CROSS-SECTORAL COLLABORATION:

CHALLENGES AND OPPORTUNITIES OF 'JOINT' ACTION

Tilburg | The Netherlands

VIA AUGUSTA | Symposium Report

2025

Editors: Shanya Ruhela and Wendy van der Valk

Contributors: Shakya Wickramanayake, David Wodak and Tom Aben

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TABLE OF CONTENTS

About VIA AUGUSTA **3**

A. Introduction: Setting the Stage for Cross-Sector Collaboration **5**
- I. Executive Summary 5
- II. Reading Guide 7
- III. Breaking Silos to Synergy: Why Collaborate across Sectors? 8

B. Theory to Practice: An Overview of the Keynote Addresses **9**
- I. Lessons from Crisis Coordination in Critical Infrastructures by MCPM Ronald Christiaans & Drs. Ing. Kenny Meesters 11
- II. AI as a Catalyst for Collaboration: Dr. Merel Noorman on the Future of Critical Infrastructures 17
- III. The Delta-Rhine Corridor: Insights on Cross-Sectoral Collaboration from an Insider, Edwin van Espen 21

C. Addressing Challenges through Interactive and Participatory Sessions **25**
- I. Governing Digital Transformation in Critical Infrastructures through Trust and Collaboration: An Interactive Game by David Wodak 27
- II. Principles for Good Governance in Collaborative Networks: A Collaborative Learning by Prof.dr.ir. Wendy van der Valk 30
- III. The Current State and Future of Cross-Sectoral Collaborations by Shakya Wickramanayake and Dr. Tom Aben 33
- IV. Session on Partnering for Responsible Infrastructures led by Prof. dr. Henk Akkermans 41
- V. Navigating Legal Complexities in the Digital and Green Transitions in the EU: Expert Perspectives 44

D. Conclusion and Future Directions **49**

E. Annexure: Symposium Concept Note and Program **55**

ABOUT VIA AUGUSTA

VIA AUGUSTA is an interdisciplinary research project focused on advancing cross-sectoral collaboration in infrastructure planning and governance. The project aims to help infrastructure managers identify situations where a systems-of-systems approach is appropriate and to facilitate the implementation of *SoS* through effective control and management of data (IT governance), collaborative relationships (inter-organizational governance), and regulatory frameworks (regulatory governance).

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Dr. Shanya Ruhela is a postdoctoral researcher at Tilburg University, the Netherlands, where she also earned her PhD. She is a corporate lawyer who holds an LLM from the University of Cambridge in the United Kingdom. Her research focuses on regulatory and governance issues related to critical infrastructure sectors of energy and finance. With expertise in trade associations and banking regulations, Shanya's work contributes to policy discussions on regulatory adaptability, resilience, and cross-sector governance.

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A. INTRODUCTION:
SETTING THE STAGE FOR CROSS-SECTORAL COLLABORATION

As societies navigate a diverse set of challenges and the (twin) green and digital transitions, siloed approaches to infrastructure planning and governance are proving insufficient. Cross-sectoral collaboration offers a path forward that enables more resilient, adaptive, and sustainable systems.

I. Executive Summary

This report reflects on the interdisciplinary symposium *Moving Towards Cross-Sectoral Collaboration: Challenges and Opportunities of 'Joint' Action*, held on December 3, 2024, in Tilburg, the Netherlands, as part of the VIA AUGUSTA research project. The symposium brought together participants from diverse backgrounds to explore how critical infrastructures can collaborate across legal, organisational, and technological boundaries. What emerged was not only a rich exchange of ideas and dialogues but also an understanding that cross-sectoral collaboration requires deliberate efforts to break silos, cultivate

trust, and reimagine governance models fit for an interconnected future.

1. **Enabling Cross-Sectoral Synergy through a Collaborative approach**

   The symposium focused on the need to break down silos across critical infrastructures, promoting cross-sectoral collaboration as a strategy for building a systems-of-systems (SoS) approach. This approach aims to transform traditionally isolated infrastructural networks and systems into an integrated network of interdependent infrastructures, enhancing its efficiency and adaptability to both digital and green transitions. Our expert speakers emphasised that achieving this requires technological innovation, coordinated governance, a conducive regulatory landscape, and strategies based on past successes.

2. **Technological Innovation: the Dual Role of AI in the Energy Transition**

   Focusing on the energy sector, Dr Merel Noorman demonstrated how Artificial Intelligence (AI) can support decentralised energy systems, enhance predictive maintenance, and optimise energy management. She highlighted AI's dual role as both an enabler and an energy consumer, presenting a paradox where AI contributes to energy efficiency while simultaneously driving high energy demands, particularly through energy-intensive data centres. The symposium discussed the need for energy-efficient AI solutions to ensure that their benefits outweigh their carbon footprint.

3. **Coordinated Governance: Building Trust and Transparency**

   Across sessions, *trust* emerged as the enabler for data sharing and digital transformation projects and initiatives. Interactive sessions and panel discussions emphasised the evolving role of infrastructure operators as data stewards. The evolving legal and regulatory landscape of managing digitalised systems was extensively debated and examined, focusing on the balance between transparency and privacy. In the energy sector, for example, local energy hubs are considered a promising solution for grid congestion, enabling community-based energy exchanges, optimised resource use, and a shift towards more localised and resilient energy ecosystems. Overall, the discussions stressed the need for digitalisation that advances sustainability without compromising public values or policy goals.

4. **Overcoming Legal, Organisational, and Technical Challenges**

   The symposium identified legal, organisational, and technical barriers as primary challenges to cross-sectoral collaboration, often exacerbated by perceived obstacles and barriers. Prof. dr. ir Wendy van der Valk introduced the principles of good governance in networked settings, emphasising the alignment between individual and collective goals to prevent standstills and vicious cycles. The Delta-Rhine Corridor project, presented by Edwin van Espen, provided a practical case study of hydrogen infrastructure development, demonstrating how to navigate complex political and logistical landscapes. Beyond technology, human expertise, organisational culture, and collaborative governance were seen as equally essential. Insights from Ronald Christiaans and Kenny Meesters, drawn from international crisis management, underscored the value of networked over command-and-control models and the need for adaptive, stakeholder-oriented governance.

5. **Importance of Public Values in Governance Frameworks**

   A recurring theme throughout the symposium was the necessity of integrating public values into governance frameworks, shifting the focus from purely technical solutions to holistic approaches that consider social impacts and community needs. The panel demonstrated that the future of infrastructure governance must align technological advancements with societal goals, ensuring that efficiency gains do not come at the cost of equity and sustainability. The need for democratic governance, particularly in AI-driven systems, was stressed, advocating for legitimacy and inclusivity in decision-making processes. The symposium called for reframing narratives, moving from what cannot be done to what stakeholders bring to the table, and fostering a collaborative culture that values transparency, inclusion, and collective benefit.

II. Reading Guide

The symposium made one thing clear: cross-sectoral collaboration is complex but not impossible. It requires more than goodwill or partnership agreements; it demands a rethinking of institutional design, as well as legal and technical interoperability, language, and accountability structures. From discussions on AI and crisis governance to reflections on law, infrastructure, and public value, this report captures a moment of shared learning across disciplines and sectors. For readers interested in diving deeper into specific themes, the following guide may be helpful:

- For reflections on **crisis governance** and **information coordination**, see pp. 11–16.
- For practical insights into **digitalisation**, **AI**, and **public infrastructure**, see pp. 17–20.
- For **project-based strategies for collaboration**, such as the Delta-Rhine Corridor, see pp. 21–24.
- For **hands-on approaches to digital transformation** and **IT governance challenges**, see pp. 26–29.
- For organisational insights into **good governance** in networks, see pp. 30–32.
- For **system-of-systems** thinking and cross-sectoral collaboration, see pp. 33–40.
- For collective infrastructure strategies to address **labour shortages**, see pp. 41–43.
- For a panel on **legal** and **regulatory innovations**, see pp. 44–48.
- For **concluding thoughts** on the symposium's value, researcher reflections, and future directions, see pp. 49–54.

We hope this report not only documents the day's exchange but also sparks continued dialogue, research, and policy experimentation. Let it serve as an invitation for all of us to think jointly, act collaboratively, and govern together!

III. Breaking Silos to Synergy: Why Collaborate across Sectors?

The Cross-Sectoral Collaboration symposium took place at the beautiful and historic LocHal library, a former factory floor that now stands as a public library in the heart of Tilburg and serves as a cultural and knowledge exchange hub. The setting couldn't have been more fitting for a day dedicated to breaking barriers, and transforming, and fostering new connections. With a blend of industrial heritage and modern design, LocHal embodies the symposium's spirit of embracing change. It demonstrates the reimagination of existing structures and its impact on new opportunities, which serves as an appropriate metaphor for the symposium's theme of collaboration across sectors.

The symposium focused on understanding how collaboration can effectively tackle complex challenges within and, foremost, between critical infrastructures. These strategies were debated and discussed in light of the twin transitions (i.e., the green and digital transitions) and accompanying the regulatory and policy challenges. Amidst discussions and interactive sessions on governance, data sharing, and technology integration, participants were encouraged to think beyond traditional models, exploring how cross-sectoral collaboration could enable and facilitate more resilient and adaptive critical infrastructure through a '*system-of-systems*' (SoS) approach.

Each session offered novel insights and learnings into the importance of working beyond silos, i.e. breaking barriers. From artificial intelligence and crisis management to legal complexities and network governance, speakers and participants shared real-world examples and anecdotes from their professional lives.

Ronald Christiaans and Kenny Meesters shared lessons from international crisis management, directly from the field, highlighting the shift from com-

mand-and-control models to more flexible, network-centric approaches. Dr Merel Noorman explained how artificial intelligence technologies can enhance energy efficiency while cautioning against AI's energy-intensive demands. Finally, Edwin van Espen from the Port of Rotterdam shared learnings from the Delta-Rhine Corridor Project and emphasised the need to align public and private interests.

What stood out was a shared realisation that genuine progress requires trust, transparency, and a thoughtful alignment of public values with the rapid pace of technological and infrastructural change. This sense of understanding echoed during the multiple interactive sessions, where participants explored barriers to collaboration, such as organisational inertia, legal constraints, and data governance challenges, all while brainstorming potential solutions.

Throughout the day, collaborative governance emerged as more than just a *buzzword*. At the end of the symposium, all agreed that collaboration is a necessary approach and a way to integrate diverse perspectives into a more resilient and forward-thinking system.

B. THEORY TO PRACTICE:
AN OVERVIEW OF THE KEYNOTE ADDRESSES

The symposium featured three keynote addresses that offered distinct yet intersecting perspectives on the governance of critical infrastructures. Each expert drew from their extensive experience. They unpacked how abstract concepts in crisis management, technological development, and cross-sectoral coordination are navigated in the real-world. Rather than abstract theorising, the speakers situated their reflections in diverse cases ranging from earthquake response to AI-driven energy hubs and pipeline development.

Christiaans and Meesters began the day with an engaging address rooted in international crisis coordination. Drawing on missions in Türkiye, Haiti and the Philippines, Christiaans shared first-hand observations of the logistical, political, and human dimensions of emergency response. Meesters provided structural context, using the Netherlands as an example of how crisis escalation moves from local to international levels. They demonstrated how various tools and digital platforms serve as the infrastructure for crisis collaboration.

Through interactive exercises, participants experienced information asymmetry and resource scarcity, mirroring the chaotic nature of real-time emergencies that may result from different crises. One important insight was that crisis leadership often depends not on command but on the ability to talk, interpret, and adapt. As Christiaans put it, coordination, more than control, saves life.

In the second address, Dr. Noorman steered attention to another form of transformation, the systemic changes in the energy sector brought about by Artificial Intelligence. Her address interrogated the promise and complexity of AI as an enabler of green and digital transitions. AI, she noted, is being deployed in everything from scenario forecasting and fault prediction in energy networks to the creation of decentralised energy hubs. Yet this technological innovation and shift is not without its contradictions. AI systems, particularly those relying on energy-intensive data centres, raise difficult questions about sustainability, data ownership, and fairness. Dr Noorman's work with projects like Megamind[1] and partnerships with DSOs and local energy actors illustrated the real limits and potential of AI implementation. Her framing of decentralisation as both a technical and political project brought the issue into sharp relief, underscoring the necessity of new governance models that reflect democratic values and societal priorities.

The third keynote, delivered by Van Espen, offered a pragmatic account of the Delta-Rhine Corridor initiative. Speaking from a unique vantage point at the Port of Rotterdam, Van Espen traced how a complex, multi-jurisdictional infrastructure project emerged from local observations during the COVID-19 lockdown. Rather than following a linear project planning approach, the initiative unfolded through iterative engagement with stakeholders across various sectors and borders. His reflections on the Port's evolving role provided a rare insight into how neutrality, trust, and timing shape large-scale transitions. He drew attention to the importance of informal networks, shifting coalitions, and flexible leadership in a project that required constant recalibration due to the complexity of political, economic, and logistical factors.

1 MEGAMIND is an interdisciplinary project funded by NWO, exploring how AI can support regulation of the electricity system. It aims to align technological innovation with legal frameworks to accelerate the energy transition. For more details, please visit https://www.tilburguniversity.edu/about/schools/law/departments/tilt/research/megamind

Across all three addresses, a recurring theme was the necessity of adaptive capacity, i.e. the ability to respond with expertise and responsiveness to evolving situations and institutional constraints. From Christiaans' and Meesters' reflections on cascading crises and political sensitivities to Noorman's discussion of the energy trilemma and Van Espen's illustration of navigating infrastructural governance, each address offered practical wisdom that cannot be attained from blueprints alone.

These keynotes made clear that governance in critical infrastructures is not confined to single disciplines or linear hierarchies and learnings. Instead, it demands multi-actor cooperation, an appreciation of context, and continuously reworking strategy and structure. They did not merely report on best practices but opened a conversation about how theory can serve as a scaffold for deeply situated practice. In doing so, the symposium became a forum for encouraging proactive dialogues between practitioners and academics in the fields of energy, infrastructure, and public governance.

The detailed extracts from the keynote addresses are below:

I. Lessons from Crisis Coordination in Critical Infrastructures by MCPM Ronald Christiaans & Drs. Ing. Kenny Meesters

The keynote by Ronald Christiaans and Kenny Meesters clubbed theoretical insights and practical knowledge as they drew from their extensive field experience, effectively bridging abstract and theoretical concepts found in academic discourse and the real-world complexities of crisis management and international collaboration.

The theme of this address was the challenges of collaboration in crisis scenarios and the strategies employed to overcome them. Christiaans highlighted the daunting scale of emergencies and the acute necessity of coordinating efforts among numerous stakeholders. Throughout the session, he integrated practical examples from field missions with reflections on systemic issues, providing a comprehensive perspective on the realities of crisis response.

Providing a brief overview of his professional background, Christiaans outlined his experience as a firefighter and his current role as an independent consultant. In the address, he highlighted significant missions to the Philippines, Haiti, and Türkiye, noting his 5.5-week deployment following the February 2023 earthquake in Türkiye. His narrative established a foundation for a more in-depth examination of the nature of interests and the diversity of stakeholders involved in international disaster response.

Meesters provided an in-depth overview of his professional role, primarily at Tilburg University, where he is a scholar in information and crisis management while actively contributing to UN and European crisis response teams, including UNDAC (United Nations Disaster Assessment and Coordination) and UCPM (Union Civil Protection Mechanism). He explained the intricate structure of the emergency response, using the Netherlands as a case study.

In the event of a fire, the response is typically initiated locally with fire departments and scaled up to regional coordination through safety regions, if needed. Organisations such as the LOCC (National Operational Coordination Centre), the EU Emergency Response Coordination Centre (ERCC), or UNDAC may become involved in major and larger crises. This escalating or tiered framework is put in place given the importance of coordination and the logistical challenges of managing increasingly complex and large-scale emergencies.

To illustrate these operational dynamics, Meesters engaged the audience with a thought-provoking question: "*What happens if there's a fire in the Netherlands?*" As participants responded, he guided them through the escalation process, from local firefighting efforts to potential international involvement. This interactive exercise highlighted the unpredictability of crises, which often deviate from predefined scenarios and require adaptable, context-specific responses to the crisis.

Meesters further observed that crises have evolved over time and are no longer bound by geography and time. Instead, they cascade across regions and sectors due to the interconnectedness of global systems. He cited the Suez Canal blockage and the COVID-19 pandemic as notable examples, where disruptions in one area had widespread, lingering effects.

To engage the audience further, Meesters introduced an interactive exercise designed to stimulate the intricacies of crisis environments. Participants were each given three pieces of paper representing resources they possessed or needed. The objective was to trade these resources with others to fulfil their requirements, mimicking the chaotic and unpredictable nature of crisis. Following the exercise, participants shared insights from their experiences, highlighting challenges such as information asymmetries, resource scarcity, and communication breakdowns. These reflections closely mirrored real-world crisis scenarios, reinforcing the critical importance of effective communication and strategic resource management.

Meesters then transitioned the discussion to his research on stakeholder mapping in crises. He emphasised the significance of identifying and understanding the roles of diverse actors, including the Red Cross, military personnel, and non-governmental organisations (NGOs). He emphasised that comprehensive stakeholder mapping is essential for uncovering overlaps, addressing gaps, and facilitating stakeholder collaboration.

With this foundational context established, the session shifted focus to Christiaans mission in Türkiye following the February 6, 2023, earthquake, a case study that brought the theoretical aspects of crisis management to life through vivid, practical examples.

The session continued with Meesters elaborating on the critical role of the political context in international crisis response. He explained how governments in affected countries often aim to demonstrate strength and capability. This need for control influences how international aid is received and managed. For instance, international responders may be restricted from speaking to the media as governments seek to position themselves as the primary managers of the crisis. Meesters emphasised that, as representatives of the European Union (EU) or the United Nations (UN), their role is to support local authorities rather than lead, recognising that decisions ultimately rest with the host government. Local politics, especially during sensitive times such as elections, significantly shapes the scope and nature of international involvement.

The theme of integration and collaboration was recurring in their address. Christiaans shared his experiences working from provincial headquarters in Türkiye, where daily engagement with local government officials was vital. He described how regular meetings with governors, mayors, and ambassadors were essential for information exchange and demonstrating the added value of the international team's involvement. He explained that the primary objective was to build trust and clearly communicate that their mission was to facilitate and support, not impose external solutions.

Meesters noted the paradoxical nature of their work, observing that while the visible aspects of crisis response, such as search-and-rescue efforts, capture media attention, the less visible yet critical tasks, like meetings, coordination, and information management, are where substantive solutions are developed. Though lacking in glamour, he emphasised that these foundational activities constitute the backbone of effective crisis management.

Christiaans reflected on the response to the Türkiye earthquake. They observed that the initial quake served as an early warning, enabling some residents to evacuate and thereby mitigating casualties in certain areas. However, the overall death toll remained tragically high, and in these particular regions, international assistance was concentrated. In Malatya, Christiaans' team was pivotal in directing organisations to areas with the need, improving coordination efforts to ensure balanced and effective resource allocation.

Meesters introduced an important concept in modern crisis management: the shift from traditional command-and-control models to a network-centric approach. In the traditional model, information flows hierarchically, moving upward for decision-making at the top level and then cascading down for execution. In contrast, the network-centric model, increasingly adopted in both international and Dutch contexts, prioritises decentralised decision-making. This approach enables stakeholders to share information and maintain situational awareness, enabling more agile and collaborative responses to crises. Christiaans asserted that elements of the traditional model, such as coordination cells, remain crucial, serving as hubs where efforts are organised and information is centralised.

A vast number of actors are involved in managing a crisis. Meesters highlighted the sheer diversity and volume of responders, ranging from NGOs like the Red Cross to private companies like DHL, which leverage their logistical expertise to support operations. Christiaans noted that the Türkiye earthquake response was among the largest international emergency operations, with over 8,000 personnel deployed. This included medical teams, telecommunications specialists from Vodafone, and volunteers from both local and diaspora communities, demonstrating the broad spectrum of expertise mobilised during large-scale crises.

Meesters explained the importance of creating an overview to prevent gaps or duplication of efforts during crisis response. He illustrated this with a practical example, noting how camper vans were deployed to provide emergency shelter for displaced individuals. However, additional infrastructure needs, such as water supply and road access, were often overlooked. This scenario highlighted the value of coordination structures like the On-Site Operations Coordination Centre (OSOC), which, while appearing simple like whiteboards in tents or *meldkamers* (control rooms), are critical for ensuring alignment among responders. Christiaans noted the use of the cluster approach within the UN framework, where specific organisations, such as the World Food Program (WFP) for logistics, take the lead in their respective sectors to streamline efforts.

Information management emerged as the cornerstone of effective crisis response. Meesters and Christiaans outlined various tools used in the field, including vOSOCO, ICMS, KoboToolbox, and even everyday communication platforms like WhatsApp and Microsoft Teams, which were adapted to meet the demands of the crisis context.

The selection of tools often evolved with the situation, initially relying on basic whiteboards and subsequently progressing to more advanced systems as needed. Christiaans stressed that information sharing is not just about IT. It is about informing decision-makers at all levels, from search-and-rescue teams to ambassadors, to enable better outcomes.

A standout example of innovative information management came from an initiative in Türkiye, where students developed a crowdsourced map that tracked local efforts and resources. Meesters connected the students with the UN, facilitating the creation of an English version that could be integrated into international coordination efforts. This initiative demonstrated how grassroots innovation and community-driven solutions can enhance formal response mechanisms.

Meesters reiterated that the ultimate goal of information management is not the mere generation of data but the dissemination of actionable insights. Effective information management helps decision-makers decide whether rescue teams or high-level officials make choices that directly impact the well-being of affected communities.

In the final segment of the address, several important facets of crisis management and the essential role of coordination in saving lives were addressed.

Christiaans outlined the crucial steps to rebuilding after a crisis, emphasising the importance of transforming information into actionable strategies. Such strategies can be executed through a flash appeal document that clearly defines what is needed to return to normalcy. These documents are vital in securing funding and providing transparency to potential donors, highlighting the urgency of the situation, and allowing people to understand why their donations matter.

One of the central takeaways from Christiaans' and Meesters' address was the idea that coordination saves lives. In a crisis, information needs to be well-organised and structured. By creating an overview of the situation, people are empower to make their own decisions and work alongside us. It is not about having all the expertise but mobilising the right resources through outsourcing or leveraging local knowledge. For instance, Meesters discovered a group of experts who were well-versed in geo-information systems in Nepal in an unplanned manner. This is a perfect example of how crisis management doesn't require owning all the expertise but knowing how to find and harness the right capabilities when needed.

Meesters further emphasised that crisis leadership is not about being in charge but facilitating cooperation. It is about enabling people to come to you with their solutions. When they do, you engage with them by understanding what they're working on and finding ways to include their efforts in the bigger picture.

He also shared a humorous yet insightful tactic to encourage collaboration. One such tactic included offering something simple like a key to the bathroom. In a high-pressure environment, small gestures like these can bring people together and ensure they're willing to discuss and collaborate. By informally linking access to a shared but necessary resource with interpersonal interaction, such gestures can open space for dialogue and build the foundations for collaboration.

Meesters added his perspective on managing crises by embracing the inherent uncertainty. He shared that, rather than waiting for the perfect solution, it is often better to act with partial information, knowing that things will evolve. Waiting for complete clarity could mean losing precious time, a critical asset. In crisis management, it is crucial to make the best decision with the available information and remain open to revisiting that decision if necessary. Meesters' approach aligns with the idea of incremental improvements. Even when the situation isn't perfect, progress is still possible and better than stagnation.

Regarding preparedness, Meesters pointed out that while having a detailed manual or protocol is helpful, the training and experience truly guide decision-making. As Christiaans jokingly mentioned, he carries his manual on every mission but rarely consults it. Instead, experience becomes the guiding force in crises.

From these discussions, several core lessons emerged that are crucial to effective crisis management:

1. **Dynamic Capabilities**: Incorporating both remote and local support is essential. Relying on local knowledge and assistance grounds the response in the realities of the situation.

2. **Facilitating Coordination:** Information coordination is vital to response efforts. Ensuring that actions are well-organised and aligned leads to better outcomes. A networked approach is preferable to traditional command-and-control methods.

3. **Adaptability:** Flexibility is crucial in crisis management. A balance between structure and adaptability, focusing on incremental improvements that can accumulate over time, is important.

The keynote address further touched on the evolving nature of crises. In the past, crises were often seen as situations for first responders in blue vests with flashing lights. With time, this narrow perspective is changing. Crises have long-term, wide-reaching effects that can extend to unexpected areas. They are distributed, cascading, and often unpredictable. This reinforces the need for a broader, more interconnected approach to crisis management involving collaboration across various sectors and expertise.

KNOW THE SPEAKERS!

MCPM Ronald Christiaans *has over thirty years of experience in crisis management, with a background in the Fire Department Service and extensive expertise at local, regional, national, and international levels. He has held diverse operational and advisory roles, contributed to planning and policy development, and holds a master's degree in Crisis and Public Order Management. Ronald currently serves as Chief Innovation Officer at Resilience Advisors and operates as an independent crisis management and innovation consultant.*

Drs. Ing. Kenny Meesters *is an experienced Information Management researcher with a strong background in international IT project management. His work focuses on the design and delivery of IT systems in the NGO and public service sectors, with a particular emphasis on humanitarian, crisis, and disaster information management. Combining hands-on project experience with ongoing research, Kenny brings an in-depth understanding of how to align IT solutions with organisational needs to ensure effective and resilient outcomes.*

II. AI as a Catalyst for Collaboration: Dr. Merel Noorman on the Future of Critical Infrastructures

In the second keynote address of the winter morning, Dr. Merel Noorman, an expert in Artificial Intelligence (AI) and Science and Technology Studies at Tilburg University, explained AI's role in the energy sector. According to her, AI in the energy and other critical infrastructure sectors is undergoing systematic transformation.

Artificial Intelligence has dominated news cycles in recent years due to its ability to generate text, images, and videos, as well as its potential to address global challenges, including the energy transition. Noorman highlighted that AI plays a pivotal role in the twin transitions (the green and digital transitions). Industry leaders have appreciated AI for its ability to enhance cost-effectiveness and efficiency, create jobs, and reduce carbon emissions. As an enabling technology, AI is being used in the shift from centralised, coal-based energy systems to more decentralised models that rely on renewable energy. This transformation involves moving from traditional systems dominated by large energy providers to more unpredictable, complex and decentralised networks, such as those powered by wind energy. These innovative processes, Noorman noted, pose significant challenges that AI technologies may be uniquely positioned to address.

AI emerges as a promising technology capable of addressing the challenges and complexities of the energy transition. According to the World Economic Forum (WEF), AI offers diverse applications in the energy domain, serving as a critical enabler for decision-making, control systems, the Internet of Things (IoT), drones, imaging technologies, measurement, reporting, and big data analysis. Noorman emphasised that within the energy sector specifically, AI can be used to run advanced scenarios, automate the optimal positioning of wind turbines and solar panels, and predict potential faults in energy networks. These capabilities enhance operational efficiency and enable proactive maintenance and smarter resource management, making AI important in navigating the challenges of decentralised energy systems and networks.

However, Noorman cautioned that AI's growing adoption comes with chal-

lenges, particularly in energy consumption. She termed these as *energy hungry data centers*. AI systems rely quite heavily on energy-intensive data centres, and the rapid increase in energy consumption due to model training has raised concerns. Additionally, technologies such as cryptocurrency mining further increase global energy demand. This paradox highlights the need for continued innovation to mitigate AI's carbon footprint, ensuring that its own environmental impact does not undermine its benefits in enabling the energy transition. As Noorman pointed out, this dynamic field demands a balanced approach that integrates technological progress with sustainability.

In her research, Noorman investigates how AI can be used responsibly to address energy and climate transition challenges. Through various projects and initiatives, such as *Megamind* and *Academische Werkplaats*[2], she collaborates with multiple stakeholders, like distribution system operators (DSOs), industry partners like IBN, and research and academic institutions. Together, they aim to generate practical insights into emerging issues in the energy and climate domains. One of the central work objectives within these initiatives addresses the role of digitalisation in these transitions. Further, Dr Noorman emphasised the importance of decentralisation and AI's role in enabling it. She views AI as a set of techniques encompassing automated reasoning capable of handling complex decision-making and machine learning methods such as pattern recognition, deep learning, and neural networks. AI serves as an umbrella term for technologies that process real-world data to produce actionable insights. In the energy domain, this includes forecasting supply and demand, simulating network behaviour using digital twins, predicting wind speeds and solar radiation, and minimising operational costs.

AI also plays a central role in facilitating local energy markets. It enables the exchange and sharing of energy within community hubs, optimises demand-response strategies, and empowers prosumers by providing insights into their energy production and consumption patterns, allowing them to make smarter energy choices. Dr. Noorman noted that this field is complex and evolving quickly. For instance, a paper by Richter et al. reviewed the applications of AI in smart grids, identifying multiple layers within smart grid models where AI techniques are being tested. These range from business applications, such as AI-supported energy trading, to energy management tasks like solving unit commitment problems.

Noorman highlighted energy hubs as a potential and practical solution for facilitating the energy transition and addressing congestion. These hubs minimise the need to expand grid capacity by optimising local energy production and consumption. Energy hubs can range from those serving households to business parks integrating resources like solar panels and electric vehicles, enabling efficient and localised energy solutions. For example, a business park energy hub might integrate solar panels with electric vehicles, enabling an efficient energy ecosystem.

Noorman and other researchers have explored how AI can support energy hubs, such as the one being developed in Tilburg's Kanaalzone for local businesses. Their work highlights the challenges of energy hub platforms, which differ from large-scale digital platforms as the former are tied to local physical systems. Constraints such as unclear and misaligned incentives for businesses to participate, the need for sensitive data sharing, and the associated loss of autonomy make establishing energy hubs challenging. While these hubs aim to reduce energy costs and carbon emissions, the lack of certain legal and policy frameworks and governance models adds to the challenge. Dr. Noorman noted that AI applications in energy hubs are still in their nascent stages, with limited implementation in grid-level systems, particularly in the Netherlands. Beyond data-sharing issues, the absence of certain energy data and the complexity of integrating diverse stakeholders make AI-driven decentralisation an ambitious and distant goal.

Implementing AI in energy systems and networks raises concerns about predictability, fairness, and data privacy. Noorman noted that the AI Act is often inapplicable to energy technologies, as standards restrict AI use in safety-critical components. Biased data may reinforce societal inequalities and ills, ben-

2 *Academische Werkplaats* or the Academic Collaborative Center for Climate and Energy is part of Tilburg University's Program for Broad Prosperity. It brings together researchers and societal partners to address the social, legal, and behavioural dimensions of the energy transition. The Centre focuses on co-creating solutions that integrate climate and energy goals with just and effective governance. For further details, please visit: https://www.tilburguniversity.edu/collaboration/program-broad-prosperity/climate-and-energy.

efiting some neighbourhoods or strata over others. Additionally, the complexity of AI systems can hinder traceability, and sensitive data, such as household energy usage, poses privacy risks by revealing personal lifestyle details.

Noorman emphasised that the regulatory landscape is rapidly evolving in energy and AI domains. New laws, such as the AI Act and developments in energy law (the New Energy Act in the Netherlands), are pushing for increased data sharing to enable digital applications and collaboration. These changes aim to create a framework for the digitalisation necessary to support innovations like energy hubs.

While the regulatory and legal frameworks surrounding energy and AI are still evolving, Noorman stressed the importance of moving forward with technological and systemic developments aligned with key values in the energy domain. Central to this discussion is the issue of "*energy trilemma*". This trilemma aims to balance energy security, equity, and sustainability. She posed critical questions about how emerging energy systems will reflect and balance these values as they transition from centralised to decentralised models, introducing new connections and relationships that require innovative coordination models. These shifts will inevitably impact various groups, including communities, businesses, and individuals, and demand active interventions to ensure equitable outcomes.

The discussion extended to the growing role of Big Tech in shaping energy systems. Companies like Microsoft and Google are leveraging AI to create decentralised solutions, such as Microsoft's AI-powered microgrid, which promotes energy efficiency and equity by enabling local energy independence. However, while these innovations challenge the existing centralised systems, they also introduce new dependencies, especially in large technology companies. Google, for example, is actively working on tools to enhance energy transparency and reduce emissions, yet its involvement in shaping energy systems raises concerns about data access and influence. With Big Tech investing in clean energy, including nuclear power for data centres, their role as powerful players in the energy sector is unprecedented and transformative.

Noorman linked this development to the concept of "*sphere transgressions*," coined by philosopher Tamar Sharon. This idea highlights how Big Tech's entry into new domains and areas, such as energy, education, or healthcare, can fundamentally transform the values and logic of these sectors. In the energy sector, this shift warrants critical reflection on the kind of systems being developed and the principles guiding them. Central questions include whether market-driven models should dominate, how to address issues like net congestion, and whether prioritisation should be based on financial and regional capacity or broader societal goals.

Noorman advocated for democratic governance of AI in energy systems and networks, emphasising the need for legitimacy and inclusiveness in decision-making, which is central to AI. She highlighted the challenges of governing foundational models, which are costly and resource-intensive to update, potentially locking systems into outdated and obsolete models. Effective governance structures must ensure that changes to these technologies are legitimate and reflect societal values.

Noorman's keynote sparked a lively discussion among the audience members, who raised insightful questions about the role of AI in energy governance, the influence of Big Tech on decentralised systems, and the ethical and regulatory challenges of integrating these technologies into the energy transition. Yet, as AI becomes increasingly embedded in energy infrastructures, the central question remains: how can we govern this transformation in ways that uphold democratic values and ensure energy justice? Noorman concluded with a reminder that AI is not merely a technological innovation, but one that reshapes how decisions are made and by whom. Its integration into the energy sector, she emphasised, must be guided by inclusive, transparent, and accountable governance frameworks.

KNOW THE SPEAKER!

Dr Merel Noorman *is an Assistant Professor at the Tilburg Institute for Law, Technology, and Society (TILT) at Tilburg University. Her research focuses on the governance and regulation of artificial intelligence (AI) and robotics, emphasising responsible development and the intersection of AI and democracy.*

III. The Delta-Rhine Corridor: Insights on Cross-Sectoral Collaboration from an Insider, Edwin van Espen

When reflecting on the Delta-Rhine Corridor (DRC) initiative to date, alternative titles for the keynote that van Espen came up with included *Change Management in public and private organisations*, *Playing hardball with soft skills*, and *Why don't they follow our strategy?* Since these accurately represent the complexity of the DRC project.

The DRC initiative concerns the construction of underground pipelines between Rotterdam and the German border at Venlo, via the industrial zone in Moerdijk. The ambition of the initiative is to transport CO_2 from Germany and tshe Netherlands to CO_2 storage facilities in the North Sea and possibly CO_2 users. Additionally, low-carbon hydrogen will be made available to industry in the Netherlands and Germany via the Rotterdam import terminal.

The DRC initiative began in 2021 when van Espen worked in the international department of the Port of Rotterdam. Due to COVID-19 travel restrictions, he focused on issues affecting the Port's direct customers and their partners, particularly in energy transition, security, and pricing. Uncertainty in these areas extended beyond the Port to inland regions, reaching parts of rural Germany. This led to the initiative's launch, with van Espen assigned a flexible role to explore solutions. The only guideline was the Port's ambition to become Europe's most efficient and sustainable hub by 2030 and beyond.

The Port first started to engage with industries that had raised concerns. The Port also contacted industries in Limburg and Germany. These businesses and their local, regional, and national governments held constantly evolving information and differing perspectives. Bringing these views together revealed multiple key lenses through which the problem can be viewed and understood.

The first lens focuses on the local area, specifically the Port and its surrounding industrial zone. The Port of Rotterdam has two main functions. The port authority is responsible for the harbour master, ensuring the safety, security, and efficiency of ships. The port developer is commercially driven. These roles are integrated within one group, meaning the Port sometimes operates like a governmental body and at other times like a commercial entity. As a government-owned organisation with public shareholders such as the Dutch Ministry of Finance and the Municipality of Rotterdam, the Port has sustainability objectives it must achieve. However, as a financially independent entity, it must do so efficiently and effectively.

The second lens examines the Port of Rotterdam as part of the interconnected energy supply system stretching to Limburg, Germany, and overseas. The Port plays a key role in Europe's energy supply chain, handling large volumes of crude oil, coal, and LNG. While essential, these activities contribute significantly to carbon emissions. The Port is also part of the feedstock system, competing and cooperating with others, such as the Port of Antwerp.

Beyond this is the lens of the "Blue Banana" region, stretching from London through the Netherlands and Southern Germany to Barcelona, which has been the heart of European innovation and wealth creation. This Northwestern cluster connects to global markets, including Brazil and South Africa. As Europe cannot sustain its energy needs alone, international supply chains are crucial.

At the macro level, scenarios are emerging for 2030 and 2050, ranging from a fully transparent economy to a protective one with trade barriers, like those expected from the new US President. Political challenges, including China's strategic autonomy and the war in Ukraine, also shape the landscape. These issues were central to discussions with industry and government.

Van Espen then raised the question of what to do with all this information. Why would the Port have to worry about these issues related to energy transition and energy independence? One important reason is that society demands the Port to be considerate of these issues, or at least that was the Port's perception. Doing so provides a license to operate. Most importantly, the Port realised that tackling all these issues would not be something it could do on its own, given all the interconnected systems and developments. But at the same time, the Port is the most neutral platform when considering all the different lenses that were discussed. Most of the stakeholders trust the Port or give the Port

their trust to act on their behalf. Meanwhile, the Port has also been very clear on its intentions to move away from fossil-based.

Van Espen explained that the Port saw itself as best positioned to lead these initiatives. It identified four roles in the energy transition: 1) developing and sharing strategic insights, 2) creating the right boundary conditions, 3) identifying and attracting opportunities, and 4) taking strategic initiatives to reshape connected systems.

Based on available information, the Port needed to determine which partners and innovations aligned best with the strategic initiative. However, Van Espen acknowledged that the Port lacked the scale and authority for full implementation, making it necessary to establish a delivery system. Recognising these limitations was essential.

He also pointed out that existing fossil-based connections were a useful reference, showing that the Port's role in facilitating large-scale transitions was not entirely new. However, the urgency of the current energy transition and the tight timeframe added significant complexity. Given this, the Port saw an urgent need to develop new, sustainable, and future-proof connections between Rotterdam and the hinterland. At the same time, there was a growing need to translate strategy into tangible actions.

The Port then considered candidate product groups in line with the strategic goals of the Netherlands and the European Union, also in terms of positioning Western Europe vis-à-vis the United States. Amongst others, hydrogen, CO_2, and ammonia were identified as potential candidates and viable business cases could be developed for some. These allowed the Port to check its long-term outlook and to match its strategic data with options derived from the discussions with the industry. The Port started before the actual markets existed, working cross-sectorally on problems for different industrial sectors. From here on, players relevant for realisation were again identified: big industrial players, such as the government, were needed as initiatives involved in cross-border infrastructure. So by definition, the initiative would be international, e.g., the international supply chains running through Germany. Overcoming initial resistance, e.g., in the form of people who said it could not be done or never happen, proved important. Also, the local political systems turned out to be an inhibiting factor at times. For example, spatial planning for pipelines with national and international significance from about ten years earlier had almost been forgotten. Still, it was considered to be a good starting point for the problems currently at hand. The Port furthermore took on the role of the private sector, as governments were on board, but no industrial company dared to step forward and support the initiative. Hence, the Port acted on behalf of these industrial companies, talking directly to the Ministries responsible for climate and economic growth, water management, and infrastructure. Simultaneously, the Port started to look for private parties with more or less aligned interests, and a limited number of organisations representing different sectors were found. The focus of the initiative would be on parts for which sufficient investors could be found, i.e., CO_2 and ammonia (but not for LPG). Once the first small group was established, Port withdrew from playing the role of the private sector and handed over part of the initiative to these private parties. This turned out to be one of the key takeaways: you have to be able and willing to adopt a different role if another party is better equipped to deal with a certain problem. After two years, a B2B and, a G2G and B2G system was in place.

The intention was to continue making choices as broad as possible, especially when developing new markets, as is the case with hydrogen. The initiative aimed to support different energy sources and continue to include as many sources as possible. Additionally, the initiative relied heavily on cross-sectoral collaboration and building the supply chains necessary for specific energy sources, from production to transportation, all the way to the end user. These chains need to be established for every modality involved, and parties willing to invest will need to be identified for each chain. Social cost-benefit analyses were also conducted to demonstrate to the government that the Port's actions were relevant. This resulted in parties stepping forward to offer help and accelerate the process. The way in which things were organised was critically discussed and then maintained, as it was considered the most effective given the complexity at hand. Other projects were identified as projects of common interest, from which insights and learnings could be obtained. All this was important for getting the initiative to move forward.

In June 2024, a discussion in Parliament about the scope mentioned that hydrogen would be there in 2032 *or later*. Nevertheless, parties needed the connection by 2032, so the work on realisation commenced. Several scenarios were investigated, involving different modality combinations. More recently, discussions have taken place in the House of Representatives regarding the acceleration of certain projects, including CO2 storage, the hydrogen network, and the DRC. Much support was given to all these initiatives.

Van Espen highlighted several key takeaways, emphasising the need to recognise interconnected layers and sectors where challenges translate into infrastructure that supports commercially effective supply chains. He pointed out that these issues are not one-dimensional, as strong social and political factors shape outcomes. The social component is as critical as the technical aspects, leading to the alternative framing of playing hardball with soft skills.

Van Espen noted that change requires identifying and involving individuals willing to challenge the status quo. Often, the same people take on this role, as they are the ones ready to push against existing systems. He asserted the importance of informal networks, which enable small initiatives to evolve into full-scale projects. However, this cannot happen all at once, and it requires multiple iterations, making it more of a social process than a standard project management approach.

He also cautioned against relying on a single analytical model, as it will not align with the complexities of interconnected systems. Instead, he advocated for a methodology focused on non-linear change that accepts inherent uncertainties and resistance. Preventing alternative use is another challenge, as actors involved may attempt to shift the narrative for their benefit.

Another important takeaway was "*the right size at the right time*". A broad coalition is needed in some cases, while a small group of decision-makers is sufficient in others. Van Espen demonstrated the importance of matching actors to the desired impact and ensuring that the most neutral party is the facilitator. Finally, he stressed the need to be explicit about objectives, as a lack of clarity can lead to a breakdown of trust among stakeholders.

KNOW THE SPEAKER!

Edwin van Espen *is the Manager of International Port Development at the Port of Rotterdam. He has over 18 years of experience in international port and industrial projects, as well as organisational development in both the private and public sectors. This experience involves solving critical problems in diverse and complex environments, as well as working with a wide range of stakeholders.*

C. ADDRESSING CHALLENGES THROUGH INTERACTIVE AND PARTICIPATORY SESSIONS

The symposium featured a series of interactive and participatory sessions designed to address the various facets of critical infrastructure systems in the era of digital and green transitions. These were not conventional lecture-style presentations or talks but collaborative forums for engagement, reflection, and idea exchange among diverse participants who shared their expertise. Through various formats, including games, collaborative workshops, group assignments, live polling, and panel discussions, participants were invited to contribute their perspectives, share their experiences, and actively shape the ongoing debates and research trajectories.

The sessions focused on operationalising challenges in real-world settings, such as cross-sectoral coordination, the role of IT and data in critical infrastructure, network governance, and the legal complexities of system integration. While the specific topics varied, the sessions shared a commitment to participatory learning and the co-production of knowledge. The emphasis was placed on identifying practical dilemmas, surfacing hidden tensions, and en-

visioning institutional, technical, and legal strategies to strengthen collaboration and resilience in infrastructure systems.

The session led by David Wodak used a serious game format to explore the real-world obstacles of digital transformation in (semi-)public organisations managing critical infrastructures. Wodak highlighted how fragmented IT systems, outdated infrastructure, and unstructured data impede effective collaboration. Participants were asked to reflect on these issues in group discussions, drawing on their own experiences and considering how trust and coordinated IT governance could be improved.

Prof. dr. ir. Wendy van der Valk's session facilitated a workshop on the principles of good governance in collaborative networks. This session foregrounded the difference between traditional hierarchical coordination and the more horizontal dynamics of cross-sectoral networks. Using examples from the energy transition and public infrastructure management, participants examined how collective goals can be pursued amid individual interests, limited resources, and high levels of network opacity.

The session led by Shakya Wickramanayake and Dr. Tom Aben, served as a prelude to an upcoming Delphi study. This session aimed to generate a common understanding of the term 'cross-sectoral collaboration' and the system-of-systems (SoS) approach. Participants contributed both anonymously and in open discussions, generating a rich set of keywords, challenges, and reflections. The session revealed the tension between existing organisational silos and the urgent need for integrated action in managing interdependent infrastructure systems. It also highlighted the need for a shared vocabulary and identified both technical and human obstacles to realising SoS governance.

Prof. dr. Henk Akkermans' session focused on developing a collaborative research proposal aimed at addressing labour shortages in infrastructure maintenance. Participants explored the concept of a 'service control tower' to coordinate skilled labour across sectors and discussed the challenges and opportunities that such a system might present. Drawing on parallels with the healthcare sector, the session explored how shared governance, digitalisation, and forward-looking labour strategies could help meet the growing demands of maintaining resilient infrastructures.

The high-level panel discussion on legal complexities in the digital and green Transitions in the EU moderated by Shakya Wickramanayake and featuring experts from law, strategy, and operations, the panel tackled big-picture questions related to data governance, transparency, regulatory frameworks, and public value alignment. Discussions centred on the evolving role of infrastructure operators as data stewards, the friction between innovation and privacy, and the need for nuanced legal and policy tools to support cross-sectoral digital integration.

Collectively, these sessions highlighted the value of participatory formats in revealing blind spots, fostering mutual understanding, and generating actionable insights. They created a space where theory met practice and where governance, law, data, and infrastructure were brought into conversation through the experiences and imaginations of those working on the ground. The following sections provide a closer examination of each session and the key takeaways that emerged.

I. Governing Digital Transformation in Critical Infrastructures through Trust and Collaboration: An Interactive Game by David Wodak

David Wodak set the stage for this interactive session by exploring the challenges of integrating IT systems in public and semi-public organisations, often characterised by failed IT projects and inefficiencies. He demonstrated the need to rethink the roles of these organisations in the context of critical infrastructures, particularly as new developments push for greater data sharing and collaboration across networks. Despite these advancements, collaboration remains limited due to diverse standards, data silos, and fragmented IT systems.

Wodak's session provided the following valuable insights:

- More data is not always better. While data is essential for decision-making, excessive amounts of unstructured or redundant data can lead to inefficiencies. Organisations may struggle to extract meaningful insights without proper governance, resulting in information overload rather than actionable knowledge.

- A new perspective on digitalisation is needed. Traditional approaches to digital transformation often focus on simply adopting new technologies. However, a more strategic approach is required, one that prioritises integration across different systems and stakeholders.

- Inadequate systems result in data sharing that cannot be applied. Many organisations operate with outdated or incompatible systems that hinder effective data exchange. When data is shared in fragmented or inconsistent formats, it becomes difficult to utilise, leading to inefficiencies and missed opportunities for collaboration.

- A holistic overview of both data and physical assets is needed, not just for individual organisations but for all collaborating parties. Effective decision-making requires a comprehensive understanding of both digital and physical resources. A siloed approach limits visibility, making coordinating efforts and optimising operations across multiple entities difficult.

The role of IT is still not well understood, and it should be. The IT is often seen as a support function rather than a strategic enabler of organisational success. There needs to be greater awareness of how IT can drive innovation, enhance collaboration, and provide the necessary infrastructure for data-driven decision-making.

Wodak first introduced the difficulty of digitalisation within (semi-)public organisations by providing recent news articles highlighting the struggles these organisations face. Wodak illustrated that the problems these organisations face are not new and have been ongoing for more than three decades. As Wodak initially depicted a situation that could not be solved anytime soon, he finished by showcasing recent developments within critical infrastructure organisations that appear to have found a way out of the struggles these organisations usually face by applying a new perspective to data and the use of IT.

Wodak further illustrated the landscape by sharing insights from the organisations he works with. These organisations pursue the same objectives as the one mentioned in the news; however, achieving these goals has proven more challenging than initially anticipated due to a more complex environment and a fragmented organisational structure. He highlighted the difficulties faced by his partner organisations with concrete examples. For instance, some organisations operate across numerous systems, sometimes as many as 28, leading to data duplication and inconsistencies. This, in turn, results in the formation of information silos that are difficult to access and often unreliable. Such silos make it challenging to determine which data is most critical, ultimately hindering collaboration and informed decision-making.

In the next part of his session, Wodak focussed on the academic literature. Wodak explained that these issues are not unique to his partner organisation but stem from high degree of data fragmentation. The presence of multiple isolated systems and processes results in data being collected and stored in various locations throughout the organisation. This decentralisation makes it difficult to track where data originates, where it is stored, and how it will be used. The challenge intensifies in cross-sector collaborations, where different stakeholders struggle to interpret and integrate data effectively, each with their own standards and internal barriers. Moreover, the absence of a centralised approach prevents organisations from gaining a holistic overview, leaving employees overwhelmed with vast amounts of data they cannot efficiently utilise.

After Wodak's presentation, he announced a group assignment for the audience. The audience was divided into two groups with diverse participants. The participants were to discuss their experiences with digital systems in their work environments and explore ways to enhance collaboration. They were

asked to combine and apply the information Wodak provided to their daily operational activities. The diverse groups included academics, industry professionals, and government representatives, resulting in a wealth of perspectives and experiences.

Group 1 included a mix of academia, NGInfra, and Hitachi participants. Their discussion highlighted the fragmented nature of IT systems across different stakeholders, each using systems tailored to their unique needs and operations. These differences made it challenging to integrate systems, particularly when priorities varied, such as between consumer-oriented platforms and those used for internal asset management and other internal processes. They noted that the overwhelming volume of data, redundant information, and "TMI" (too much information) further compounded these challenges, creating hurdles to effective collaboration. Fragmented IT systems also hindered the ability to address immediate and urgent problems effectively. The group emphasised that collaboration requires more than mere technological backing but also (and more importantly) human expertise and the willingness to share information. However, the ambiguous role of IT in enabling collaboration often creates resistance among those who lack the necessary capabilities or understanding to work with complex systems.

Group 2 explored challenges faced in environments characterised by diverse stakeholders, such as farmers, municipalities, and companies, each with unique data needs and interests. They identified the disconnection between data sources and a lack of clarity about data ownership and content as significant barriers to collaboration. Trust deficits, particularly when sharing sensitive information and data, further complicate efforts to collaborate or work in harmony. The group discussed the potential of neutral intermediaries, like the Port of Rotterdam initiative, to facilitate collaboration. These intermediaries utilize tools such as Non-Disclosure Agreements and safe houses to anonymize data and level the playing field, thereby encouraging cooperation and collaboration. However, participants stressed that addressing trust and shared goals was more important than focusing solely on technology. They suggested a model where maximum data is shared while protecting only the most sensitive information, creating new opportunities for collaboration.

The session recap emphasised several major postulations. First, trust emerged as the most important factor for fostering collaboration, often outweighing the role of technology. While technology can enable data sharing, the success of these processes depends on mutual trust among stakeholders. Second, participants highlighted the importance of defining clear boundaries for data sharing, advocating for a model where most data is shared to promote collaboration while having sufficient safeguards to protect sensitive data and information. Third, the fragmented nature of IT systems remains a major obstacle to collaboration, especially in environments with diverse stakeholders and priorities. Ultimately, addressing human challenges, such as expertise gaps and collaboration skills, is crucial for enhancing governance in critical infrastructures.

Wodak concluded by highlighting the importance of moving beyond technology to address the human and trust dimensions of digital transformation in critical infrastructures. He emphasised the need for coordinated governance structures that align with the realities of fragmented systems and diverse stakeholders, encouraging ongoing dialogue and research to address these pressing challenges.

II. Principles for Good Governance in Collaborative Networks: A Collaborative by Prof.dr.ir. Wendy van der Valk

The workshop by Prof.dr.ir. Wendy van der Valk focused on principles of good governance, particularly between horizontal partners, as opposed to vertical buyer-supplier relationships, which are traditionally governed by a mix of contractual and relational mechanisms. A guiding question is how governance in network settings featuring collective or shared objectives and interests takes place. How do the parties involved coordinate and collaborate?

The key learnings from this workshop include (but are not limited to) the following:

- Identifying the network and its environment requires identifying its objectives and its boundaries. Objectives can be derived from interdepend-

encies in the network, which may allude to a higher-level objective that these interdependent parties may contribute to. Alternatively, objectives can be established with reference to a societal goal, after which (potential) contributors may be identified.

- Network member contributions involve striking a balance with, and sometimes even compromising on, achieving individual objectives. Both activity alignment (coordination) and interest alignment (cooperation) are key.

- Network opacity refers to network relationships becoming increasingly difficult to observe. Segmenting the network into distinct sub-networks, each tailored to specific objectives or challenges, may be helpful when opacity is high.

- Scientific literature has advanced various network governance models. The Network Administrative Organisation (NAO) model, which involves the creation of a separate entity exclusively for the purpose of network governance, generally seems to support cross-sectoral collaboration and its structured coordination mechanisms.

- Robust information sharing and intensive communication at various levels of organisation (micro, meso, macro) with varying scopes are key to effective network governance.

Many activities of infrastructure managers take place in a networked setting -i.e., a system-of-systems- involving collaboration between public and private actors. The network is a collection of individual subsystems, whereby the balancing of network versus individual subsystem objectives is a major challenge. Where are or should parties be willing to compromise and where not? How are activities organised and monitored? Collective action is needed when dealing with complex challenges such as those involved with the energy transition. The energy collaborative network is used as an illustrative and representative example of the kind of settings infrastructure managers are involved in. The network involves many main entities, such as businesses, consumers/ residents, and the government at various levels. There are many and large interdependencies between these parties; hence, in the energy transition, they must collectively take steps forward. There is also great diversity in terms of opportunities for each individual actor; the same holds for challenges that individual actors face and need to address. More generally, parties in these settings experience difficulty deciding the best way forward to avoid a standstill or enter vicious cycles. Moving forward collectively, however, may involve individual organisations having to face certain dilemmas. As a result, some members in the collective may be more hesitant than others to engage in collective action. Alternatively, individual organisations may see opportunities for themselves and decide to move forward, which also creates challenges in keeping the collective together.

It is clear that this is a complex playing field. Sometimes, it is also hard to see who is or should be part of the network. The larger the number of actors included, the more complex the network becomes. Too small, and certain actors, interests and competencies may be overlooked. How do parties coordinate in these networks? How can activities be aligned? And how to align interests, also in relation to the overall network objective?

The discussion in small groups subsequently focused on two main issues:

- How can parties handle these issues, i.e., how to navigate the collective?
- Who should be handling these issues, i.e., who is navigating?

Groups discussed these questions from their own perspectives and experiences, or the group can take a specific example of a network and discuss the question related to that setting.

Outcomes:

- In many situations, all the actors are there but in reality there is no network yet really.

- Initially, it may be a business that has a certain challenge and that hence starts pushing/ facilitating. They cannot solve their issue on their own and

hence they start looking for others to collaborate with, by transferring (part of) the problem or showing opportunities. After some time, another party (usually the government) takes over as facilitator.

- At the same time, often, the fact that collaboration is necessary is not acknowledged.

- This may also relate to competences, whether parties are sufficiently well-equipped to understand the position and interests of others. Something like "empathic engineering" (i.e., outside-in understanding) could work as a governance mechanism.

- Resources are another issue. Think of tools such as the RACI matrix (Responsible, Accountable, Consulted, Informed): do people in organisations have the resources for this? In many cases, people just put in a lot of extra effort on top of their daily work activities, while in earlier symposium sessions, it was suggested that this should be a fully dedicated activity. The question then becomes where and how to free up resources, especially across organisational boundaries.

- More generally, everybody is overworked with case-by-case questions, while nobody in the organisation is looking at the bigger picture and thinking about whether these questions can and should be answered by that specific organisation or not. Perhaps, a more formal way of communicating between parties should be established, to facilitate exchange and build some mutual responsibility and commitment.

- The illustrative example did not feature regulators, e.g., the Authority for Consumers & Markets (ACM). Regulatory forces should be included in the discussions. The example of an onshore wind park was given, where there have been heated debates on where coordination should reside (i.e., at the local, regional or national level). When it comes to spatial planning and the rollout of physical infrastructure, probably the regional level is most appropriate, and not The Hague as now often is the case. The role of the government should then be to ensure that coordination takes place. Thus, the framing is important: first, the idea was that the government "directed" (in Dutch: "regie"), now the keyword is "orchestration". An actor such as ACM could also facilitate coordination, but currently, they are far from that. Tailor-made decisions are needed, while also taking into account the broader impact and applicability of such decisions.

- The notion of framing has broader significance. Now, the message usually is that certain things cannot be done or are not allowed. The message should be: what do parties bring to the table, what do they have to offer? Changing the narrative and framing it around the common objective would help to advance these discussions.

- One of the biggest issues from an implementation point of view seems to be a lack of information availability and transparency, which causes parties to be unable to act responsibly. This point of equal playing field when it comes to information was also raised in earlier symposium sessions, where some opportunities may emerge just because you have a more complete understanding of things.

Summarising, the challenge of defining network membership and boundaries involves identifying the necessary stakeholders and ensuring they recognise their importance within the network. A critical question is whether these individuals or entities are fully engaged and if not, how to involve them effectively without overwhelming the network. To address this, a balance must be struck between inclusivity and operational efficiency, aiming for completeness while remaining actionable and pragmatic.

One potential strategy is to segment the network into distinct sub-networks, each tailored to specific objectives or challenges. This approach allows for more focused and manageable collaboration while maintaining interconnectivity. Theoretical frameworks offer various models of network governance, such as the Network Administrative Organisation (NAO) model, which seems preferable in the current setting due to its structured coordination mechanisms. Another commonly observed approach is the designation of lead organisations (often a governmental entity) to guide the network.

A cornerstone of effective network governance is robust information sharing. Establishing clear and sufficient protocols for disseminating and accessing information ensures transparency, builds trust, and enables informed decision-making across the network. This foundation of communication is vital for fostering collaboration and achieving shared goals.

III. The Current State and Future of Cross-Sectoral Collaborations by Shakya Wickramanayake and Dr. Tom Aben

In their breakout session, researchers Shakya Wickramanayake and Dr. Tom Aben organised an interactive exchange that focused on the current and future state of cross-sectoral collaborations. This initiative helped create the foundation for a Delphi study within the VIA AUGUSTA research project. This Delphi study aims to find a common understanding of the concept of 'cross-sectoral collaborations', a phenomenon that is becoming increasingly important. It aims to investigate, from legal, IT, and organisational perspectives, the possibility of enabling cross-sectoral collaborations between the various critical infrastructures (CIs) in the Netherlands. Each of the different CIs in the Netherlands is managed and maintained by a small group of semi-public organisations, each operating within their respective sectors. The VIA AUGUSTA project consortium includes several of these organisations operating CI, namely, Rijkswaterstaat (responsible for managing and maintaining all major roads and waterways in the Netherlands), Alliander (one of the five semi-public organisations that maintain the Dutch electricity grid), the Port of Rotterdam (responsible for the management and maintenance of the harbour in Rotterdam), and ProRail (responsible for maintaining and operating the Dutch railway infrastructure.

The session included a short introduction by the researchers on the state of the art regarding systems of systems approaches and system integration, as well as an interactive discussion with participants that served as a miniature Delphi study. Participants, including representatives of infrastructure operators and academics, shared their expertise on cross-sectoral collaborations through anonymous survey answers (facilitated via real-time submissions on the online app WooClap) and in an open forum following the survey.

In summary, the following were the major learnings from this session:

- There is a lack of shared understanding of what constitutes a system-of-systems (SoS) or cross-sectoral collaboration, demonstrating the urgent need for a common vocabulary across disciplines and infrastructure sectors.

- Current infrastructure networks are deeply interdependent, yet governance, legal, and IT systems remain siloed, preventing timely and strategic collaboration.

- Experts agreed that a SoS approach must incorporate both 'hard' and 'soft' systems, requiring alignment of digital tools and human governance structures to be effective.

- Barriers to implementation include organisational inertia, competing logics (economic vs. societal), and internal challenges such as high workloads, security concerns, and loss of autonomy.

- While some CI-organisations have begun dedicating resources to cross-sectoral partnerships, many still lack the capacity, incentives, or culture to prioritise collaborative governance over individual goals.

The CI-organisations have to navigate a variety of different grand societal challenges, such as climate change, the ongoing digitalisation of the world around us, and the current energy transition, while at the same keeping their respective CI-networks up and running for society. In other words, there is a push for CIs and their managers to become future-proof, which means becoming resilient to climate change, becoming more efficient and data-driven and facilitating the shift towards a carbon-neutral and data-centric economy. Next to these grand challenges, the CI-networks are also becoming increasingly interdependent. An issue at one CI-network can quickly cascades down to the other networks, leading to major issues for society as a whole. A good example of this interdependency (and the need to become more data-driven) was provided by one of the keynote speakers of the symposium, whose arrival was

delayed due to a major road accident that prevented him from travelling by car to Tilburg. He instead had to take the train and effectively switch to another CI-network that, luckily, did not experience any issues (except for increased numbers of passengers as more people made the switch from their cars to the train). However, if there also would have been a power outage, the trains would not run, making commuting impossible on that day. In order to react quickly and reduce harm, managers of these CI-networks will have to collaborate more intensively with each other by, among other things, digitally sharing information with each other and their end users. For example, if Rijkswaterstaat notices major issues on one of their roads, they should be able to promptly inform ProRail and their users of this issue and allow them to prepare for the impact from this issue. For the train operators, this will mean an increase in the number of passengers; for ProRail, it will mean increased congestion as more trains will be running to accommodate this increase in passengers; and for end users, this will mean they have to arrange alternative ways to complete their journeys.

Unfortunately, the various CI-sectors are organised in silos. Each sector is primarily focused on optimising the management and maintenance of its respective CI-network, and each sector has its own specific (legal) requirements regarding its activities. To become future-proof and to be able to navigate the various societal challenges that are coming towards us, the researchers posit that CI-managers will need to break the silos on multiple levels: on the IT, organisational and legal levels. The goal, according to the researchers, would be to have all the different CI-managers work 'as one' in a so-called '*system of systems*' (SoS) to enable efficient (digital) collaboration and to achieve affordable, accessible, reliable and safe access for end users to the various CIs. Within such a SoS, cross-system IT governance needs to take place, cross-organisational coordination and collaboration need to be installed, and cross-sectoral regulation needs to be established; only then can seamless data and information exchange between CI-managers take place. This, the researchers argue, will require collaborations 'on steroids' that entail deeper connections than simple market-based transactions and mere physical interdependencies.

Thus, the VIA AUGUSTA project asks the central question "*When does a system-of-systems (SoS) approach offer potential for coordinated infrastructure governance, and how can this potential be leveraged without (substantially) compromising individual infrastructure operators?*". When discussing the SoS approach with their partner organisations, the researchers found that numerous names and definitions were being used. In addition to 'system-of-systems', they also heard practitioners talk of 'systems integration', 'cross-sectoral collaboration' and "acting as one infrastructure manager". Although these definitions are related, they are not necessarily identical. To make matters more complicated, they noticed a disconnection between definitions in the academic literature and those in industry language. Moreover, there is no alignment between, as well as within, organisations, sectors or fields, as everyone has their own definition and idea. To facilitate the conversation and enable proper academic research, the researchers argue that a common language and terminology are needed. As such, Wickramanayake and Aben plan to conduct exploratory research in the form of a Delphi study, targeting industry experts to create a common language. The goal of this research is not only to establish a common definition but also to foster a shared understanding of the possibilities and challenges associated with creating a SoS and enabling cross-sectoral collaboration.

1. Discussion point I: what is a SoS, and what is cross-sectoral collaboration?

After their introduction, the researchers began the interactive part of their session by posing the first question to the expert participants. The first question revolved around the notion of SoS and cross-sectoral collaboration. The participants were asked "*What words come to mind when you hear the words SoS or cross-sectoral collaboration*". The participants were asked to answer this question through the Wooclap application on their devices in private. On the screen, the answers were (anonymously) shared with the whole group. This allowed the researchers to ensure that the experts did not influence each other while establishing their initial thoughts. Once all participants entered their answers into the Wooclap application, a general discussion was started based on the answers that were given and presented on the projection screen. The experts provided answers such as: 'complexity', 'coordination', 'networks', 'hard and soft skills', 'ecosystem', 'governance and design', 'multi-actor', 'interrelated', data and ICT access', 'resilience', 'multimodal', 'synergies', 'platformisation', and 'cross-domain'.

An interesting finding from the discussion is that quite a few experts put forward that a SoS is more than just 'hard' systems (i.e., databases and IT-systems), but that it also includes 'soft' systems such as people and the governance of the SoS. It was shown that this is not only a technical question, but it also includes questions about how to design and execute the governance of the organisations in the cross-sectoral collaboration. Moreover, participants agreed that it should not only include technicians, but also other professionals in the CI-organisations that aim to collaborate.

Another interesting element that popped up was the notions of 'synergies' and 'interdependencies'. Wickramanayake pointed out that there are already interdependencies between the different CI-networks (and hence their organisations) and, hence, asked the experts: *"How is a SoS different from what you are currently doing?"*. Participants acknowledged that the CI-organisations should become more open to each other under a SoS approach. It was noted that currently, CI-organisations do not work in the same IT-systems and hardly meet each other to discuss long-term and more strategic manners. Instead, currently, they work on a case-by-case basis and only if a situation occurs that forces them to collaborate across sectoral boundaries.

In addition to discussing how a SoS approach differs from the current ways of working, participants accepted the need to shift towards cross-sectoral collaborations. Some participants noted that more coordination is needed as the interconnections between the various CI-networks in the physical space become increasingly complex, while simultaneously the physical space becomes increasingly limited. This requires effective coordination to avoid clashes between networks and spatial issues. A way to support this coordination would be to encourage the active sharing of data and information between the Critical Infrastructure-managers regarding their current and future plans, but also their current activities. This can, for example, be collected in a 3D-map that helps discussions about the coordination of the (limited) physical space. Related to the point of spatial issues, another participant pointed out that CI-managers need to collaborate with each other to manage the environmental space effectively. All CI-managers deal with environmental regulations and restrictions regarding, among other things, CO_2 emissions (also known as the 'stikstofdiscussie in the Netherlands) and PFAS. Participants also noted that *"we are all connected and in the same physical space, and we have to collaborate to solve issues that are highly regulated"*.

After discussing the results from the experts, which mainly focused on the practitioner perspective, Wickramanayake and Aben shortly presented the latest discussion from the academic field regarding SoS and cross-sectoral collaboration. They explored discussions from three perspectives: IT, organisational and legal. Based on the work of their colleague David Wodak, the researchers showed that the IT-field mostly talks about a 'digital SoS', which can also be very useful for CI-managers. A digital SoS refers to: *"The integration and management of independent interconnected digital systems, networks, and technologies that work together to support the operations and visions of physical CI systems"*. The ultimate goal of a digital SoS for CIs is to improve the cooperation, communication, and control of CI systems. When setting up a digital SoS, organisations should carefully review the main characteristics of such a system or approach, including autonomy, belonging, connectivity, diversity, emergence, fault tolerance, and guardedness.

From his own field, Aben explained that organisational researchers often speak about 'network collaboration' when referring to collaborations that include multiple actors, which are more than hierarchical or arm's-length relationships and can potentially be cross-sectoral. Networks typically consist of inter-connected actors that collaborate to jointly control material and information flows between the source and the end user. Networks focus on the focal offering or a system for managing an issue of public concern whereby organisations are dependent on all others and typically form a group of loosely coupled entities that share a common fate. In such a network, it is vital that the various actors are all aligned regarding the overall goal that they want to achieve.

Finally, Wickramanayake explained that in the legal field, there has been no discussion in the literature on SoS approach nor any regulation for/of it in the EU. However, European Union (EU) policy does discuss 'system integration'. She noted that there has always been a push by the EU for the integration of

CI-networks, such as energy systems and road systems, across the EU-member states, in the pursuit of a greater trans-border network. The closest we get to a SoS approach in the regulatory space is a proposed policy by the EC for energy system integration as part of the green transition and the creation of a circular economy. However, there are still no specific EU laws requiring cross-sectoral system integration. Additionally, the EC noted that organisations in the energy systems work in silos: the gas companies only focus on extracting, transporting and supplying gas, the 'green energy' companies only focus on building solutions for renewable energy, etc. This siloed approach according to the EC is insufficient to achieve the transition to clean energy systems. Instead, integration across energy value chains, as well as across infrastructure and consumption sectors that are not traditionally concerned with energy are needed to achieve the energy transition. For example, the Delta Rhine Corridor project in the Netherlands shows that the involvement of organisations such as Port of Rotterdam and Rijkswaterstaat are also needed to enable the switch to hydrogen, and not only companies from various energy sectors such as Alliander and Gasunie.

As a round-up for the first discussion point in their breakout session, the researchers asked their participants a follow-up question: "*Now how do you see SoS or cross-sectoral collaboration?*". This question aimed to analyse the extent to which the various viewpoints that were shared may have influenced the participants' own viewpoints and to assess whether some degree of consensus could be found. As with the previous question, the participants were once again asked to provide answers (anonymously) in the Wooclap application. Around half of the participants mentioned that their viewpoint were "*the same as before*" or "*similar*" after the previous discussion. However, the other half did change their viewpoint regarding SoS and cross-sectoral collaborations. For example, they mentioned the 'complexity', the 'more organic' nature, the 'importance of a common goal', and the need to 'integrate public values' were all new elements that they had not considered before.

In the resulting discussion, the researchers were able to identify the most pressing issues that need to tackled regarding SoS and cross-sectoral collaborations. One important issue that was raised by the experts is that the explanations that were discussed by the researchers were still too technical: "*Your findings are technical. For example, I hear a lot about planning. But to what end do we have these networks and how do these reflect public values?*". Rather than mainly focusing on the technical aspects of SoS and cross-sectoral collaborations, one participant suggested to include a more social view on networks as well.

Another question that was raised by the experts was whether the idea of a SoS approach was in fact new. One participant argued that the idea of SoS is not actually new as there have always been strong ties between infrastructure networks such as those between electricity grids and railway networks. In fact, many railway networks run on electricity and can be seen as a large electricity grid. Connections between the different CI-networks have been there for a long time, but the key difference now is the heightened degree of fragmentation, which leads to longer processes. It was noted that right after the Second World War, many European governments took on the role of direct providers of numerous CI-networks, ensuring a close connection between public values and governance. However, from the 1990s onwards, decentralisation took place as many European governments pushed the management and maintenance of CI-networks to 'the market'. This has led to the need for more integration between the decentralised networks, but the physical connections between the various networks have remained more or less the same. In short, the idea of SoS is not new, but the way the individual CI-networks are governed and the role of social and public goals have changed. Moreover, the law is not lacking behind in this area. It is actually the driving force behind the push towards more integration.

Lastly, the role and integration of public values were other important issues that was raised by the experts. One participant mentioned that definitions provided by literature all come from a different era. Moreover, these are all related to the specific fields they are coming from. For example, the management field looks at how we can make (more) money from networks, while the legal field mainly talks about inefficiencies. Instead, we should include broader goals that benefit the whole society: "*Let's not define goals too narrowly, let's keep public values*". It seems that academia may be behind as they still hardly incorporate public values as the main goal, while practitioners are increasingly taking these into account when making decisions.

2. Discussion point II: how can we make it work?

The second discussion point of the interactive session focused on finding ways to make a SoS or a cross-sectoral collaboration work in practice. Defining it and creating a common language was only the first step, making it work in day-to-day activities is a whole other venture. Unfortunately, some barriers make it challenging for organisations to set-up and govern an SoS or cross-sectoral collaboration in practice and which stops us from achieving public values. In academia, these barriers are typically categorised into economic, legal, organisational or technical barriers. However, through the proposed Delphi study, the researchers aim to (1) generate a list of barriers that practitioners currently face and (2) map the severity of each barrier. Not all barriers have the same impact. Some might be only minor bumps in the roads, while others might be major showstoppers that prevent the introduction of a SoS altogether. Moreover, not all barriers are actual barriers; some are perceived barriers, i.e., barriers that form in people's minds but are not actually present in reality.

For this second discussion point, participants were asked the following question: *"Assuming that it is technologically feasible, what other obstacles or barriers do you see when organisations want to implement a SoS or cross-sectoral collaboration"*. Participants once again provide their answers (anonymously) through the Wooclap application. Participants were also asked to split their answers into either the 'external obstacles/factors' category or the 'internal obstacles/factors' category. The experts suggested the following obstacles or barriers:

- External obstacles/factors: 'organisational inertia', 'legal', 'immaturity of new ways of working', '(lack of/differences in) governance', 'goal alignment', 'incomplete data', and 'individual economic logic vs. collective societal logic'.

- Internal obstacles/factors: 'high work pressure', 'organisational complexity', 'scarcity of staff', 'security', 'ego', 'loss of autonomy or control', 'knowledge of existing systems', 'ownership', 'lack of focus on the bigger picture', and 'priorities'.

Reflecting on the answers presented, a brief discussion ensued that yielded several interesting insights. First, one participant explained that the different forms of governance make it difficult for CI-managers to collaborate with each other across sectoral boundaries effectively. As an example, a possible collaboration between Port of Rotterdam and Rijkswaterstaat was put forward, two organisations with vastly different governance forms. For such a collaboration, several questions come up: *"How can we come to the best decision?"* and *"How can we take the different forms of governance into account?"*. Port of Rotterdam and Rijkswaterstaat might have similar goals, but do not have the same way of achieving these. They use different lenses to see the world around them.

Another participant elaborated upon the notion that the 'new ways of working' are not yet mature. The digitalising world around us means that everything and anything is becoming data-driven. Organisations will increasingly rely on algorithms that can predict what they (and their employees) need to do. This requires large amounts of data. But how do you convince your employees that the algorithms can be trusted? And how do you deal with the sense among employees that they are losing autonomy to make their own decisions? The new way of working needs to be accepted by employees before it can be effective for the entire organisation and its cross-sectoral collaborations.

A final interesting insight that was shared by one of the participants was regarding the current prioritisation of tasks within the various CI-organisations. Most of the time, employees at CI-organisations are busy with day-to-day activities, and they are not allowed to have any inefficiencies in the work. This leaves not much time for employees to think about aspects that do not fall (yet) under day-to-day activities, such as setting up a SoS or thinking about how their own day-to-day activities might impact the activities of other CI-organisations active in other sectors. Employees *"are working like a robot"* and they typically have no time to think about the greater good.

Following up on the barriers that the participants have put forward, Wickramanayake asked them whether they already have people within their respective organisations who are actively dealing with cross-sectoral collaborations. Responses to this question were mixed. Some CI-organisations seemed to already

have dedicated staff or allocated time for employees to manage cross-sectoral collaborations. A representative from Alliander, for example, explained that they have a 'partnership office' at the strategic level, which is a dedicated team to set up and optimise strategic and/or cross-sectoral partnerships. Similarly, Rijkswaterstaat has given tasks to specific employees (the 'omgevingsmanagers') that entail setting up cross-sectoral collaborations, albeit only on a local level. Other CI-organisations do not invest yet in investigating and setting up cross-sectoral collaborations as their organisation lack the capacity (time and people) to allow for such activities. Moreover, they state that the pressure to focus on their organisational goal of ensuring that their respective CI-network is available 24/7 is too high.

Related to this final question from the researchers, one participant suggested that human resource management should be involved in setting up cross-collaborative initiatives at CI-organisations. Another participant made a case for allowing for more experimentation at the CI-organisations to ensure that (perceived) obstacles can be taken away. A related point was made that critical infrastructures should allocate time for reflection among their employees to ensure that they are not only focused on day-to-day activities and their specific organisational goals, but also have time to consider the broader implications of their actions and how they might impact other CI-sectors. Lastly, one participant mentioned that there is currently a lack of incentive to produce collaborative results for employees at the individual CI-organisations, preventing extensive cross-sectoral collaborations among them.

IV. Session on Partnering for Responsible Infrastructures led by Prof. dr. Henk Akkermans

This interactive session was led by Prof. dr. Henk Akkermans, a professor of supply chain management at the Department of Information Systems and Operations Management at Tilburg University. In this session, Akkermans detailed the basis and rationale behind his proposed research project for the NWO (Dutch Research Council) & NGinfra called 'Next Generation Infrastructures: Responsible Transformations', aiming to receive feedback from infra-partners on the proposal.

The main insights during this session were as follows:

- Given that skilled labour shortages significantly affect the maintenance of infrastructure assets and, therefore, the operation of infrastructure systems, it is necessary to consider innovative solutions to this issue. Such as the use of centralised control towers to coordinate the sharing of labour among infrastructure operators and maintenance projects.

- Contractors play a significant role in maintaining infrastructure assets in the Netherlands, and initiatives or systems for labour sharing will need to take into consideration the role of these contractors and possibly even coordinate with them.

- It may not be necessary to reinvent the wheel when creating a system for labour sharing and coordination, as there are already examples of small-scale labour coordination practices among infrastructure operators. While these practices are usually limited to coordination within a sector or even a single infrastructure operator, lessons can be learned from certain tried and tested elements of these practices and potentially applied in scaled-up systems of coordination.

- There is consensus among participants that it is essential to establish a governance structure for the proposed labour coordination system, and that this structure should be based on, or at least aligned with, EU and Dutch law.

The Via Prudenti project would explore the possibility of facilitating shared & '*smart*' management of labour shortages in infrastructure maintenance. Akkermans explained that skilled labour shortages in infrastructure systems are now increasingly becoming problematic, resulting in necessary maintenance being forgone or postponed. According to Akkermans, innovation and collaboration amongst infrastructure partners is needed to maintain and increase the productivity of maintenance systems. He went on to explain that this innovation can be both automation of processes and the digitalisation of systems.

His proposed solution to the issue of labour shortages is to facilitate the coordination and allocation of skilled labour for different maintenance tasks through a 'service control tower'. According to this solution, labour would be treated as a system in itself, with different skill sets and staff being treated as assets. The use of such a system for allocating staff and servicemen is not entirely novel, as there are cases already of it being used in the healthcare sector. In the Netherlands, a control tower system is being used to remotely monitor over 5,000 patients with chronic illnesses and administer telehealth services. This has resulted in reduced costs for both patients and hospitals, while ensuring that patients receive adequate care. Akkerman's research project will investigate whether and how such a system can be implemented in the context of infrastructure systems.

The participants at the session, which consisted of representatives from the infrastructure partners and academics, were asked to share their ideas and opinions on the coordination of labour supply and demand in public infrastructures across different infrastructure systems. The participants agreed and acknowledged that there was a labour shortage and that, in some cases, infrastructure operators were competing against each other for the same pool of skilled labour. However, despite this situation, some believed that only once a *crisis* emerges will operators be prompted to shift to a collaborative system for labour. It was thus acknowledged that one of the project's main tasks may be to establish an urgent need for operators to invest in such a collaborative system. It was suggested that a case for the shift in systems could be made by looking at other historical cases of similar shifts.

During the discussion, participants noted several factors that the project will need to consider when investigating the possibility of labour coordination, as well as suggestions on key themes that the project should explore. One key consideration, which the participants pointed out, was the involvement of contractors in infrastructure operations and maintenance. The partners noted that any labour coordination efforts must also consider how to account for contracted labour, which would require collaboration with contractors. Another key consideration was the interoperability of labour. Given that the consortium comprises a diverse group of partners from various infrastructure sectors and different functions within these organisations, interoperability between these organisations may be limited in terms of labour. Additionally, the partners noted that the regional distribution of labour and the needs of smaller communities must also be considered when assessing how labour will be coordinated and shared. During the discussion, an interesting strategy adopted by some operators came to light: to address the issue of labour shortages, these operators employed skilled labour with future capacity and needs in mind, rather than hiring primarily for today's needs. This indicated that there may be sufficient surplus labour in some organisations that could be utilised by partner organisations, further strengthening the case for a system to coordinate labour jointly.

The discussion also involved suggestions on coordinating labour and facilitating a collaborative system. The use of private data pools to gather and share data for the joint system was suggested. If the data in this pool would include confidential information, it was suggested that the services of a digital clearing-house be used to determine personal and/or confidential data and provide the necessary safeguards for sharing that data, such as controlled access. It was also acknowledged that there are already small-scale and less structured forms of labour coordination, especially among contracted labourers in infrastructure operations. For instance, electricity network operators in the Netherlands coordinate with one another to avoid conflicts when employing contractors. Such coordination was especially crucial when installing smart meters, as there were limited qualified contractors available to set up the meters. It was suggested that the project draw inspiration from these existing coordination systems and explore their scalability. Another suggestion made was for infrastructure partners to utilise program structures, such as work packages, to coordinate their oper-

ations for a period of at least 5 years. Some participants argued that this would help operators converge their operations and coordinate labour over time.

In addition to technical feasibility and mechanisms, participants also noted the need for research into governance and regulatory strategies. It was suggested that researchers explore options for governing this joint system, particularly in establishing a clear chain of command during a crisis and a hierarchy for decision-making and executing decisions within this system. Given that maintenance work on infrastructure systems, especially major and critical assets, can impact all other infrastructure assets, it was agreed that having a governance framework was essential. Furthermore, it was emphasised that such a governance framework should be based on law or at least consider the legal restrictions and obligations, especially regarding who is authorised to make decisions and how the process and procedure surrounding those decisions are structured. This would ensure transparency, accountability and legality of the joint coordination system and its operations. Some partners also believed that there may be legal obstacles preventing joint coordination of labour in this manner, given the strict and complicated labour laws in the Netherlands. Thus, it was noted that an investigation into the labour laws may be needed.

The session concluded with Prof. Akkermans acknowledging and thanking the participants for their valuable insights. Akkermans stated that he will use these insights to further evaluate the direction of his research and strengthen his research proposal.

KNOW THE EXPERT!

Prof. dr. Henk Akkermans *is an expert in the digital transformation of organisations and is known for his reliable, resilient, and empathetic leadership. Over the past three decades, he has combined academic research with hands-on experience in numerous technology-driven firms and networks across both the public and private sectors. His work focuses on innovation, implementation, and organisational change, blending IT and business, as well as hard and soft skills. As a practice-driven researcher and reflective practitioner, he has published and lectured extensively.*

V. Navigating Legal Complexities in the Digital and Green Transitions in the EU: Expert Perspectives

The symposium resumed post-lunch with an engaging panel discussion on the intersections of digital transformation, data governance, and the green transition within the EU. The session featured insights from experts across academia and industry, who discussed the challenges faced by and opportunities presented to infrastructure operators, as well as their roles in an ever-evolving landscape. The panellists included Dr Brenda Espinosa, a legal scholar of data and innovation, Dr Charlotte Ducuing, a legal scholar working on datafication of society, and Daan Rutten, a senior business and strategy consultant at an ENTRNCE, an energy distributor. Shakya Wickramanayake moderated the discussion.

The following were the main takeaways from the panel discussion:

- Data is increasingly viewed as a form of infrastructure, and this framing requires nuance, especially in balancing its public good potential with the need for clear cost-benefit analyses and sustainable use.

- Transparency in data sharing is now expected from infrastructures, but achieving it remains a challenge due to privacy concerns, limits on institutional capacity, as well as fragmented data systems.

- Digitalisation has shifted the role of infrastructure operators into that of data stewards, requiring them to operate within evolving public expectations, outdated legacy systems, and conflicting sectoral values.

- Effective governance of the twin transitions (digital and green) must strike a balance between innovation, and policy and ethical concerns, such as privacy, cybersecurity, and sustainability, necessitating adaptive and context-sensitive regulatory approaches.

- Law can serve as a driver of innovation and collaborative governance, provided it is aligned with evolving societal and public values in the digital and energy transitions.

1. Data as Infrastructure

The first contention posed to the expert panel was whether data should be considered a form of infrastructure. This ignited a diverse array of perspectives from the panellists, and multiple perspectives were discussed thoroughly.

- Ducuing argued that while the concept of data as infrastructure is increasingly prevalent, this broad sentiment risks overlooking critical nuances in discussions involving data. She used the case study of Belgium, where policymakers focus on drawing lessons from traditional infrastructures such as telecommunications to govern data. She emphasised that while data is not inherently infrastructure as per the current economic taxonomy, it can be classified as a public good, aligning with efforts by the European Union to unlock its potential uses. However, she cautioned that ongoing discourses often lack a clear cost-benefit framework, which limits the ability to weigh the benefits of data against its risks. She further highlighted the importance of leveraging data for ecological transitions, emphasising its potential beyond mere availability.

- Rutten shared learnings from his work in the energy sector, highlighting how data management has evolved from fulfilling core services to driving innovation. He asserted that companies are increasingly seeking data for various new and novel purposes, such as developing renewable energy sources. However, he acknowledged ongoing challenges, including obtaining permission to access and utilise data and ensuring its accuracy. Rutten further emphasised the need for centralised structures, such as a single point of truth, to effectively support decentralised operations.

- Espinosa reflected on the evolution of data-sharing discussions over the past five years, stating that there has been a shift from debates about whether to share data to discussions on its purpose and optimisation. She observed that while digitalisation aids sustainability, challenges such as grid congestion and capacity limitations need to be addressed to achieve green transitions. Dr Espinosa urged stakeholders to strike a balance between data processing and privacy concerns, especially as data collection increases with the proliferation of smart devices.

2. Trust and Transparency in Data Sharing

The second question presented to the expert panel centred on the role of trust and transparency in data sharing, prompting a lively debate into how these elements can be cultivated and sustained among diverse stakeholders in the landscape of digital and green transitions.

- Rutten raised the argument that external pressures, such as regulatory demands, have compelled infrastructure companies like Alliander to be more transparent rather than operating in a black box, as they had in previous decades. However, he acknowledged that balancing transparency with privacy remains challenging, particularly when sharing data with other infrastructures. Rutten stressed that achieving this balance requires careful deliberation and time. He also noted that the extent to which the push for data sharing and transparency can be addressed is also limited by the capacity of the organisation to allocate staff for these tasks.

- Espinosa remarked that the twin transitions create a *chicken-and-egg* situation as digitalisation is needed for the energy transition and allows for energy efficiency, but at the same time, it consumes a vast amount of energy. She highlighted the explosion of rules governing data access and sharing, which complicates efforts to harmonise procedures across the energy sector. While policies aim to enhance infrastructure resilience, she noted that they must also further address core values such as security, sustainability, and digital integration.

- Ducuing spoke about the potential role of the European Union and its architecture in fostering trust and transparency in data governance. She suggested that while the EU's primary tool remains market regulation, it must adopt a strategic approach in its application. Dr Ducuing called for a nuanced governance model that balances the benefits of data sharing with the potential risks and unintended consequences, ensuring that regulatory frameworks remain adaptive and effective.

3. The evolving nature of Infrastructure Operators

The panel discussed the shifting responsibilities and roles of infrastructure operators in society, resulting from the digitisation and datafication of systems. The panel was asked to reflect on how the relationship infrastructure operators have with society has shifted or will shift, given that they are now increasingly seen as data operators in addition to being infrastructure and service providers.

- Ducuing mapped the historical evolution of infrastructure governance, noting how market liberalisation has transformed public value considerations. While market-based solutions have improved resource efficiency, she argued that they often fail to address issues like grid congestion, necessitating alternative approaches. She introduced the concept of the rebound effect, where optimising systems can unintentionally create new problems. She noted that this raises the question of whether systems should instead focus on degrowth, rather than simply optimizing.

- Rutten noted that the transitions have resulted in a change in society's expectations of infrastructure operators rather than a change in the public values being pursued by operators. He noted that previously, operators had the authority and legitimacy to operate in a black box, which is no longer the case. He also pointed to cultural and operational challenges within infrastructure companies, such as outdated systems and fragmented data. He advocated for greater transparency and long-term thinking to rebuild trust and address capacity issues.

- Espinosa observed that the proliferation of laws incentivises data sharing and access held by energy operators such as Distribution System Operators (DSOs). She remarked that the intertwining of digital and energy sector values, such as cybersecurity and sustainability, complicates the decision-making process. She stressed the need to identify core values to guide governance, particularly in the context of expanding data-driven systems.

The audience engaged with the panel through thought-provoking questions that enriched the discussions and provided food for thought for the panellists. The moderator, Wickramanayake, emphasised the importance of continually evaluating the purpose and objectives of data sharing, advocating for a balance between transparency and privacy that aligns with sustainability goals.

Espinosa highlighted the trade-offs between privacy and innovation, drawing attention to the need for a thoughtful approach to navigating these competing priorities. Rutten called for tailoring data-sharing practices to specific contexts to ensure efficiency while maintaining trust and privacy. Dr Ducuing talked about the importance of aligning governance frameworks with public values, advocating for a balanced approach that leverages market-based tools while addressing their limitations.

The panel concluded by acknowledging the complexities governing digital and green transitions in the EU. It was noted that data systems are hungry for resources, especially that of energy. As infrastructure operators assume expanded roles as data stewards, the need for trust, transparency, and alignment with public values becomes increasingly paramount. While technology provides the tools to navigate these transitions, the panel emphasised that human and regulatory dimensions will ultimately shape their success. It acknowledged that in the short run the transition and the shift in roles will be difficult for infrastructure operators. The role of law as an external force for change and innovation was recognised. The moderator closed the session with a call to action, encouraging stakeholders to prioritise purpose-driven data sharing and collaborative governance in their efforts to tackle the challenges of digital and green transitions.

KNOW THE EXPERTS!

Dr. Brenda Espinosa Apráez *has investigated the legal and ethical aspects of governance frameworks for data and AI models used in the electricity sector to ensure that core values, such as energy justice, privacy, fairness, accessibility, transparency and responsibility, are safeguarded. She has worked on various multi-stakeholder projects,*

collaborating with critical infrastructures in the Netherlands, including Alliander, Vitens, the Port of Rotterdam, ProRail, and Rijkswaterstaat.

Daan Rutten *is a senior business and strategy consultant at ENTRNCE, a subsidiary of the Dutch energy distribution system operator, Alliander. With a background in regulatory affairs and experience at an international think tank, he combines a keen eye for detail with strategic insight. He specialises in analysing policy and market trends and translating them into actionable strategies for business development in the energy sector.*

Dr Charlotte Ducuing *is a postdoctoral researcher at the Centre for IT and IP Law (CiTiP), KU Leuven. She specialises in data legislation, data protection, and the regulation of public utilities and infrastructures. At CiTiP, her work encompasses the legal dimensions of data governance across various sectors, including transport, the circular economy, and digital infrastructures, drawing on interdisciplinary approaches that incorporate regulatory studies, commodification theory, and legal theory.*

D. CONCLUSION AND FUTURE DIRECTIONS

When we first began organising this symposium, we could not have anticipated just how interdisciplinary, engaging, and energising the day would turn out to be. What began as an academic gathering quickly evolved into a vibrant exchange of ideas across sectors and disciplines. Throughout the day, we witnessed participants mingling freely, expanding their horizons, and forming connections that we hope will spark future collaboration.

As researchers of the VIA AUGUSTA project, we found the symposium to be not only insightful but also deeply inspiring. It provided us with the opportunity to reflect on our individual and collective research projects, share findings, and explore new lines of inquiry shaped by the dynamic conversations we had with practitioners, policymakers, and fellow academics. The day challenged and expanded our perspectives in ways that will undoubtedly inform the next phases of our work.

The following is a personal note from each of the VIA AUGUSTA researchers, capturing how the symposium influenced and inspired them.

1. **Wendy van der Valk**

As a researcher specialising in purchasing and supply management, I have long been concerned with the management of buyer-supplier relationships, particularly the interplay between the contract, contact and collaboration. In contemporary organisational landscapes, entities must increasingly operate within complex networks to effectively address major challenges. Consequently, the concept of network governance, particularly the mechanisms through which networks self-organize and self-govern, has become an area of great academic interest to me.

My research endeavours focus on understanding how networks organise themselves, the roles assumed by different stakeholders, the processes through which agreements are formulated, the mechanisms of aligning activities and interests, and the decision-making frameworks that underpin network functionality. During the symposium, various perspectives on network governance were extensively discussed, providing valuable insights.

For instance, in the opening lecture by Meesters and Christiaans on crisis management settings, I was particularly intrigued by the notion that an information broker can evolve into a network orchestrator, which essentially assumes the role of a facilitator and effectively guides coordination efforts in a manner that is accepted by all parties involved. This raises important questions regarding the extent to which this model that features in intensely high-pressure and also quite temporary situations can be transposed onto less pressured network settings that last for long(er) periods of time. Furthermore, the discussions led by van Espen reinforced the importance of communication and coordination across varying scopes, orders of magnitude, and hierarchical levels. Effective network governance necessitates sustained engagement, continuous strategic (re)positioning, exploration and adaptation.

The symposium also underscored two contrasting conceptualisations of networks: one in which the network is perceived as a structured and identifiable entity that can be managed through clear inter-organizational arrangements, well-defined task distributions, explicit agreements, and appropriate incentive structures, and another where the network emerges as a system of interconnected systems, exhibiting the well-documented five characteristics of the so-called systems-of-systems, with emergence being one of the key features.

This theoretical tension raises fundamental questions regarding the extent to which networks can be deliberately controlled and managed. It also highlights the need to reconcile flexibility and adaptability within governance structures, and these discussions will certainly inform both my future theoretical inquiries and empirical field research.

2. **Tom Aben**

As a researcher, I am fundamentally interested in how digitalisation and digital innovations radically change the way organisations and their inter-organisational relationships are organised and governed. On the one hand, these digital advancements bring along many opportunities to enhance intra-organisational (i.e., internal) processes, as well as inter-organisational processes, and provide new ways to tackle today's grand societal challenges such as the energy transition and the need to become more sustainable. On the other hand, it also brings along challenges that need to be addressed, such as preparing organisations for the new advancements (e.g., making sure employees are willing to accept the new technologies) and connecting the various technologies that are implemented by collaborating partners in efficient ways. An important aspect in successfully implementing (new) digital advancements and tackling grand societal challenges is the need to set up cross-sectoral collaborations. These collaborations go beyond the traditional collaborations organisations had (i.e., collaborations with first-tier customers and suppliers within their sector) and increasingly require organisations to team up with organisations outside of their traditional supply chain and even sector.

To gain more insight, Wickramanayake and I set up a Delphi study to bet-

ter understand the current and future state of cross-sectoral collaboration. What do we mean by it? And what are the main challenges and opportunities? In our workshop, which included a preliminary roundtable discussion with various experts, we addressed these questions and concluded that 'cross-sectoral collaboration' entails that the organisations involved should ideally act as one in often complex settings. The participants of the workshop also indicated that these collaborations tend to have a multi-actor nature (typically involving more than two partners) and that new interdependencies between organisations (both within and outside sectors) will arise, which in turn require changes to the hard and soft skills of employees, as well as new governance structures. Unfortunately, making a cross-sectoral collaboration work is not straightforward as both internal (e.g., missing ownership, lack of focus on the bigger picture, different priorities, high work pressure) and external obstacles (e.g., organisational inertia, legal considerations, lacking goal alignment) will make it difficult to set up these kinds of collaborations. It also clearly shows that the establishment of cross-sectoral collaborations requires a broad view of organisations: it should not only include organisations both within and outside sectors but also entail the involvement of different departments within these organisations as employees from legal, operations and IT departments, for example, all must be consulted.

Reflecting on the other sessions that were held during the symposium, I see similarities with the findings from the workshop that Wickramanayake and I did, but also useful extensions of the insights we collected. Similar to the discussions in our workshop, in most other sessions, the multi-actor aspect was discussed as well, and the call was made to critically examine the way we are currently organised on various occasions. Our current organisational structures are not suitable for effectively tackling grand societal challenges, and we need to radically rethink the way we collaborate and set out to reach large, common goals with major (positive) impacts on society. Additionally, the keynote by Christiaans and Meesters showed that it is also important to focus on the dynamic capabilities that employees of organisations will increasingly need to have in cross-sectoral collaborations. Moreover, the keynote by Dr Noorman showed how a specific digital technology, AI, can act as a catalyst for (cross-sectoral) collaboration and not only as merely an enabler. Lastly, the panel discussion with Espinosa, Ducuing and Rutten showed us that we should also consider the evolving roles of the infrastructure operators that are triggered by both digital advancements and new/changed demands from society.

3. Shanya Ruhela

I was intimately involved with the process of organising the symposium and then arranging and organising post-event activities, including editing this report. This opportunity taught me how much effort, creativity, and coordination go into creating a truly interdisciplinary and inclusive space. It takes not just intent but also logistics to not only invite people into the conversation but also encourage them to stay, engage, and reflect. Watching conversations unfold in real-time during the symposium was quite gratifying, especially as we had hoped to move beyond siloed exchanges and foster genuine, cross-sectoral understanding.

One of the most inspiring aspects of the day was witnessing how eager participants were to learn from one another. Diverse participants shared challenges that were both sector-specific and strikingly familiar across various domains. It became clear that concepts such as coordination, resilience, and public value have outgrown their theoretical definitions. They're real and urgent concerns that shape how people work on the ground. For someone researching legal and governance responses to systemic challenges, this was an invaluable reminder of the stakes involved.

The symposium also sharpened my thinking about language, both its power and its limitations. As we spoke of cross-sectoral collaborations and governance models, it became clear that not everyone interprets these terms in the same way. This reinforced the importance of building a common vocabulary, not only for academic clarity but also to facilitate real-world cooperation. This theme echoed many of the insights from our VIA AUGUSTA breakout session and has since become a thread I plan to explore further in my work.

This is especially relevant to my current work on an edited volume examining regulatory strategies in the sectors of energy and finance. One of our core aims is to break disciplinary silos and explore how digitalisation and data governance are becoming central themes in both domains. The symposium provided fresh perspectives that directly informed this project, strengthening my understanding of regulatory overlaps, the need for cross-sectoral alignment, and the importance of integrating real-world practitioner insights into academic discourse.

Finally, the day reminded me of the value of interdisciplinarity, not just in theory but in practice. Law, infrastructure, and digitalisation are often treated as separate realms, but the symposium demonstrated how intertwined they are. My learning from the event is not just a list of new questions or contacts but a renewed sense of purpose and inspiration. I am grateful to have had the chance to contribute to this event, and I look forward to seeing how the conversations it sparked will evolve in the months to come.

4. Shakya Wickramanayake

As a legal researcher working with infrastructure operators, I have seen that the law is typically seen as a restricting force which constrains innovation and the operations of systems, with legal compliance being viewed as a box-checking activity. However, during the course of this project, we were able to see that law is not an inhibitor of innovation and change, but it, in fact, can facilitate innovation and the creation of opportunities. This belief was echoed by many speakers at the symposium. Dr Noorman, for instance, showed that laws regarding AI are pushing for increased data sharing and digitalisation in the energy sector. Similarly, during the panel discussion on the twin transitions, Dr Espinosa and Dr Ducuing discussed how both transition policies and laws are acting as drivers for change, compelling operators to innovate but also facilitating this innovation by providing the necessary frameworks for stakeholders to invest in innovation. An example of this was the creation of EU data spaces that facilitate the sharing of data between companies and operators.

Another interesting point that was brought up was the role of law with regard to an SoS approach. As was discussed during my session with Dr. Aben, there is no currently law that compels the integration of systems or the adoption of an SoS approach by infrastructure operators. However, there is clearly a push by the European Commission for the integration of systems on the basis of energy networks, which will involve both energy and non-energy operators. Given that integration of infrastructure networks in the EU- albeit on a sectoral basis- has been happening in the EU as mandated by EU law (such as with the railway and electricity networks), we can assume the Commission's plans for cross-sectoral integration will likely become official policy and law in the near future. Thus, it is imperative that all infrastructure operators already consider their role in the energy transition and what it would mean to operate in an integrated energy system. How non-energy operators could do this was illustrated by Van Espen's keynote on the Port of Rotterdam's Delta Rhine Corridor Project. In his keynote, van Espen explained that due to the Port of Rotterdam being a public actor, it was obligated to respond to the societal demands for a transition away from fossil fuel systems. He showed that in addition to this obligation, there was also a compelling business case for non-energy operators to proactively engage with the energy transition.

Finally, a key point that I have made in my research, which was validated by the discussions in the symposium, was the importance of infrastructure operators using public values as their north star as they pursue and facilitate the different transitions. As was noted throughout the discussions, the regulatory landscape is still very much evolving, and this flux can create legal uncertainty. However, due to the urgency surrounding the transitions, infrastructure operators cannot afford to wait for the regulatory landscape to settle and delay their investments for the transition. Instead, as suggested by Dr Noorman in her keynote, operators should align their decisions and governance frameworks with the key public values of their sector. In the context of cross-sectoral collaboration, I argue that this may require operators to also align with the public values that underpin the transition policies. Additionally, it was suggested by many speakers that concepts such as democracy, legitimacy and justice - which are typically within

the domain of the state and civil society - should now be considered by infrastructure operators and adopted into their operations. It was argued that doing so would not only reduce regulatory risk but also ensure that there is social acceptance of the infrastructure operations and the transition. This point ties in well with Rutten's comments on how the transition has also meant that the role of infrastructure operators has changed and that society has new expectations from these operators, including greater transparency. This shows that future research is required on not only how public values and public interest can be incorporated into the governance frameworks and decision mechanisms of infrastructure operators but also on how trade-offs should be made between competing values and interests in cross-sectoral projects and integrated systems.

5. David Wodak

Throughout this symposium, I have gained profound insights into the pivotal role of technology in fostering cross-sectoral collaboration. The presentation by Meesters and Christiaans was particularly interesting, highlighting different approaches that can drive effective collaboration across different sectors. Their emphasis on using widely accessible tools like WhatsApp and Microsoft Teams for real-time coordination underscored the importance of leveraging readily available technologies to enhance collaboration without the need for complex, high-cost solutions. Additionally, Dr Noorman's discussion on AI's role in the energy sector showcased how advanced technologies can optimise operations and predict potential faults, contributing to more efficient and sustainable infrastructure management. However, she also cautioned about the energy-intensive nature of AI, reminding us of the need for balanced technological adoption. van Espen's insights from the Delta-Rhine Corridor project further emphasised the necessity of aligning public and private interests to achieve successful cross-sectoral collaboration.

Looking ahead, I am eager to explore how organisations can move beyond fragmented digital infrastructures and toward truly integrated, cross-sectoral digital collaboration. Currently, many sectors face disjointed IT systems that hinder effective data sharing and decision-making. By investigating the adoption of a 'system-of-systems' approach, I hope to provide insights into creating interoperable digital ecosystems that facilitate seamless cooperation across sectors. Based on the knowledge gained from this symposium, it is clear that much work remains in this area, but the potential benefits for all parties involved are substantial. To further explore this topic, I intend to collaborate more closely with NGinfra to examine how their facilitated partnerships enhance data sharing and drive more effective digital collaboration across sectors.

Based on the insights I gathered from the symposium as a whole, I think it is important to highlight that while technology might offer many benefits, its successful implementation requires a deeper understanding of its application. Whether from a managerial, legal, or policy perspective, the sessions demonstrated that technology alone cannot drive progress. Stakeholders must also ensure that governance structures, regulatory frameworks, and collaborative mechanisms are in place. This was evident in the session led by Prof.dr.ir. Van der Valk as she also underscored the need for strong governance principles in collaborative networks, emphasising that trust and structured coordination are crucial for successful cross-sectoral partnerships. Just as infrastructure must function across multiple sectors to serve society effectively, so too should researchers, policymakers, and industry professionals collaborate across disciplines to develop holistic solutions to societal challenges. The discussions throughout this symposium reinforced that breaking down silos, whether digital, organisational, or regulatory, is essential to leveraging technology effectively. As we move forward, fostering interdisciplinary cooperation will be key to ensuring that technology serves as an enabler of resilient infrastructures rather than as a barrier to progress.

E. ANNEXURE:

SYMPOSIUM CONCEPT NOTE AND PROGRAM

MOVING TOWARDS CROSS-SECTORAL COLLABORATION: CHALLENGES AND OPPORTUNITIES OF 'JOINT' ACTION.

DATE: DECEMBER 3, 2024

TIME: 09:15 - 16:30

LOCATION: DE BIBLIOTHEEK LOCHAL, TILBURG

As our world becomes increasingly interconnected, the need for cross-sectoral collaboration in managing critical infrastructures has never been more urgent. This event, part of the NWO/NGinfra VIA AUGUSTA project, will bring together experts from diverse fields to discuss the challenges and opportunities of coordinated action in infrastructure planning and operations, including topics such as the energy & green transition, the digital transition and data governance issues, competition law and regulated industries, and public- private partnerships.

The event will feature keynotes from both industry and academic leaders (from legal, management & economic backgrounds), as well as interactive sessions. This symposium is designed to inspire new thinking and foster productive partnerships between sectors that often work in silos but share common goals. You'll have the opportunity to engage with industry, exchange insights, and contribute your experience. Plus, post-event drinks!

Details

Date:	December 3, 2024
Location:	De Bibliotheek LocHal, Tilburg
Address:	Burgemeester Brokxlaan 1000, 5041 SG Tilburg

Program

09:15 - 09:45:	Arrival with coffee and cakes
09:45 - 10:00:	Setting the Stage: Words of welcome *Prof. dr.ir. Wendy van der Valk, Tilburg University*
10:00 - 10:45:	Keynote: Lessons Learned from Crisis Coordination in Critical Infrastructures *Ronald Christiaans, UNDAC & UCPM*
10:45 - 11:30:	Keynote: AI and Critical Infrastructures: Enabling Cross-Sectoral Synergies *Dr. Merel Noorman, Assistant Professor, Tilburg University*
11:30 - 11:45:	Coffee break
11:45 - 12:30:	Parallel Breakout Sessions
	Session I: The Current State and the Future of Cross-Sectoral Collaboration: A Delphi Study *Led by Dr. Tom Aben & Shakya Wickramanayake, Tilburg University*
	Session II: Governing Digital Transformation in Critical Infrastructures through Trust and Collaboration *Led by David Wodak, Tilburg University*
12:30 - 13:30:	Lunch
13:30 - 14:30:	Panel Discussion - Navigating Legal Complexities in the Digital and Green Transitions in the EU *Panelists: Brenda Espinosa, Tilburg University; Charlotte Ducuing, KU Leuven; Daan Rutten, ENTRNCE* *Moderator: Prof. Dr. Wijnand Veeneman, TU Delft*
14:30 - 15:30:	Parallel Breakout Sessions
	Session III: Partnering for Responsible Infrastructures *Led by Prof. Dr. Henk Akkermans, Tilburg University*
	Session IV: Principles for Good Governance in Collaborative Networks *Led by Prof. dr.ir. Wendy van der Valk, Tilburg University*
15:15 – 15:30	Break for hot beverages
15:30 - 16:15:	Keynote : The Delta-Rhine Corridor: Insights for Cross-Sectoral Collaboration *Edwin van Espen, Project Lead, Port of Rotterdam*
16.15 - 16.30:	Closing the Curtains: Insights to Take Forward *Prof. dr.ir. Wendy van der Valk, Tilburg University*
16:30 onwards:	Networking and drinks at LocHal

Why Attend?

- Learn from successful cross-sectoral collaboration case studies.
- Engage in interactive discussions and breakout sessions.
- Network with peers and thought leaders across industries.
- Help shape future strategies for more effective infrastructure management.

Please save the date: December 3, 2024.

If you are interested in attending, please contact us at s.a.wickramanayake@tilburguniversity.edu or s.ruhela@tilburguniversity.edu. We hope you can attend the symposium and contribute to shaping the future of infrastructure management.

COLOFON

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Cross-Sectoral Collaboration: Challenges and Opportunities of 'Joint' Action is an open-access report offering fresh insights into the governance of critical infrastructures. By blending perspectives from academia and industry, it explores how sectors such as energy and transport can collaborate across legal, organisational and technological boundaries in the era of digitalisation and the green transition.

The report speaks directly to academics, policymakers and industry leaders. Its sections span diverse contexts, from crisis coordination in international emergencies to the role of artificial intelligence in energy networks, and from lessons learned from the Delta-Rhine Corridor initiative to analysing pressing challenges in infrastructure maintenance, the legal complexities of transitions, trust in digital transformation and the principles of good governance in collaborative networks.

A central message is that collaboration requires more than good intentions. It demands deliberate governance choices, active trust-building and the integration of public values such as transparency, inclusivity and sustainability. The report positions cross-sectoral collaboration not only as an urgent necessity but also as a transformative opportunity: a way to reimagine governance models, bridge expertise across domains and build infrastructure systems that are resilient, adaptive and sustainable. By breaking sectoral silos, it shows how infrastructures can be prepared for an interconnected future.