

Commons for Interoperability

Governing Collaborative Networked Organisations
in the era of Data Spaces

MSc Thesis Engineering and Policy Analysis
Celia Martínez Sillero

*There is no
"they" in
standardisation*

Oskar van Deventer

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Organisations in the era of Data Spaces

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One of the many easter eggs at TNO offices. Picture taken by
author. Merits to Oskar van Deventer.

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It takes a village. This thesis has reminded me of the precious village that has accompanied me throughout this journey.

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All my loving,

A handwritten signature in cursive script, reading 'Martínez Fillero', with a long, sweeping underline that extends to the right.

Summary

The European Union's vision of a single European market is evolving to include the free movement of research, innovation, data, and knowledge (Letta, 2024; Roeingh, 2025). Achieving this ambition depends on effective collaboration between organisations, which in turn requires a high degree of interoperability (Letta, 2024). This research reflects on the growing societal relevance of interoperability in boosting industry collaboration in the European Union. Commissioned by the TNO Data Ecosystems Department, this master's thesis provides new insights to support their consultancy work and informs the development of future frameworks such as BOMOS and the European Interoperability Framework (EIF).

Cross-organisational collaboration has become strategic for companies seeking competitive advantage in an increasingly hyperconnected world (Camarinha-Matos et al., 2019). Technological advances have enabled organisations to collaborate in ways previously infeasible, giving rise to Collaborative Networked Organisations (CNOs) (Camarinha-Matos et al., 2009, 2019). These communities of entities pursue common goals and share an explicit organisational structure (Camarinha-Matos et al., 2009). As CNOs move into the digital domain and create digital ecosystems, their success depends more on interoperability. Borrowing from the European Interoperability Framework, this thesis understands interoperability as *“the ability for organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems”* (European Commission & Directorate-General for Digital Services, 2017, p. 5). CNOs need interoperability to agree on their goals more deeply and share information, knowledge, and data in “more real time” than ever before (Camarinha-Matos & Afsarmanesh, 2021).

However, despite technical progress, many barriers to achieving further interoperability are institutional or governance-related rather than purely technical (Durugbo, 2016). Nevertheless, research and practice continue to focus primarily on technical solutions, limiting the solution space and ultimately undermining the effectiveness of interoperability initiatives. Treating interoperability as merely a technical issue overlooks the complex interplay of human, organisational, and institutional factors that shape collaborative outcomes. Therefore, it is essential to frame interoperability as a governance challenge, aligning with the view of CNOs as socio-technical systems (Camarinha-Matos, 2026). This perspective is at the core of the present thesis, which adopts an Engineering and Policy Analysis (EPA) vision by explicitly examining the intersection of digital technologies and governance.

This thesis proposes using the commons scholarship to study interoperability at CNOs. Adopting this perspective acknowledges that the challenges faced by CNOs are inherently complex, requiring solutions that integrate both technical and human dimensions. While commons scholarship has traditionally focused on the governance of shared resources in physical communities such as fisheries and land tenure (E. Ostrom, 1990), recent years have seen its extension to intangible resources like data and knowledge (Purtova, 2017; Van Der Valk & Ryan, 2025). Building on this evolution, this thesis explores how the commons approach can be further adapted to address the specific context of CNOs and their interoperability challenges. Accordingly, the central research question is: **How can commons scholarship inform the governance of interoperability in Collaborative Networked Organisations (CNOs)?**

Through two desk analyses and a case study, several key findings emerge. First, interoperability is multidimensional, yet CNOs often address its dimensions in isolation, especially the semantic and organisational ones. Second, not all Collaborative Networks are suitable for study through a commons lens. The results show that CNOs must at least have a deliberate organisational structure and be a long-term collaboration. Following Camarinha-Matos et al. (2019)'s classification of Collaborative Networks, this means that *ad-hoc collaborations* nor *opportunity-grasping networks* are not suited for a commons analysis, leaving *long-term strategic networks* and *goal-oriented networks* as candidates.

Third, commons scholarship helps systematically identify divergences between formal institutional arrangements and daily practice. Among the frameworks evaluated, Hess & Ostrom (2007), Purtova (2017), and the Governing the Knowledge Commons framework emerged as suitable candidates for studying interoperability at CNOs. Additionally, this thesis found the European Interoperability Framework (European Commission & Directorate-General for Digital Services, 2017) useful as a normative supporting framework for investigating potential causes of these divergences in terms of interoperability dimensions.

To support future research and replication of this thesis' methodology, we provide three guideline tools: (1) a decision tree for framework selection, (2) a set of guidelines to apply question-based frameworks such as the Governing the Knowledge Commons framework, and (3) a checklist for the topic. The thesis also demonstrates these tools through a detailed case study, showing how to implement the proposed approach in practice. These deliverables aim to bridge commons scholarship and collaborative networks by providing practical steps for integrating these approaches into future research. Notably, this thesis expands the commons framework by introducing interoperability as a new evaluative criterion, whereas prior analyses have primarily focused on sustainability, resource depletion or IP rights (Frischmann et al., 2014; Hess & Ostrom, 2007a; E. Ostrom, 1990).

Looking ahead, further research should apply these deliverables to additional cases to test their versatility and effectiveness across diverse contexts. It is also valuable to refine and adapt GKC-inspired guidelines for use with other frameworks, such as those developed by Hess & Ostrom, to continue expanding the commons approach to new domains and challenges. Moreover, further research could use the findings and deliverables from this thesis to officially adapt the EIF to a new version that includes private entities. Lastly, research should further explore with the commons scholarship the AI-human collaboration within collaborative networks (Camarinha-Matos, 2026) and its implications for the design of institutional arrangements and governance.

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Abbreviations

Abbreviation	Definition
BOMOS	Management and Development Model for Open Standards (<i>Dutch: Beheer en OntwikkelModel voor Open Standards</i>)
CNO	Collaborative Network Organization
EIF	European Interoperability Framework
GKC	Governing the Knowledge Commons framework
IAD	Institutional Analysis Development framework
SETU	Foundation for Electronic Transactions in the Temporary Employment Sector (<i>Dutch: Stichting Elektronische Transacties Uitzendbranche</i>)
SME	Small and Medium-sized Enterprise

1

Introduction

One of the European Union's central ambitions is to strengthen innovation through industry collaboration by boosting the free movement of research, knowledge, and data across the Union (Letta, 2024). Realising this ambition depends on Collaborative Networked Organisations (CNOs): associations formed by public and private entities that share a common purpose and work together within a specified organisational structure (Camarinha-Matos et al., 2009; Technopolis Group et al., 2026). By allowing resources held by one or a few organisations to be shared and used by many, CNOs strengthen the collaborative system as a whole and can create new business opportunities (Letta, 2024; Technopolis Group et al., 2026).

Effective collaboration of this kind depends on interoperability (Durugbo, 2016). To pursue shared goals, organisations must coordinate their business processes and exchange information, knowledge, and data across organisational boundaries. Following the European Interoperability Framework, interoperability is understood here as *“the ability for organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems”* (European Commission & Directorate-General for Digital Services, 2017, p. 5).

In many settings, technology is no longer the main bottleneck. Even so, CNOs continue to struggle to align their IT infrastructure with both their individual and their collective business needs (Santana Tapia, 2009). These difficulties erode the motivation to collaborate further, putting innovation and business opportunities across the industry at risk (Technopolis Group et al., 2026).

Interoperability is often understood and treated as a technical issue, even though many barriers are institutional or governance-related (Durugbo, 2016). Winner-takes-all dynamics, for instance, shape how a CNO's community is governed and, in turn, what interoperability it can achieve (Technopolis Group et al., 2026). Framing interoperability as a purely technical challenge therefore narrows the solution space and overlooks the human, organisational, and institutional factors that ultimately determine collaborative outcomes.

While frameworks like the European Interoperability Framework (European Commission & Directorate-General for Digital Services, 2017) and the Dutch management and development model for open standards (also known by its Dutch abbreviation, BOMOS) (Folmer, 2025) have taken the first steps toward a better understanding of interoperability as a multidimensional concept, most industry consultancy work tends to centre on its technical implementation. The efforts of TNO, the commissioner of this thesis, and others often do not adequately address interoperability as governance or lack the necessary tools to do so.

The deliberate organisational structure of CNOs is itself a form of self-governance. Collaborative Network organisations organise repeated interactions among heterogeneous actors, create formal rules to dictate good behaviour and to prescribe punishment for misconduct, shape how resources are governed, and develop informal norms through their interactions. For instance, the collective agreement on

technical infrastructure is a challenge beyond the technical, as it requires alignment among the parties. Therefore, this thesis studies the interoperability of CNOs as a governance challenge. The social scientist Elinor Ostrom demonstrated that communities can govern themselves. She developed a formal method to study and compare the institutional arrangements made by communities that shared a resource referred to as *commons* (E. Ostrom, 1990). Applying this lens to CNOs offers a way to study interoperability as something communities govern.

1.1. Research gap

This section identifies the research gap. It starts describing the search strategy for the literature review. Next, it presents the results of the literature review, and identifies several knowledge gaps. Lastly, the section concludes by formulating the Main Research Question (MRQ) and subquestions.

1.1.1. Search strategy and selection process

The literature review uses SCOPUS to identify relevant publications across three main themes: Commons, semantics, and Collaborative Network organisations. The search combined these terms with AND operators, first in pairs and then as a group. The preliminary search resulted in a limited number of results. To broaden the scope, the search queries included synonyms and related concepts for each term (see the search queries in Figure 1.1). Secondly, a systematic query was developed by combining the main concepts using Boolean operators. It consisted of two searches using AND and OR operators. The first one explored the application of Elinor Ostrom's theory in semantics and knowledge management. Next, this search was further filtered by adding the business context to it. Figure 1.1 illustrates this process.

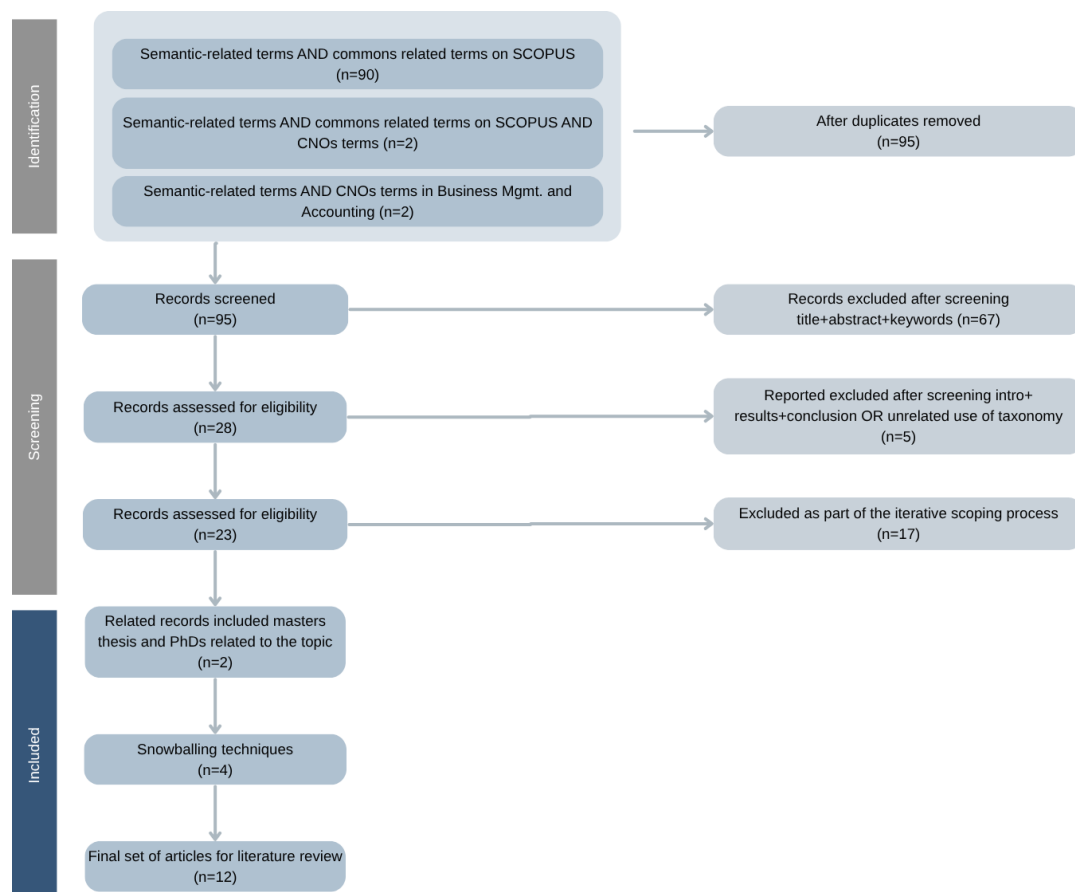


Figure 1.1: Literature search and selection process

After screening and filtering, twelve relevant articles were selected for detailed analysis. The twelve

included articles are collected in Table 1.1.

Table 1.1: Final selection of studies resulting from the PRISMA process.

Author(s) & Year	Title	Source / Outlet
Camarinha-Matos et al. (2009)	Collaborative networked organisations – Concepts and practice in manufacturing enterprises	Computers & Industrial Engineering
Camarinha-Matos et al. (2019)	Collaborative Networks: A Pillar of Digital Transformation	Applied Sciences
Camarinha-Matos & Afsarmanesh (2021)	The Evolution Path to Collaborative Networks 4.0	IFIP Adv. in Information and Communication Technology
Durugbo (2016)	Collaborative networks: A systematic review and multi-level framework	Int. Journal of Production Research
Erkuş-Öztürk & Eraydın (2010)	Environmental governance for sustainable tourism development: Collaborative networks and organisation building in the Antalya tourism region	Tourism Management
Frischmann et al. (2014)	Governing Knowledge Commons	Oxford University Press
Hess (2008)	Mapping the New Commons	SSRN Scholarly Paper
Hess & Ostrom (2007)	Understanding Knowledge as a Commons: From Theory to Practice	The MIT Press
Ostrom (1990)	Governing the Commons: The Evolution of Institutions for Collective Action	Cambridge University Press
Purtova & van Maanen (2024)	Data as an economic good, data as a commons, and data governance	Law, Innovation and Technology
Ramakrishnan et al. (2021)	Innovation Centric Knowledge Commons – A Systematic Literature Review and Conceptual Model	J. of Open Innovation
Uba & Sanfilippo (2025)	Governing knowledge commons in information science	Information Research

1.1.2. Literature Review

CNOs increasingly depend on interoperability. Over the past few decades, many CNOs have explored the digital domain and adapted their business models accordingly, now relying on digital ecosystems (Camarinha-Matos & Afsarmanesh, 2021). As such, interoperability is now a core pillar, enabling intra-communication between smart machines, digital twins, human workers, and inter-collaboration across organisations (Camarinha-Matos et al., 2019).

Many barriers to achieving further interoperability are institutional or governance-related (Durugbo, 2016). The CN literature acknowledges that governance is central to CNOs, claiming it is fundamental to the “*value creation and distribution, coordination and leadership of geographically dispersed teams*”. (Durugbo, 2016, p. 16). However, most of the research is focused on interoperability at CNOs as a technical challenge (Camarinha-Matos et al., 2019; Durugbo, 2016). Scholars have prescriptively described some governance practices conducted by CNOs (Camarinha-Matos & Afsarmanesh, 2021; Camarinha-Matos et al., 2019; Durugbo, 2016), but at the moment there is no comparative method developed to realise normative assessments.

The commons scholarship offers tools for studying this kind of collective governance. Elinor Ostrom was the first scholar to study self-governed communities. The Institutional Analysis and Development (IAD) framework created by E. Ostrom (1990) is a rigorous method to systematically compare situations where humans interact repeatedly and develop a set of rules, norms, and strategies (Hess & Ostrom, 2007a). It provides a set of independent variables to study behaviour in the community and a potential causal schema to order them into a coherent narrative (Hess & Ostrom, 2007a). Since its origins with Elinor Ostrom, the commons scholarship has been applied to natural ecosystems (e.g., the fishery in Alanya (E. Ostrom, 1990)). The scholarship has gradually expanded into other domains, reaching a peak in publications in recent years. (see Figure 1.2 below) For instance, lately the publications on studying data, energy or knowledge as (part of) a commons have significantly increased (Fouladvand et al., 2026; Frischmann et al., 2014; Purtova & van Maanen, 2024). The literature refers to these new application domains as *new commons* (Hess, 2008).

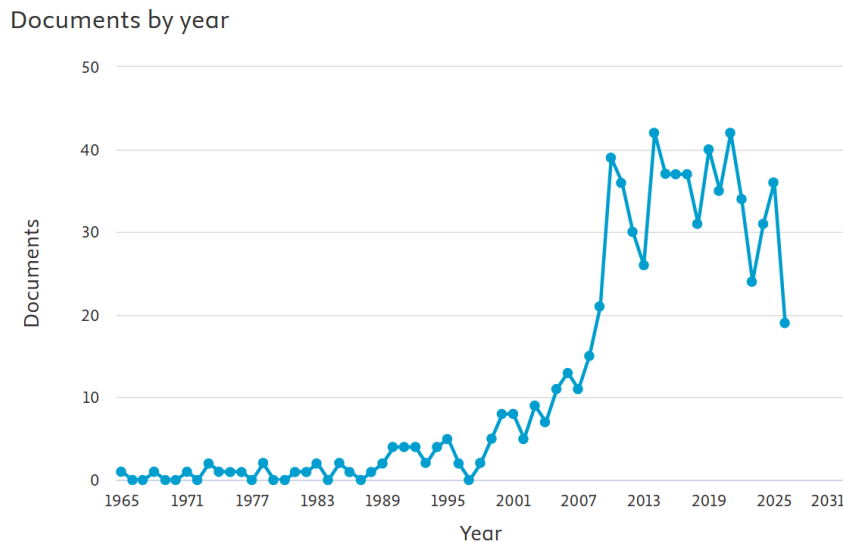


Figure 1.2: Number of publications of the common scholarship per year. This is the resulting analysis in SCOPUS from the search query: TITLE-ABS-KEY (ostrom AND ("common-pool resource*" OR "data commons" OR "knowledge commons" OR "relational commons" OR "urban commons" OR "digital commons" OR "global commons" OR "cultural commons"))

CNOs share characteristics and resources that resemble and may fit the definition of a self-governing community that governs a common. They collectively develop rules to orchestrate their repeated interactions among heterogeneous actors and shape how resources are governed (Camarinha-Matos et al., 2009). Their shared resources can also face social dilemmas when these agreements fail to reflect the community's dynamics, fitting Ostrom's definition of commons (E. Ostrom, 1990). These features may indicate that CNOs are a suitable object of study for commons scholarship.

Yet commons frameworks have rarely been applied to CNOs. A search for applications of Ostrom's work to CNOs returns very few papers. Erkuş-Öztürk and Eraydın (2010), for example, studies environmental governance networks in the tourism sector of a Turkish region, but applies the framework loosely rather than as a systematic analytical tool. The few existing applications are thus both scarce and, where they exist, only weakly connected to the commons theory they invoke, sometimes without defining the resource being governed (Purtova & van Maanen, 2024).

A second obstacle is terminological. The expansion of the commons scholarship, while beneficial, has brought terminological confusion and framework proliferation, as each author has applied the commons spirit to a new object (Frischmann et al., 2014; Hess & Ostrom, 2007a; Purtova & van Maanen, 2024). Although they depart from the same Ostromian theory (E. Ostrom, 1990), these strands have developed types of commons whose meanings are not consistent across subdomains, even when the same term is used. The literature reviews of Ramakrishnan et al. (2021) and Uba and Sanfilippo (2025) both find that references to commons theory are frequent but superficial: in collaborative information and technology studies, *knowledge commons* denote micro-level shared resources (Uba & Sanfilippo, 2025), whereas in knowledge management they are mechanisms for resolving conflicts over shared resources (Ramakrishnan et al., 2021).

Commons scholarship has also not been used to evaluate interoperability governance. Traditionally, the field has been tied to sustainability in an environmental, resource-depletion sense: even Erkuş-Öztürk and Eraydın (2010), though concerned with organisational networks, ultimately examines their environmental sustainability. But the commons lens can serve purposes beyond sustainability, such as intellectual property (Frischmann et al., 2014). However, interoperability remains not explored.

In conclusion, the literature review reveals methodological gaps in the CNO literature, as well as unexplored topics within the domain of CNOs. In the next subsection, we structure these findings as knowledge gaps for the present research.

1.1.3. Knowledge gaps

The literature review identifies four key knowledge gaps:

1. **Limited application of commons frameworks to CNOs.** Applications of the commons to CNOs as a case study are few. Ostrom's institutional frameworks have rarely been used to analyse how CNOs govern their shared arrangements, leaving a gap between a mature governance theory and an organisational form for which it appears well suited.
2. **Loose application of the commons scholarship.** Scholars invoke the commons but apply it selectively and, critically, fail to define the resource being governed (Purtova & van Maanen, 2024). Without a well-defined resource, commons analysis loses its diagnostic power (Hess & Ostrom, 2007a; Purtova & van Maanen, 2024).
3. **Terminological inconsistency and proliferation of frameworks.** There is no shared vocabulary across fields, leading to confusion over terms such as *learning commons* and *knowledge commons*, which carry different meanings across subdomains and hamper overarching conclusions.
4. **Interoperability has not been studied as an evaluative criterion.** The few commons applications to collaborative networks focus on environmental sustainability (Erkuş-Öztürk & Eraydın, 2010; Fouladvand et al., 2026) or intellectual-property protection (Frischmann et al., 2014); interoperability across organisations remains unexplored.

Read together, these gaps point to a research opportunity. The commons scholarship offers a mature theory of collective governance, yet it has neither been rigorously applied to CNOs nor been used to examine interoperability. CNOs, meanwhile, must govern interoperability across organisational boundaries but lack an integrative governance narrative to do so.

1.1.4. Research Questions

This thesis proposes that the commons scholarship can connect and further explain the strength of the organisational and semantic interoperability of CNOs by (1) studying them under alternative criteria to economic-driven approaches (Van Der Valk & Ryan, 2025), and (2) defining what the tangible and intangible shared resources are. The commons scholarship can help identify the community's attributes, the places where decision-making takes place, and map the decision making process. Ultimately, we expect that doing so could reinforce the *interoperability governance* of CNOs. Hence, we structure the present thesis around the following main research question:

Main Research Question

How can the commons scholarship inform the interoperability governance in Collaborative Network organisations (CNO)?

To answer this question, we break it down into four subquestions. Each subquestion is addressed by a dedicated chapter, moving from a theoretical foundation, through a comparison of candidate frameworks, to an case study, and finally to practical design guidelines.

Subquestion 1

How do Collaborative Network organisations (CNOs) achieve and govern interoperability across organisational boundaries?

Subquestion 2

Which frameworks in the commons scholarship are most suitable for studying interoperability governance in CNOs?

Subquestion 3

What does the chosen framework reveal about how the SETU community has managed its institutional arrangements to achieve interoperability?

Subquestion 4

Which guidelines can be developed to analyse the interoperability governance in CNOs?

1.2. Research flow & outline

Each chapter of this thesis addresses one of the subquestions introduced above. Below, we explain the content and method of each chapter. Figure 1.3 illustrates the research flow of the present thesis.

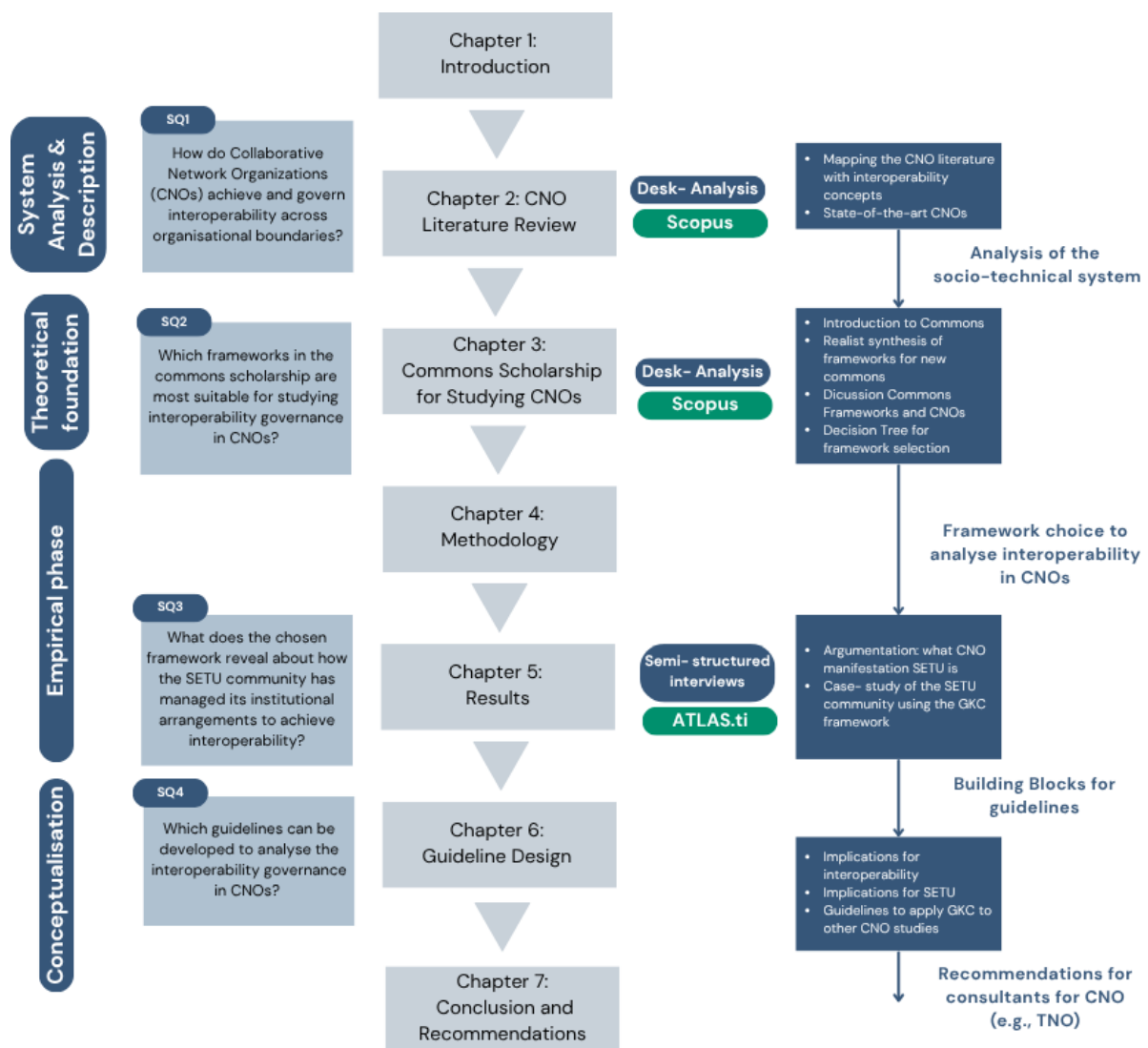


Figure 1.3: Research Flow Diagram

Chapter 2 answers the first subquestion by analysing the status quo in the CNO literature and how interoperability is understood in this field. The method is desk analysis. This chapter provides a theoretical foundation for CNO typologies and the evolution of interoperability's role over the past few decades. This first chapter analyses CNOs as a socio-technical system.

Chapter 3 answers the second subquestion. This chapter takes a deep dive into commons scholarship, tracing its origins and some of its recent developments, and conducts a second desk analysis. This chapter evaluates the suitability of a set of commons frameworks for studying interoperability in CNOs.

Chapter 4 presents the methodology, including the motivation for the case study, the data sources, the interview design, and ethical considerations.

Chapter 5 presents the findings from the case study of the Stichting Elektronische Transacties Uitzendbranche (SETU) project, in which TNO acts as a neutral convener. Here, the third subquestion is addressed by applying the selected framework from the previous chapter to assess the suitability of commons scholarship for analysing CNOs.

Chapter 6 answers the fourth subquestion. The chapter steps back, gathering previous findings and transforming them into practical design guidelines.

Finally, chapter 7 synthesises the subquestions once again to provide an answer for the Main Research Question. It provides recommendations for consultants, and discusses the social and academic relevance and the fit of this thesis with the Engineering and Policy Analysis master's programme. The document concludes with references and appendices.

1.3. Case study: SETU

Since 2007, the Stichting Elektronische Transacties Uitzendbranche community (SETU). is a data sharing initiative and standardisation authority.

In the flex staff sector, organisations rely on many bilateral, supplier-specific IT connections. These are becoming increasingly complex as the number of clients grows. Moreover, it is considered common practice in the sector that big clients (e.g. Municipality of Amsterdam, Schiphol Airport) periodically change suppliers. These circumstances make flex staffing companies incur significant IT alignment costs for both the former and the new flex staff supplier. The IT from the incoming supplier must adapt its systems to continue the same assignments. This leads to significant alignment costs for both outgoing and incoming suppliers

The SETU project emerged as a collective initiative to reduce these inefficiencies by introducing standards for electronic data exchange across the entire staffing value chain. Instead of relying on proprietary, bilateral formats, SETU creates a shared language, thereby enhancing common understanding, reducing complexity, and avoiding vendor lock-in. Currently, SETU is studying the adoption of data spaces to leverage their semantic standardization to a new level. In this thesis we will focus on the institutional arrangements that the SETU community has made to maintain interoperability within its network, and the current changes the CNO is considering to welcome this new technology. By study this case, we provide commons-informed descriptive analysis on this community, studying its institutional arrangements, social dynamics, threats in terms of appropriation to ultimately discuss whether they succeed in terms of interoperability.

2

CNOs & Interoperability

Cross-organisational collaboration has become essential for companies seeking competitive advantage in an increasingly hyperconnected world. This chapter examines the role of interoperability in CNOs, and traces the gaps that motivate the rest of this thesis. As a reminder for the reader, we provide the first subquestion:

Subquestion 1

How do Collaborative Network organisations (CNOs) achieve and govern interoperability across organisational boundaries?

This research method is desk analysis, which consists of reviewing the work that has been done before, using data collected and processed by previous scholars (Moore, 2006). This method is suitable for getting an understanding of the field of Collaborative Networks and its main contributors. Moreover, it allows us to identify the open challenges based on their latest findings. The desk analysis started with the main sources found during the prior literature review for the Research gap section. Further sources were later included through snowballing. Given the industry's relevance to this topic as a key participant, grey literature was incorporated to provide a richer perspective. Moreover, additional grey literature commissioned by or from the European Commission was added to incorporate the governance state-of-the-art (e.g. (DSSC, 2025; European Commission, n.d.; European Commission & Directorate-General for Digital Services, 2017)). This chapter answers SQ1 by (1) introducing the levels of interaction between organisations, (2) defining Collaborative Network Organisations and Camarinha-Matos and Afsarmanesh (2021)'s taxonomy, (3) introducing relevant terms about interoperability, (4) and analysing the CNOs' evolution in terms of interoperability.

2.1. Maturity levels of interaction between organisations

Organisations have always interacted in various ways in addition to direct competition. In this subsection, we describe these maturity levels of interaction between organisations: networking, coordinated networking, cooperation and collaboration. These definitions help better understand Collaborative Networks in later sections of this chapter (Camarinha-Matos et al., 2009).

The five aforementioned levels form a progression of increasing maturity, moving from loosely connected entities toward groups that jointly create value¹. At the least mature level, networking involves only communication and the exchange of information for mutual benefit, while each entity retains its individual identity and merely non-conflicting goals (Camarinha-Matos et al., 2009). Coordinated networking adds the alignment of activities to achieve more efficient results, although participants still act mostly on their own (Camarinha-Matos et al., 2009). Cooperation goes further by sharing resources and dividing labour to pursue compatible goals. Each participant performs its assigned part in a complementary way, yet they still work independently (Camarinha-Matos et al., 2009). Finally, collaboration

¹The reader is encouraged to consult Figure 1 of Camarinha-Matos et al. (2009) for a visual overview of this progression.

is the most demanding level, in which members share information, resources and responsibilities to jointly plan, implement and evaluate activities toward a common goal (Camarinha-Matos et al., 2009). Here, value is created collectively, which makes individual contributions harder to isolate and may lead to the emergence of a joint group identity (Camarinha-Matos et al., 2009). Below, Table 2.1 displays the definitions of the aforementioned interactions:

Table 2.1: Definitions of the four levels of interaction between organisations, in order of increasing maturity.

Interaction level	Definition
Networking	Sharing of information, data and knowledge for reciprocal benefit. Each entity retains its individual identity and pursues merely non-conflicting goals (Camarinha-Matos et al., 2009).
Coordinated networking	Networking extended with the alignment of activities to achieve more efficient results, although participants still act mostly on their own (Camarinha-Matos et al., 2009).
Cooperation	Sharing of resources and division of labour to pursue compatible goals; each participant performs its assigned part in a complementary yet independent manner (Camarinha-Matos et al., 2009).
Collaboration	Sharing of information, resources and responsibilities with a common goal in mind to be achieved collectively. Value is created collectively and a joint group identity may emerge (Camarinha-Matos et al., 2009).

2.2. Classification of Collaborative Networks

The development of IT technology over the past few decades has accelerated the transformation of society into a networked structure, broadening the scale and reach of the aforementioned interactions, especially new forms of collaboration (Camarinha-Matos, 2026; Camarinha-Matos & Afsarmanesh, 2021). Among these emerging forms, *Collaborative Networks* (CNs) is an umbrella term for the socio-technical systems in which heterogeneous, distributed, and largely autonomous entities collaborate toward a common goal (Camarinha-Matos, 2026; Camarinha-Matos et al., 2009).

To classify these systems, we adopt the working taxonomy of Camarinha-Matos and Afsarmanesh (2021) that builds on Camarinha-Matos et al. (2009). This taxonomy distinguishes two main types of CNs. On the one hand, Ad-hoc Collaborative Networks are spontaneous systems that lack formal organisation of their activities and task division. For example, Wikipedia emerged as a voluntary initiative of an Ad-hoc Collaborative Network (Camarinha-Matos & Afsarmanesh, 2021). On the other hand, Collaborative Network Organisations (CNOs) are groups of heterogeneous autonomous entities that have an explicit organisational structure and collaborate towards a common goal, jointly generating value (Camarinha-Matos et al., 2009). Figure 2.1 illustrates one of the latest updates on the CN taxonomy Camarinha-Matos and Afsarmanesh (2021).

This thesis examines the institutional arrangements in cross-organisational collaboration. To do so, it focuses on cases where collaboration is sustained over time and governed by a deliberate, formalised organisational structure. Collaborative Networked Organisations (CNOs) are therefore the primary object of study, as opposed to ad-hoc collaborations, which typically do not generate long-term joint value. Moreover, when ad-hoc collaborations do persist, they often evolve into a specific type of CNO. Following the previous example, Wikipedia has gradually developed an organisational structure, evolving into a continuously producing, network-driven organisation (Camarinha-Matos & Afsarmanesh, 2021).

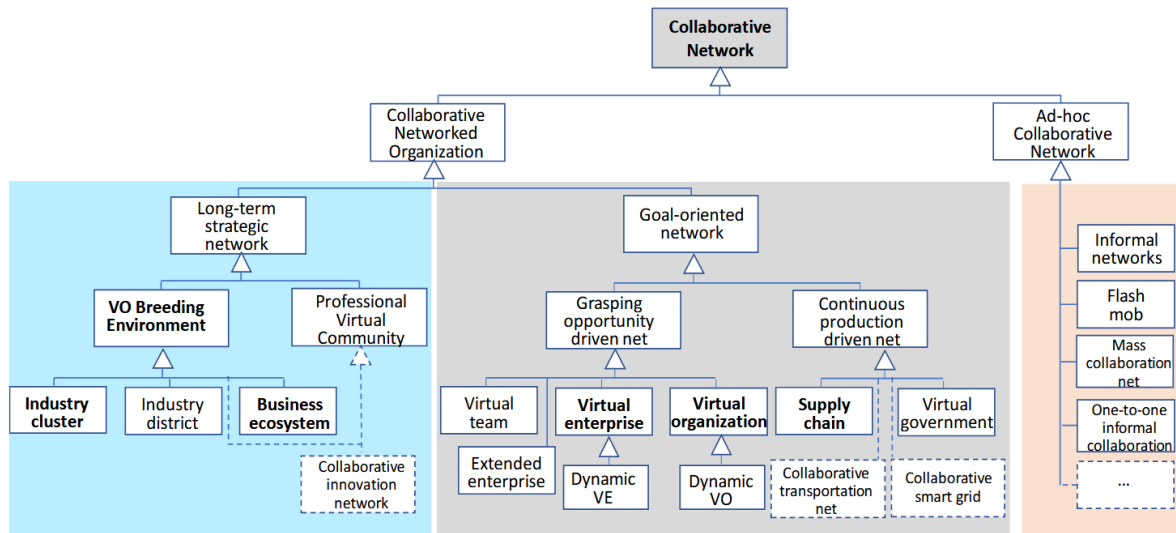


Figure 2.1: CN taxonomy. Copied from Camarinha-Matos and Afsarmanesh (2021, p. 3)

Table 2.2 below provides an overview of the CN definitions presented so far, together with the CNO subclasses. For definitions of lower-level CN classes, we encourage the reader to consult Camarinha-Matos et al. (2009).

Table 2.2: The collaborative networks (CN) taxonomy and the definitions of its classes (Camarinha-Matos, 2026; Camarinha-Matos & Afsarmanesh, 2021; Camarinha-Matos et al., 2009, 2019).

Class	Definition
Collaborative Network (CN)	Socio-technical systems in which heterogeneous, distributed, and largely autonomous entities collaborate toward a common goal.
Ad-hoc networked collaboration	Spontaneous collaboration without a predefined structure or formal division of tasks, arising to address an immediate need and dissolving once it is met.
Collaborative Networked Organisation (CNO)	A collaborative network with an explicit organisational structure, formed by diverse and independent entities that collaborate toward common or compatible goals and jointly generate value.
Long-term strategic network	A CNO established for the long term whose purpose is to build preparedness, enabling members to rapidly engage in collaboration opportunities when they arise, rather than to pursue a single predefined goal.
Virtual organisation Breeding environment (VBE)	A long-term strategic network in which entities share common operating principles and infrastructure, aiming to increase their readiness to rapidly form virtual organisations.
Professional Virtual Community (PVC)	The long-term association of individual professionals and their operating environments, providing the conditions to rapidly form virtual teams when opportunities appear.
Goal-oriented network	A CNO in which members collaborate intensively toward a specific, shared goal.
Grasping opportunity-driven network	A goal-oriented network created to seize a single collaboration opportunity, dissolved once that goal is achieved (e.g. a virtual organisation).
Continuous production-driven network	A goal-oriented network aimed at the continuous production or provision of goods or services under a relatively stable set of goals (e.g. a supply chain).

In this section, we defined the main classes of CN and narrowed down the scope to CNOs. Interoperability is what makes that collaboration possible. Without it, collaboration toward a common goal is

just an aspiration. The next section maps how interoperability is understood, setting the basis for an overview of its evolving role in CNOs.

2.3. Three Perspectives on interoperability

The purpose of this section is to introduce three perspectives that will be mentioned later during the overview of the evolving role of interoperability in CNOs. The desk analysis identified three relevant perspectives on interoperability for CNOs: the European Interoperability Framework (European Commission & Directorate-General for Digital Services, 2017), BOMOS (Folmer, 2025), and Santana Tapia (2009)'s work on cross-organisational business-IT alignment. This thesis takes the EIF as its backbone and reads the other two as sources that refine how it applies to CNOs. Accordingly, we use EIF's definition of interoperability: *"is the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems."* (European Commission & Directorate-General for Digital Services, 2017, p. 5)

2.3.1. European Interoperability Framework

The European Commission has developed the European Interoperability Framework (EIF), designed to achieve interoperability across public administrations. Like CNOs, public administrations need to reduce setup costs to fully leverage emerging forms of collaboration. This is done by creating interoperable environments, where solutions are systemic and not limited to becoming isolated patches (European Commission & Directorate-General for Digital Services, 2017). The EIF identifies five relevant layers of interoperability: legal, organisational, semantic, technical, and governance as the background layer (European Commission & Directorate-General for Digital Services, 2017).

Table 2.3: EIF's definitions of interoperability layers. Copied from (European Commission & Directorate-General for Digital Services, 2017).

Concept	Definition
Legal Interoperability	<i>"ensuring that organisations operating under different legal frameworks, policies and strategies are able to work together."</i> (European Commission & Directorate-General for Digital Services, 2017, p. 27)
Organisational Interoperability	<i>"refers to the way in which public administrations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals. In practice, organisational interoperability means documenting and integrating or aligning business processes and relevant information exchanged. Organisational interoperability also aims to meet the requirements of the user community by making services available, easily identifiable, accessible and user-focused."</i> (European Commission & Directorate-General for Digital Services, 2017, p. 28)
Semantic Interoperability	<i>"ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between parties."</i> (European Commission & Directorate-General for Digital Services, 2017, p. 29)
Technical Interoperability	<i>"covers the applications and infrastructures linking systems and services. Aspects of technical interoperability include interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols."</i> (European Commission & Directorate-General for Digital Services, 2017, p. 30)
Governance Interoperability	<i>"refers to decisions on interoperability frameworks, institutional arrangements, organisational structures, roles and responsibilities, policies, agreements and other aspects of ensuring and monitoring interoperability at national and EU levels."</i> (European Commission & Directorate-General for Digital Services, 2017, p. 22)

These five layers give a comprehensive but deliberately high-level map. They were also designed with public administrations in mind, whereas CNOs span a wider range of collaborations. The following perspectives help on both counts.

2.3.2. BOMOS

Interoperability is inextricably linked to the existence and implementation of standards (Folmer, 2025). Once members agree on shared goals, standards are incorporated into processes and information systems architecture to operationalise interoperability. Each layer of the European Interoperability Framework requires its own set of standards (European Commission & Directorate-General for Digital Services, 2017). For example, legal interoperability depends on laws, organisational interoperability requires organisational standards, and semantic and technical interoperability each necessitate their respective standards (Folmer, 2025).

In 2009, the Netherlands released the first version of BOMOS (Management & development model for open standards) to guide the creation and maintenance of standards (Folmer, 2025). BOMOS takes a governance-oriented view. The premise of BOMOS is that interoperability only emerges when standards are properly managed, adopted, and maintained (Folmer, 2025).

2.3.3. Cross-organisational business IT alignment

In 2009, Santana Tapia (2009) assessed business-IT alignment for the first time at the cross-organisational level. The term refers to a continuous improvement process to enable IT to effectively respond to business needs, thereby improving the organisational structure and performance of CNOs.

According to Santana Tapia (2009), there are four universal core domains that CNOs should address to achieve Business-IT alignment. Figure 2.2 shows the interdependencies and chronology of these domains.

- Partnering Structure: a clear cross-organisational work and role division.
- Information Systems (IS) Architecture: agreeing on a target structure for how the software applications interact
- Process Architecture: a *"choreography of all (individual and collective) processes needed to reach the shared goals of the participating organisations"* (Santana Tapia, 2009, p. 152)
- Coordination Mechanisms: robust and diverse channels of communication for members to interact and update each other.

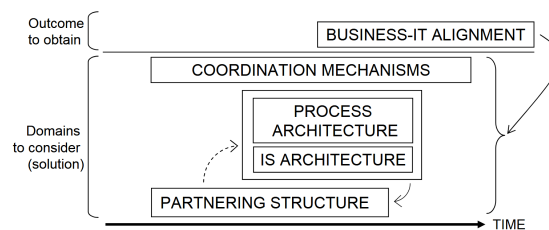


Figure 2.2: Business-IT alignment interdependencies. Copied from (Santana Tapia, 2009, p. 125)

The conceptual model by Santana Tapia (2009) can be mapped to the European Interoperability Framework (European Commission & Directorate-General for Digital Services, 2017) by comparing their respective definitions. Overall, Santana Tapia (2009) provides more granular domains, while the EIF stays high-level. Business-IT alignment is intrinsically linked to organisational and semantic interoperability, as it requires both. The domains of partnering structure, process architecture, and coordination mechanisms are an operational breakdown of organisational interoperability. They address the distribution of roles and responsibilities across organisations, the alignment and orchestration of inter-organisational processes, and the communication structures required for collaboration (Santana Tapia, 2009).

At the same time, the four domains are fundamental to semantic interoperability by defining how applications interact and exchange information. Once members agree on the common goals, the task division, and the main information to be exchanged, it is time to discuss *how* this information will be exchanged within the IS architecture.

2.4. The evolving role of interoperability in CNOs

During the past few decades, the role of interoperability in CNOs has evolved in the literature from a mere instrumental enabler composed of fragmented ICT islands (Santana Tapia, 2009) to a core domain for collaboration (Camarinha-Matos et al., 2009, 2019). Camarinha-Matos (2026) identifies five generations of Collaborative Organisations. Figure 2.3 illustrates each generation.

Interoperability in CNOs originated from the organisational dimension (aligning common business goals). Many CNOs have since developed semantic interoperability, agreeing on a common language. Technical and legal interoperability, however, remain mostly in their early stages. BOMOS has evolved in parallel to address these gaps, responding to the standardisation needs of CNOs.

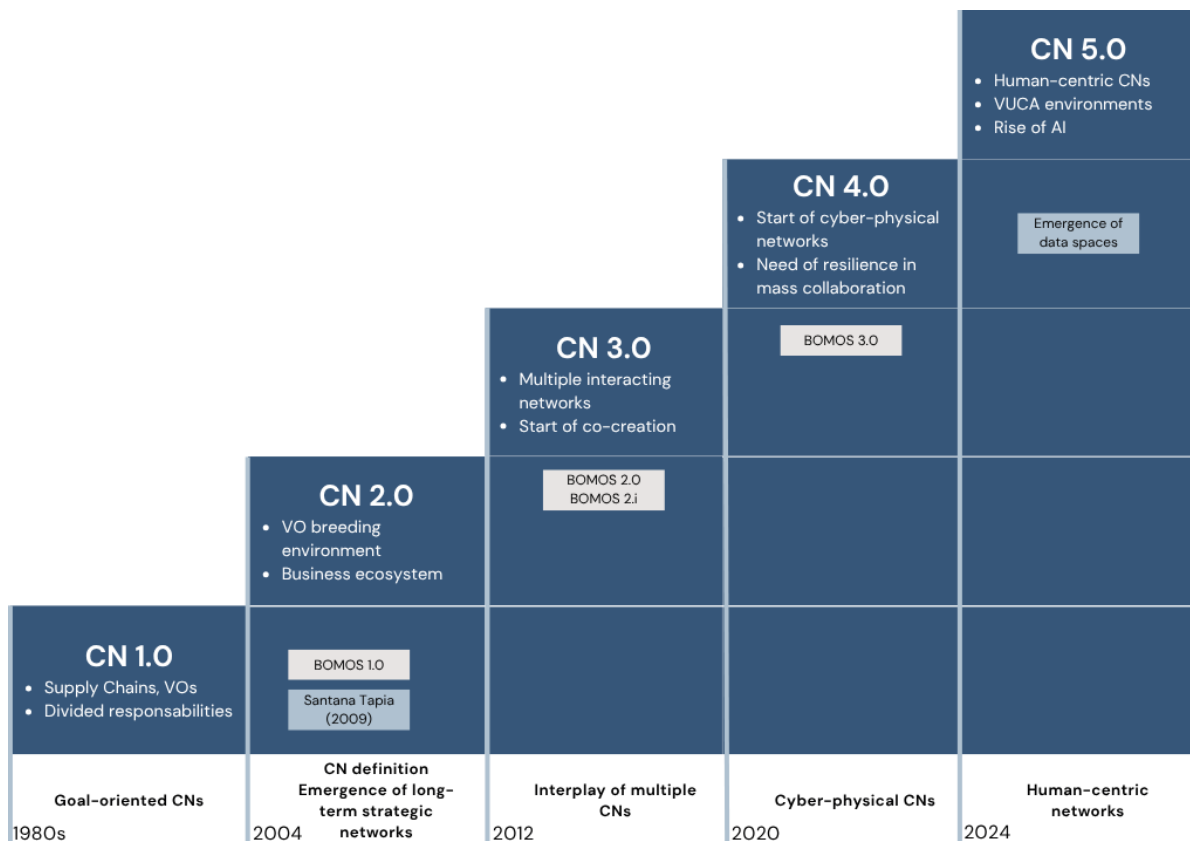


Figure 2.3: The evolution of CNOs and interoperability. Adapted from Camarinha-Matos and Afsarmanesh (2021, Fig.2) and Camarinha-Matos (2026, Fig 1) under CC BY 4.0.

2.4.1. Collaborative Networks 1.0

Traditional supply chains are considered the starting point of CNOs (Camarinha-Matos & Afsarmanesh, 2021). These networks started to emerge during the 1980s to leverage economies of scale and create stable and long-term partnerships. Supply chains are *goal-oriented networks*, the goal being the provision of a service or product to the end user (Camarinha-Matos et al., 2009). Each participating company had a clear role in the value chain, from raw material acquisition to delivery to the end user (Camarinha-Matos et al., 2009).

Collaborative Networks 1.0 were mainly focused on *organisational interoperability*, by agreeing on basic common principles and a specific structure. In contrast, semantic and technical interoperability were not yet developed. ICT was used primarily for basic information exchange and coordination in stable supply chains. In these settings, organisations often faced siloed solutions where data was trapped in home-grown applications with inconsistent semantics (Santana Tapia, 2009). Many organisations relied on a mix of electronic and paper records. These practices were highly time-consuming and slowed service delivery (“BOMOS: Elaboration 3.0.1”, n.d.; Camarinha-Matos et al., 2009).

2.4.2. Collaborative Networks 2.0

As communication technologies matured, organisations started to connect and create *Virtual Organisation Breeding Environments (VBEs)* (see Table 2.2). This class of CNOs supports the emergence of Ad hoc collaborations and/or smaller Goal-oriented projects. According to Camarinha-Matos (2026), this era saw the formal introduction of the term Collaborative Networks. The same era saw Santana Tapia (2009) publish their research on cross-organisational collaboration, and it also marked the first release of BOMOS. This first version, BOMOS 1, focused on lifecycle management, task division, and implementation support (Folmer, 2025). In doing so, it covered all the domains identified by Santana Tapia (2009), translating them into practice.

2.4.3. Collaborative Networks 3.0

The mass adoption of strategic networks worldwide has led to a significant increase in interdependencies across sectors. For instance, several supply chains from Europe and America (e.g., the German automotive industry) were global and heavily reliant on manufacturing in China. At the same time, the European Union commissioned the creation of Industry clusters to enhance regional connectivity to ultimately boost innovation in the region or a specific sector². Based on this context, the third generation of collaborative networks focused on managing interdependencies across the CNO (Camarinha-Matos, 2026).

BOMOS was expanded to BOMOS2 and BOMOS2i (Boer, 2026). The focus shifted from the creation of standards to their sustainable governance, becoming a governance model. The high connectivity across institutions required not only technical alignment but also trust-building. Hence, BOMOS included governance and versioning, as well as adoption strategies, as key elements to ensure the success of the standards.

2.4.4. Collaborative Networks 4.0.

Camarinha-Matos and Afsarmanesh (2021) refer to this era as Collaborative Networks 4.0, characterised by the use of a large amount of data, the normalisation of distributed networks, and the creation of new business models to monetise them (Camarinha-Matos & Afsarmanesh, 2021). CNOs play in a market characterised by volatility. There is a higher demand for faster data exchange to gain a competitive advantage by accessing information faster than competitors. In this context, the latest IT technologies enable real-time negotiation and data sharing (Camarinha-Matos et al., 2019).

To address these new demands for interoperability and coordinated action, BOMOS was updated to 3.0, offering a comprehensive starting point for standardisation with a focus on engaging an active community participation. This comprehensive framework emphasises the role of the community in the production and maintenance of standards. Knowledge about standards management is created and evolves within communities, not in isolation (Folmer, 2025). Consequently, standards are based on shared meaning (semantics) and coordinated use. Without these, the community will fail to maintain their shared interpretations and definitions, and its shared vocabularies will remain unaligned. This will lead to a decline in standards because members do not mean the same thing when they talk, ultimately harming the layers of interoperability. Hence, BOMOS reflects on community participation to improve legitimate decision-making, shared ownership, transparency, and trust (Folmer, 2025).

2.4.5. Collaborative Networks 5.0.

Since 2024, CN have reached the 5.0 development phase (Camarinha-Matos, 2026). As explained by this researcher, Collaborative Networks 5.0 has two main research and development directions: *"(1) the emergence of hybrid human-AI CNOs, and (2) the ability to operate effectively in VUCA (volatility, uncertainty, complexity, and ambiguity) environments. This phase emphasises advancements in value creation, as well as enhancing resilience and fostering antifragility within collaborative systems."* (Camarinha-Matos, 2026, p. 2).

Both directions place data at the centre of collaboration. The use of AI in CNOs needs large volumes of high-quality, interoperable, and trustworthy data, together with agreements that machines can read and execute. Operating in VUCA environments, in turn, requires partners to form, reconfigure, and dissolve collaborations quickly and safely (Camarinha-Matos, 2026), without ever losing control of their

²See, as an example, the Spanish regional industry cluster for the aerospace industry: Andalucía Aerospace

own data. Meeting both demands requires solutions that address all dimensions of interoperability, and it gives governance interoperability a special role. In particular, legal and technical interoperability must be explored further. However, neither CN literature nor BOMOS have explored them as much as organisational and semantic interoperability.

These data demands do not weigh equally on all collaborators, because the size of companies matters in how they join CNOs and manage interoperability. While capstone players have enough market power to set their own IT architectures, Small and Medium-sized Enterprises (SMEs) have limited resources to do so independently. Hence, SMEs often join external data-sharing initiatives such as data marketplaces, data platforms (Moonen et al., 2025) (An overview of these initiatives is provided in table A.1 in the appendix).

Among these initiatives, the European Union has begun promoting data space architecture as a means to reconcile data sharing with privacy, control, and, crucially, technical interoperability. Data Spaces are an alternative data-sharing initiative in which data control remains with their owners at all times. Data spaces are decentralised, unlike a platform where all data is stored on a single server. Participants store their own data and have the right to grant or deny access to others, thanks to control mechanisms (Moonen et al., 2025). Ultimately, the European Union aims to boost collaboration across Member States by enabling safe data exchange between companies (European Commission, n.d.). This could be especially beneficial for SMEs without their own IT systems, making it easier for them to join a Collaborative Network Organisation.

Data spaces offer advantages and address some of interoperability gaps in data exchange. Data spaces provide a strong infrastructure for data interoperability at semantic, syntactic and technical levels by enforcing CNO members to agree on the same protocols, transmission standards, data models, ontologies, shared vocabulary, and data formats used in data exchange. Moreover, Data Spaces have focused on developing mechanisms to "operationalise trust" (DSSC, 2025), with considerable advances in identity and attestation management. The main idea is that trust is established between participants when the data space infrastructure formalises negotiation before data exchange and enables data traceability and provenance (DSSC, 2025). These practices allow the CNO to become more reliable and a safe space where participants can retain their sovereignty even as they enter and leave collaborations quickly, which is exactly what VUCA environments demand.

Data spaces answer the data and interoperability demands of CN 5.0 with technical and semantic interoperability. However, CN 5.0's human-centric ambition is more than a technical problem. The design of these protocols and machine readable contracts ultimately depends on humans and how they decide to govern the system. CNs 5.0, as a socio-technical systems, pursue value creation for society, meaning that they are not exclusively designed for efficiency or economic reward exclusively, but to reach a sustainable and equally benefitting system for participating members (Camarinha-Matos, 2026). This is critical for long-lasting collaborations and for systems to stay resilient against VUCA environments.

The CN literature has yet to explore the aforementioned aspects. While frameworks such as BOMOS address the community aspect of CNOs, the CN discipline lacks a systematic framework for understanding or governing the broader institutional and community arrangements that lead to successful collaboration. Latest research has proposed methods like Social Network Analysis or game theory (Camarinha-Matos, 2026). As such, it is necessary to conduct further research on how CNOs can manage and govern value creation in long-lasting governance systems in CNOs.

2.5. Synthesis of SQ 1

This chapter answers the first subquestion:

How do Collaborative Network organisations (CNOs) achieve and govern interoperability across organisational boundaries?

Interoperability is a multi-layered capability, spanning the legal, organisational, semantic, technical, and governance dimensions (European Commission & Directorate-General for Digital Services, 2017). The desk analysis revealed that CNOs have historically addressed these dimensions in isolation, operating as fragmented ICT islands (Santana Tapia, 2009). Most CNOs have developed organisational and semantic interoperability to some extent: they agree on common principles, formalise their structure, and, in some cases, adopt a shared language and shared standards, whose maintenance is guided by governance models such as the Dutch BOMOS (Folmer, 2025).

Technological progress, particularly in communication technologies and AI, has created new ways of collaborating in which real-time data exchange is possible and autonomous systems can participate as full members. These opportunities have increased demand for the remaining interoperability dimensions. Consequently, CNOs that pursue full interoperability need to be orchestrated through interoperability governance. Data-exchange approaches such as data spaces can support this task at the technical and semantic levels. Nonetheless, the interoperability ambition is not only a technical problem. As socio-technical systems, CNOs pursue value creation for society, so their design ultimately rests on human decision-making and governance (Camarinha-Matos, 2026). Yet, the CN discipline still lacks a systematic framework for governing these institutional and community arrangements; hence further research is needed.

Commons scholarship offers formal methods to compare the institutional arrangements that different communities use to govern a shared resource (E. Ostrom, 1990). It is therefore a promising candidate for CNOs that seek to govern interoperability. However, adapting E. Ostrom (1990)'s original work to new commons has produced a proliferation of frameworks. The next chapter analyses the characteristics and propositions of each framework and discusses their suitability for CNOs.

Commons Scholarship for Studying CNOs

As a reminder for the reader, we provide the second subquestion:

Subquestion 2

Which frameworks in the commons scholarship are most suitable for studying interoperability governance in CNOs?

To answer this question, we use desk analysis. This research method consists of reviewing the work that has been done before, using data that has been collected and processed by previous scholars (Moore, 2006). Desk analysis is suitable for the overview of the commons scholarship and its some of its contributors. The review is intentionally selective, because the purpose is not to map the whole commons literature but to identify the frameworks most relevant for studying interoperability governance in CNOs. Most of the sources are academic, with special interest in foundational papers (e.g. (Frischmann et al., 2014; Hess & Ostrom, 2007b; E. Ostrom, 1990, 2005)) and literature review on the field (e.g. (Purtova & van Maanen, 2024)). Most of these papers are the results of SCOPUS query searches and later snowballing through Elinor Ostrom's rich work. Ultimately, this chapter's output is a comparative table of the evaluated frameworks and a discussion on their respective suitability for CNOs. Therefore, this chapter works as a second foundational layer to tackle the case study in Chapter 5.

3.1. History of the Commons Scholarship

Elinor Ostrom was the first scholar to use comparative institutional analysis methods to study the governance of *commons* (E. Ostrom, 1990). *Commons* are "*resources shared by a group of people that [are] subject to social dilemmas*" (Hess & Ostrom, 2007b, p. 3). The research of this scholar did not uncover a single recipe or process that correlated directly with long-lasting governance systems, which means that there are no panaceas (E. Ostrom et al., 2007). Each case of a self-governance system is highly context-dependent and requires individual study (E. Ostrom et al., 2007). To address this, Ostrom developed the Institutional Analysis Framework (IAD) and the Common-Pool Resource (CPR) theory as a rigorous scientific method and a supporting theory to study these communities and, to some extent, facilitate their comparison.

Before turning to *how* shared resources are governed, it is worth clarifying *what* kinds of resources (or goods) exist in the first place. Elinor and her husband Vincent Ostrom examined this question in their earlier work on the typology of resources, which laid part of the groundwork for later frameworks such as the IAD. Traditional economics literature classified resources primarily on the basis of *excludability*, which refers to how easy it is to prevent others from using a good. On this basis, goods were treated as pure private goods (easy to exclude others from) or pure public goods (difficult to exclude others from). V. Ostrom and Ostrom (1979) argued that this binary classification failed to capture the full complexity of

Subtractability			
Exclusion		Low	High
	Difficult	Public goods	Common-Pool Resources (CPR)
	Easy	Toll or Club goods	Private Goods

Figure 3.1: Types of Goods. Adapted from (V. Ostrom & Ostrom, 1979)

goods and left many types unaccounted for. Ostrom and Ostrom therefore added a second dimension, *rivalry* (or *subtractability*), which refers to the extent to which one individual's consumption of a resource reduces its availability to others. Combining the two dimensions produced a fourfold typology (Hess & Ostrom, 2007b; V. Ostrom & Ostrom, 1979), illustrated in Figure 3.1.

3.1.1. The IAD framework

As Hess and Ostrom (2007a, p. 41) state: "The IAD framework is a diagnostic tool that can be used to investigate any broad subject where humans repeatedly interact within rules and norms that guide their choice of strategies and behaviours". On the one hand, it provides with a checklist of independent variables to look at to study behaviour in the system. On the other hand, it provides a potential causal schema to order those independent variables into a coherent narrative (Hess & Ostrom, 2007a).

The IAD framework is meant to study the institutional arrangements of commons regardless of the field of study and the type of goods (E. Ostrom, 1990). The framework identifies three clusters of exogenous variables that together define the context of any governance situation: the biophysical characteristics of the resource in question, the attributes of the community that uses or manages it, and the rules-in-use (the formal and informal rules that actually govern behaviour in practice, as opposed to rules that may exist on paper but are not followed) (E. Ostrom, 2005, pp. 13–15). These three sets of variables feed into what Ostrom calls the action arena, the social space in which participants with diverse preferences interact, exchange, solve problems, or come into conflict (E. Ostrom, 2005, p. 14). A given action arena involves specific action situations and specific actors, whose interactions produce observable patterns and outcomes (E. Ostrom, 2005). Crucially, these outcomes are not static: they feed back into the exogenous variables, potentially altering the resource, the community, or the rules over time, giving the framework an inherently dynamic and iterative character.

The IAD framework does not prescribe what the resource, community, or rules should look like, nor does it privilege any particular theory of human behaviour; rather, it is designed to be compatible with multiple theoretical perspectives, including microeconomic theory, game theory, transaction cost theory, and theories of public goods and common-pool resources (E. Ostrom, 2005, pp. 28–29). This generality is by design: the framework is intended not as a theory that predicts outcomes but as an analytical scaffold that enables researchers to ask the right questions, organise empirical observations systematically, and compare findings across diverse institutional settings. Below, figure 3.2 provides the IAD framework.

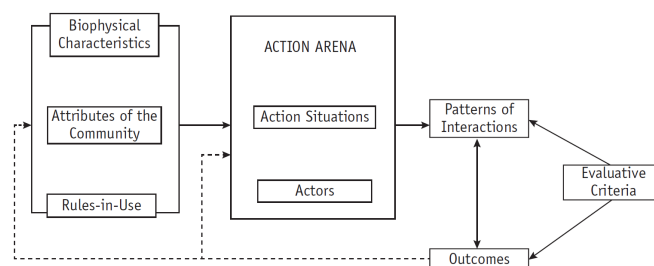


Figure 3.2: IAD framework. Copied from (Frischmann et al., 2014, p. 14). Original from (E. Ostrom, 1990).

3.1.2. The Common-Pool Resource (CPR) theory

Common-pool resources are resources subject to high subtractability and difficult to exclude others from (see top right corner in table 3.1). In her famous book "Governing the Commons"¹, Ostrom identified patterns between successful stories studied over the years and formalised them in the CPR theory. The CPR theory, including the eight design principles, is one specific set of findings that emerged from applying the IAD framework to a common-pool resource (E. Ostrom, 1990). This is the work that directly counterargues Hardin's tragedy of the commons (Hardin, 1968).

In 1968 (prior to Ostrom), Hardin (1968) argued that unregulated resources shared by communities were a chronicle of a death foretold. Due to the lack of rules, its members would prioritise their individual profits and exploit the resource until it was depleted. The author claimed that only through privatisation or state control could this misfortune be prevented (Anderies, 2016). Nonetheless, and fortunately, this tragedy has already been avoided by self-governed communities more than once, long before Hardin's time. Ostrom was the first to develop an institutional analysis framework to compare successful cases in history and around the world. Ostrom's CPR theory proved empirically that Hardin was originally referring to specifically *unmanaged* common resources and that his binary ultimatum - privatisation or state intervention - was false, as there is a third alternative: self-governance. For example, the inhabitants of Törbel, Switzerland, have been self-governing tenure and land transfers on the high mountain for centuries. Documents dating back to 1517 state rules that the inhabitants set firm boundaries for the shared resources, stating who owned the land, which shepherds had access to grazing, and when

(Netting, 1976). (E. Ostrom, 1990). Ostrom's CPR theory formalised the eight famous principles for self-governance of CPR identified in long-lasting successful communities: (E. Ostrom, 1990, pp. 90–102)

Table 3.1: Ostrom's eight design principles for long-enduring CPR institutions

#	Design principle
1	Clearly defined boundaries
2	Congruence between appropriation and provision rules and local conditions
3	Collective-choice arrangements
4	Monitoring
5	Graduated sanctions
6	Conflict-resolution mechanisms
7	Minimal recognition of rights to organize
8	Nested enterprises (for CPRs that are parts of larger systems)

Source: Retrieved from Ostrom (1990), Table 3.1, p. 90.

The box below shows the illustrative examples of the Alanya's fisheries in Turkey. It uses the IAD framework specified to a case of governing a CPR. This is a famous case from Elinor Ostrom's *Governing the Commons* book (E. Ostrom, 1990). The textbox below is a quote provided by (Anderies, 2016, p. 75) about E. Ostrom (1990)'s analysis on this case.

¹Despite the title, it is important to emphasise that the term *commons* is not a synonym or colloquial abbreviation of CPRs, but an umbrella term. Elinor encouraged the use of *commons* as a general term and common-pool resources to specifically refer to high substitutability and difficulty to exclude

IAD application on Alanya's case. Extracted from (Anderies, 2016, p. 75), original from (E. Ostrom, 1990)

"Alanya, an inshore fishery in Turkey, experienced overfishing in the early 1970s and violence frequently erupted over competition for good fishing spots. In response, the fishers experimented with new institutional arrangements designed to enable them to recover the fish stock and solve problems related to excessive competition. The institutions that the fishers developed are as follows: Each year in September, a list of eligible fishers is prepared, consisting of all licensed fishers in Alanya. All usable fishing locations are named and listed. The stock is such that fishing in one site will not directly reduce the available fish in adjacent sites. At the beginning of the fishing season the eligible fishers draw lots and are assigned to one of the fishing locations. Each day thereafter each fisher moves to the next location. Under this rotational scheme, all fishing boats have equal chances to fish at the best spots. Fishers are now themselves the monitors. Each fisher knows which spot is available for their turn for each day of the fishing season. If a fisher wants to fish on a productive spot while it is not his turn, the fisher whose turn it is will defend their right to the good spot. Hence, due to the self-monitoring of fishers there is no incentive to cheat" (Anderies, 2016, p. 75), original from (E. Ostrom, 1990).

3.1.3. New technologies, new commons

New technologies are capturing new values of traditionally unmanageable and unowned resources. The ability to exploit these traditionally unowned public good resources transforms their nature as a resource (Hess & Ostrom, 2007a). The term *new commons* refers to those traditionally unowned resources that lack the pre-existing rules or organisational structures (Hess, 2008; Van Der Valk & Ryan, 2025). This new scenario, accelerated by globalisation (new technologies are adopted quicker worldwide), strengthens the argument by commons scholars that *"commons may apply to any collective management of resources benefitting society"* (Van Der Valk & Ryan, 2025, p. 4).

As an example, not long ago, outer space was a public common good all beings benefitted from equally (Hess & Ostrom, 2007a). It is impossible to *exclude* others from accessing the rays of the sun or the ozone layer. Nonetheless, the development of the aerospace sector and communication technologies have enabled considering space as a resource that can satisfy other human needs such as space-based satellite navigation systems. These new applications are easier to exclude other actors from. As a result, there is an increasing worry on the sustainability and preservation of the space and the atmosphere due to the potential privatization of outer space.

Commons scholars agree that the change of nature of resources due to new technology makes them (e.g. outer space (Hess & Ostrom, 2007a), deep sea (Hess & Ostrom, 2007a), energy communities (Fouladvand et al., 2026), privacy ("Governing Privacy in Knowledge Commons", 2021; Regan, 2002)) suitable to study as commons. However, there is lack of consensus across scholars on (1) how the nature of the resource changes, and (2) what can the commons add here as a field of study.

3.2. Data/Information/Knowledge commons

The (new) commons literature is broad and extensive. This thesis focuses on the subfield of data and knowledge commons, a choice aligned with the challenges that CNOs face. As established in chapter 2, CNOs are dependent on data, information and knowledge flows (Gil et al., 2025). These resources are intangible and may differ from the traditional resources found in nature or urban ecosystems. Nonetheless, many scholars in the new commons subfield advocate, with varying degrees, for collective management of these resources (Purtova & van Maanen, 2024).

The lack of consensus on what precisely distinguishes data, information, and knowledge tends to be confusing, and the commons scholarship is not exempt from it. For instance, Hess and Ostrom (2007a) use information and knowledge indistinctively when referring to information or knowledge commons. Similarly, in their systematic literature review, Purtova and van Maanen (2024) refer to this subdomain as "data commons" as a convenient label while then including knowledge commons frameworks within (Frischmann et al., 2014; Sanfilippo et al., 2021; Hess & Ostrom, 2007a). In this thesis, we follow

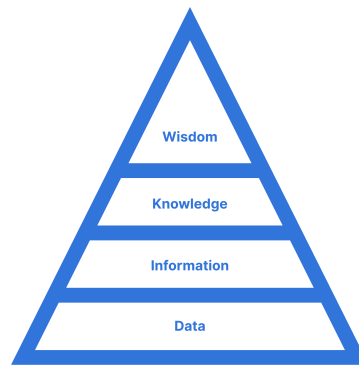


Figure 3.3: DIKW pyramid. Adapted from (Ackoff, 1989).

the Data-Information-Knowledge-Wisdom (DIKW) pyramid by Ackoff (1989). This framework indicates that the top categories built on the bottom ones. Hence, knowledge consists of information and data interpreted by a (group of) individual(s) who get applicable insights from it. See figure 3.3.

We build on Purtova and van Maanen (2024)'s systematic literature review to understand the several approaches data (or knowledge) commons literature proposes for the study of communities that work related to data exchange. In the current section, we introduce each data commons strand: Regan (2002)'s naturalist approach, Hess and Ostrom (2007a)'s knowledge commons, Purtova (2017)'s data commons, and Frischmann et al. (2014)'s Governing Knowledge Commons framework. The next section will discuss their suitability for the study of CNOs.

3.2.1. Naturalist approach: Applying the CPR theory in the literal sense

Some scholars propose the literal application of the CPR theory to study how communities govern data. Nowadays the data that can be collected has increased considerably, (e.g, smart meters for individual household consumption, medical devices that allow real-time health monitoring like heart rate or glucose level evolution). In other words, technology is enabling the capturing of personal data, making it "commodifiable" and subject to exploitation. This "naturalist" approach, as (Purtova & van Maanen, 2024) labels it, claims data can be considered a CPR, hence it is suitable for Ostrom's CPR theory.

Regan (2002) argued personal data should be consider a CPR because it is accesible to more than one person, difficult to exclude others from it, and it is subject to (quality) degradation and overuse (Purtova & van Maanen, 2024; Regan, 2002) This scholar predicted in 2002 that if the personal data in the cyberspace was not treated as a CPR, it would eventually lead to the a provision problem. Over time, internet users would realise that their personal data is being collected in predatory ways from actors in the free market. Their mistrust towards the market would increase and they would withdraw themselves from the internet, leading to a decline in the quality and quantity of personal data available (Regan, 2002). Scholars that follow this vision argue that (personal) data is a common-pool resource (rival and subject to exclusion), and that it is appropriate to apply the eight design principles of Ostrom to strive for their correct governance.

3.2.2. Knowledge as a CPR; Ostrom & Hess' perspective

Ostrom herself contributed to the application of the IAD framework to knowledge (Hess & Ostrom, 2007a). Ostrom co-authored with Hess the book *Understanding the Knowledge Commons*, where the main focus is the preservation of scientific knowledge in a increasingly digital world. They use a rather broad definition of knowledge: "*All intelligible ideas, information, and data in whatever form is expressed or obtained*" (Hess & Ostrom, 2007a, p. 7). The authors argued that digitalisation was putting at risk the equal access to knowledge. At the beginning of the 2000s, there were already signs of academic publication companies gate-keeping publications behind paywalls. In the book they focus on how to treat knowledge as a common-pool resource. Their contribution is the first attempt to adapt the IAD framework to knowledge, information and data (Frischmann et al., 2014; Hess & Ostrom, 2007a).

They argued that the IAD framework and the CPR theory could be used for intangible resources like

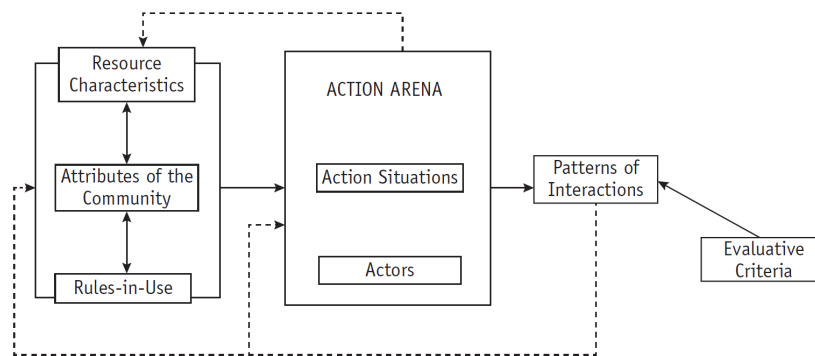


Figure 3.4: GKC framework. Copied from (Frischmann et al., 2014, Fig 1.2)

knowledge after some modifications. For Hess and Ostrom (2007a), knowledge has a dual functionality: a human need (constructive for society) and a economic good (a commodity). Unlike tangible resources (e.g. land tenure), which can be found or built, knowledge is generated through human cognitive and social processes. Therefore, its structure as a CPR is different from traditional tangible resource, having to acknowledge these human processes. Instead of a stocks and flows structure, knowledge commons are composed by facilities, artifacts and ideas.

3.2.3. Data Ecosystem as CPR

Purtova (2017) and Purtova and van Maanen (2024) takes the torch up from Hess and Ostrom (2007a), modifying it to make it suitable to governance of digital data. First, they identify the data ecosystem as the common-pool resource, arguing that data is part of a bigger systems resource. Contrary to the naturalists, Purtova (2017) explains that data is too dynamic to be considered a CPR. Any common-pool resource needs stable boundaries. Expanding the scope of the CPR under study to data ecosystems allows to study the three main elements of the system resource: people, platforms and data (Purtova, 2017; Purtova & van Maanen, 2024). Secondly, they broaden the definition of subtractability to include more social dilemmas beyond depletion or deterioration of data, such as the "long-term effects of commoditization of personal data and modern data processing practices" (Purtova, 2017, p. 109). Following this line of thought, these scholars warn that current regulations tend to be dominantly economically-driven, overlooking social norms and threatening "*commodification of human interactions*" (Van Der Valk & Ryan, 2025, p. 32)(Purtova & van Maanen, 2024).

3.2.4. Governing the Knowledge Commons (GKC) framework

To Ostrom and her followers ((Hess & Ostrom, 2007a; E. Ostrom, 1990; E. Ostrom et al., 2007; Purtova, 2017; Purtova & van Maanen, 2024; Regan, 2002)), argue that it is the nature of the resource that justifies governing it collectively. Alternatively, (Frischmann et al., 2014) flip the logic when studying knowledge commons. The authors claim that is the collective that decides how to govern the shared resource. Therefore, the community can decide to govern it collectively. GKC scholars acknowledge the contribution of Ostrom in the commons scholarship and build from it. They use the IAD framework as solid foundation. While IAD is a "good start" for the study of knowledge commons, it needs to be adapted.

However, the CPR scholars disregard the CPR theory for knowledge commons. Unlike (Hess & Ostrom, 2007a), they do not think that knowledge per se is a common-pool resource all the time. Knowledge is non-rivalrous (its usage does not prevent others from using it), but it sits on top other resources that are rivalrous (e.g. time and money), and can create resources that are rivalrous (e.g. time and fame) (Frischmann et al., 2014). Moreover, the scientific knowledge studied by Hess & Ostrom is also produced by its members, but in an aggregative way: knowledge is a stock that accumulates contribution by contribution, and no single contribution requires the alignment of the whole community to be valid. Their concern is therefore the preservation of and access to that stock, not the coordination of its creation (Hess & Ostrom, 2007b). However, not all intangible shared resources fit that characteristic. For example, a shared ontology (an agreed set of definitions so its members understand each other)

is only a useful resource if all parties involved agree to use it. A specification adopted by only one party, while others disregard it, results in the development of separate vocabularies. This fragmentation undermines the original shared ontology and ultimately defeats the goal of achieving semantic interoperability (Camarinha-Matos & Afsarmanesh, 2021). In the GKC framework, the resource and the collective alignment that sustains it are inseparable. Below, find a summary of the main reasons the authors argue for the modification of the framework:

- Since knowledge commons are constructed, their characteristics cannot be exogenous. In the natural resources field, it was possible to discuss the bio-physical conditions like something the community can seldom change, however the fluid nature of knowledge does not fit into that description.
- Knowledge production is inherently collaborative and cumulative. It is not possible for an individual to "un-know" what they been exposed to, so creators always borrow from others, creating coordination challenges around who can use what and how.
- Knowledge commons' boundaries are constructed.
- Knowledge must be created before it is shared. Therefore, the new framework must account for production and sharing social dilemmas (e.g. coordination, combination, competition issues) in addition to the traditional preservation problem.

Building on the resource-agnostic nature of the IAD framework, GKC scholars have expanded its applicability to new contexts. Figures 3.2 and 3.4 illustrate these modifications graphically. Two main changes are particularly noteworthy. First, in the GKC framework, the role of emerging interactions is redefined: whereas the IAD treats patterns of interaction and outcomes as separate elements, the GKC merges these into a single component (Frischmann et al., 2014). Second, the GKC framework emphasises that the resource is intrinsically linked to the community that maintains it. To reflect this, an arrow is introduced from the action arenas back to the endogenous characteristics of the resource, highlighting this dynamic relationship (Frischmann et al., 2014).

Below, table 3.2 provides the representative research questions the GKC scholars suggest as a start to study the knowledge commons.

Table 3.2: GKC framework guiding questions. Extracted from (Sanfilippo et al., 2018, Table 7)

No.	Question
Background Environment	
Q1	What is the background context (legal, cultural, etc.) of this particular commons?
Q2	What normative values are relevant for this community?
Q3	What is the "default" status of the resources involved in the commons (patented, copyrighted, open, or other)?
Q4	How does this community fit into a larger context? What relevant domains overlap in this context?
Attributes	
<i>Resources</i>	
Q5	What resources are pooled and how are they created or obtained?
Q6	What are the characteristics of the resources? Are they rival or nonrival, tangible or intangible? Is there shared infrastructure?
Q7	What is personal information relative to resources in this action arena?
Q8	What technologies and skills are needed to create, obtain, maintain, and use the resources?
Q9	What are considered to be appropriate resource flows? How is the appropriateness of resource use structured or protected?
<i>Community Members</i>	
Q10	Who are the community members and what are their roles?

Continued on next page

(Table 3.2 continued)

No.	Question
Q11	What are the degree and nature of openness with respect to each type of community member and the general public?
Q12	What noncommunity members are impacted?
<i>Goals and Objectives</i>	
Q13	What are the goals and objectives of the commons and its members, including obstacles or dilemmas to be overcome?
Q14	Who determines goals and objectives?
Q15	What values are reflected in goals and objectives?
Q16	What are the history and narrative of the commons?
Q17	What is the value of knowledge production in this context?
Governance	
<i>Context</i>	
Q18	What are the relevant action arenas and how do they relate to the goals and objectives of the commons and the relationships among various types of participants and with the general public?
Q19	Are action arenas perceived to be legitimate?
<i>Institutions</i>	
Q20	What legal structures (e.g., intellectual property, subsidies, contract, licensing, tax, antitrust) apply?
Q21	What are the governance mechanisms (e.g., membership rules, resource contribution or extraction standards and requirements, conflict resolution mechanisms, sanctions for rule violation)?
Q22	What are the institutions and technological infrastructures that structure and govern decision making?
Q23	What informal norms govern the commons?
Q24	What institutions are perceived to be legitimate? Illegitimate? How are institutional illegitimacies addressed?
<i>Actors</i>	
Q25	Who are the decision makers and how are they selected? Are decision-makers perceived to be legitimate?
Q26	How do nonmembers interact with the commons? What institutions govern those interactions?
Q27	Are there impacted groups that have no say in governance?
Patterns and Outcomes	
Q28	What benefits are delivered to members and to others (e.g., innovations and creative output, production, sharing, and dissemination to a broader audience, and social interactions that emerge from the commons)?
Q29	What costs and risks are associated with the commons, including any negative externalities?
Q30	Are outcomes perceived to be legitimate by members? By decision-makers? By impacted outsiders?

3.3. Discussion: Applicability of the frameworks to CNOs

The CNO concept itself exhibits parallelisms with the commons: a community that shares a common goal and works together, sharing resources and processes under a specific organisational structure (rules-in-use and institutional arrangements). It is tempting, then, to map each type of CNO directly onto a commons framework. We argue this would be misleading. The suitability of a framework does not depend on the *label or the type* of the CNO, but on the *characteristics* it exhibits. For instance, a static supply chain with a fixed and isolated task division between partners is goal-oriented network on paper is a continuous production driven network. Nonetheless, if it does not share resources collectively at all, the commons is simply not the right lens. Nevertheless, this does not preclude the possibility that some continuous production-driven networks may effectively utilise the commons framework.

Knowing this, in this section we provide an overview table 3.3 summarises the frameworks under comparison. Next, we provide a decision tree to facilitate the selection of a commons frameworks for the study of CNOs, further explaining some of the key aspects researchers should consider when choosing a framework.

Table 3.3: Comparison of several commons frameworks

Framework	Key Author(s) & Year	Relationship to Ostrom's Original IAD Framework	What is Identified as the CPR / Commons?	How is Subtractability Understood?	Normative or Descriptive?	Main Features	Main Limitations / Critique
IAD (Original)	E. Ostrom (1990)	Does not apply. It is the original.		Physical depletion of resource through overuse	Descriptive	Designed for tangible resources (e.g. fisheries, urban areas). Commons are modelled with stocks and flow units.	Requires a well-defined resource before applying it. In the case of intangible resources, this is an assumption prior to the investigation. Focus on sustainability, leaves other social dilemmas out. The evaluative criteria must be chosen by the researcher (e.g. sustainable preservation of fisheries); in intangible commons this risks becoming subjective.
Naturalist Approach	Regan (2002)	Literal application of Ostrom's IAD framework and CPR theory to data.	Data(set) is a CPR.	Depletion of resource through overuse. Data degrades through overuse (becomes incomplete, inaccurate, outdated); users withdraw due to distrust.	Normative (see (Regan, 2002)'s prediction on bad use of cyber space).	Calls for the collective governance of data per Ostrom's principles (clear boundaries, graduated sanctions, conflict resolution...)	Weak argumentation on application of the IAD and CPR theory. Data is not physically subtractable and is easily replicated, so it does not neatly fit the CPR definition.
Knowledge Commons	Hess and Ostrom (2007a)	Adaptation from original author (Ostrom) to intangible shared assets.	Knowledge is a CPR.	Knowledge deteriorates through exclusion — digital publishers restrict access to smaller libraries and poorer communities, impairing both appropriation and provision of new knowledge.	Descriptive	Changes the structure of the CPR. CPR has an "ecological makeup" of three components: ideas (intangible content), artefacts (physical/digital representations like articles), and facilities (libraries, the internet).	Mostly focus on one specific case of knowledge commons : academic scholars. The ecological makeup is specific to scientific knowledge; applying it elsewhere requires constructing a new ecosystem model

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(Table 3.3 continued)

Framework	Key Author(s) & Year	Relationship to Ostrom's Original IAD Framework	What is Identified as the CPR / Commons?	How is Subtractability Understood?	Normative or Descriptive?	Main Features	Main Limitations / Critique
Data Ecosystem as CPR	Purtova (2017) and Purtova and van Maanen (2024)	Continues the adaptation of Hess & Ostrom (see previous row).	Data Ecosystem is a CPR.	Not physical degradation of data (like naturalists), but long-term effects of commoditization of personal data and modern data processing practices that compromise social values, leading to <i>"extinction of society as we would like it to be"</i> (Purtova, 2017, p. 200).	Normative (see cell on the left).	Changes the CPR structure. CPR = a system resource composed of three elements: people, platforms, and data. Data itself is not the CPR but a flow unit/benefit generated by the core resource (people).	Strongly linked to normative values (avoiding "commoditization of society), risks remaining at high level. Unclear whether it fits for smaller communities or CNOs
GKC	Frischmann et al. (2014)	Builds on IAD, but departs from its underlying logic: collective governance makes a resource a commons (not the other way around).	Rejects the CPR theory for intangible commons. Commons = any resource governed collectively.	Knowledge is non-subtractable (its usage does not prevent others from using it), but it sits on top of other resources that are rivalrous (e.g. time and money), and can create resources that are subtractable (e.g. time and fame). These dictate the social dilemmas to be managed, not knowledge itself.	Descriptive; meant to be an analytical tool.	Knowledge variables are co-constructed and mutually influential; GKC is resource-agnostic; interaction patterns as the main outcome.	Morally and politically "neutral".

3.3.1. Decision Tree for selecting a commons framework

After comparing the frameworks, we provide a decision tree for selecting between the frameworks studied in this chapter. This decision tree aims to guide researchers and consultants during the early stage of research. We first explain some key aspects to take into account during the selection process.

The Naturalist framework is not applicable

Not all commons frameworks are suitable. We argue that the "naturalist" approach is unsuitable for studying CNOs for two reasons. First, the naturalist approach systematically disregards any institutional analysis beyond data (Purtova & van Maanen, 2024). In CNOs, however, data is embedded in a broader ecosystem of shared resources. CNOs face more social dilemmas in addition to depletion of (good quality) data, such as "coopetition", trade-off between autonomy and dependence, and free-riding. Most of these are not central to data itself, but to the shared resources that enable the infrastructure, alignment and participant trust (Camarinha-Matos & Afsarmanesh, 2021). Second, far from becoming reality, Regan (2002)'s prediction did not come true. Two decades after her prediction, there is plenty of data, if anything, only less accessible (Purtova & van Maanen, 2024), possibly due to the emergence of digital business models towards it (e.g. paywalls, data procurement). The current reality indicates how easy it is to exclude others from it, but does not necessarily mean it is subject to depletion or rivalry.

Two conditions for a CNO to be suitable for a commons analysis

Before selecting a framework, a CNO must *at least* meet two conditions for a commons analysis to be possible. First, it must have an agreed organisational structure, as argued in Chapter 2; without these there is no institutional arrangement to study. Second, and equally important, the collaboration must persist over time. The commons scholarship studies action arenas and the patterns of interaction it produces; both presuppose repeated interaction. For this reason, ephemeral *opportunity-grasping networks* fall outside our scope even when they display a clear organisational structure. If they dissolve soon after forming, there is no room for repetitive interactions, no stable action arena to observe, and therefore no dynamics to analyse (Camarinha-Matos et al., 2009). These requirements leaves the durable manifestations of CNOs: *long-term strategic networks* and *continuous production-driven networks*.

Does the resource exist before or because of the CNO?

If the community comes together precisely to *produce* a shared resource whose character is co-constructed and feeds back into the community, the GKC framework is the better fit, as it inverts Ostrom's logic: it is the collective that decides to govern, regardless of the nature of the resource (Frischmann et al., 2014). In contrast, if the resource pre-exists and shapes the community more than the community shapes it, its characteristics can be treated as exogenous. In this case, the ecosystem perspectives of Hess and Ostrom (2007a) or Purtova and van Maanen (2024) could be suitable candidates.

Definition of subtractability

This desk analysis revealed that one of the most differentiating aspects across frameworks was their definition of subtractability. Researchers and consultants should carefully consider which definition of subtractability resonates with the case under study in the early stages of their research. The comparison table 3.3 provides a starting point to reflect on this.

It is worth noting that, traditionally, E. Ostrom (1990) defines subtractability as physical depletion. Many new commons, such as data, are intangible and not subject to physical depletion. This is why the naturalist approach was discarded, as it proposes the literal application of the IAD framework to data commons (Purtova & van Maanen, 2024). Nonetheless, since some CNOs may involve traditional commons where physical depletion is pertinent, the possibility of applying the IAD framework is included in the decision tree.

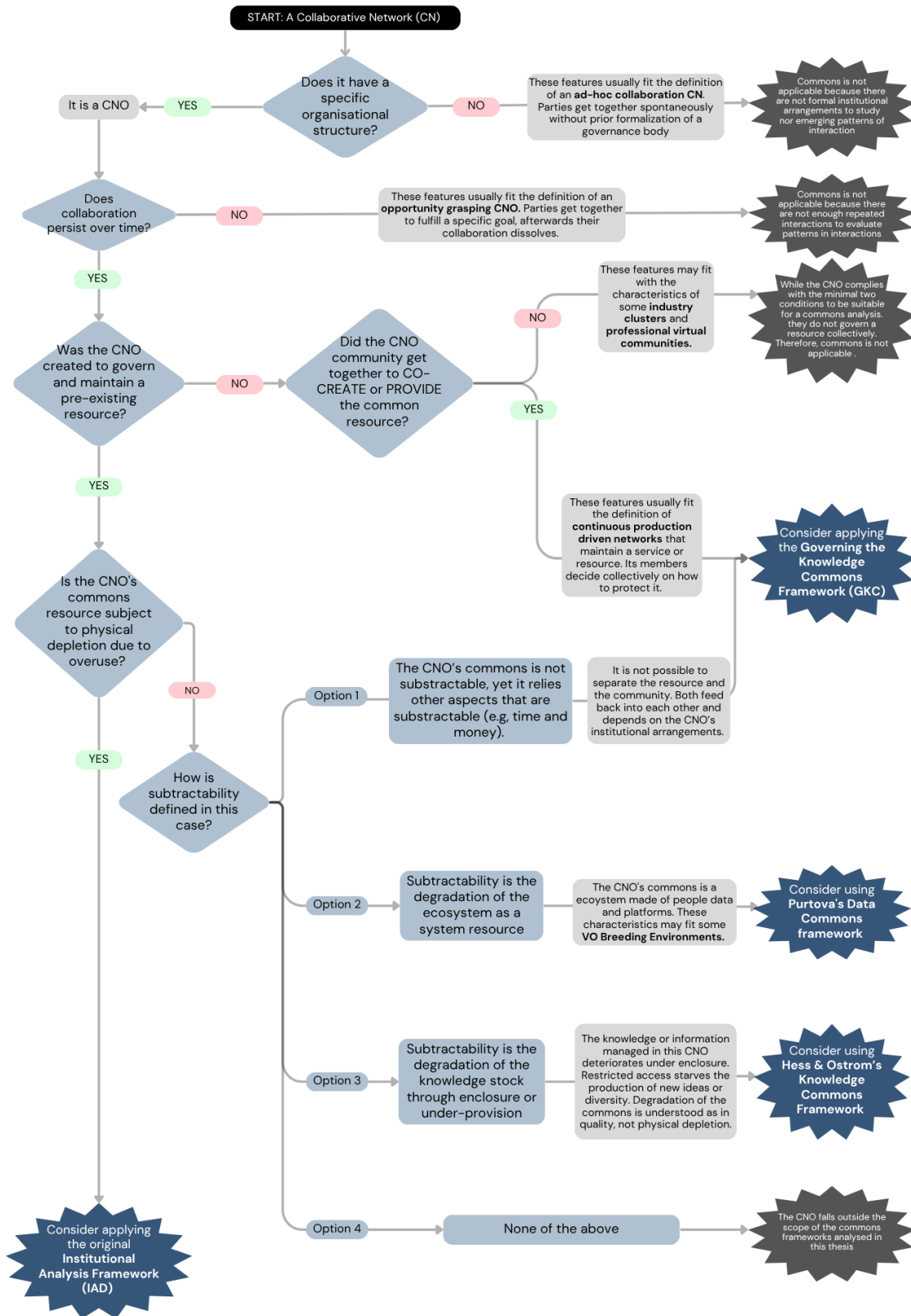


Figure 3.5: Decision Tree for framework selection for study of CNOs for interoperability. Elaborated by author.

Taking into account the aforementioned aspects, we now proceed to generalise the findings to CNO taxonomy. On the one hand, some *Long-term strategic networks* such as Virtual Organisations Breeding Environments (see VBE in Table 2.2), *tend* to inherit rather than author their shared resource. Their common goal is preparedness: building a breeding environment so that future collaborations can take place almost as soon as they sprout (Camarinha-Matos & Afsarmanesh, 2021). The shared resource is a minimum alignment and the networking knowledge of the community, which the network maintains and updates rather than creates. This common resource is subject to deterioration if not constantly maintained, and subject to appropriation if powerful partners overpower the rules to limit others' access. The challenges of these long-term strategic networks lie in the interaction within and between people, data, and infrastructure – precisely the ecosystem that Purtova treats as a system resource (Purtova & van Maanen, 2024)

Continuous production-driven networks, in contrast, are goal-oriented and project-driven. Here, the reality in industry *tends* to be the opposite: organisations decide to work together in order to *create* a common resource they can benefit from. Hence, the characteristics of the resource created collectively do influence back the community. As the following quote from the original source explains:

Unlike commons in the natural resource environment, knowledge commons arrangements usually must create a governance structure within which participants not only share existing resources but also engage in producing those resources and, indeed, in determining their character. In fact, knowledge commons' members often come together for the very purpose of creating particular kinds of knowledge resources. The relevant community is determined not by geographical proximity to an existing resource, but by some connection—perhaps of interest or of expertise—to the knowledge resources to be created. These characteristics of knowledge commons suggest that neatly separating the attributes of the managed resources from the attributes and rules-in-use of the community that produces and uses them is impossible (Frischmann et al., 2014, p. 16)

3.4. Synthesis of SQ2

This chapter answers the second subquestion:

Which frameworks in the commons scholarship are most suitable for studying interoperability governance in CNOs?

Through a desk analysis, this chapter compared several commons frameworks and assessed their suitability for CNOs. The selection of a commons framework for the study of CNOs should consider at least three main criteria: whether the CNO meets two minimal conditions, whether the common resource precedes the CNO, and the type of subtractability the common resource is subject to.

First, the desk analysis identified two minimal conditions that a CNO must meet for a commons study to be suitable: (1) a deliberate organisational structure, and (2) a collaboration that persists over a significant period of time, so that there is room for the repeated interactions that create action arenas. The CNO classes that comply with these features are *long-term strategic networks* and *continuous production-driven networks*. Second, if the CNO creates the resource, then Frischmann et al. (2014)'s GKC framework may be most suitable. If the resource pre-exists, then Hess and Ostrom (2007a)'s knowledge commons, Purtova and van Maanen (2024)'s data commons, or the original IAD framework by E. Ostrom (1990) become candidates. The choice between these three mostly depends on the third criteria: the definition of subtractability. This chapter consolidates these criteria in a comparison table and a decision tree. In the next chapter, we test these tools on a CNO case study: the *Stichting Elektronische Transacties Uitzendbranche* (SETU).

4

Methodology

This chapter describes the qualitative research methodology for this thesis, before presenting the results in the next chapter. First, it briefly introduces the case study and the rationale for choosing it. Next, it explains semi-structured interviews as the chosen qualitative research method. It also justifies the selection process of interview participants. Then, it argues in further detail how the Governing the Knowledge Commons framework (GKC) by (Frischmann et al., 2014) is adapted for the case study and the interview questions. Lastly, it elaborates on the selection of direct content analysis as the qualitative analysis method to study the interview transcripts and grey literature. The qualitative research methodology described in the current chapter will ultimately be used to answer the third subquestion in Chapter 5.

Subquestion 3

What does the chosen framework reveal about how the SETU community has managed its institutional arrangements to achieve interoperability?

This subquestion has three objectives in the research. The first objective is to test the effectiveness of the decision tree developed in Chapter 3 in assessing the suitability of several commons frameworks for CNOs. The second objective is to evaluate whether the framework suggested by the decision tree provides useful insights about the CNO under study. Lastly, the third objective of this subquestion is to provide input to the guidelines for consultants that are developed in Chapter 6.

4.1. Brief description of the case study: SETU

In this thesis we will study the institutional arrangements made by CNOs to enhance interoperability by analyzing the following case study: the Stichting Elektronische Transacties Uitzendbranche project (SETU). Since 2007, SETU is a data sharing initiative and creator of standards project in which TNO participates as a neutral convener.

4.1.1. Context

In the flex staff sector, organisations rely on many bilateral, supplier-specific IT connections. These are becoming increasingly complex as the number of clients grows. Moreover, it is considered common practice in the sector that big clients (e.g. Municipality of Amsterdam, Schiphol Airport) periodically change suppliers. These circumstances make flex staffing companies incur significant IT alignment costs for both the former and the new flex staff supplier. The IT from the incoming supplier must adapt its systems to continue the same assignments. This leads to significant alignment costs for both outgoing and incoming suppliers.

The SETU project emerged as a collective initiative to reduce these inefficiencies by introducing standards for electronic data exchange across the entire staffing value chain. Instead of relying on proprietary, bilateral formats, SETU creates a shared language, thereby enhancing common understanding,

reducing complexity, and avoiding vendor lock-in.

Currently, SETU is studying the adoption of data spaces to leverage its semantic standardisation to a new level. In this thesis, we will focus on the institutional arrangements that the SETU community has made to maintain interoperability within its network, and the current changes the CNO is considering to welcome this new technology.

4.1.2. Motivation of SETU as a case study

SETU is an initiative with almost twenty years of trajectory. Since 2007, the foundation has developed and maintained open standards for electronic exchange in the staffing industry. SETU is a compelling case for this thesis for the following reasons:

1. **SETU matches the definition of a CNO.** SETU is a group of heterogeneous autonomous entities (flex staff agencies, flex staff hirer IT suppliers and TNO) that have an explicit organisational structure (board and working groups) and collaborate towards a common goal(s) (facilitating data exchange in the staffing industry), jointly generating value. More specifically, since it provides a service for the flex staffing industry by producing and maintaining standards, it is a goal-oriented continuous production driven network (Camarinha-Matos et al., 2009).
2. **Using SETU case to test the decision tree developed in Chapter 3.** The following section uses the decision tree to choose a suitable framework for SETU.
3. **SETU has a feedback relationship with the BOMOS model, understanding SETU can provide insights to improve BOMOS.** SETU was structuring following the recommendations of the first version of BOMOS. Over time, SETU has influenced BOMOS, which has incorporated some of SETU's best practices in the model.
4. **SETU case study will inform guidelines for the future application of commons to other CNOs.** SETU is a 20 years old CNO that has achieved success and established as a standard authority in The Netherlands. We propose that SETU has become a community that creates, develops, and maintains a common resource (the open-standards). Using Commons scholarship will help us understand which institutional agreements and set of variables sustain its governance, and what changes have been made through its History. These findings will be input for future guidelines aimed for consultants who want to apply commons to a CNO.
5. SETU is currently transitioning to use data spaces. This makes it a good case to study how CNOs can leverage data space technology and manage their own transition.

4.1.3. Application of the decision tree for the framework selection

To select an appropriate commons framework, we applied the decision tree developed in Chapter 2 to the SETU case. The first decision node asks whether the initiative possesses a specific organisational structure. This criterion was met, as SETU operates as a Collaborative Network Organisation with a defined governance structure consisting of a decision-making body and multiple working groups. Furthermore, its activities are guided by formal statutes, internal regulations, and a publicly available manifest (SETU, n.d.-a). The next decision node considers whether collaboration persists over time. SETU satisfies this condition, as it has operated for more than twenty years and has become an established standardisation authority within the Dutch flex staffing sector. The subsequent decision node examines whether the organisation was created to govern an existing resource. In the case of SETU, this condition was not met. Rather than managing a pre-existing resource, the community emerged in response to the absence of interoperability standards in the sector. The final decision node therefore asks whether the organisation was established to create or provide a common resource. As SETU was founded to develop and maintain shared interoperability standards, this condition was met. Following this path through the decision tree leads to selecting the Governing the Knowledge Commons (GKC) framework as a suitable analytical lens for the case.

Figure 4.1 illustrates the decision tree from Chapter 3 applied to SETU. The path is highlighted with blue arrows.

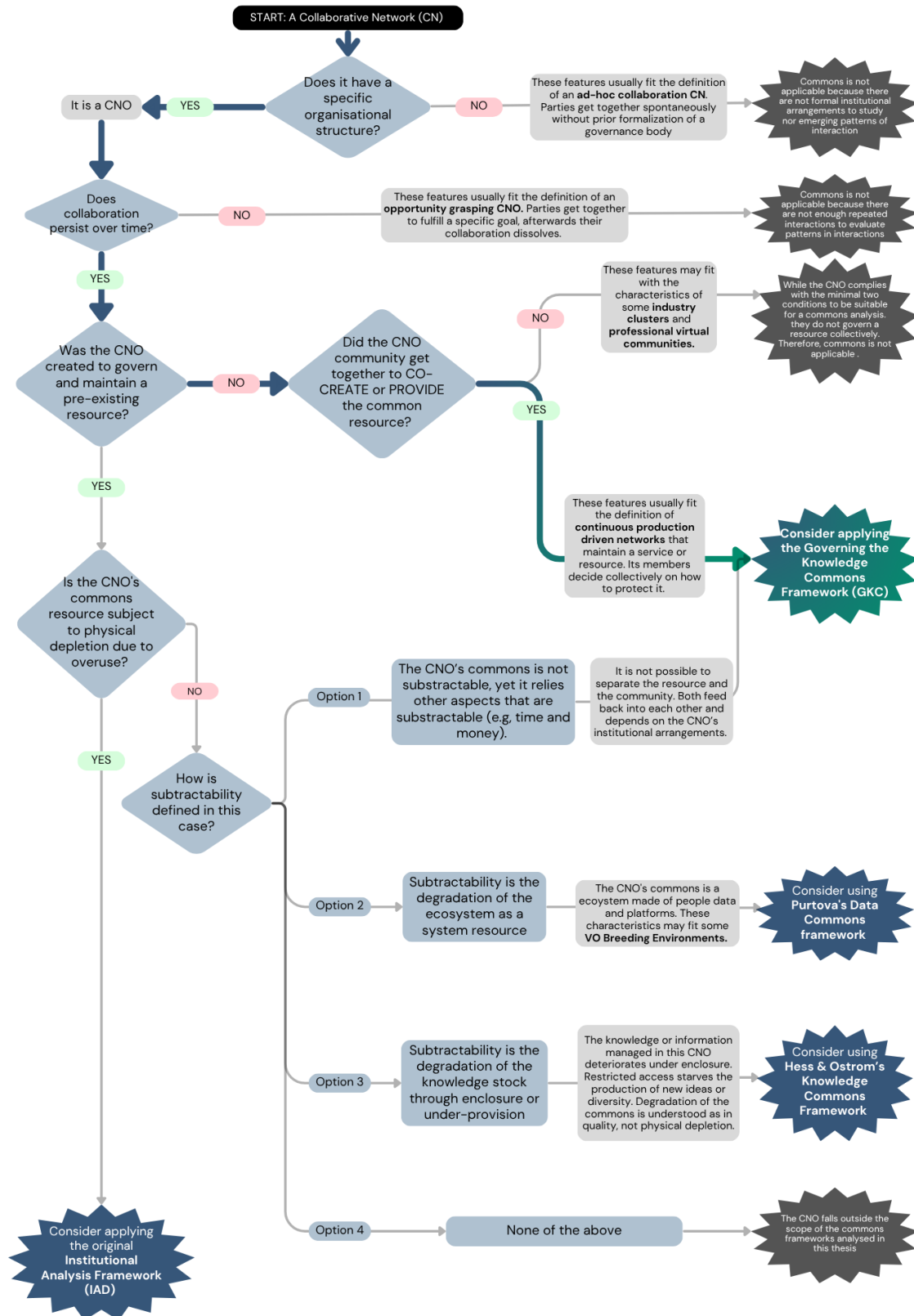


Figure 4.1: Decision tree applied to the SETU case.

4.2. Data Collection & Analysis

We collected data from two sources. The first source comprised public documentation from the SETU community, including the manifest, foundation statutes, internal regulations, and working methods. The second source consisted of nine semi-structured interviews with experts from the SETU community. A topic guide (see Figure 4.2) was developed in advance to address central themes. The semi-structured format enabled a flexible protocol, open-ended questions, and opportunities for follow-up questions (DeJonckheere & Vaughn, 2019). This approach allowed participants to elaborate on their observations. Despite the flexibility, common topics and similar viewpoints emerged across participants.

4.2.1. Participants

Participants were selected based on their relationship with the SETU community and their role. We sought a diverse pool of interviewees across two dimensions. On the one hand, we aimed to cover the almost 20-year history of SETU. Hence, we aimed to interview people who have been long-term members, people who joined at a later stage, and new members. We are confident these groups have different perspectives on the impact and dynamic interactions within the community. For example, a new participant of SETU may have different priorities for what to standardise first than different focus than one who has been in the community for longer.

On the other hand, we distinguish two groups based on role: the management-focused members who lead the decision-making, and the operationally driven members who focus on day-a-day tasks within the community. It is key to have both groups as interviewees. This is especially important to identify whether normative rules on paper (e.g., in the statutes) are unknown to other participants or not enforced by others. Hess and Ostrom (2007b) refer to these as *rules-in-form*, whereas *rules-in-use* refer to the institutions that take place in practice.

Below, Table 4.1 provides a list of the participants and their roles.

Table 4.1: List of participants for the interviews

Code	Role	Reason for Inclusion
P1	Consultant	Staff working in SETU project
P2	Consultant	Lead staff working in SETU project
P3	Consultant	Staff working in SETU project
P4	Middleware provider	long-term participation in the SETU's working groups with experience in IT and business
P5	Senior Consultant	staff working in SETU project. Experience in working group lead and strategy
P6	Software provider	Their company has recently actively joined SETU. They provides a software provider perspective to the interviewee pool.
P7	Former consultant	envisioned and participated in the founding of SETU
P8	Flex Staffing Agency IT Manager	Long-term participation in the SETU's working groups. Provides a temporary flex staffing experience.
P9	Flex staffing Agency Software Development Specialist	SETU board member. Provides a temporary flex staffing experience.

4.2.2. Design of the semi-structured interviews

The GKC scholars provided representative research questions with a dual purpose: to guide interview structure and, in the later analysis stage, to provide a framework for organising insights from interviews and related materials (Frischmann et al., 2014). Table 3.2 illustrates the original questions from the GKC scholars. We use the latest version they provided in ("Governing Privacy in Knowledge Commons", 2021).

As implied by the name, the representative research questions are designed to be merely represen-

tative. In other words, they are meant as a first step for the researcher to think about the questions to analyse the particular case study. In the case of SETU, the set of questions must be adapted to the study of knowledge created in the digital domain. Moreover, the questions must be translated to a language that is understandable for people who is not used to the commons's vocabulary. For instance, the GKC question "*What informal norms govern the commons?*" can be ambitious and too dry for a interviewee. Instead, we analyse the manifest and compare the rules in paper with the answers people give to "*How is a day working for SETU?*". After the interviews, we map both sides and identify similarities and inconsistencies, the latter potentially being informal norms that do not written down in paper but an unspoken agreement.

Figure 4.2 illustrates the topic guide designed specifically for the study of the SETU community, in which the questions of the GKC scholars have been adapted. Each question maps to the original set of questions, with the original number in brackets. We reduced the number of questions to meet the one-hour benchmark. However, we have made sure that each the categories (e.g. Background, resources, attributes, goals & objectives) are covered in detail by merging some questions into one.

Because grey literature is available for the interviews, the adapted questions focus on information that is difficult to find in grey literature. Hence, some of the original questions from Table 3.2 are answered directly with grey literature and do not appear on the topic guide.

The order and logic of the questions in 4.2 follow Edwards and Holland (2015)'s recommendations. First, it starts with an introduction and a "hook". This introduction helps the interviewee understand the importance of the interview and the relevance of their participation. Moreover, it sets a friendly tone that helps them feel comfortable and open up later. Next, the first questions are intentionally broad so the interviewee can elaborate freely on their own experience at SETU and feel heard. Later, the researcher asks more targeted questions about the community. The questions in this phase are preliminary. We believe that adapting them on the spot based on previous answers allows us to ask even more specific and tailored questions to the interviewee, achieving more specific answers. Finally, there is a buffer time to ask for clarifications, recap, and gently wrap the interview. In addition to data collection, the main objective of this design is to create a friendly and trusted environment for interviewees, so they feel comfortable talking about their feelings, experiences, and perceptions about the community they are part of (Edwards & Holland, 2015).

The topic guide serves as a reference for the interview, but it does not constrain the researcher from asking follow-up questions or seeking clarification.

Start Interview - 5 Minutes

- Welcome
- Thank you
- Small talk

Start recording

- Repeat informed consent
- Hook
 - Introduce myself
 - What the study is about
 - Why I am interested
 - Why they should be interested
 - Why they are a key person to interview to understand the institutional arrangements of the SETU community
- Ask if they have any question

Core Questions - 40 minutes**Initial phase - "Grand tour questions"**

- Could you briefly introduce yourself? Also please explain your job at your company and your role at SETU (Q1)
- What is SETU in your own words? How is it structured? (Q10, Q6, Q16)
- Why do you think SETU is needed? What is the added value for members and non-members? (Q16, Q28)
- How is a day in working in your role at SETU? (Q23)

Intermediate phase - "Specific questions"

- How is your experience while collaborating with other companies & institutions at SETU? How do you as a team accommodate your different interests? (Q28)
- Where and how can you voice your ideas for the SETU community? (e.g. update a standard, add a technical feature, modify a statute?) Are you satisfied with the available mechanisms? (Q19, Q21)
- What non-members are impacted by SETU? (Q12)
- What knowledge and technology is essential to create and maintain an open-standard? (Q5, Q8)
- To what extent is that knowledge in-house or outsourced? (Q9, Q8)
- What comes to your mind when I ask about legitimacy?(Q24, Q30)
- Each year the board sets yearly goals, how are these determined? (Q13)
- What legal context, other external factors and/or actors influence decision-making at SETU? (Q20, Q27)
- Next year SETU will celebrate its 20 anniversary, do you recognize clear phases in SETU's history? (Q16)
- Now SETU is adopting data space technology, how is the process going? What are the benefits, risks, and conflicting interests in this transition? (Q28)
- What do you think is the future of SETU? What will be the next step?

Concluding phase - Seeking clarification and closure - 20 minutes

- Summarize key takeaways
- Time to ask for any clarification
- Is there anything you still want to share with me?
- Thank you for your time and disposition

Figure 4.2: Topic guide for semi-structure interviews. Elaborated by author, based on (Edwards & Holland, 2015)

4.2.3. Data Analysis

The interviews were recorded and transcribed using Microsoft Teams and subsequently coded in ATLAS.ti. The codebook was developed deductively from the GKC framework and the representative research questions proposed by GKC scholars (see Table 3.2). Additional codes emerged during the analysis and were added inductively, including the code *Interoperability*. The complete codebook appears in Appendix B.

The coded interviews formed the basis for the Results chapter. Findings were developed through an iterative process of comparing coded excerpts, identifying recurring patterns, and relating these patterns to the theoretical framework.

After drafting an initial version of the Results chapter, we compiled all quotations and references attributed to each participant into an individual feedback form. Interviewees were invited to review these excerpts and indicate whether the quotations accurately reflected their intended meaning. Participants could clarify, suggest factual corrections, elaborate on their statements, or identify passages that needed additional context. The feedback received was used to refine the data interpretation and improve the accuracy and validity of the findings.

4.3. Ethical considerations

As this research relies on interviews, it involves data collected from human research participants. The methodology was designed in accordance with the requirements of the TU Delft Human Research Ethics Committee (HREC). Before data collection, we submitted a detailed ethics application describing the data to be collected, the planned analysis, and the measures taken to protect participants. The committee approved the proposed methodology.

Before each interview, participants received an informed consent form explaining the purpose of the study, the nature of their participation, and the intended use of the collected data. Participation was voluntary, and we informed interviewees that they could withdraw their consent at any time. No sensitive personal data was collected, and all interviewees are referred to by pseudonyms throughout this thesis. Only members of the research team can access the data.

Through the feedback form, participants could review how their contributions were represented in the research. They could also request modifications or removal of quotations before publication.

5

Results of the case study

This chapter presents the interview results and will follow as an structure the categories of the GKC framework: Background Environment, Attributes of the knowledge commons, Governance, and Patterns & Outcomes. For further information, please refer to Table 3.2 in Chapter 3.

The findings presented in this chapter will answer the third subquestion:

Subquestion 3

What does the chosen framework reveal about how the SETU community has managed its institutional arrangements to achieve interoperability?

5.1. Background Environment

The background environment is the flex staffing industry, constituted by temporary staffing agencies, hirers, and software and middleware providers. Hiring companies (entities that hire the services of staffing supply agencies, e.g., Schiphol Airport hires Adecco's flex staffing services) tend to periodically switch flex staff agencies, mainly because they tender every 4 or 6 years. This leads to a periodic migration of IT systems. As P8 further explains:

P8: [...] for some customers, we can pursue that; we can tell them: "Hey, we are doing a good job. Stay with us; we will improve our services." And then they will skip tendering. But at a certain moment in time, they will tender; they will do it, and then you either have to be very, very sharp in your offer, or you will lose them. Well, then there's no man overboard, because then you get another customer, because it happens at all the temp agency firms.

During each migration, the three roles involved (the hirer, the former staff provider, and the new one) often incur costs that do not generate additional value. As P8 notes, clients often return after a few years, illustrating the cyclical nature of these transactions. This cycle means that flex staffing agencies may undergo multiple IT migrations with the same client over time. In this context, standardisation emerges as a practical solution to reduce these recurring transaction costs.

SETU standardises the information that the sector already exchanges. Actors traditionally exchange timecards, placement records, and other operational data. These are the backbone of the temporary-staffing sector, yet they are neither copyrightable expressions nor patentable inventions. The SETU standards themselves, the main output of this collaboration, are open by default. Hence, the central dilemma in the SETU community is therefore not about who owns the operational data or timecards and who should have access to them, but about coordination and the transaction costs of exchanging this information.

5.2. Attributes of the knowledge commons

After portraying the background environment and the default status of the resources, the next step is to identify the set of resources that constitute the knowledge commons (Frischmann et al., 2014).

5.2.1. Resource characteristics

Most interviewees agreed that SETU relies on the following types of knowledge as input:

- **Expertise on the flex staff sector:** refers to knowing how actors tend to interact, best practices, and upcoming regulations in the sector. While most interviewees think of it as knowledge, those from software companies argue it is also a skill to keep up to date with this sector nomenclature. For instance, P6 said that it is only after several years working for flex staff sector clients that he feels more comfortable with most of the terms. Logically, this type of knowledge is mostly provided by the flex temporary staffing agencies and the hirers who work directly on it as its main business. Nevertheless, over the years, other involved actors, such as the software providers and TNO, have learned the foundations.
- **Organization and project leader knowledge.** The SETU community is heterogenous, formed by actors with different backgrounds (technical or business), and different constituencies. A software provider will have different priorities than a flex staffing agency. P2 and P5 note that it is key to know how to manage organizations and leadership. Following this line of thought, P5 identifies this rather as a skill than plain knowledge:

P5: Working for an industry collective and having to deal with working to consensus on the standards also requires a lot of people and collaboration skills. [...] And so from a skills perspective, we need to understand their perspectives, where they come from, or at least have the ability to ask and check that.

- **Expertise on ICT for standardisation:** this refers to a deep understanding of data modelling, semantics, handling of version control, effects of modelling choices into the IT systems that must comply with the standards, XML, SOAP, etc. P2 confirms that most of this knowledge is collected in BOMOS. However, P7 agrees on the relevance of domain knowledge and ICT, yet he clarifies that, the SETU's case inspired the logic and argumentation of the first version of BOMOS, since some of the authors were the same people. Later, and as studied in CNOs & Interoperability, BOMOS evolved and incorporated practices from other examples in the field. Nowadays, BOMOS and SETU have a symbiotic relationship where they feed into each other (Folmer, 2025).
- **Expertise about the standardisation world:** The standardisation world has standardisation bodies such as ISO, and "industry consortia", like SETU or W3C, where companies decide on procedures collectively. Hence, it requires experience to navigate and understand these and how they can impact the SETU. According to P7, the interrelationship between these standards is a "mess":

P7: But the world of standardisation has really gotten a mess. There are more than 1000 standardisation bodies. You also have to have what we call "industry consortias", such as W3C. [...] You also see a lot of standards that are being set by industry consortias also have a different sort of kind of parallel process in the formal standardisation.

Are the resources in-house?

When asked about whether these types of knowledge are in-house in the SETU community or outsourced, interviewees provided counterintuitive answers. First, the domain-specific knowledge is in-house due to the presence of the main players in the domain. However, P4 and P6 point out that, while that is the case, these parties tend to send their technical personnel to the SETU meetings. Hence, the meetings end up with only technical people from the staffing industry side and the software providers.

Second, ICT and standardisation expertise is mainly brought by TNO. While this could be considered in-house, the interviewees belonging to this company see themselves as contractor, and not stakeholders. When asked, they concluded that the knowledge they provided is outsourced because they are not part of the community.

P5: TNO, I would say, is not a stakeholder of the SETU. We are contracted by SETU to

perform the activities. So you mentioned it twice now that we are not a member anymore. Although that is true, I would say we were never a member. It was it was administratively done so. But We were never a true stakeholder of the SETU standards.

P2: And we as TNO, we are a different organization because we are not a staffing customer that's using the SETU standards themselves. We are not an IT provider. We are actually being hired by the SETU.

Nevertheless, other parties tend to mention the SETU board and TNO quite often together in the interviews, and it is a fact that TNO is partially responsible for the foundation of SETU. In his long trajectory at SETU, P9 considers one of the TNO colleagues part of SETU in practice.

P9: I have worked with him for I guess ten years. He feels within SETU, he feels just like a colleague within SETU. Not really like he's an outsourced or something. No, that's not how it feels. For me, he's a big part of SETU, I say.

The SETU standard

The previously defined set of knowledge and skills helps create and maintain the SETU standards. In the GKC framework, these can be studied as a resource and as an output. The emphasis of GKC framework on the interdependencies makes that resources that are created once as output can be studied in later iterations as part of the input. In the present section, we study them as a resource. In this sense, we focus on existing standards that are part of the endogenous environment in which more material outputs and new social interactions take place as outputs (Frischmann et al., 2014).

The standards are created by the community in the specific working groups. These standards are open to everybody to use inside and outside the community, and royalty-free by decision of the community in its foundation. Hence, the SETU community has managed access, but its output is meant to be publicly available. Each SETU standard focuses on a part of the hiring process of flex workers (Setu, n.d.). We provide a list of the SETU standards up to date below:

- Exchange of vacancies.
- Exchange of CVs.
- Ordering and Selection: requesting, proposing and selecting workers.
- Assignment: exchange of placement data.
- Planning & Scheduling: standardized set of message specifications
- Reporting Time & Expenses: reporting hours worked and expenses incurred
- Invoicing: invoicing of efforts made and costs incurred.
- Transmission & Security: Transmission of SETU messages
- Equal pay: requesting all terms of employment from the client

5.2.2. Community Members

We start this section by defining the most relevant type of actors in the flex staff sector related to SETU. Next, we introduce ABU/NBBU and TNO as actors of critical relevance for the foundation of SETU in 2007.

The flex staff industry

- temporary staffing agencies: companies whose main business is the provision of temporary workers to clients in exchange for a service fee. Examples are Adecco or Manpower.
- Hirers: this term refers to entities that hire the services of temporary staffing agencies. They can be private or public. Examples are Schiphol Airport, DHL, municipalities, etc.
- Software and middleware providers: these assist temporary staffing agencies and hirers in implementing the necessary ICT infrastructure for them to exchange information.

According to the internal regulations (Huishoudelijk Reglement), the SETU community has three types of membership: *participants*, *subscribers*, and *donors*. In the following Governance section, the characteristics will be further detailed.

ABU and NBBU

On the one hand, ABU (Algemene Bond Uitzendondernemingen) is the general union for temporary staffing agencies. On the other hand, NBBU is the trade association of professional intermediaries on the labor market. This association includes temporary staff agencies, hirers, recruiters, mediators between self-employed persons and clients.

ABU is the founder of SETU and has a constitutional oversight role.

- ABU appoints and can replace board members (Statutes, Art. 4)
- ABU receives a two-month notice before any dissolution decision (Statutes, Art. 14)
- In case of dissolution, ABU's total invested amount is paid out first (Statutes, Art. 15)
- ABU handles the administrative onboarding of new members and manages the SETU website
- ABU processes membership registrations and invoicing

TNO

In addition to these actors, the TNO plays both the role of strategic advisor and executive body of the SETU. This actor has been involved with SETU since its foundation. Despite originally paying a membership fee in the past, all interviewees from TNO consider themselves external to the community, (see section Resource Characteristics).

5.2.3. Goals & Objectives

In knowledge commons literature is usual that communities under study want to solve problems like the production of intellectual goods that are shared, overcoming transaction costs, and the creation of platforms to boost the creativity of the community to solve other challenges (Frischmann et al., 2014). These three are problems the SETU community aims to solve. According to their manifesto, the SETU wants to: *"enable temporary staffing agencies, hirers, and HR software suppliers to solve digital interaction challenges in a modern, flexible, and cost-efficient manner"* (SETU, n.d.-b, p. 1). They do this by enabling usable message standards for the flex staff sector.

Goal 1: Reducing transaction costs

Across the interviewee pool, there is a general agreement that the main goal of SETU is to reduce costs and improve efficiency. P3 explains:

P3: *"if [a large staffing company] would go to a client, their sales pitch is we can deliver you flexible work with, you know, we can give you high-quality flexible workers that fit the description of your vacancy and we can do it very quickly. So those are like the main things that fit: quickness and quality. They will not say we can then process that in the cheapest way because that's not what the price is determined on. So reducing costs is purely an increase in margin for them, but it's not a competitive advantage because it doesn't help with speed, quality of match, and quality of the applicant."*

Goal 2: Achieving further member engagement in the production of standards

SETU community aims for the engagement of its participants and subscribers. This is a key aspect for the SETU since the material outcome (the standards) relies heavily on the quality of the input directly given by the participants. P4 says:

P4: *SETU actually needs input for updating, maintaining, and creating new standards. Those input needs to get, needs to come from the participants, but it depends on how much effort the participants can deliver, how they act, and what the value of that information is.*

Goal 3: Achieving further adoption of the standards in and outside the flex staff sector

After 2023, the SETU manifesto has incorporated over time another goal: encouraging the further adoption of their standards in the flex staff sector and other companies. Additionally, and as a strategy to encourage such adoption, SETU aims to attract potential adopters by being a frontrunner and in the sector (e.g., new laws, latest technology). As P2 explains:

P2: *I think another one which is quite important and which we somewhat need to protect is that we are SETU, we really try to be a... on top of every new, whether that's a regulation*

or whether that's a certain trend or development that's taking place within the sector. We really want to be on top with that and see how that reflects our standards.

Thereby, the SETU can provide additional services to its community that can reinforce its own relevance. P5 emphasises:

P5: What we are now exploring more is to have a more active role in the digitization topics in the industry, be more present there, perform more activities for the community, and with that, grow our members. So it's more on a positive side. So, add more value and then ask participants to pay a membership fee. That's more the path we are now on.

5.2.4. History & narrative

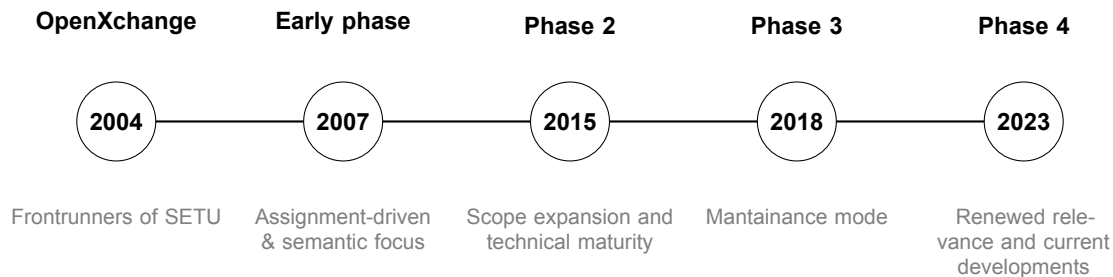


Figure 5.1: SETU phases

SETU started in 2007, as a case study for a deliverable of the OpenXchange European project. The project aim was the implementation of *electronic business XML* (exXML standards and semantic interoperability across European supply chains. Along other European research partners, TNO studied the importment of ebXML interoperability for two use cases: the procurement of materials for the building industry and the procurement of temporary labour by the flex staffing industry. P7 was part of that project team. In his experience, the first case was not successful, and did not have a follow-up after the European project was finished. The flex staffing industry actors, however, were eager to collaborate. Hence, the OpenXchange project became the step towards what is known today as the SETU foundation. For additional context, figure 5.2 shows the foundation in 2004 of PleinU, a frontrunner that eventually evolved to SETU.



Figure 5.2: Front page at Computable in 2004 with the foundation of PleinU.

When asked why was the study of interoperability so welcomed by the staffing industry, P7 identifies the several unique characteristics of the sector back then. First there were emerging standard initiatives in the sector at international level. XML for Human Resources (hrXML) caught the attention of some

Dutch flex staffing sector companies, who raised it the interest to ABU. Eventually, ABU created a working group to study the hr-XML.

From a GKC perspective, this means that the background environment was favourable, as there was already an institutional setting the future SETU standards could build on. Second, the flex staffing sector had numerous information exchanges between and across temporary staffing agencies and hirers. These exchanges relied heavily on analogue processes, (e.g fax machines, paper-based timecards, carbon copies). As these processes were repetitive and already routinised they provided a clear basis for automatisisation and digital standardisation, exactly what the openXchange project was offering. Moreover, the transactional costs of these repetitive did not translate into added value, so there was an strong economic incentive to participate. Lastly, TNO brought the IT knowledge that the businesses lacked and was a trusted authority, known for its business-neutrality. This combination of expertises (IT and domain-specific) and trust set the foundation to a cohesive community with strong incentives to collaborate.

First, P7 created the timecard specification and the first working groups, but it was ad hoc. Eventually, SETU was formed with a deliberate organizational structure. This shows that SETU started as an opportunity-grasping CNO.

Early phase

After the foundation of SETU, the initiative entered an early phase in which only a limited number of standards existed. According to P5, this made the relevance of SETU relatively easy to understand for the actors involved. The flex staffing sector recognised the importance of standardisation, which supported adoption in the first years. At the same time, this early phase was strongly shaped by technical and procedural discussions. P4 recalls that much of the documentation was provided in large PDF documents, which made it difficult for participants to follow the theoretical explanations behind the technology. Working groups also tended to discuss in detail how the standards should look in practice. For example, participants could debate whether a gender field should be filled in as “male” or as “M”. In P4’s view, this level of detail was sometimes excessive, as such decisions could have been provided by the standard itself rather than negotiated among participants. This illustrates that, while SETU had a clear value proposition, the early working groups also struggled with the balance between collaboration, technical detail, and decision-making efficiency. This perception is also reflected in P8’s account of the early meetings. According to P8, the meetings were not always focused on developing fundamentally new standards, but often on small incremental changes while still generating extensive debate.

P8: The meetings were not that advanced in a way that we were discussing a new standard. For example, we are going from an assignment 1.2 to an assignment 1.3, and we are adding three fields, and we had 20 discussions about 3 fields or something like that. I’m exaggerating a little bit, but that was my meaning of the SETU. SETU was like the NATO, no action talk only.

Phase 2: scope expansion and technical maturity

In a second phase from 2015 to 2017, the scope of SETU expanded. P5 explains that while the number of standards increased, adoption stagnated. In his view, the ambitious goals of the active community made the standards more complex. P4 recalls that SETU had developed around seven standards which were relatively stable and used by the largest companies in the sector. They also acknowledge that the total number of active participants remained low. This phase therefore shows a tension between technical maturity and community size: SETU had become more established as a standardisation initiative, yet this did not automatically translate into broad adoption across the sector.

At the same time, the broader technological environment also changed. In 2015, SETU released the Standard for Invoicing version 1.4. This supports the exchange of invoicing information between two organisations from the staffing sector. As P8 notes, this version also incorporated timecard specifications requested by the community members.

Shortly thereafter, a significant change occurred at the European level. The European Committee for Standardisation (CEN) released the EN 16931, the European semantic standard for electronic invoicing. TNO participated as a Dutch stakeholder in the negotiations, aiming to include similar timecard specifications as a requirement. However, this effort was unsuccessful, and EN 16931 ultimately did

not include timecard specifications. Consequently, SETU needed to update its Standard for Invoicing to align with the new European norm, leading to the removal of timecard specifications in version 2.0, released in November 2016.

This change was not universally welcomed. P8 describe that there remains ongoing resistance from their customers to adopting version 2.0. They believe it is primarily because it lacks the timecard specifications. From a business perspective, as P4 observes, there was no strong necessity to upgrade, since many customers continue to use version 1.4. Nevertheless, P4 concedes that the update may have been a logical step from a standard maintenance perspective.

Overall, this phase illustrates how changes in the external standardisation environment can create pressure for adaptation, even when existing users and customers do not perceive the same urgency for change.

Phase 3: maintenance mode, 2018–2022

Between approximately 2018 and 2022, SETU entered what P5 describes as a *maintenance mode*. In this phase there were few new ideas, few new members, and even a slight decline in membership. This created concern within TNO and the SETU board, because the initiative risked becoming less dynamic. At the same time, there was uncertainty about how new legislation would be implemented, which made it difficult to determine what kind of standardisation work was needed. Nevertheless, this period also brought improvements in how SETU standards were made available. According to P4, the move away from large PDF documents towards smaller building blocks was an important implementation improvement. This made the standards easier to use and helped address some of the difficulties experienced in earlier phases.

Phase 4: renewed relevance and current developments

In the current phase, SETU is again more actively searching for new challenges in the domain where its community and expertise can contribute. According to P5, the foundation is exploring areas where the existing SETU structure can help address sector problems, such as planning and scheduling, JSON REST APIs, and data exchange related to pay equity. This more active orientation also appears to have made SETU more attractive to new participants. One software provider explains that they joined when meetings became more regular and when participants could raise their own issues and hear from others. This suggests that the community function of SETU has become more visible and valuable in recent years. At the same time, new regulation continues to shape SETU's agenda. As upcoming legislation creates new data exchange requirements, SETU needs to be prepared to respond. Recent work on the planning standard and the collective labour agreement standard illustrates this renewed relevance. P8 assesses this development positively, stating that SETU is doing *a very good job*, while also noting that the work is becoming *tremendously complicated*. The current phase can therefore be understood as one in which SETU has regained strategic relevance but also faces increasing complexity as it moves into more legally and technically demanding areas of standardisation.

5.3. Governance

In this section, we study the governance of SETU from multiple perspectives. First, it outlines the formal organisational structure of SETU, including the board and working groups. Then, building on the concept of the action arena, it identifies informal but also significant places where decisions affecting SETU are made. Second, it discusses the institutional context in which SETU operates, focusing on the other actors with whom SETU must interact and maintain compatibility. Third, it details the established membership mechanisms for contributing to SETU. Finally, it assesses the openness of the SETU community based on the GKC framework's definition.

5.3.1. Organisational structure

The GKC framework inherits the *action arena* definition from E. Ostrom (1990). In a nutshell, action arenas refer to the moments or places where a set of actors interact and take action and/or decisions about a particular situation related to the community. In the SETU there are several action arenas. We first provide an overview table of the action arenas in Table 5.1 below, followed by a more detailed explanation of each one.

Table 5.1: Overview of the action arenas in the SETU community

Action Arena	Function
SETU Board	Strategic governance arena responsible for defining the direction of SETU, approving releases and budgets, establishing working groups, and resolving conflicts escalated from lower-level arenas.
Working Groups	Operational arena where members collaboratively develop, maintain, and revise standards. Most coordination, discussion, consensus-building, and issue resolution takes place in these groups.
Helpdesk	Support arena that provides guidance on standards implementation, answers user questions, and redirects formal change requests to the appropriate governance processes.
Public Consultations	Punctual external consultation arena through which non-members and other stakeholders can provide feedback on draft standards and proposed releases.
HR-XML International Convention	External institutional arena that influences SETU through international standardisation efforts and provides a channel for aligning Dutch and international interoperability standards. SETU aims to influence this arena.
GitHub	Action Arena where members and non-members can access the standards, download them, and flag bugs, and leave comments. Users mostly use the issue tracking

SETU board

It is the decision-making body of the SETU community. They decide the direction of the SETU and take high-level decisions. The board sets the annual plan for the SETU foundation, approves budgets, decides when major releases happen, established and dissolves working groups, and approves which participants may join the working groups (Internal regulations, Art.8) (SETU, n.d.-b). As a board member himself, P9 explains:

P9: ...we're discussing what is the future of SETU, what is happening in the Flex staffing sector, what changes are happening, how does it affect our SETU standard. Mainly discussing how we're going to do that, what do we need to help working groups to get where they can really define what needs to happen. Because in the board, it's more on a global level, whereas the working groups go more into the details for what needs to be changed.

The board must at least have four members. These are nominated by the board itself, but appointed by ABU. According to statute 4, ABU has the right to replace any board member at any time. Inside the board there are three special roles: Chair, secretary and treasurer. The last two may be combined. It is noteworthy that only members of temporary staffing agencies that are members of the ABU have the right to apply or be nominated for a seat at the board.

The voting procedure of the board requires quorum of at least of three members by simple majority vote. In case of a tie, the proposal is brought to the next meeting; if tied again, it is rejected. Votes on matters are preferably oral; votes on persons are written (Statutes, Art. 7). Moreover, the must meet at least three times per year.

Working groups

These are teams established by the board with a specific objective in mind. The working groups are hosted by TNO staff and a ABU-member staffing company designated as chair of the respective working group by the board. These groups mostly deal with the operational aspects of the SETU, the creation and the maintenance of specific standards. The SETU manifest explains:

SETU has short development cycles for the (further) development of standard message specifications, in which elaboration is tested in practice with feedback from practice to the working groups. (Manifest, Point 5)

The dynamics differ per working groups. In general, working groups consist of periodical meetings where invited participants discuss with each others and TNO staff their preferences for what should be included in the standard under study. Most of them are temporary and dissolve after their objec-

tive is met, making them a subtype of goal-oriented CNO: opportunity-grasping network according to Camarinha-Matos et al. (2009)'s definition in the Collaborative Network taxonomy. The current temporary working groups are: SETU 2.0., Equal Pay, and Planning & Scheduling.

At the moment, there are two permanent working groups. These fit the definition of continuous production driven network, since they are meant to provide a specific service for a long period of time. The current permanent working groups are: Trends & Developments and Adoption & Communication.

All interviewees have identified a nice, transparent working environment in these groups. Participants willing join the groups with a interest on the outcome. P5 thinks this is due to the fact that members send experts to these working groups and are passionate about the technologies under study in these collaborative groups. From a middleware perspective, P4 agrees that the environment is good:

P4: ...if it's a staffing company or software vendor, if they give commitment, they are committed. I never have complained about or no commitment while they were saying they committed. For every new subject or item on the SETU, anyone can sign in for those working groups. If partners or members of the SETU do that, they have something, they have some belief in it or something is in it for them, they feel. Same applies to us, so when we're on the SETU group sessions, the input is great, the collaboration is great. Everyone is open and transparent.

While satisfied with the working atmosphere, P6 thinks that the distribution on contributing to the standards is unbalanced. As a software company, they think that they flag most of the bugs in the standards. Their contribution improves the standards for all the community, yet they are the ones using their own resources to do so.

P6: ...but sometimes it [the progress of the working groups] takes a bit too long. Sometimes it is a bit one-sided. Right now, I would say like 70, 75% of the issues that get flagged are from us, meaning we are the ones involved moving the needle to get new changes. But how it gets done, I think it's legitimate. There's the [overview summary] board where everybody can see it [the flagged issues], and there's a structured way to go about those issues.

Additionally, P1 sometimes identifies some priority conflicts. Due to heterogeneity in the community, members have different priorities. For example, P1 mentions that some flex staffing companies have clients (hirers) with housing requirements. It is in their interest to include housing fields in the standards; however, the majority of members do not need that, so it tends to be discarded. Currently, TNO is studying "community standards", so these companies with specific requirements could develop specific unofficial standards between them. Furthermore, as working groups moderators, TNO staff notices stronger voices, but as moderators they make sure to deal with them such as *brain writing* (P3) and *consensus model* (P5). As P1 explains:

P1: ...I haven't seen any big conflicts. I also, I haven't seen really small conflicts. So in general, I would say that this collaboration is quite amicable. Even though they are mostly competitors with each other, they seem to be able to collaborate. The only thing we might see a small conflict is the conflict of priorities. That's because some issues can only be seen within certain staffing companies and which might be less relevant for other staffing companies.

Lastly, these working groups aim to address most of the issues emerging within them. They do this by a voting system across participants in the working group. If there is no consensus, TNO tries to develop a common proposal for the next meeting. If there is no consensus again, then TNO elevates the issue to the board. This is, in general, the conflict resolution mechanism. Notably, the board is composed solely of flex staffing agencies, whereas the working groups are more diverse. This means the final say could benefit flex staffing companies at the expense of other actors' interests. Hence, it is in the best interest of other actors to avoid involving the board.

Helpdesk

SETU operates a helpdesk via a Google Workspace discussion group. Questions are distributed among staff based on expertise. Questions that actually constitute change requests are redirected to the formal Semantic Treehouse issues channel. SETU uses the release policy as a passive mecha-

nism to combat free-riding. If someone approaches the helpdesk with a deprecated version, the service they provide is limited. They encourage adopting the latest standard.

Public Consultations

External actors to the community have an official opportunity to give their input to the standards. As P2 explains:

P2: *...They [non-members, externals] only have influence during the public consultation of a standard. So when a new standard or a new version of a standard is being released, what they're always doing is a one-month public consultation. So everybody outside the SETU can react on that, provide feedback. Then again, we'll be taken in by the working group to decide what to do with it. But that's their only moment in the sense to have some influence.*

HR XML international convention

HR XML conventions inspired the foundation on the SETU in 2007. Moreover, later TNO was tasked by [one of the largest staffing companies] to make sure international standards fulfilled The Netherlands' interests. However, some interviewees like P8 claimed it was not accomplished.

GitHub

GitHub serves as an important action arena within the SETU community, providing a central location where both members and non-members can access and download standards, report issues, and provide feedback. According to P6, who participates as a software provider, it is the community's primary platform. Formally, the platform is presented as a virtual space for discussion, knowledge sharing, and collaboration around SETU standards, API specifications, and best practices. In practice, however, the general discussion forum appears to see limited use. P6 indicated that feedback is commonly provided through GitHub issues tracking tool, while broader concerns and suggestions are often collected directly and communicated via email. This suggests that community interaction takes place primarily through issue tracking and alternative communication channels (e.g. email) rather than through the GitHub discussion forum itself.

5.3.2. Context: the institutional setting

SETU standards do not exist on their own. Like any commons, the SETU is nested in an institutional setting. This refers to the interdependencies of the SETU with international and national actors. On the one hand, they must comply with international standards while accurately representing the Dutch context. For example, SETU is a member of the HR XML, an organisation that standardises HR-related information. Hence its standards follow those. To some extent, SETU is the Dutch implementation of XML. Additionally, SETU standards can overlap others. This was the case with Google Jobs standards. Once that overlap was identified, the SETU board studied the situation and opted to recommend that members and non-members adhere to the Google Jobs.

On the other hand, SETU must take into account the national context. Since 2009, SETU is part of the "comply-or-explain" list (from the Dutch "Pas toe of leg uit") (Forum Standaardisatie, n.d.). This list includes all the standards public agencies and governments must follow as much as possible. If, for some reason, they are not able to follow them, they have to explain to the *Forum Standaardisatie* why. For SETU, being in the list provides them with status and relevance, especially in the government sector (P7). The standards SETU produces and updates are periodically evaluated by this regulatory body. As P2 explains:

P2: *...when you want to submit your standard to such a list from the Forum Standaardisatie, there is a whole testing procedure and a criteria procedure. Experts from Forum Standaardisatie will look at the standards while you submit to the list to ensure that you are indeed part of the list, to really evaluate whether this standard should be listed on the list.*

5.3.3. Membership

As stated before, the SETU community has three types of membership: *participants*, *subscribers*, and *donors*. Temporary staffing agencies and hirers can become participants by paying an annual contribution fixed to their turnover. In contrast, Software, middleware providers, and "other parties" can become subscribers. Lastly, Donors are essentially flexible financial supporters whose access is determined

ad hoc by the board. Below, Table 5.2 provides a summary of the possible roles entities can relate to when interacting with the SETU community.

Table 5.2: SETU community roles, rights, access levels, and membership fees.

Role	Description	Workgroup Access	Helpdesk	Change Requests	Board Eligibility	Membership Fee
Staff (<i>Medewerkers</i>)	Executes development and maintenance (TNO employees).	Full	Yes	Yes	No	N/A
Participants* (<i>Participanten</i>)	Staffing agencies and hirers.	Yes (Board approval)	Yes	Yes	Yes	Tiered by ABU membership and turnover: €1,329–€13,289 (ABU); €2,658–€5,317 (non-ABU). Cap: €33,223/holding/year.
Subscribers* (<i>Abonnees</i>)	Software vendors and other organisations.	By Board invitation	Yes	Yes	No	Fixed: €3,321/legal entity/year.
Donors**	Organisations providing financial support. Services decided case-by-case by the Board.	By Board decision	By Board decision	By Board decision	No	Min. €5,000/year.
Users (<i>Gebruikers</i>)	Anyone using the standards.	No	Yes, but limited	Via public consultation	No	None

* Cancellation in writing before 1 October; otherwise renewed for a full calendar year.
 ** Agreement ends immediately upon cancellation.

5.3.4. Degree of openness and control

The GKC framework identifies two levels of openness: (1) resource openness: how easy is to access the resources, (2) community openness: to what extent it is possible for an individual to contribute in an active role (not a mere user) to the community (Frischmann et al., 2014). The nature of the commons is highly relevant when analysing its degree of openness (Frischmann et al., 2014). For example, it is often hard to draw boundaries in nature-based commons, such as the ocean, due to its biophysical conditions. In contrast, knowledge commons such as the SETU, tend to be intangible and are not constrained by biophysical conditions. In these cases, it is the community that decides who can access the resource and contribute to the community (Frischmann et al., 2014). In this subsection, we discuss the two degrees of openness in the SETU.

At the resource level, the SETU community is known to be open, having open-access resources. The SETU standards are open by decision of the community. Since its foundation in 2007, its board has decided to keep the SETU standards open and royalty-free. Nonetheless, the SETU also deliberately limits the access to other resources such as the helpdesk facilitated by TNO for the implementation of standards, the tacit information members have by collaborating, the newsletter only available for participants or subscribers with the latest information, and the knowledge shared in the working groups. While these may not appear directly limited, they are valuable assets of the community whose access is most of the times implicitly limited.

At the community level, there are several ways to contribute to the resource, although not all provide the same degree of influence. As P2 explains, all users can freely contribute through the periodic public consultations SETU organises when launching a new or updated standard. In addition, since most of the standards and technical artefacts are accessible via GitHub, both members and non-members can flag bugs or leave comments. P6 considers Github the main platform for member and non-members.

. The diversity of channels show that SETU provides opportunities for feedback beyond formal membership. Nonetheless, the largest action arenas, where most of the material outcomes emerge, are the working groups. Access to these groups is limited to members and participation must be approved by the SETU board. Throughout the interviews, it becomes visible that openness may differ per working group. Some working groups are closely linked to the maintenance or update of existing standards and therefore attract members that already see a direct operational value in participating. Exploratory working groups work differently. Since their value is not always clear for members at the beginning, they tend to require more active promotion and selection. In this context, TNO, as a research institute and lead of the Trends & Development working group, carries out management role together with the SETU board. As a board member, P9 explains that TNO tends to approach and forward an invitation to members that they consider may benefit from, or contribute to, the technology under study. However, P9 also notes that a fewer number of the original invited parties usually end up participating.

P9: I think they [TNO] just made suggestions based on their experience, what companies would be willing to collaborate and would be big enough and are active participants now of SETU working groups ...And I guess they asked more companies than eventually really participated.

This dynamic became visible in the exploratory working group on data spaces technology for SETU. TNO proposed the technology and, together with the board, developed a demo around the equal pay use case. Upcoming Dutch regulation requires flex workers to receive comparable pay and benefits to employees hired directly by client organisations, including salary, vacation, pension, and mobility-related benefits. Staffing agencies therefore need access to relevant employment conditions from hirers. However, this information is sensitive because it concerns how hirers attract and retain personnel. Data spaces could offer a safer exchange mechanism by allowing staffing companies to request access while hirers grant it selectively and with limited administrative effort. The case therefore illustrates the dual character of openness in SETU: while the standards and feedback channels remain broadly accessible, participation in the arenas where emerging technologies are explored is more actively mediated by TNO and the SETU board.

5.4. Patterns & Outcomes

According to the GKC scholars, the outcomes of knowledge commons will typically be two-fold: (1) an *"intellectual or knowledge-related output"* and (2) social patterns as a result of the governance in the action arenas (Frischmann et al., 2014, pp. 35–36).

In the case of the SETU foundation the intellectual output is the SETU standards. Although earlier we examined them as resources that define community attributes, here we consider them as the product of the community's collective effort. In other words, the standards are both input and output of the knowledge commons. Once created, they reinforce the identity of the community and guide its practices. For example, the first standard of SETU, the timecard, has become a founding cornerstone of the community. If its use were to decline significantly it could potentially impact how the community operates; perhaps members might call for changes or consider even whether to discontinue the standard altogether.

Assessing the second kind of outcome is less direct. In the GKC framework, as in the IAD framework it builds on, evaluating the social patterns that emerge from the action arenas requires an additional *"normative yardstick"* supplied by the researcher (Sanfilippo et al., 2018, p. 124). This is by design: the GKC offers a way of working that applies across a wide range of topics precisely because it does not carry a normative assessment of any particular one (Frischmann et al., 2014). The yardstick adopted in this thesis is interoperability, operationalised through the European Interoperability Framework (EIF) (European Commission & Directorate-General for Digital Services, 2017) introduced in chapter 2. The remainder of this section evaluates how the SETU community performs along the EIF's four dimensions of interoperability: organizational, semantic, technical, and legal. Table 5.3 summarises the findings, which are then discussed in turn.

Table 5.3: Summary of SETU findings through the combined GKC and EIF lenses.

EIF dimension	Main SETU finding	GKC interpretation
Organisational interoperability	Business process alignment remains limited. SETU initially replaced fax-based exchanges with XML messaging without fundamentally changing organisational processes. Deeper process alignment remains sensitive because it affects costs, benefits, and client relationships.	The action arenas enable coordination, but rules-in-use are shaped by actor interests, market power, and dependence on clients. Larger staffing agencies can impose standards more easily than smaller agencies.
Semantic interoperability	SETU's strongest achievement is the development of a shared sector-specific language around staffing processes, messages, and data fields.	The community collectively produces and maintains shared meanings as a knowledge resource. The standards are both outputs of the commons and inputs for future collaboration.
Technical interoperability	SETU provides technical standards and implementation guidance, but actual implementation remains decentralised and often depends on software and middleware providers.	The commons does not fully internalise implementation capacity. Complementary actors mediate between the shared standard and heterogeneous organisational systems.
Legal interoperability	New SETU activities are increasingly driven by regulation, such as equal pay and licensing-related developments. Legal implementation remains uncertain because public authorities and sector actors may interpret requirements differently.	External institutional conditions shape the community's agenda. Regulation acts as an external shock that creates new action situations and mobilises participation.
Interoperability governance	SETU Standard for invoicing had to be adapted to the norm one year after the first release.	SETU is heavily dependent on the institutional setting. The decisions made in external action arenas such as the European Standardisation body impacts the output of the SETU standards. This signs a trade-off between autonomy vs. compliance.

Organisational interoperability

In practice, organisational interoperability requires the alignment of business processes (European Commission & Directorate-General for Digital Services, 2017). Achieving such alignment requires organisations to disclose and coordinate parts of their internal operations, making organisational interoperability dependent on trust and institutional arrangements. The interviews revealed that this sensitivity has shaped SETU's approach from the beginning. Originally, the TNO team was not allowed to change the processes of the participating organisations. Instead, they had to replicate the existing fax-based process and replace only the communication technology with XML. Although this approach was recognised as inefficient, P7 explained that organisational interoperability was considered too sensitive to be pursued at that stage.

P7: ...During our first assignment we're not allowed to change the business process. It

should be the same process that they used with the fax, but then replacing the fax for XML messaging. Later on, we were also allowed to change a little bit the process. But the process itself was always very tricky because that really affected also the costs and benefits of each organization. ...changing process is much more complicated than replacing the same process with a technical new feature, in this case, the external messaging.

While some process agreements have been achieved over time, the alignment of business processes remains limited. The interviews suggest that organisations differ in their willingness and ability to commit to further standardisation. This appears to be linked to organisational size and market power. Larger staffing agencies generally benefit more from standardisation. They have greater technical and financial resources to implement standards and can more easily absorb the costs of compliance. Because they process higher transaction volumes, standards also generate larger efficiency gains. Smaller agencies, in contrast, often perceive compliance as a burden rather than a benefit. As P4 explains, many smaller firms lack the resources to implement standards themselves and depend largely on the capabilities of their software vendors:

P4: ...everything beyond top 10 [in the flex staffing industry], may even not have the means or the capacity or the resources in which terms of money or people or whatsoever to comply with those standards. So they just rely on the software vendors....They just use a generic front-office tooling. And that front-office tooling will never say: "okay, well, let's do SETU!". There is no any benefit for them. And there is not for the smaller recruitment company.

The interviews also indicate that market power influences the extent to which organisations can promote standardised ways of working. Staffing agencies ultimately depend on hirers, who are often less interested in the standards themselves than in the service outcome. As a result, hirers may resist adapting their own processes to accommodate new standards. While large staffing agencies are often able to persuade clients to adopt agreed standards, smaller agencies have less leverage and remain more dependent on client-specific requirements. As P8 notes:

P8: We are generally the same except for [a large staffing company]. Because it is capable of telling customers, "hey, this is the way you have to do it" and I can only try to sell it.

The consequences of this asymmetry can be observed in the aforementioned transition to SETU Invoicing 2.0. Although the update was required by developments in the wider standardisation ecosystem, many hirers saw little direct benefit because it required changes to their existing processes for reasons external to their business operations. As a result, the migration has progressed slowly and many organisations continue to operate on the older SETU Invoicing 1.4 standard.

These findings suggest commitment to organisational interoperability is not solely determined by the perceived value of standards. It is also shaped by organisations' resources, market position, and ability to influence the business processes of their clients.

Semantic Interoperability

Semantic interoperability concerns preserving the meaning of exchanged information so that all parties interpret data consistently (European Commission & Directorate-General for Digital Services, 2017). Within SETU, this involves agreeing on common definitions, concepts, and data structures that can be understood across organisations.

The interviews suggest that semantic interoperability has been the strongest interoperability dimension within SETU. Unlike organisational interoperability, discussions about data definitions and message contents were generally considered less sensitive, making participants more willing to engage in standardisation efforts from the outset. Nevertheless, opinions differed regarding the level of detail that should be prescribed by the standard. P8 recalls that discussions, particularly during the early years of SETU, often focused on highly specific semantic details and questioned whether such decisions should be determined collectively at all. In his view, the standard could have imposed more of these choices directly instead of democratising them. P7, in contrast, argued that allowing alternative interpretations and implementations was necessary to encourage adoption, especially during the early stages of SETU when organisations were still hesitant to commit to the standard. These differing perspectives reflect a trade-off between semantic precision and adoption. While stricter definitions can improve consistency,

greater flexibility may increase the willingness of organisations to participate in the standardisation process.

One of the most remarkable achievements of the SETU community is the creation of the "SETU language". Contributing members over the years have developed a tacit and formal sharing understanding of what they are talking about. P4 notes that at the beginning the formal agreement on terms did not translate in tacit sharing understanding. After agreeing on something, its implementation was still subject to interpretation. One of the changed methods is from large PDFs to building blocks that are easier to implement. This also allowed for more adoption, since partial adoption is possible.

Technical interoperability

Technical interoperability concerns the technical components that enable information systems to exchange and process data (European Commission & Directorate-General for Digital Services, 2017). This includes elements such as interface specifications, data integration services, data exchange mechanisms, and communication protocols (European Commission & Directorate-General for Digital Services, 2017). Within SETU, technical interoperability is achieved by defining standardised messages and data structures, while leaving the technical implementation to the participating organisations.

One of SETU's main objectives was to reduce transaction costs by standardising information exchange. However, the interviews revealed that this division of responsibilities has created a distinct role for software vendors and middleware providers. P7 recalled that, in the early days of SETU, one of the largest staffing companies aimed to reduce its dependence on software intermediaries by implementing the standards in-house. However, while large organisations often possess the financial and technical resources required to develop and maintain such integrations, many smaller staffing agencies do not. As a result, a market emerged for specialised software and middleware providers that facilitate the implementation of SETU standards.

From the perspective of these providers, standards reduce complexity but do not eliminate the need for integration services. P4 explains that complete standardisation is rarely achieved in practice and that organisations continue to require support in connecting SETU with other standards and proprietary systems:

P4: Full adoption of a standard is rarely achievable in practice. Therefore, I view SETU's move towards flexible, reusable building blocks as a positive development. Even with strong standards, there will remain a need to bridge between SETU and other standards or proprietary implementations. This interoperability gap is precisely where organisations such as ours can add value.

A recurring challenge is that staffing organisations typically operate multiple software systems, each serving a different purpose. These systems are usually not specific to the staffing sector, nor they follow SETU.

P4: ...a staffing company may use an ATS, a planning tool, and an ERP system. All these systems need employee and organisation data, and this data needs to be synchronised consistently. That is where our Connector [a Company Y's data integration platform] comes in: we connect those systems and integrate the data in a stable and consistent way. Of course, we also leverage SETU if the systems support it. However, in many cases, especially on the front-office side of the staffing industry, there is not much adherence to the SETU standard. SETU is used more classically on the mid-office and back-office side, for transaction processes such as timecards and invoices, where the data needs to be fixed and cannot easily be changed. ...There is therefore no reason for Salesforce to fully comply with the SETU standard, because SETU is too niche for them. For that reason, we often need to connect different kinds of standards with each other, including SETU. We leverage SETU especially for semantics and best practices: how a process should flow in this sector, and whether we can use the standards developed within our specific branch.

The interviews suggest that SETU provides a common basis for data exchange, organisations continue to rely on software vendors and middleware providers to integrate diverse systems and bridge the remaining interoperability gaps. In this way, SETU reduces transaction costs associated with information exchange, but it does not eliminate the need for intermediaries that operationalise the standard

in practice.

Legal interoperability

Legal interoperability concerns enabling organisations operating under different legal frameworks, policies, and obligations to work together (European Commission & Directorate-General for Digital Services, 2017). In the context of SETU, this involves developing standards that help organisations comply with evolving regulatory requirements while maintaining interoperability across the sector.

The interviews suggest that legal interoperability has become an increasingly important driver of standardisation activities. Several interviewees noted that new standards are increasingly regulation-driven, meaning that they emerge in anticipation of, or in response to, upcoming legislation. In this context, SETU members seek to establish common approaches to legal implementation before regulations come into force by developing standards that support compliance across the sector.

However, it remains difficult to assess the effectiveness of recently developed standards. Although regulatory requirements may be known, the way public administrations will implement and enforce these regulations is often still unclear. Consequently, organisations face uncertainty regarding whether the standards being developed today will fully satisfy future compliance needs. Despite this uncertainty, legal interoperability appears to have become an important source of engagement within the community. Emerging regulatory developments have stimulated discussion and attracted contributions from organisations that were previously less involved in SETU activities. This was the case in the Planning & Scheduling and the Equity Pay working groups.

This suggests that legal interoperability is increasingly motivating collective action, as organisations recognise the benefits of coordinating their response to common regulatory challenges.

Interoperability governance

Interoperability governance concerns the institutional arrangements, organisational structures, decision-making processes, roles, responsibilities, and policies used to establish and maintain interoperability (European Commission & Directorate-General for Digital Services, 2017). The interviews suggest that SETU's governance is characterised by several trade-offs that emerge when translating the principles stated in its statutes and manifest into practice.

A first trade-off concerns autonomy and external influence. While SETU aims to develop standards for the Dutch flex staffing sector, its activities are increasingly shaped by developments in the wider standardisation and regulatory ecosystem. Several interviewees noted that recent standards have emerged in response to evolving European regulations and external standardisation initiatives. As a result, SETU not only needs to coordinate stakeholders within its own community, but also monitor and respond to developments originating outside the sector. This creates a governance challenge in which SETU seeks to proactively influence how external requirements are translated into the staffing sector while remaining dependent on decisions made by other standardisation and regulatory bodies.

A second trade-off relates to the pursuit of open interoperability while accommodating the strategic interests of participating organisations. SETU's statutes emphasise interoperability and non-competition, yet interviewees noted that organisations naturally participate in ways that reflect their own business interests. P4 notes that while SETU aims to develop open standards for the broader ecosystem, participants may naturally approach proposals from the context of their platforms and customers. Where participants have aligned interests, some viewpoints may be represented more prominently in the decision-making process. Similarly, P7 recalls observations from one of the company members on interoperability in SETU. These reflections, shared in an informal context, date back to the early days of SETU, so it is not possible to verify whether the company's perspective has remained unchanged since then.

P7: I still recall a story that I had with the boss of [a large staffing company], and he said to me, "P7, well, nowadays, I'm convinced about this interoperability, but you always talk about your standards. But 80 to 90% interoperability is, in my opinion, good enough. So let's standardise 80 to 90%, and we can create a little bit of lock-in in that final 5%. Not that we need this big project of millions to get these systems connected, but still we need this 5% of tweaking, the standard tweaking, the implementations that feel a little bit of locking. If they really want, they can move, but still it's not like, okay, plug-and-play and replace it

with another vendor.”

This example illustrates that support for interoperability may coexist with the desire to preserve some degree of differentiation between organisations. A third trade-off concerns transparency and participation. Transparency is one of SETU's stated principles, yet some interviewees indicated that they have limited insight into how strategic priorities are determined by the board. P6 reported being unaware of how the board decides on its goals, while P8 remarked:

P8: “I don’t, they don’t inform us that much [...] I think I have to join the board as well, but I’m not going to do that.”

These accounts suggest that understanding governance processes may depend in part on the degree of participation within the community.

Finally, the interviews revealed a trade-off between stability and adaptability. SETU's manifest emphasises both robust and reliable standards as well as flexibility and extensibility. In practice, achieving both objectives simultaneously can be challenging. For example, interviewees noted that the Equity Pay standard required a substantial revision from version 1.0 to version 2.0 after shortcomings became apparent in practice. Likewise, the transition to SETU Invoicing 2.0 demonstrates how external developments in the broader standardisation and regulatory landscape can necessitate changes to existing standards. At the same time, P4, P6, and P8 each characterised the standardisation process as relatively slow. Although discussions themselves may progress efficiently, reaching consensus depends on participants who contribute alongside their regular organisational responsibilities.

Taken together, these findings suggest that interoperability governance within SETU involves balancing competing objectives rather than pursuing a single governance principle in isolation. Governance activities must accommodate different stakeholder interests, levels of participation, and external developments while maintaining sufficient alignment to develop and sustain common standards.

5.5. Synthesis of SQ 3

This chapter answers the third subquestion:

What does the chosen framework reveal about how the SETU community has managed its institutional arrangements to achieve interoperability?

The case study of SETU, examined through the combined lens of the Governing the Knowledge Commons (GKC) framework and the European Interoperability Framework (EIF) and supported by structured interviews, revealed two main things: (1) it demonstrates the application of the GKC framework and the decision tree from Chapter 3 to the study of Collaborative Network Organisations (CNOs), and (2) it shows that progress in SETU differs across the interoperability layers, because the institutional arrangements the community has developed have advanced some layers further and faster than others.

Viewed through the EIF, the founding motivation for SETU was semantic interoperability, and this layer is now one of the most developed within the community. In contrast, organisational interoperability was originally avoided because the members considered the sharing of business processes too sensitive. Within the technical layer, the arrangements adapted as members reported implementation barriers, eventually supporting partial adoption by providing the standards as building blocks. The trade-off was uneven implementation and a heavier reliance on software and middleware providers. Legal interoperability has recently become a very active layer, because forthcoming regulations are an increasingly important driver of collective action within the community. Lastly, the findings show that SETU's interoperability governance cannot be understood without its broader institutional context. While a large part of the decision-making happens in internal action arenas, such as the working groups, SETU is also subject to external action arenas, such as European standardisation bodies. SETU, together with TNO, does not merely react to these developments; it also actively seeks to influence European standardisation processes, so that the needs of the Dutch flex-staffing sector are represented.

In the next chapter, the aforementioned results are interpreted and translated into guidelines to conduct future research.

Discussion & Guidelines Design

The SETU case study conducted in the Chapter 5 showcases the applicability of the decision tree (see Chapter 3) for framework selection and the suitability of the Governing the Knowledge Commons (GKC) Framework for the study of CNOs. This chapter interprets the aforementioned results, translating them into operational guidelines. It answers the last subquestion:

Subquestion 4

Which guidelines can be developed to analyse the interoperability governance in CNOs?

The chapter is structured in the following way: it first narrates the implications of the findings for interoperability. Next, it reflects on two observations about the institutional arrangements of SETU. Then, it explains the strengths and weaknesses of the GKC to study CNOs. These lessons converge in a set of guidelines aimed at consultants who consider studying interoperability in other CNOs with the commons scholarship.

6.1. Implications on Interoperability

The Governing the Knowledge Commons (GKC) framework does not provide a normative metric. Instead, it is the role of the researcher to provide the *normative yardstick* (Sanfilippo et al., 2018, p. 124) to evaluate the case under study. As stated many times in this thesis, we evaluate the interoperability of Collaborative Network Organisations. In chapter 5, we concluded by describing patterns of the SETU's action arenas and linked them to the interoperability dimensions. In this section, we interpret these results and their meaning for interoperability governance.

Interoperability is multidimensional

The SETU case demonstrates that willingness to be interoperable does not necessarily mean willingness to tackle all interoperability dimensions proposed by the European Interoperable Framework (European Commission & Directorate-General for Digital Services, 2017). Notably, during the early phases, members were motivated to join to achieve semantic interoperability. However, there was resistance to aligning business processes to increase organisational interoperability. This is a surprising finding given that according to CNO literature this is one of the strongest points of CNOs (Camarinha-Matos et al., 2009, 2019; Durugbo, 2016). Organisational interoperability was tackled years later because changes in business processes redistribute costs and responsibilities within actors' own structures. Organisational interoperability is more sensitive and may require a higher level of trust between parties than other dimensions. Moreover, the development of a shared language by Collaborative Network Organisations (CNOs) through repeated interactions demonstrates that semantic interoperability can be conceptualised as an outcome of the knowledge commons. These shared definitions are collectively produced, maintained, and revised over time. However, achieving semantic interoperability requires more than formal definitions; it also depends on tacit shared understanding, explicit agreement in implementation, and ongoing interaction among members.

Strategies for interoperability governance; Trade-off between broader adoption and fragmentation

Decentralised implementation can result in the emergence of new middleman roles responsible for translating the agreed knowledge commons into practice. This challenges the assumption that voluntary standardisation always reduces transaction costs; while some costs are reduced, new implementation dependencies may arise. The SETU case demonstrates that standardisation does not necessarily eliminate all intermediation. SETU's evolution from PDF manuals to modular building blocks indicates that permitting partial adoption can serve as a deliberate interoperability governance strategy when broader adoption is sought. Instead of enforcing full compliance, the community prioritises wider adoption and aims for incremental engagement. Additionally, SETU delegates implementation decisions to its members, thereby providing greater flexibility.

Adapting EIF's legal interoperability term to CNOs from one country

The concept of legal interoperability in the European Interoperability Framework has a different meaning when applied to CNOs from a single country. The EIF works on interoperability among public administrations across member states with more than one legal system. Hence, being in a single, unique legal framework, as many one-country CNOs are, is not a given in the EIF. Nonetheless, this does not mean the legal landscape is less relevant in these CNOs. In a business-driven setting like the CNOs studied in this thesis, legal implementation motivates collaboration and membership. For instance, in SETU, the community is developing standards in response to expected or emerging regulations. This regulation-driven approach has led additional actors to engage with the standards and join the CNO.

6.2. Observations from the SETU case study

During the study of SETU, two dynamics emerged that go beyond the framework itself. They are specific to this case and cannot be generalised to all CNOs. Still, we present them here because they informed the guidelines in the next section, and because we recommend that future analysts watch for similar patterns.

Background diversity at member-level

Diversity of entities may not translate into diversity of active profiles within CNOs. In SETU, entities have sent more technical profiles to the action arenas (especially the working groups) over the years. This technical composition of the working groups may strengthen the technical quality of the intellectual output. However, it may also weaken the alignment with operational business practices. CNOs should be aware of the risk that the person participating on behalf of the company becomes detached from the company itself. When the community has a more technical composition, its outputs in the action arena may converge towards results that are distant from the internal discussions of the respective companies. This may create extra effort to onboard the senior management of an entity that already belongs to the CNO.

Member heterogeneity & effects of an uneven playing field

The GKC proved very useful to determine motivation and commitment in the community under study. It showed that organisational interoperability cannot be understood separately from the attributes of the community and its power asymmetries. The SETU case showed that commitment to the further development of the main intellectual output (standards) could be correlated with the market power of the actors. For instance, larger temporary staffing agencies can benefit more by lowering their transaction costs through the adoption of the standards. They can also impose those standards on their clients. In contrast, smaller companies carry more burden from the same standards, because they did not have such high transaction costs to begin with.

6.3. Strengths of GKC as a framework for CNOs

During the application of the GKC to SETU, three aspects were particularly valuable for understanding the institutional arrangements of this CNO. First, one of the most valuable contributions of applying a commons perspective to SETU was that it forced a careful reconsideration of what the shared resource actually is. This is not a trivial question, and it is hardly asked in business or technically oriented analyses. In the case of SETU, the ambiguity surrounding the resource required a deeper examination of what is actually being developed, maintained, and governed by the community. In collaborative

networked organisations (CNOs), the resource is not always a clearly bounded common-pool resource that naturally determines collective action as the most appropriate governance form. Instead, collective governance may emerge around something that actors decide to govern together because of a shared strategic or operational goal. This insight is particularly relevant for goal-oriented CNOs, where collective action may not arise from resource scarcity or rivalry, but from the need to align actors, coordinate systems, and sustain a shared infrastructure over time. This paradigm is proposed by the Governing the Knowledge Commons framework (Frischmann et al., 2014). Rather than treating the standard as a static and exogenous artefact, this framework allowed to study SETU's commons as a broader set of knowledge resources, institutional arrangements, practices, relationships, and expectations that enable interoperability in the flexible staffing sector. These are outputs of the community that feed back into it over time.

Second, the GKC proved useful to determine the degree of openness of the SETU community. Initially, we understood that SETU was an open community because it produces open standards. This means openness was interpreted as unidimensional. In contrast, GKC proposes two dimensions: access to the resource and the possibility to contribute to the resource. The SETU case proved that adhering to the definition of openness in the aforementioned sense does not automatically translate into openness in the latter. SETU decides its output is open access, yet the possibility to contribute to that resource is deliberately constrained to its members. Similarly, BOMOS accounts for several dimensions regarding openness ("BOMOS: Elaboration 3.0.1", n.d.).

Third, the definition of action arenas by the commons literature helped identify more critical places and interactions in the decision-making of SETU than expected. Based on the formal documentation of the SETU, one identifies the SETU board and the several working groups as action arenas, where different sets of actors repeatedly interact, and as a result, patterns and outcomes emerge. Nonetheless, the broad definition of the action arena led to the identification of the helpdesk and public consultations as one. Additionally, we discovered that the social network of SETU interacts heavily outside the community as well. While this is not inside the community, their conversations eventually influence it.

6.4. Weaknesses of GKC to study CNOs

Several aspects of the framework had to be adapted for this case study.

- GKC is useful for identifying institutional arrangements, but it needs an evaluative framework to assess a specific outcome such as interoperability.
- Legal scholars developed the GKC. Many of its examples concern Intellectual Property, which applies to SETU and was mentioned, but it is not the main focus of SETU nor its study as a commons.
- The representative research questions tend to rely on previous knowledge of the commons. These were adapted to get valuable insights from interviewees. Therefore, the original questions were simplified, converted to open-ended prompts, and used in a semi-structured interview style. This way, information for each category was gathered not only through direct questions but also through answers to other related questions.

This case study showed that the GKC framework is suitable for the study of CNOs and can be adapted for evaluating the interoperability with the European Interoperability Framework. In the next section we discuss a set of guidelines to replicate the adaptation of the GKC taking into account the aforementioned pros and cons.

6.5. Development of design guidelines

To replicate the study carried out in this thesis, this section provides three guideline tools to assist TNO consultants to make informed decisions when studying the institutional arrangements of a CNO in the context of interoperability. We first remind the reader of the decision tree developed in Chapter 3 for the selection of a commons framework. Then, we present a seven-step guide for applying the GKC framework to studying interoperability in CNOs. Finally, we provide a checklist of topics to cover in the analysis.

6.5.1. Decision Tree

The decision tree deliverable is meant to assess whether the commons analysis is suitable at all and, if so, to scope down the suitable frameworks. In addition, it helps the user to assess which type of CN is the one studied according to the Camarinha-Matos et al. (2009) taxonomy.

The two minimum requirements for a Collaborative Network to be suitable to be studied by the commons scholarship are that (1) it has a formal organisational structure (e.g. statutes) and (2) the collaboration has persisted for some time so that there is enough data to later identify emerging patterns out of the interactions between and within participants and institutions. Next, the interpretation of how the resource is subtractable makes each CNO case lean more towards a specific framework. Chapter 2 illustrates the decision tree in Figure 3.5. The Methodology Chapter exemplifies how to use it by applying it to the SETU case in Figure 4.1.

6.5.2. GKC Guidelines

The GKC guidelines deliverable provides seven steps to apply the Governing the Knowledge Commons (GKC) framework. While it may be specific to GKC, it also applies to other frameworks if they are question-based. For example, Hess and Ostrom (2007a, Chapter 3) provides guiding questions in prose when presenting the categories of their adapted IAD framework to knowledge. Hence, the following guidelines could be used by changing the first step to the other set of questions.

The guidelines presented in Figure 6.1 consist of eight steps. First, researchers should become familiar with the representative research questions provided by the GKC scholars. These questions are listed in Table 3.2. Next, the CNO under study may have publicly available information regarding its organisational structure and/or recent developments. This information may already answer several questions from the GKC table. Once the existing information has been assessed, the remaining unanswered questions will form part of the interview topic guide. At this stage, it is encouraged to customise these questions to ensure interviewees are engaged. As stated in previous sections, the GKC must be adapted for a non-academic audience. Because interviewees are unlikely to be familiar with common scholarship or the GKC, the remaining questions should be adapted to use the interviewees' vocabulary. Given that the researcher has done some grey literature research, it will be easier to identify which terms interviewees are more familiar with. The next step is to consider the order of the questions. Although Table 3.2 presents them in categories, this structure may not be ideal for a natural conversation. The semi-structured interview should feel as natural as possible, starting with open questions and then moving to more specific ones (Edwards & Holland, 2015).

Before reaching out to potential interviewees, it is advisable to develop a data management plan and ethical guidelines. Interviewee candidates must be informed of the research objective so they can address the sensitivity of their statements. Additionally, the interviewees should always have the right to withdraw if desired.

After conducting the interviews, researchers could use qualitative coding software (e.g., ATLAS.ti). The codes should be the GKC categories and the interoperability dimensions. In Appendix C, we provide the Codebook developed for the SETU case study as an example.

Finally, by analysing these codes, researchers should generate a descriptive analysis for each category. It is recommended to ensure all relevant topics are covered, as outlined in the final guideline tool: the checklist.

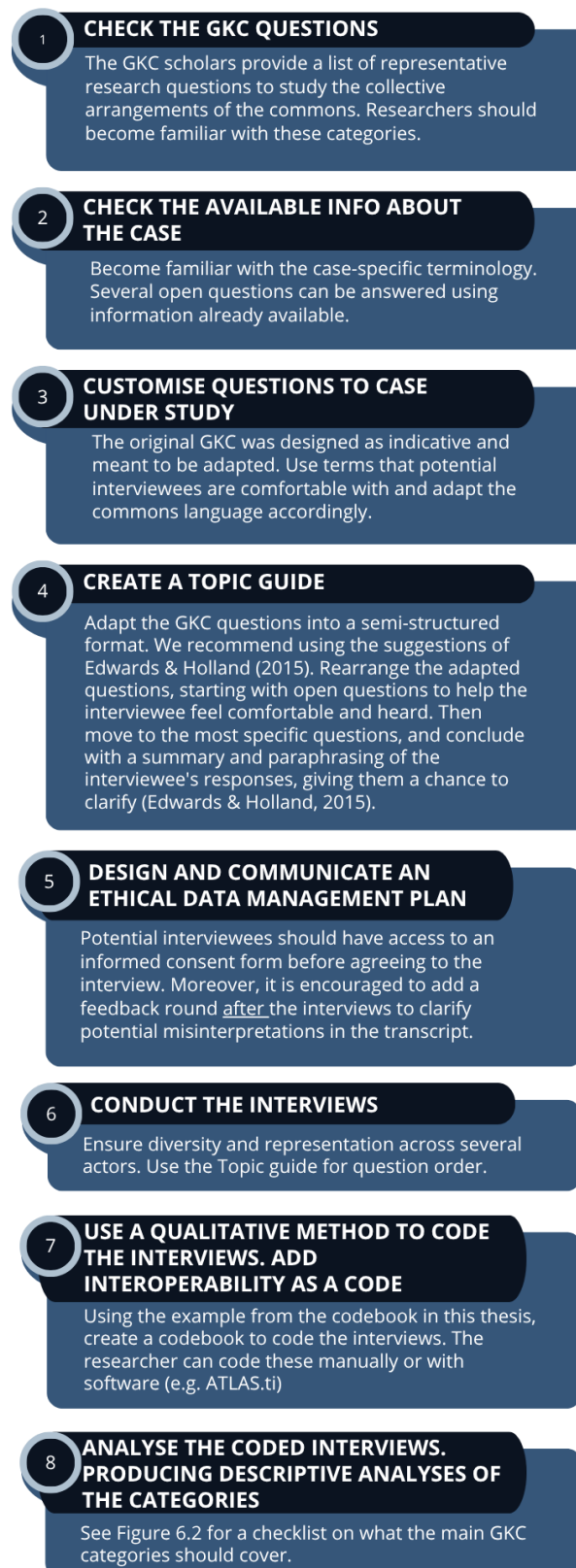


Figure 6.1: Guidelines for the application of the GKC framework for CNOs. Elaborated by author.

6.5.3. Checklist

Lastly, we provide a checklist for researchers to cover the main topics. The checklist is structured in the main categories of the GKC, which the Results chapter is also structured in. Inside each box there is a mix of tasks, key questions and subcategories to analyse. The idea of this instrument is to facilitate the readability of the GKC framework in Frischmann et al. (2014), helping the consultant to identify quickly the strongest areas of the framework and overcome the hurdles mentioned in the previous section. These highlighted categories are also useful later to identify emerging patterns & outcomes in a similar way to in the last section of Chapter 5. In the last check, we add some questions intended to be food for thought while conducting the analysis. They come from aforementioned observations in the previous section that have emerged during the study of SETU. While it is not possible to generalise for all CNOs based on a single case study, we recommend keeping an eye on these and similar dynamics. The checklist is presented in Figure 6.2 together with the aforementioned guidelines.

BACKGROUND ENVIRONMENT

- ☒ REQUIRED KNOWLEDGE, SKILLS & TECHNOLOGY (RESOURCES)

ATTRIBUTES OF THE COMMUNITY

- ☒ WHICH RESOURCES ARE IN-HOUSE RESOURCES. WHICH RESOURCES ARE OUTSOURCED?
- ☐ WHO ARE THE COMMUNITY MEMBERS
- ☐ ESTABLISHED GOALS & OBJECTIVES
- ☐ COMPARE NARRATIVES ABOUT THE HISTORY & EVOLUTION OF THE CNO FROM ALL INTERVIEWEES

GOVERNANCE

- ☐ FORMAL ORGANISATIONAL STRUCTURE
- ☐ ACTION ARENAS:
 - are there also informal ones?
- ☐ INSTITUTIONAL SETTING:
 - how are the knowledge commons and the CNO dependent on other entities and communities?
- ☐ HOW CAN A PARTY BECOME A MEMBER? ARE THERE DIFFERENT TYPES OF MEMBERSHIP?
- ☐ DEGREE OF OPENNESS
 - Resource access; to what extent can a party access the resource
 - Contributor access; to what extent can a party contribute to the resource

PATTERNS & OUTCOMES

- ☒ PREVIOUSLY CHOSEN EVALUATIVE CRITERIA
- ☐ IDENTIFY EMERGING PATTERNS OUT OF THE ACTION ARENAS
- ☐ WHAT DOES THE CNO PRODUCE? DOES IT FEED BACK INTO THE COMMUNITY ATTRIBUTES?
- ☐ REFLECT ON:
 - How does each party benefit from the resource? Is there an equal distribution of the benefits?
 - Is there a correlation between the market power and leadership in the CNO?
 - Is there a dominant background education across the active individual members? If so, does it affect the output?

Figure 6.2: Checklist with the main topics to be covered in the analysis. Elaborated by author.

6.6. Synthesis of SQ4

This chapter answers the last subquestion:

Which guidelines can be developed to analyse the interoperability governance in CNOs?

As discussed in Chapter 3, several frameworks from the commons scholarship are suitable for the study of CNOs. However, they do not address interoperability governance on their own, so they must be adapted. Because this adaptation is not trivial, consultants at TNO and other entities can benefit from guidelines that present the commons frameworks and their add-ons for studying interoperability in operational steps. To achieve this, this thesis provides four deliverables across its chapters. First, a decision tree assesses whether the commons analysis is suitable for the CN under study and maps it onto Camarinha-Matos et al. (2019)'s taxonomy to support framework selection. Second, the set of seven guidelines applies the selected framework. While this deliverable is specific to Frischmann et al. (2014)'s GKC, it can also serve as a reference for other question-based frameworks such as Hess and Ostrom (2007a). Third, the checklist ensures the analysis covers the GKC framework categories, which can later be related to the EIF's governance dimensions in the Patterns & Outcomes category. Together, these deliverables give consultants a structured methodology for studying how interoperability is governed. These deliverables bridge CNOs and commons literature in the context of interoperability, as an operational method.

Conclusion and Recommendations

This thesis explored the suitability of commons scholarship frameworks for the study of organisational collaboration and interoperability. This final chapter recalls the answers to the questions discussed before. These build up to the final answer to the main research question. The chapter continues with academic and social relevance, the limitations of this research, the final recommendations, future research, and the link to the Engineering and Policy Analysis (EPA) programme.

7.1. Answer to the subquestions

Subquestion 1

How do Collaborative Network organisations (CNOs) achieve and govern interoperability across organisational boundaries?

Interoperability is a multi-layered capability that covers the legal, organisational, semantic, technical, and governance dimensions (European Commission & Directorate-General for Digital Services, 2017). The desk analysis revealed that CNOs have historically addressed these dimensions in isolation. Most CNOs have developed organisational and semantic interoperability to some extent: they agree on common principles, formalise their structure, and, in some cases, adopt a shared language and shared standards, whose maintenance is guided by governance models such as the Dutch BOMOS (Folmer, 2025). However, interoperability is not only a technical problem: as socio-technical systems, CNOs pursue value creation for society, so their design ultimately rests on human decision-making and governance (Camarinha-Matos, 2026). The CN discipline still lacks a systematic framework for governing these institutional and community arrangements, which is why further research is needed.

Subquestion 2

Which frameworks in the commons scholarship are most suitable for studying interoperability governance in CNOs?

The selection of a commons framework for the study of CNOs should consider at least three main criteria: whether the CNO meets two minimal conditions, whether the common resource precedes the CNO, and the type of subtractability the common resource is subject to. First, the desk analysis identified two minimal conditions that a CNO must meet for a commons study to be suitable: (1) a deliberate organisational structure, and (2) a collaboration that persists over a significant period of time, so that there is room for the repeated interactions that create action arenas. The CNO classes that comply with these features are *long-term strategic networks* and *continuous production-driven networks*. Second, if the CNO creates the resource, then Frischmann et al. (2014)'s GKC framework may be most suitable. If the resource pre-exists, then Hess and Ostrom (2007a)'s knowledge commons, Purtova and van Maanen (2024)'s data commons, or the original IAD framework by E. Ostrom (1990) become candidates. The choice between these three mostly depends on the definition of subtractability,

which is the third differentiating criterion across frameworks. This thesis consolidates these criteria in a comparison table and a decision tree.

Subquestion 3

What does the chosen framework reveal about how the SETU community has managed its institutional arrangements to achieve interoperability?

The case study of SETU, examined through the combined lens of the Governing the Knowledge Commons (GKC) framework and the European Interoperability Framework (EIF) and supported by structured interviews, revealed two main things: (1) it demonstrates the application of the GKC framework and the decision tree from Chapter 3 to the study of Collaborative Network Organisations (CNOs), and (2) it shows that progress in SETU differs across the interoperability layers, because the institutional arrangements the community has developed have advanced some layers further and faster than others.

The founding motivation for SETU was semantic interoperability, and this layer is now one of the most developed within the community. In contrast, organisational interoperability was originally avoided because the members considered the sharing of business processes too sensitive. Within the technical layer, the arrangements adapted as members reported implementation barriers, eventually supporting partial adoption by providing the standards as building blocks. The trade-off was uneven implementation and a heavier reliance on software and middleware providers. Legal interoperability has recently become a very active layer, because forthcoming regulations are an increasingly important driver of collective action within the community. Lastly, the findings show that SETU's interoperability governance cannot be understood without its broader institutional context. While a large part of the decision-making happens in internal action arenas, such as the working groups, SETU is also subject to external action arenas, such as European standardisation bodies. SETU, together with TNO, does not merely react to these developments; it also actively seeks to influence European standardisation processes, so that the needs of the Dutch flex-staffing sector are represented.

Subquestion 4

Which guidelines can be developed to analyse the interoperability governance in CNOs?

Three guideline tools can facilitate the study of CNO interoperability. First, a decision tree to assess whether the commons analysis is suitable for the CN under study and to map the CNO under study to the Camarinha-Matos et al. (2019)'s taxonomy. Second, a set of seven guidelines to apply the selected framework as best practices. While this deliverable is inspired by the application of Frischmann et al. (2014)'s GKC, it can also be a reference for other question-based frameworks such as Hess and Ostrom (2007a). Lastly, a checklist ensures the analysis covers categories that can later be related to the EIF's governance dimensions. These deliverables give consultants a structured methodology for studying how interoperability is governed in Collaborative Networked Organisations.

7.2. Answer to the Main Research Question

SQ1 studied interoperability in CNOs. SQ2 compared some commons frameworks for interoperability, creating a comparison table and a decision tree for framework selection. SQ3 applied and tested these on the SETU case. Finally, SQ4 interpreted the case study results and translated them into guidelines. The four subquestions can now be read as a single line of reasoning that leads to the main research question.

Main Research Question

How can the commons scholarship inform the interoperability governance in Collaborative Network organisations (CNO)?

CNOs are increasingly relying on emerging ICT systems to pursue deeper levels of collaboration that were not possible before (e.g., aligning their activities with real-time data exchange). However, achieving interoperability across collaborating parties is ultimately a governance and human-centric challenge.

As such, this research found interoperability to be a multidimensional problem that cannot be understood in isolation in CNOs and extends beyond the technical dimension to the organisational, semantic, legal, and governance layers.

While existing frameworks such as BOMOS combine best technical practices with governance concepts, they do not provide a systematic method for identifying CNOs' institutional arrangements and the divergence between normative ambitions and daily practices. This thesis illustrated the suitability of the commons scholarship to complement the study of the CNOs as socio-technical systems, given that the CNO under study checks two minimal conditions: (1) it has a deliberate organisational structure and (2) it has a significant collaboration trajectory, so there are enough repeated interactions to study emerging patterns.

Suitable commons frameworks, such as the Governing the Knowledge Commons framework, can inform CNO interoperability governance by identifying trade-offs, systematically comparing members' perspectives, and contrasting formal rules with unspoken social norms and the implicit strategies parties use to advance their agendas while collaborating. Overall, commons scholarship provides a systematic methodology for identifying gaps between formal governance and operational outcomes and locating them in action arenas. Additionally, when combined with the European Interoperability Framework, this methodology provides narratives to explain possible causation of these gaps. This thesis outputs an adapted methodology for interoperability at CNOs, designed as a supplementary module to existing frameworks such as BOMOS.

7.3. Societal Relevance

The European Union aims for a single European market. Over the past few decades, the EU has established four remarkable freedoms—movements of goods, services, people, and capital. Now, the Union aims to broaden the scope of this market by enabling the free movement of "research, innovation, data, and knowledge" (Letta, 2024; Roeingh, 2025). Achieving free movement of data and knowledge depends effective industry collaboration which ultimately relies on interoperability (Camarinha-Matos & Afsarmanesh, 2021; Letta, 2024; Technopolis Group et al., 2026).

The TNO Data Ecosystem department provides expertise to policymakers at national and European level on interoperability by collaborating in the development of BOMOS and the European Interoperability Framework. This thesis provides a commons-informed perspective for TNO consultants to provide policy advice for future iterations of the EIF and BOMOS by providing an operational methodology with four tools. Ultimately, the improvement of these frameworks can improve collaboration in the EU and strengthen its industries.

7.4. Academic Relevance

Elinor Ostrom acknowledged that each case is highly context-dependent and that no panaceas or one-size-fits-all breakthroughs exist (E. Ostrom et al., 2007). In other words, no single recipe or process was found that led to an immediate correlation with success. Commons scholarship has historically argued for more case studies in the literature to better understand the commons (Frischmann et al., 2014; Hess & Ostrom, 2007a; E. Ostrom, 1990).

Accordingly, this thesis contributed to the scholarship of the commons by expanding its application to Collaborative Network Organisations. Studying them as commons offered insights into how CNOs work, and revealed strengths of commons frameworks in systematically identifying divergences between formal governance and daily practice. Additionally, this thesis expands the applicability of the commons to a new evaluative criterion: interoperability. Furthermore, this research provides a set of guidelines as a first attempt to bridge these three fields. These guideline tools can be used as a reference for future research and as an example of how to adapt the commons to industrial needs.

7.5. Limitations

We must acknowledge several limitations before making recommendations. First, this thesis carried out a case study. Although several findings are interesting to other CNOs, they need to be tested in future case studies in other contexts. For example, the SETU community is based in the Netherlands,

known for its open and transparent communication style at work. Therefore, the study of CNOs as knowledge commons would benefit from testing whether these findings hold in countries with other collaboration cultures.

Another limitation relates to the interview process. The interviews were a key source of information for the case study. However, the window for identifying, contacting, and scheduling interviews with potential participants was restricted, which consequently impacted the number and diversity of interviewees included in this research. While this work achieved diversity in its interview pool by interviewing temporary staffing agencies, software and middleware providers, TNO staff, and a SETU board member, it would have ideally also included hirers and externals to SETU, which would have broadened the perspective in the findings. In addition, the interviewee pool was arranged through TNO intermediation; while insightful, this brokering may also introduce bias into the pool, as it is formed by very active members who tend to collaborate with TNO more than others.

The guidelines developed in this thesis were influenced by the application of the Governing Knowledge Commons (GKC) framework and the insights generated through its use in the case study. As a result, while the guidelines draw on lessons derived from the GKC perspective, they are intended to be adaptable to other question-based analytical frameworks. Future research could assess the extent to which they apply across different frameworks.

Additionally, GKC representative research questions (see Table 3.2) had to be adapted and shortened since most interviewees were only available for less than 1.5 hours. While these adjustments were made thoughtfully, the adaptation decisions may have influenced the depth and scope of the findings, and ultimately the recommendations.

Finally, it is worth mentioning that the author is not a native Dutch speaker. Given that SETU and BOMOS are embedded as part of the industrial Dutch landscape, most of the information was in Dutch. The language barrier may have limited the perception of some details by word choice in the analysis of documentation. Regardless, this gap was mitigated by the use of AI and constant cross-checking with TNO colleagues and supervisor. Moreover, the interviewees were kind to have the interviews in English and fluently.

7.6. Recommendations

The findings and implications in this thesis converge into several of recommendations.

Methodological recommendation

Expand the BOMOS framework with a commons-informed health checks tool. Use the three guidelines tools provided in this thesis as a first version for a commons-informed supplementary module.

This thesis was commissioned by the TNO Data Ecosystems (DE) department to explore the insights the commons perspective can bring to their current projects with CNOs. As a trusted broker and neutral convener, TNO DE consultants employ a series of tools to enable collaboration between competitors, most of which are designed to support the activities listed in BOMOS for effective management (van der Berg, 2025).

The SETU project is closely connected to BOMOS, as both were developed almost in parallel. During the interviews, P7 explained that SETU's case inspired the logic and argumentation of the first version of BOMOS, since some of the authors were the same people. Later, BOMOS evolved and incorporated practices from other examples in the field. Today, BOMOS and SETU have a symbiotic relationship in which they feed into each other. Based on this, SETU can be considered a BOMOS 'best example' (Boer, 2026).

Nonetheless, this thesis has identified several threats and areas for improvement resulting from the application of the GKC (e.g., conglomeration, fragmentation across several versions of standards, power asymmetries, TNO embeddedness in the project...). These observations are not identifiable with the available BOMOS tools. Therefore, we encourage adding a commons-informed perspective to BOMOS. This would allow consultants to identify the aforementioned threats systematically and in an industry-

friendly manner. The guideline tools developed in this thesis are intended to serve as the foundation for developing a new BOMOS supplementary module. We propose that the initial iteration of this module be directly informed and structured by these tools.

Prescriptive recommendation

Examine how TNO's position as an external or member influences its integration within the CNO and analyse how this is perceived by CNO members.

The case study identified a notable discrepancy between TNO's self-perception and the views of CNO members regarding TNO's membership status (see Section Are the resources in-house?). This divergence may contribute to differences in governance, participation, legitimacy, and decision-making dynamics within the action arenas. Developing a deeper understanding of this dissonance could clarify the origins of misunderstandings or conflicting expectations within the collaboration in SETU and other collaborative projects TNO participates in.

Prescriptive recommendation

Aim for background diversity at operational level in CNOs

Diversity of member entities does not necessarily translate into diverse active profiles at the operational level within CNOs. The case study showed signs of technocratic capture: over time, business discussions were increasingly displaced by technical debates driven by members whose motivation was technological rather than business-oriented. TNO should be aware of this risk, as the background of community members directly impacts the outcomes in the action arenas. The outcomes may be technologically efficient, but do not respond to the business need in the market, hindering implementation and eventual adoption by the respective participating companies. Eventually, this could lead to dissatisfaction from the business side of the participating companies and lead to the exit of their membership.

To improve this, TNO could create less technical-driven action arenas, such as working groups, where it invites both technical and business colleagues from the same companies. Commitment will come from direct engagement with the project. This is perhaps best summarised in the words of interviewee P5 : *In my experience, the more involved people are, the better they understand why it is important in the long run, and the more willingness to comply with the standard there is.*

7.7. Future research

This thesis illustrates the suitability of the commons scholarship for studying interoperability in CNOs. We hope that this document contributes to additional future case studies of CNOs as commons. This could help academia better understand how industry can benefit from a commons perspective to enhance cross-organisational collaboration. We discuss some topics and recommendations for researchers to continue this line of research:

- **Conduct other case studies in different sectors and countries.** To gather more data about interoperability governance in other cultural contexts. This knowledge could help make the guideline tools more universal.
- **Test the applicability of the guidelines to other question-based frameworks such as Hess and Ostrom (2007a)'s framework to a suitable CNO.** As stated before, the guidelines have only been applied to the Governing the Knowledge Commons framework by Frischmann et al. (2014). The guidelines would benefit from studying a CNO that fits best with a different framework, according to the decision tree.
- **Adapt the European Interoperability Framework (EIF) further beyond public administrations to encourage a shared understanding of interoperability as multidimensional across CNOs.** In Chapter 2, this thesis found that the CNOs have traditionally explored interoperability dimensions in isolation. A follow-up research topic will further inform a new version of the EIF using this thesis as the first iteration, to bridge the EIF with CNO initiatives and commons scholarship.

- **Explore the other side of the Collaborative Networks 5.0: the AI-human collaboration in hybrid networks** This research focuses on the human-centric nature of CNO as socio-technical systems. As explained in Chapter 2, this is only one part of the Collaborative Networks 5.0. described by Camarinha-Matos (2026). Future research could also explore how the emergence of AI could disrupt these knowledge-driven communities. During the case study, some interviewees expressed their concern about how the dynamics within and the use cases of SETU could change.

7.8. EPA Relevance

This research sits at the intersection of digital technologies and governance by studying CNOs as a socio-technical system. In doing so, this research aligns with EPA's central premise that technical systems and the institutions governing them cannot be understood in isolation. Interoperability between organisations is not achieved by specifications and protocols alone; it depends on the institutional arrangements that determine who may participate and/or contribute to its design, and how collective decisions are enforced. This thesis therefore looks beyond the technical layer of interoperability.

On the one hand, this thesis explored the suitability of commons scholarship for studying interoperability in CNOs. This required a multi-disciplinary approach. We conducted two desk analyses on CNOs and commons literature, respectively. The findings were translated into three methodological deliverables that operationally bridge both commons and CNO disciplines. This aligns with the EPA. These deliverables combine engineering ICT expertise and social science knowledge. They are designed to facilitate future studies of CNOs as socio-technical systems for researchers and consultants. Ultimately, they help these stakeholders make evidence-based policy interventions.

On the other hand, this thesis examines the SETU community through a case study supported by semi-structured interviews as a qualitative research method. Conducting this case study required a deep dive into the world of standardisation, along with the ability to identify relationships between participants, their dynamics, strategies, and tacit knowledge. The findings provided the basis for portraying the SETU community from a systems thinking and multi-actor perspective, an approach rarely covered in business or technically driven reports.

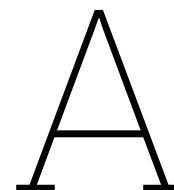
In general, this EPA thesis takes the grand challenge of digitalisation and focuses on the role of interoperability for industry collaboration. It provides operational deliverables and recommendations for decision-makers in the public and private domain.

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Overview of approaches to data sharing

Table A.1: Approaches to data sharing. Retrieved from (Moonen et al., 2025, p. 27).

Technology	Description	Examples	Pros	Cons
Data Platforms	Centralized approach in which all data is collected and stored in a central repository, such as a data warehouse or data lake.	Amazon Redshift, Google BigQuery, Snowflake, Microsoft Azure Synapse.	Easy access, consistent data management, strong security features.	Centralized control can create bottlenecks; scalability challenges with growing data volumes.
Data Space	Decentralized / federated data sharing where data remains in its original location, and only necessary data points are accessed and processed when required.	Federated frameworks, Apache Drill, Google Cloud AI's Federated Learning, IBM FL.	Improved privacy, reduced data duplication, no need to move sensitive data.	Requires sophisticated governance frameworks and data model alignment.
Data Marketplaces	Online platforms that facilitate data exchange between data providers and consumers.	Dawex, Ocean Protocol, Snowflake Data Marketplace.	Clear monetization options, easy data discovery, growing adoption in industries like finance and healthcare.	Data quality, trust, and compliance concerns.
API-Based Data Sharing	APIs enable real-time data exchange between applications or services.	RESTful APIs, GraphQL, gRPC, OpenAPI.	Flexible, scalable, and widely used for web services.	Requires robust security practices to prevent data leaks.

B

Codebook

Codes are grouped according to the GKC framework categories.

Table B.1: Codebook.

Framework Group	Code	Quote Example
Background Environment	Context	P2: “[Forum Standardisatie has] what they call the comply or explain list, and that list is for the government institutes that need to comply to that list. It’s not for commercial organisations ... And SETU is indeed part of that list.”
	Normative values	P5: “Everybody has a say and everybody gets heard.”
Attributes	Community Members	P3: “There’s always going to be people that want to say more than others and they have an opinion and they want to voice it ... Coincidentally, it was the chairman of the state, who was also working at Randstad, who was one of the more outspoken people.”
	Resources: Knowledge	P1: “The [companies in] working groups bring the expertise of the sector to the organisation, while [the TNO] office staff are more people who organise the whole system.”
	Resources: Technology & Skills	P8: “We evolved from XML SOAP messages to JSON messaging.”
	Resources: Resource Characteristics	“The necessary data standards and message exchange formats do not stand on their own; they are built up from concepts and relations with corresponding terminology and definitions that are recorded in the SETU language (SETU-taal).” Manifest (SETU, n.d.-a, Art. 3)
Goals & Objectives	Dilemma	P5: “So you can call or email us [at the Helpdesk] and then you get support that’s included in your membership fee. But there’s also a dilemma there, because if a non-member asks for support, that could be a [future] paying member. So we now try to combine providing support and giving the answer with trying to get them on board as a member ...”
	Established Goals	P2: “Everybody indeed speaks the same language, terms and definitions, and their wishes that each individual organisation has is indeed being reflected in the standard.”

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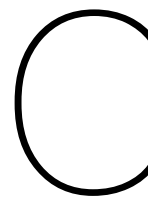
(Table B.1 continued)

Framework Group	Code	Quote Example
Governance	Strategies	P6: "[We] make tests around it and then note everything down that doesn't work. And then later on, I made an Excel file with priorities of what's high priority, low priority, etc. And that's when I sent that to P2, and that's how the whole ball got rolling for the new issues and now the meetings."
	Norms	P1: "...if the working group doesn't approve, then the board will not approve."
	Rules	P7: "You have to pay to become a member and to be part of the working group."
	Action Arenas	P4: "Attendees of SETU: in the past, over 10 years ago, like 80% of all the attendees were staffing companies. Everyone was very involved in the sector, and there were too few software vendors. Now you see the other way around: mainly only software vendors and only a few bigger staffing companies, and that's not a good balance."
	Mechanisms	P9: "My former manager was a part of the board when he became our director. He had no more time to be on the board of SETU, so they needed a successor from our company. Our company thought it was still valuable to be part of the board of SETU. [Since] I was in a lot of groups ... he suggested me to the board."
	Influence of External Actors	P2: "They [general external users of the standards] only have influence during the public consultation of a standard. So when a new standard or new version is being released, we always run a one-month public consultation. Everybody outside SETU can react, provide feedback. Then it'll be taken in by the working group to decide what to do with it."
	Perceived Legitimacy of Decision-makers	P4: "I do think that TNO itself, who is included in SETU in some way, is delivering the most effort, and I'm really happy with their input and help and guidance."
	Perceived Legitimacy of Institutions	P8: "Every [working group] meeting is very open. They will definitely listen to what you have to say. There's not an air of keep quiet and listen to us, and you have to follow the rules. No, it's fairly open and everyone has a voice."
Patterns & Outcomes	Benefits to Members	P2: "There are a lot of added values next to [contributing to] improving SETU, because you're part of the community; you get everything, you get the newsletters, you're upfront with everything that's happening within the sector, so you're up to date."
	Benefits to Others	P8: "...that's a major selling point from SETU. You can tell your customer: 'hey, if you are going to invest in a SETU integration, you can keep that work, you can keep the integration if you change to another temp agency, and that's in your advantage'. Actually, in my disadvantage."
	Costs & Risks Related to the Commons	P6: "...but then we've made a solution that doesn't actually get used in practice, because that's where we come in. We see that we have this in the standard, but it doesn't get used that way [by our customers]."
	Adoption of Standards	P2: "I think a beautiful example is with Athos, which is a huge software provider. They are using SETU, but we would really love to also have them on board ... they are using SETU, but not for everything, and we really want to have that open discussion with them."
	Perceived Legitimacy of the Outcomes	P6: "We are mainly the ones involved in moving the needle to get new changes. But how it gets done, I think it's legitimate. There's the board, everybody can see it, and there's a structured way to go about those issues."

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(Table B.1 continued)

Framework Group	Code	Quote Example
	Interoperability	P5: <i>"I think that [the added value of SETU] lies in the common goals or reasons behind open standardisation. They apply also for SETU and SETU members. That includes interoperability, being able to connect systems in a scalable and cost-efficient way. Adhering to industry standards makes systems more interoperable and also more cost-efficient in IT integration."</i>



AI statement

I used artificial intelligence tools to enhance the quality and clarity of the academic writing. I am responsible for the content, argumentation, and conclusions of this thesis; they rest entirely on me, as the author. I always critically evaluated the output of AI and rewriting to clarify *my* thinking. This was a constant practice since, no matter how much AI progresses, it tends to overwrite implicit ideas or argumentation. The following statement details the specific ways AI was employed throughout the research process.

AI tools used

I used the following AI language models: Claude (Anthropic), Grammarly, and TNO Co-pilot TNO environment. Claude was mainly used for brainstorming, formatting and language improvement, and coding in VS Code and $\LaTeX$ formatting. Grammarly was used for language and text suggestions. Co-pilot environment was used to navigate through internal documentation on the case study in a safe and effective manner.

Brainstorming and research development

I used AI as an interactive brainstorming partners to help clarify research focus and scope. For example, I used them to refine the SCOPUS searches for the first literature review.

Academic writing and editing

I used AI to reformulate ideas and train of thought to better align with academic writing conventions and structure. To do so, I developed a chat in which the Claude AI takes a critical supervisor role. In this chat, we would have a conversation about my intended ideas. This helped me articulate my thoughts simply by being asked about my intentions. Given the level of abstraction a thesis can reach, this practice was a nice way to develop my thinking beyond the meetings I had with my committee. I provide the first prompt, hoping it is useful for others. Example prompts included:

Task: *Act as my thesis supervisor and help me structure the research-gap section.* **Context:** *You are a social scientist and my master's thesis supervisor.* **Language:** *English, C1 level.* **Tone:** *Informal but consistently precise and academically grounded.* **Output format:** *Have a conversation with the student by asking them questions about their research.*

Programming and document navigation

Given that most of the grey literature and documentation of SETU was in Dutch, I used VS Code to create code to translate the public documentation to English. To enhance my coding, I made use of Claude for VSCode and Copilot.

TNO has a Copilot license that creates a safe environment within the company. I used this tool to navigate the company's documentation more quickly and get automatic translation from PowerPoint webinars of SETU,

LaTeX formatting

AI tools were also used to assist with the formatting of this thesis in $\text{\LaTeX}$. This included converting plain text drafts into properly structured $\text{\LaTeX}$ code, formatting tables, figures, and resolving formatting and compilation errors. Example prompts included: *"Create a simple timeline template of 5 phases"*, *"This LaTeX table is not rendering correctly; what should I modify to make the second column wider?"*