*Second-order codes*	Example Raw Data
Translating	***Translating to Requirements***	'The challenge is our ambitions aren't concrete or measurable, or our KPIs so it's hard to guide daily work' **(Int.3**)." 'In practice, it's difficult—we lack a clear view of health and condition of assets and planning suffers. Maintenance asks for large budgets, but when we ask for specifics, they admit they don't know the exact needs.' **(Int.13)**
	Translation to Process	'Our system is highly decentralized, with over 100 local networks, but they don't always align with the broader soil and water system. We now need to extract from optimal locations and transport water, which calls for a more centralized approach.' **(Int.1)**
	Translation to Roles	'As strategists. we should take a proactive role — for example, based on input from departments and external stakeholders. Department managers can then translate those into tactical actions.' **(Int.3)** 'The challenge is adapting our .structure to new strategic goals—very different from those we've for 100 years. Without leadership ownership. progress won't happen.' **(Int.8)**
Trade-off Navigating	***Aligning priorities between actors***	'Some focus on reducing daily consumption, while others feel they have enough supply and see no need —so aligning goals is challenging.**' (Int.13)** The main challenge is cooperating with all actors with transitions—climate, agriculture, energy—to create one integrated area plan **(Int.9)** '. dueto labor scarcity we can only do one at a time'**(Int.3)**
	Balancing values/ uncertainties	'We can't just use fully bio-based materials and raise costs—it's all about balancing sustainability with affordability.' **(Int.8, Int.4)** 'The current drinking water law was made for a time of abundance, not scarcity. . . . facing decisions like whether to supply a city or a factory first.' **(Int.4)**
	Creating Urgency	'most time, energy, and funding go to urgent issues, while long-term goals stay disconnected. Scarcity of people and money makes it harder to balance . . . it's up to top management to decide how much to invest—otherwise, the short term always dominates.' **(Int.12)** "It's about convincing everyone of the urgency. It would help if all ten water companies joined forces —with shared arguments, a common program, and support from the ministry to raise awareness on coming water scarcity "**(Int.5)**
Taking-advantage	***Tactical Reframing***	'We assumed water supply was secure, but 2018 drought was wake up call, showed we lacked resources to meet future demand or connect new companies. This pushed us to invest in infrastructure and expand to strategic planning'**(Int.13)**
	Tactical new collaborations	'Now we see the need to engage with local governments, environmental groups, and agriculture—external dialogue is becoming essential.' **(Int.4)** 'Space is limited. . .Focusing on specific locations allows coordination—like placing drinking water infrastructure alongside a heat well or energy cable. Sometimes we can even build together, like with Organization C' **(Int.13)**
Transferring	***Learning from Constraints***	'I'm lobbying to align national groundwater reserves with the drinking water transition. If kept for emergencies only, they could block our plans—especially with overlapping priorities' **(Int.11)**
	Learning from Experiments	'Traditionally we have been always used the groundwater. but few times we tried new innovations, tests with the surface water . . . but innovation pilot to scale up it's the challenge' **(Int.2)**
	Cross-agency Learning	'New housing methods use rainwater or greywater. With our knowledge of water quality and public health, we can offer unique value to the transition.' **(Int.2)**

Table A3. Electric infrastructure tactical analysis.

Aggregate Code	*Second-order codes*	Example Raw Data
Translating	***Translating to Requirements***	'since 2021, the reliability is no longer the most important KPI, changing the energy system for transition and being prepared for that is as much as important as reliability now' **(Int.1)**
	Translation to Process	'We have a lot of customers on the waiting list—that's maybe the biggest problem. We've always just put cables in the ground, but now we need insight and control. Steering the grid based on measurements is the biggest transition we're facing.' **(Int.4)** 'We're moving from an internal perspective to an external, customer-centered approach' **(Int.9)**
	Translation to Roles	'but at the same time, we know that we don't have the people who actually carry out the physical work to realize all the work on time' **(Int.5)** 'Now we ask customers to reduce usage—it's a different kind of communication, involving new roles and departments.' **(Int.4)**
Trade-off Navigating	***Aligning priorities/ motivations***	"We need to discuss the value of allocating electricity on the high-voltage grid. Is it better to supply thousands of small firms or a few large ones? And value isn't just financial—it includes sustainability and social impact too. "**(Int.6)** 'It's taking too much time to align the other grid operators before we can implement anything, it's challenging' **(Int.9)**
	Balancing values/ uncertainties	'A key challenge is managing expectations—explaining how the system works and why flexibility and realistic timelines are needed.' **(Int.6)** 'We face strict rules, while customers treat it as a free market and demand what they want. There's little guidance on pricing, and we rely on their cooperation. We're shifting to a more enforceable approach, but it remains challenging.' **(Int.7)**
	Creating Urgency	'We used to delay replacements to stretch asset life—as long as nothing failed, it worked. But with rising grid demand, that's no longer viable. About 20–25% of the work exceeds our capacity, so we now prioritize by urgency, not just financial logic.' **(Int.5)**
Taking-advantage	***Tactical Reframing***	'It can't be that we only start investing once everyone's on a waiting list. That may make sense financially or regulatorily, but from a societal view, it's the worst. So, we're shifting from reactive to proactive investments.' **(Int.5)**
	Tactical new collaborations	'Now with the net congestion happening, we need more in connection with the municipalities, provinces, housing associations' **(Int.1)**
Transferring	***Learning from Constraints***	'With congestion, we're exploring non-firm contracts for new demands. A few years ago felt like a startup—no contracts, building from scratch. Now, with operations and new functions, the culture's shifting—we need to work across teams, not just within our own.' **(Int.4)**
	Learning from Experiments	'One-size-fits-all doesn't work—each region has different grids and customers. With congestion and regional differences, learning through hands-on cases has proven effective.' **(Int.7)**
	Cross-agency Learning	'We're increasingly working with local governments on energy planning—looking at where new housing or industrial areas will be and whether they'll use district heating or go all-electric.' **(Int.5)**