

**The Strategic Nexus of Emerging Innovation
Ecosystems:**

***A Case Study of the FNS Consortium and Its Role in
6G Technology Development***

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Abstract

This study examines how R&D consortia can support their partners in shaping emerging innovation ecosystems during the early stages of technological evolution. Prior research has focused on various antecedents of ecosystem emergence, including technological innovation; however, it has fallen short in addressing ecosystem emergence through consortia engaging in such technological innovation. Drawing on an in-depth case study of a Dutch R&D consortium in the telecommunications sector, the findings demonstrate how a consortium's structure and set of partners can facilitate joint-value creation and support its partners in forming and scaling innovation ecosystems during the early phases of technological evolution. While technological evolution increases ecosystem-wide uncertainty, an R&D consortium that blends divergent (exploratory) and convergent (coordinative) activities creates a structured yet flexible vehicle that enables partners to collectively navigate uncertainty, explore joint-value propositions, and position themselves for future ecosystem dynamics. This study contributes to research at the intersection of innovation ecosystems and R&D consortia by highlighting how a value-chain-spanning composition of partners can support these partners in shaping emerging innovation ecosystems.

Keywords: innovation ecosystems, R&D consortia, technological evolution, standardization, emergence

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Introduction

Today's technological innovations increasingly demonstrate that a firm relies on external networks of partners to successfully commercialize its innovations (Teece, 2006). This is particularly amplified for complex system offerings, where complementary innovation is necessary to materialize a central, customer-facing value proposition (Ethiraj, 2007). Complex system offerings are often enabled by a modular architecture that allows independent actors to produce interdependent, complementary components that come together to form the value proposition (Jacobides et al., 2018).

Naturally, alignment among these independent actors is needed to coordinate toward a coherent value proposition. Consequently, ecosystems emerged as a way to depict the alignment structure of a set of interdependent actors “that need to interact for a focal value proposition to materialize.” (Adner, 2017, p. 42). Specifically, innovation ecosystems, where the focal value proposition is central, give rise to alignment between actors within a complex system offering (Baldwin et al., 2024). Innovation ecosystems allow actors to offer a focal value proposition where the alignment of their partners creates more value than the sum of the individual partners (Adner & Kapoor, 2010; Holgersson et al., 2022).

However, to align interests and manage opportunism, some form of governance must be in place. Whereas centralized control would be ideal, Olk and West (2023) argue that, where centralized governance results in hierarchical decision-making at one end, market governance relies on price signals; however, innovation ecosystems can also be indirectly governed by individual firms. In large and complex ecosystems where knowledge and control are dispersed, firms may attempt to influence the ecosystem through indirect control. Olk and West (2023) illustrate how firms can shape ecosystems through indirect, distributed governance by engagement in one or more consortia.

Whereas a consortium, in essence, also represents a set of autonomous actors that come together to achieve a common goal, it generally differs from the ecosystem construct in its purpose (Buchanan et al., 2025). Typically, consortia engage in research and development to tackle issues relevant to all partners (Aldrich & Sasaki, 1995). Whilst the pooling of resources in a consortium is needed to advance research, firms tend to be prudent in committing resources to uncertain technologies (Dattée et al., 2018). Therefore, governments typically sponsor research and development (R&D) consortia to advance basic and applied research (Browning et al., 1995).

At the same time, such R&D may have implications for new value propositions. At the basis of an innovation ecosystem often lies an underlying technology that enables customer-facing functionalities (Adner & Kapoor, 2010; Dattée et al., 2018). As a result, technological change may lead to the emergence of new value propositions, which in turn enable the formation of innovation ecosystems (Dattée et al., 2018). This is especially apparent in telecommunications, where distinct technological generations enable new functionalities and therefore new value propositions (Ranganathan et al., 2025). While knowledge and control are dispersed, technological ecosystems such as telecommunications are, at a higher level, often coordinated through technical standards that ensure interoperability and efficiency; it lessens ecosystem-wide uncertainty (Toh & Pyun, 2024). During standardization, standard organizations, comprising mostly industry member firms, converge on the technical specifications of a component or interface, through which different generations of standards represent technological evolution. Although the outcomes of these standards allow for coordination, standardization is increasingly seen as an important tool to indirectly shape an ecosystem by promoting technical standards that are favorable to a firm (e.g., through patents, or complementary technology) (Toh & Pyun, 2024).

Altogether, the early phases of technological evolution, where no standards have converged yet, portray uncertainty regarding new value propositions and how firms can play a role in these new value propositions (Toh & Pyun, 2024). Although extant research indicates that technological advancements can foster the creation of value propositions and, subsequently, ecosystems (Adner & Kapoor, 2010; Dattée et al., 2018; Holgersson et al., 2022), as well as highlighting that firms participate in consortia to reduce uncertainty surrounding these value propositions (Lavie et al., 2007; Leiponen, 2008; Olk & West, 2023), it remains uncertain how these consortia can influence the shaping of emerging ecosystems. Therefore, this study focuses on the following question:

How do R&D consortia support their partners in shaping emerging innovation ecosystems during the early stages of technological evolution?

In this study, an in-depth case study is conducted of the Future Networks Services (FNS) consortium in the Netherlands. Following government approval in 2023, a total conditional funding amounting to €203 million enabled the consortium to materialize. The consortium comprises approximately 65 partner organizations that collaborate on the development of 6G (Future Network Services, 2023). The consortium aims to contribute to the development of 6G through its four program lines, namely: Intelligent Components, Intelligent Networks, Leading Applications, and Strengthen Ecosystem (Future Network Services, n.d.). Whereas 6G development is

still in its early stages, with the first commercial 6G systems expected to be available around 2030, standardization efforts have already begun.

This study contributes to strategy literature at the intersection of ecosystems, consortia, standards, and technological change in several ways. The findings highlight how, by adopting an ecosystem approach to both value creation and value appropriation, an R&D consortium can anticipate emerging ecosystems and, holistically, provide the most value to its partners. More specifically, the analysis demonstrates how a consortium can empower its partners to shape emerging ecosystems through an interplay of inward and outward focus, supporting partners in value creation and value appropriation. The outcomes of this study signal important implications for managers and policymakers who aim to shape emerging ecosystems through consortia, as they highlight the mechanisms involved that enable ecosystems to emerge.

In the following chapter, a review of relevant literature will be included to explain and describe relevant theoretical concepts. The final part of the literature review will illustrate an integrative perspective to examine the interaction between R&D consortia and emerging ecosystems. Then, the methodology of this paper is discussed. Subsequently, the findings are presented, followed by a discussion of their theoretical and practical implications.

Literature Review

This chapter elaborates on relevant literature, gives a theoretical perspective on the concepts introduced in the introduction, and works toward an integrative perspective. First, the literature on ecosystems, and more specifically innovation ecosystems, and their emergence will be discussed. Next, the research context of multi-partner alliances, and more specifically, R&D consortia, will be explored. Finally, the last part of the literature review will seek to integrate relevant literature into an integrative perspective.

2.1 Innovation Ecosystems

Research on ecosystems in business settings has been growing exponentially (Adner, 2017; Hannah & Eisenhardt, 2018; Jacobides et al., 2018; Kapoor, 2018). Although the term is borrowed from biology, Moore (1993) was the first in business literature to introduce the notion that firms should be perceived not as members of a singular industry, but rather as members of a business ecosystem that encompasses firms from a variety of industries. More recently, Adner defines an ecosystem as “the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialise” (2017). Ecosystems are unique in their ability to capture the complex dynamics of interdependencies that arise from non-generic complementarities (Jacobides et al., 2018; Kapoor, 2018).

Generally, for a set of actors to be considered an ecosystem, it must satisfy three criteria: modularity, complementarity, and autonomy (Baldwin et al., 2024). For ecosystems to emerge, some degree of modularity is necessary (Jacobides et al., 2018). Modularity in a technological system allows for different components of a technological system to be designed independently by various producers, yet function together (Shipilov & Gawer, 2020). This, in turn, enables different actors to design complementarities that enhance the overall value proposition, with limited coordination required. Yet, some level of coordination is necessary, which cannot be managed solely within markets, nor does it require a central authority to dictate that coordination (Jacobides et al., 2018). Hence, an ecosystem gives structure to aligning a set of mutually interdependent and independent partners, where the alignment of ecosystem actors is to ensure joint-value creation and mitigation of conflict (Kapoor, 2018).

Complementarity refers to the idea that the combined value of contributions from all members exceeds the value that individual members or smaller groups can achieve separately (Milgrom & Roberts, 1995). Ecosystems can differ in their complementarity in both production and consumption (Jacobides et al., 2018). For some product systems (irrespective of ecosystems), coordination among actors is not necessary in production or consumption, although coordination can create greater utility for both. For instance, aesthetically matching home accessories can be beneficial to produce in coordination, and can be pleasing to consume in coordination with each other. However, they can both be produced and consumed independently; these are generic complementarities. On the other side of the spectrum, production and consumption of complementarities may be supermodular as well. Group-level coordination in both production and consumption, then, is increasingly beneficial. Notably, in open-source software production, coordination is needed to increase the quality and lower production costs. Similarly, coordination in consumption is rewarding as more value is derived from bringing together these complementarities. Apple's iPhone is a good example of how Apple manages its interdependencies effectively while leveraging external complementarities to enhance the iPhone's user value proposition.

Joint-value within an innovation ecosystem is created through contributions to a focal value proposition, whose components are modular and complementary (Baldwin et al., 2024). As noted in the introduction, innovation ecosystems allow actors to offer a focal value proposition where the alignment of their partners creates more value than the sum of the individual partners (Adner & Kapoor, 2010; Holgersson et al., 2022). This, in turn, also allows actors to appropriate more value (Teece, 2006). In technological systems, actors combine technologies to create greater value. However, a firm's ability to appropriate the value is also dependent on complementary patents (Teece, 2006). Value appropriation is a crucial attribute of innovation ecosystems, as it influences how alignment converges, the competitiveness of an ecosystem, and the distribution of value among its actors (Adner, 2017).

To come back to telecommunication networks, Jacobides et al. (2018) suggest that telecommunications networks and devices are supermodular in production, but that different generations of telecommunications networks (e.g., 4G and 5G) resulted in varying levels of modularity in consumption. 5G, for instance, gave way to more modular product systems, such as Internet of Things applications, increasing the need for an ecosystem perspective (Jacobides et al., 2018).

Finally, the last criterion that distinguishes ecosystems is that actors within an ecosystem should be autonomous (Baldwin et al., 2024). Ecosystem strategy primarily concerns aligning partners, as actors can have

distinct end states and objectives. Hence, when one actor has full control over all other actors, the alignment of actors becomes unnecessary; there is no need for an ecosystem logic (Adner, 2017). Within ecosystems, partners may have formal dyadic relationships, through contracts, for instance. However, all actors should be aligned for the value proposition to materialize (Shipilov & Gawer, 2020). This presents unique coordination challenges, as no one firm has full control, and actors, at least to some extent, remain independent and autonomous.

Ecosystem literature has established various perspectives on ecosystems. At a higher level, Adner (2017) argues for a distinction between an ecosystem-as-affiliation view and an ecosystem-as-structure view. The affiliation view considers the ecosystem as the organizations, institutions, and individuals that affect, or are affected by, the focal firm (or platform), its customers, and its suppliers. This perspective considers a focal firm, or platform, at the center of an ecosystem, where ecosystem strategy is concerned with enhancing its centrality and expected power (Adner, 2017). The second view considers a focal value proposition as the unit of analysis and looks at the activities and actions that need to be undertaken for this value proposition to materialize (Adner, 2017). Ecosystem-as-structure considers the search for alignment of partners at the heart of its strategy.

Although other perspectives of ecosystems share some overlap with Adner's grouping of ecosystems, these other perspectives remain valuable to nuance and extend Adner's work. Jacobides et al. (2018) consider three distinct groups of ecosystems: business ecosystems, innovation ecosystems, and platform ecosystems. Where business ecosystems are quite similar to the ecosystem-as-affiliation view of Adner (2017), innovation ecosystems share similarities with the ecosystem-as-structure view in that an innovation is at the center of the ecosystem, rather than a focal firm. Adner (2017) argues that platforms share some overlap with the ecosystem-as-affiliation view, in that increasing the platform's centrality and affiliated partners is central to the platform owner and its affiliates. Kapoor (2018), on the other hand, considers a platform as the technological architecture that is the foundation for complementary products and services to come together, but argues that the focal offer, and not the firm or alliance of firms, is at the heart of the ecosystem. Jacobides, Cennamo, and Gawer (2018) consider a platform view of ecosystems to be distinct, in that a central platform enables multiple independent actors to interact, co-create value, and innovate through complementary products or services, often coordinated by the platform owner but sustained by the collaborative engagement of diverse participants.

2.1.1 Emergence of Innovation Ecosystems

Ecosystem emergence refers to the process by which a novel ecosystem develops to a significant size and is recognized as a distinct structure (Daymond et al., 2023). As mentioned above, modularity is necessary for ecosystems to emerge (Jacobides et al., 2018). Modularity alone, though, does not initiate the emergence of ecosystems; it merely creates the conditions for an ecosystem to emerge. Jacobides et al. (2018) argue that merely modularization is more likely to result in the emergence of markets. However, the call for coordination that cannot be addressed through markets alone, nor does it need to be centralized under a single authority, allows ecosystems to emerge. Central firms may choose to modularize a process or opt not to design and sell complementary products and services, instead forming an ecosystem. That way, a firm sees added value in setting up an ecosystem. On the other hand, many value propositions require multiple actors to coordinate their activities and technologies to materialize them (Adner & Kapoor, 2010).

In some cases, technological innovation itself has led to the emergence of a new ecosystem (e.g., electric vehicles), while in others, changes in the environment may also lead to the emergence of ecosystems as a preferred organizational form. Holgersson et al. (2022) found that centripetal forces, such as technological complementarity, can push towards more coordination of activities, and centrifugal forces, such as distributed knowledge, can pull activities more towards the market. A balance between these forces allows ecosystems to emerge. Technological innovation may have an effect at the component level of a technological system or impact the system as a whole (Adner & Kapoor, 2010; Holgersson et al., 2022). Adner and Kapoor (2010) highlight that the role of upstream complements differs from the role of downstream complements, depending on whether challenges arise in upstream components or downstream complements.

When uncertainty regarding a new value proposition is high, firms postpone specialized investments, which delays ecosystem emergence (Song et al., 2024). Of course, when a new value proposition is still nascent and evolving, firms see specialized investment as risky. As a result, firms invest in generic complementarities that limit the development of the value proposition. Song et al. (2024), however, argue that indicators of collective value creation, enhanced potential for value appropriation, and ultimately multilateral complementarity contribute to a thriving ecosystem. Within innovation ecosystems without a clear leading party, alignment of actors and pooling of resources becomes even more important (Drori & Lavie, 2024). This especially counts for emerging innovation ecosystems, where “unlike business and platform ecosystems, innovation ecosystems typically call for the intervention of the government and academia that can furnish the needed infrastructure” (Drori & Lavie, 2024).

2.2 Multi-partner Alliances

It is no secret that a firm's competitive advantage is intricately linked to its ability to innovate and harness technological advancements (Abernathy & Clark, 1985; Lengnick-Hall, 1992). But as product life cycles shorten and the need for product interoperability increases, firms are less likely to innovate successfully independently (Lavie et al., 2007). Especially in technology-driven industries, technological interdependence influences a firm's ability to create value and to appropriate value from the value creation (Adner & Kapoor, 2010; Ranganathan et al., 2018).

As a result, cooperation between multiple firms has become an important phenomenon in business (Lavie et al., 2007). Companies increasingly rely on external knowledge through partnerships to drive innovation (Powell et al., 1996). Within technology-driven industries, the need for product interoperability in combination with various multilateral interdependencies calls for coordination of multiple firms. Often, in such industries, this is approached through alliances consisting of more than two firms. In business literature, a single term to depict an alliance involving more than two organizations is not ubiquitous. Terms such as "multilateral alliance" (Gulati, 1995), "multi-partner alliance" (Lavie et al., 2007), and "multi-firm alliance" (Hwang & Burgers, 1997) have been used. These terms have in common that they differ from bilateral (dyadic) alliances in that the alliance agreement involves more than two firms (Anderson et al., 1994). Similarly, multi-partner alliances differ from alliance networks, which consist of multiple independent alliances formed at different times for various purposes (Gulati, 1995). Altogether, multi-partner alliances represent a unified collaboration among multiple partners within a single agreement, which makes it a distinct phenomenon (Li et al., 2012).

Lavie characterizes this type of alliance as "a collective, voluntary organizational association that interactively engages its multiple members in multilateral value chain activities, such as collaborative research, development, sourcing, production, or marketing of technologies, products, or services" (2007). A multi-partner alliance can take various forms (e.g., standard development organizations and consortia) and is generally established to address complex problems (Doz, 2019). Furthermore, multi-partner alliances stand out for their capability to integrate partner resources and skills, in line with the resource-based view (Wernerfelt, 1984), while reducing the risks and costs associated with complex projects (Fonti et al., 2017).

Firms may benefit from multi-partner alliances by gaining access to complementary resources, market information, and investment opportunities. A distinction can be made in that multi-partner alliances can create common benefits for participating firms and private benefits that may vary from firm to firm. A particular multi-

partner alliance can create common benefits when it competes against other alliances and emerges as the ‘winner’ (Khanna et al., 1998), creating opportunities for value appropriation for participating firms. Nevertheless, Lavie (2007) argues that firms benefit from such alliances to different extents, specifically in multi-partner alliances. This heterogeneity in private benefits partly arises from the timing of partners' entry and how they are internally and externally involved in the alliance (Lavie et al., 2007). It follows that firms may not always benefit from being more involved in the alliance, by being a board member of the alliance organization, for example. On the other hand, being involved in multiple competing multi-partner alliances and thus having access to more technical and market information may increase common and private benefits. Being involved in multiple alliances, though, may pose coordination challenges since a single firm has to deal with relationships in multiple multi-partner alliances (Lavie et al., 2007).

Multi-partner alliances depend on the partners' willingness to commit and pool their resources in a joint effort to solve a complex problem (Fonti et al., 2017). After all, as the number and diversity of partners grow, the alliance's performance is anticipated to improve (Vandaie & Bechara, 2024). Both a larger number and increased diversity of participants enrich the pool of resources, which can help solve a complex problem; however, coordinating such an alliance becomes increasingly challenging (Li et al., 2012). Compared to dyadic alliances, multi-partner alliances require more explicit communication and coordination to define decision-making processes, to decompose and assign roles and tasks, and to monitor and assess partners' contributions (Dorobantu et al., 2020).

From this and other reasons, it follows that governance and coordination are necessary to ensure successful collaboration. Generally, alliance structures can differ regarding the degree of hierarchical elements they embody (Gulati, 1998; Osborn & Baughn, 1990). Joint ventures, for example, tend to be more contractual and hierarchical, whereas research and development (R&D) consortia are often more consensus-based and informally coordinated (Buchanan et al., 2025; Gulati, 1998). The focus of this research is on R&D consortia.

2.2.1 R&D Consortia

A research and development (R&D) consortium can be characterized as an entity established to coordinate research and development activities to address the collective needs of firms (Buchanan et al., 2025). However, it is not always required to form a separate entity; it can also take shape in the form of an agreement/partnership. R&D consortia differ from joint ventures and other collaborative research forms by involving direct competitors

to pool their resources to pursue basic and applied research on relatively long-term projects (Aldrich & Sasaki, 1995). Often, R&D consortia are temporary in nature as the organizations work together on a specific objective.

Doz, Olk, and Ring (2000) argue that the formation of R&D consortia broadly happens along two distinct paths: an emergent process and an engineered process. Through an emergent process, participants recognize shared needs due to environmental changes and common interests among potential members, and voluntarily collaborate. In contrast, an engineered process involves active recruitment by a triggering entity (such as a company or government agency) that assembles participants to form a consortium. However, Doz, Olk, and Ring (2000) emphasize that there is not one best practice to pursue, highlighting the hybrid nature of network creation. Governments, usually motivated by national competitiveness or economic development goals, can drive alliance formation through financing to facilitate an R&D consortium (Olk & West, 2023).

Some literature has shown through case studies how R&D consortia can create a vehicle for collaboration (Blazevic et al., 2021). For example, the semiconductor manufacturing technology consortium (SEMATECH) in the US was initially characterized by competitive tensions and inaction of partners, as firms struggled to balance competition with collaboration (Browning et al., 1995). Slowly, a culture of trust developed through institutionalizing cooperation and other industry-wide practices, allowing a resurgence of the US semiconductor industry. The authors interpret SEMATECH's evolution using complexity theory, illustrating how cooperation emerged from uncertainty across the industry.

2.3 Toward an Integrative Perspective

An integrative perspective reveals how R&D consortia and innovation ecosystems interlock and how each construct contributes to both value creation and value appropriation. To work toward an integrative perspective of R&D consortia and innovation ecosystems, these concepts will be compared and positioned in relation to each other, alongside standards.

2.3.1 The Strategic Nexus of Innovation and Innovation Ecosystems

First, let's discuss the commonalities and differences of R&D consortia and innovation ecosystems. R&D consortia and innovation ecosystems serve a similar purpose: creating a structure to facilitate business collective

action; an effort by a group of actors to construct and advance a shared interest (Buchanan et al., 2025). Next to that, compared to other forms of collaborative forms, business collective action, such as through consortia or ecosystems, can have the effect of affecting entire industries or sectors, including changes in regulations, the creation of standards, or generally the development of new collective innovation (Buchanan et al., 2025). Additionally, both constructs include self-interested actors and have to be governed through informal and formal governance mechanisms to manage interdependencies among these actors (Kapoor, 2018).

Despite their commonalities, these constructs are fundamentally distinct in business literature. R&D consortia have pre-defined objectives and are often temporary in nature or project-based, unlike innovation ecosystems, where objectives and their temporal scope are not predefined. Moreover, the objectives of R&D consortia are more focused on generating pre-competitive knowledge or early-stage technologies, whereas the objectives of an innovation ecosystem are centered around a user value proposition (Kapoor, 2018). While research on alliances considers the firm or the alliance of firms as its starting point, ecosystem literature starts from the user value proposition and considers the activities and consequently the actors that must align with each other (Adner, 2017). In the absence of platforms, dyadic or multi-partner alliances/arrangements may serve as a vehicle to manage interdependencies (Baldwin et al., 2024), but an ecosystem may not always need an alliance to manage this. Buchanan et al. (2025) argues that ecosystems can generally be more relational and informally coordinated, but that governance depends on the ecosystem's structure, goals, and maturity.

Inter-organizational alliances and agreements can be embedded within a larger ecosystem (Baldwin et al., 2024). Alliances serve not only as tools for participants, but at a higher level, to set the foundation for ecosystem development (Jacobides et al., 2018). However, whereas some ecosystems (e.g., platforms) permit alliances or agreements to encompass the entirety of the ecosystem, large and complex ecosystems allow for many consortia to be embedded within the ecosystem. This has implications for the governance of the ecosystem and how individual firms may influence the ecosystem's direction. West and Olk (2023) discuss how large organizations may repeatedly cooperate with one another in various consortia to influence an ecosystem through an indirect, distributed orchestration approach. This can be linked back to the alliance literature, where Lavie et al. (2007) discussed how being involved in multiple alliances may increase common and private benefits. Although these papers highlight the benefits of being involved in multiple alliances/consortia, the incentives differ. West and Olk (2023) stress ecosystem orchestration, where Lavie et al. (2007) highlight how involvement in multiple alliances "contributes to the productivity of partners, market acceptance of their products, and their overall reputations" (p. 596).

Several papers have sought to integrate these research streams. West and Olk (2023) investigate how R&D consortia orchestrate the Alzheimer's knowledge ecosystem through distributed governance, rather than centralized control. Analyzing 46 consortia with corporate, nonprofit, and governmental members, they identify three consortia models: Regional, Sponsored, and Umbrella/Nested. Each allows organizations to coordinate ecosystem activities without centralized oversight. They find that these distributed structures enhance scientific collaboration and facilitate innovation, particularly in complex knowledge ecosystems where individual firms cannot solely drive advancements. West and Olk (2023) indicate that their findings on ecosystem governance through distributed governance have broader implications for ecosystem governance in fields such as healthcare and telecommunications, highlighting large or complex ecosystems.

Reiter et al. (2024) explore how innovation ecosystem orchestrators govern relationships with diverse complementors. Based on a multi-case study in financial services, they show that orchestrators use tiered governance, applying different organizational forms and coordination mechanisms depending on complementor roles and the uncertainty of their ecosystem domain. They find that complementors close to the core engage in convergent roles, relying on formal coordination and contractual agreements, while those at the periphery take on explorative roles, requiring informal collaboration and shared incentives. Especially within nascent ecosystems with high uncertainty, informal coordination is necessary in resolving this uncertainty.

In conclusion, these studies illustrate how governance structures shape ecosystems and how consortia are embedded within these ecosystems. Whereas these case studies do not conclude an exhaustive list of papers on this topic, they do give important insights into how actors are involved simultaneously in multi-partner alliances embedded in complex ecosystems, where they can utilize these alliances to influence ecosystem evolution (Olk & West, 2023).

2.3.2 Standards

In discussing the relation of consortia and complex ecosystems, standards and standard development organizations (SDOs) play a crucial role, especially in telecommunications. Standards are a fundamental pillar of technological advancement, organizational processes, and market competition. They facilitate coordination, interoperability, and efficiency across industries, shaping innovation and structuring market dynamics (Grillo et al., 2024). The interdisciplinary nature of standardization underscores its significance in shaping ecosystems, regulatory landscapes, and global trade. Grillo et al. (2024) define standards as “interface specifications and corporate

practices that function as governance mechanisms within innovation ecosystems” (p. 792). A well-known example of standards is the latest standard for the Universal Serial Bus (USB), and more specifically, USB-C connectors.

Standard development happens at multiple tiers. Where platforms set internal standards to collaborate and scale efficiently (Baldwin et al., 2024), at a higher level, dedicated standardization consortia develop standards that enable distributed innovation and interoperability within the ecosystem (Olk & West, 2023). Standards development organizations (SDOs) are formal institutions that can be perceived as multi-firm coordination platforms for shaping ecosystem rules through consensus-seeking coordination (Ranganathan et al., 2025). One of the most influential SDOs is the 3rd Generation Partnership Project (3GPP), a European consortium formed in 1998 for developing telecommunications standards (e.g., 3G, 4G, and 5G).

Specifically in telecommunications, standards ensure seamless communication across different networks and devices, facilitating global connectivity. Standardization in telecommunications is highly interdisciplinary (Grillo et al., 2024), as the interests of many stakeholders have to be represented. Toh and Pyun (2024) acknowledge the importance of standards for coordination as it lessens ecosystem-wide uncertainty, but stress the implications of these standards on the ability of value appropriation at the firm level. Firms with technologies complementary to the standard are better positioned to appropriate value (e.g., through out-licensing patents) and play a more significant role in the ecosystem (Olk & West, 2023). Thereafter, standardization can be seen as a tool for ecosystem coordination, but it is increasingly viewed as a strategic tool to shape the rules of the ecosystem (Leiponen, 2008; Ranganathan et al., 2025; Teece, 2006; Toh & Pyun, 2024). However, shaping efforts are constrained by concerns over value appropriation: when a firm is perceived as likely to gain disproportionate control (e.g., through IP rights), other participants resist its proposals. Thus, standard-setting becomes a complex socio-technical process where relational influence, technological centrality, and competitive positioning jointly determine a firm's success in shaping ecosystem rules (Ranganathan et al., 2025).

One particular study by Leiponen (2008) captures the dynamics of firm behavior in consortia that aim to contribute to standard setting in telecommunications. The study highlighted, much like the papers of Lavie (2007) and Olk and West (2023), that firms participating in multiple consortia have a greater impact on telecommunication standards. As a result, firms with broader cooperation strategies (consortium connections and alliances) have greater success in shaping technological evolution.

2.3.3 Summary

All in all, technological innovation poses important implications for how firms can appropriate value from them (Adner & Kapoor, 2010; Holgersson et al., 2022; Teece, 2006). Complex system offerings, where components are modular and complementary, are increasingly coordinated through innovation ecosystems (Baldwin et al., 2024). In a balance of forces that push toward integration on one hand and pull activities onto the market on the other, innovation ecosystems may emerge to create greater joint-value than the sum of their parts (Baldwin et al., 2024; Holgersson et al., 2022).

In the context of telecommunications, where knowledge and control are dispersed, cooperation among firms is necessary to advance technological development (Lavie et al., 2007; Olk & West, 2023). At the same time, telecommunications presents a context where technological evolution leads to technological discontinuity, resulting in firms cooperating to establish standards and reduce ecosystem-level uncertainty in the early phases of technological evolution (Leiponen, 2008; Toh & Pyun, 2024). By regarding technological evolution as a trigger of ecosystem-wide uncertainty (Leiponen, 2008) and, in turn, firm-level uncertainty (Toh & Pyun, 2024), it becomes evident that consortia engaging in R&D to contribute to technological evolution play a central role in shaping emerging ecosystems (Olk & West, 2023).

Nevertheless, a gap in the literature pertains regarding how R&D consortia can influence the shaping of emerging ecosystems, particularly in contexts of dispersed knowledge and control. The current literature serves as the basis for exploring this gap empirically, through qualitative case research.

Methodology

This chapter discusses the methodology of this research. First, the general approach to the methodology will be provided. Then, the empirical context and a rationale for choosing this empirical context will be explained. Furthermore, the data collection and the analysis approach will be described. Lastly, the quality of the research will be discussed.

3.1 Research Design

As mentioned in the introduction, the central point of this research is to understand how an R&D consortium supports its partners in shaping emerging ecosystems. For this study, an abductive case research approach was employed. Abductive reasoning presents a strategy for approaching the relationship of theory and data involving a “back-and-forth engagement with the social world as an empirical source for theoretical ideas, and with the literature, in a process of ‘dialectical shuttling’” (Bell et al., 2019, p. 24). The decision to follow an abductive approach was based on the empirical context and the nature of the research inquiry. Abductive research offered a certain amount of flexibility to modify research topics and techniques based on the data gathered to gain insights (Ghauri et al., 2020). The initial research inquiry was focused on exploring the interaction between the consortium and the ecosystem. While data collection was conducted, certain factors relevant to studying this interaction became clearer. Hence, abductive reasoning was necessary to remain flexible in altering the research inquiry and to allow logical inferences to be made.

By using a case study approach, this research aims to uncover the fundamentals of the "how" and "why" in order to gain a more holistic view of a complex real-life phenomenon and its contextual conditions (Yin, 1994). This type of research works best when a researcher's aim is to understand a specific phenomenon in depth. The phenomenon is considered complex in that more than 60 organizations are involved in advancing a particular technology while managing interdependencies both within and outside the consortium. Additionally, standardization processes that impact both the consortium and emerging ecosystems add to this complexity. Therefore, a qualitative research method was chosen over a quantitative method to gain insight into a complex, ever-changing environment and allow participant interpretations to give way to context-specific explanations.

This is done by employing an embedded single case study approach. According to Yin, a case study is an “empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (2003, p. 13). The single case study design was chosen over a multiple-case study design, as this case can be seen as a unique case. It is a rare opportunity to analyze such a large-scale innovation effort, which makes it worth documenting and analyzing (Yin, 2003). Additionally, employing a multiple-case study design with the same amount of time and resources would not yield significant insights, as it would fail to capture perspectives from different actors well. A disadvantage of a single case study is that the findings are less generalizable. However, the goal is not necessarily to generalize, but to develop theory by adding context-specific insights.

An important part of designing the case study is identifying the relevant unit of analysis (Yin, 2003). For this research, an embedded case study is used to incorporate subunits of analysis. The study aims to analyze subunits of analysis in the form of individual organizations involved in the consortium, and the consortium as a whole as the larger unit of analysis. Analyzing subunits can provide significant opportunities for in-depth analysis, enriching the insights for the single case (Yin, 2003). In this case, the perceptions and interpretations of individual organizations are regarded as essential, as they vary greatly but contribute to the whole story.

3.2 Empirical Context

The following section provides a brief description of the empirical context and a rationale for selecting this case.

3.2.1 Future Network Services Consortium

The Future Network Services (FNS) consortium came about in 2022 when a thorough analysis of 5G development led to the conclusion that Dutch companies are merely involved in specific parts of the value chains of 4- and 5G networks, whilst the Netherlands has a strong industry that is relevant for 6G technology (e.g., semiconductors). The development of 5G applications was initiated by Dutch companies when the technology of 5G was already advanced.

So, in early 2023, a proposal was submitted to the National Growth Fund in the third application round to realize the FNS program. Later that year, the positive decision by the National Growth Fund regarding a grant

award enabled the consortium to materialize. The total conditional funding amounted to € 203 million. The start of the program was in January 2024. The program's vision is as follows:

Mobile networks are driving the digitalisation of our society. They contribute to the growth of earning power in all sectors of the economy. Through innovation and cooperation between companies, knowledge institutions and the government, the Netherlands is acquiring a strong position in the global 6G value chain. The Future Network Services program will create an international top position for the Netherlands in 6G which will give a boost to the Dutch economy and sustainable earning capacity. (Future Network Services, n.d.)

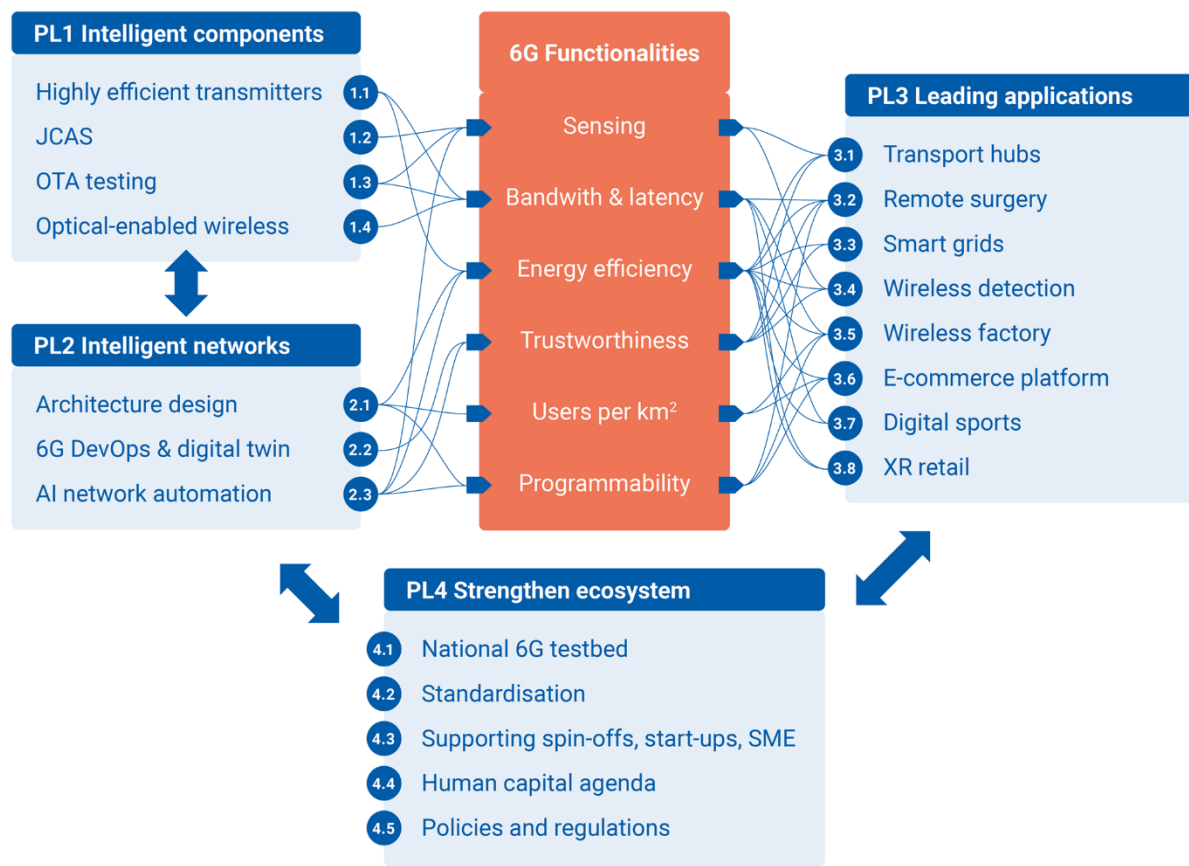
The initiation of FNS originated primarily from the independent research institute TNO. While independent, they support the government by strengthening the Dutch economy and enhancing the welfare of society, through carrying out statutory and other government tasks in the public interest (TNO, n.d.). TNO plays a coordinating and leading role in this consortium, where they lead the core team and are also involved in most program lines in which they have expertise to offer. The Dutch Ministry of Economic Affairs and Climate Policy is responsible for the project.

The consortium consists of 60 organizations, including businesses (e.g., Ericsson, KPN), knowledge institutions (e.g., Technical University Eindhoven, TNO), and governmental bodies (e.g., Ministry of Economic Affairs and Climate Policy). These 60 partner organizations are divided into four program lines: PL1, intelligent components; PL2, intelligent networks; PL3, leading applications; PL4, strengthen ecosystem. Within these program lines, organizations work together on several work packages. This is visualized in Figure 1, which also shows which work packages are included and how the program lines are related to each other.

Program line 4, strengthen ecosystem, is unique for an R&D consortium to have explicitly mentioned. Next to the scale and wide range of technology this consortium aims to develop, the explicit goal to strengthen the ecosystem attributes to make this a unique case. The standardization and encouragement of international collaboration on 6G make this case especially interesting to study. This connects the consortium with its partners to a larger ecosystem, making this interaction explicit.

Other than that, telecommunications have been central to many case studies concerned with standardization, industry consortia, or (innovation) ecosystems (Genschel, 1997; Leiponen, 2008; Ranganathan et al., 2025; van den Ende et al., 2012). This is due to several reasons. For starters, telecommunication systems often

Figure 1. Overview of the Different Program Lines (PL) and Their Corresponding Work Packages

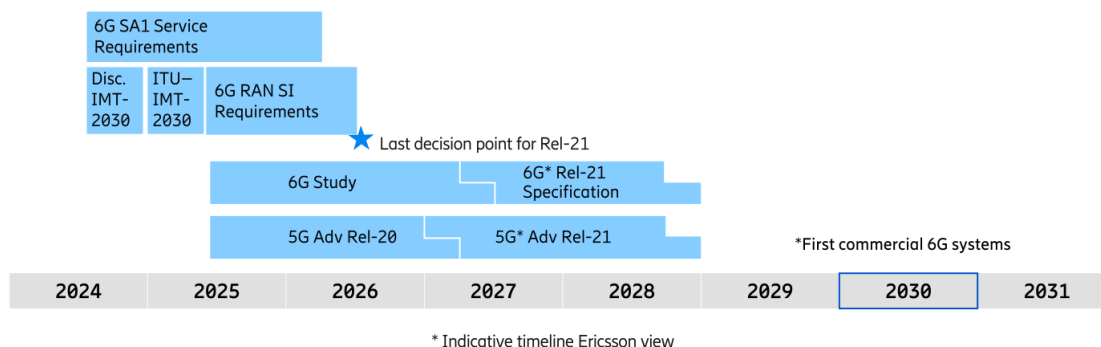


Note. Image by Future Network Services. (n.d.). *About 6G Future Network Services*. Retrieved April 10, 2025, from <https://futurenetworkservices.nl/en/about-fns/>

reflect a high level of technical complexity (Leiponen, 2008) with high modularization (Jacobides et al., 2018) and a high level of multilateral interdependencies (Ranganathan et al., 2025). This requires a significant effort to align actors (Ranganathan et al., 2025), through standards or consortia, for example. The absence of centralized control implies that companies have to find ways to govern ecosystems indirectly (Olk & West, 2023). Lastly, a new generation of wireless telecommunication (6G) presents a renewed standards battle (Leiponen, 2008) and the ‘re-shuffling’ of competitive dynamics globally.

3.2.2 6G

6G refers to the standard for the sixth generation of mobile systems. While 5G technology was introduced in the Netherlands not so long ago, the development of the next generation technology has already begun. The Europe-wide public-private partnership Smart Networks and Services Joint Undertaking (SNS JU) describes the transition

Figure 2. Indicative Timeline of 6G Development, Considering 3GPP Timing

Note. Image by Ericsson. (2024). *6G standardization – an overview of timeline and high-level technology principles*. Retrieved April 30, 2025, from <https://www.ericsson.com/en/blog/2024/3/6g-standardization-timeline-and-technology-principles>

to 6G as follows: “6G networks will move beyond connectivity to become intelligent, context-aware, and adaptive systems, leveraging artificial intelligence (AI), deep-edge computing, non-terrestrial networks (NTN), and integrated sensing and communication (ISAC).” (2025). This joint undertaking is led by the industry association 6G IA and the European Commission, and is considered an influential body in 6G development worldwide.

6G development is still in its early stages. Broadly speaking, one global organization is considered the leading organization in defining the technical specifications that provide a complete system description of 6G: 3GPP. This alliance comprises telecommunication standard development organizations from Europe, North America, and Asia, and has been the main body for global standards of 3G, 4G, and 5G. Ericsson (2024) has laid out an indicative timeline of what can be expected of 6G development in the coming years, based on the timing of 3GPP (see Figure 2). It is generally expected that 6G will be commercially available by 2030. In the meantime, global initiatives are focusing on the requirements, use cases, and technology of 6G.

3.3 Data Collection

Primary data was collected through semi-structured interviews. Semi-structured interviews were held at a single point in time. Therefore, this study adopted a cross-sectional time horizon, as opposed to a longitudinal one. While the literature argues that a single cross-sectional case study produces less strong evidence for theoretical generalization (Tsang, 2014), time and resources within this thesis make other approaches, such as longitudinal, not feasible. A semi-structured interview method is often used in qualitative research, as it places a greater emphasis on understanding the interviewee’s point of view (Bell et al., 2019). It allows interviewees to ‘ramble’,

giving insight into what the interviewee views as important or notable. Semi-structured interviewing involves asking open questions, making it a more naturally flowing conversation. This establishes a certain level of trust, but also gives freedom to the interviewee to reveal their definition of the situation (Duwors & Phillips, 1967).

An interview guide was prepared for the interviews that included a list of questions on various topics. Questions for the interview guide were prepared based on three factors. Firstly, questions were formulated to help make sense of the problem statement, which is central to this study. Secondly, prior literature provides some insight into what is important in this context. However, the literature was consulted with care to avoid too many preconceptions, which is detrimental to qualitative research. Thirdly, informal discussions and two interviews with scholars were conducted to provide direction for designing the interview questions. As new themes and ideas emerged from the interviews, the questions were reviewed accordingly.

For this research, purposive sampling was used to select the participants within the consortium. In qualitative research, purposive sampling is often used to select the information-rich cases (Ghauri et al., 2020). Information-rich cases are those that provide significant insights about issues central to the purpose of the inquiry (Patton, 2002). Purposive sampling was done by selecting a diverse group of organizations within the consortium that could give insight into various perspectives. This is called generic purposive sampling (Bell et al., 2019). Generally speaking, the consortium consists of governmental bodies, knowledge institutions, large enterprises, and SMEs. Hence, a selection was made to cover this variety. This resulted in the selection of the following organizations: one government, two knowledge institutions, four large enterprises, and one small to medium-sized enterprise (SME). Some organizations or individuals were recommended as they are important to the consortium. This way, a few people from the core team of the consortium were interviewed, for instance. This part is called snowball sampling (Bell et al., 2019). As the core team has a coordinating role in the consortium, interviews with individuals from the core team were slightly altered to get the right insight from this coordinating role, and naturally, some questions did not apply to the individuals of the core team. This can be traced back to the embedded case study design, where the interviews with the core team are essential for understanding the holistic aspects of this case. An overview of the participants of the conducted interviews is included in Table 1.

The core team of the consortium recommended the individuals who are most involved in strategic decision-making regarding the consortium for their respective organizations, and also assisted in reaching out to the managers to smooth the process of getting the interviews.

Table 1: Participant List

<i>Interview</i>	<i>Position</i>	<i>Organization</i>	<i>Organization Type</i>
Interview 1 (P1)	Alliance Director*	TNO	Knowledge institution
Interview 2 (P2)	Program Director*	TNO	Knowledge institution
Interview 3 (P3)	Business Validation Manager*	KPN	Large enterprise
Interview 4 (P4)	Program Line Lead*	TU/e	University
Interview 5 (P5)	Principal Scientist	Philips	Large enterprise
Interview 6 (P6a & P6b)	CTO & Principal Solution Architect	Ericsson NL	Large Enterprise
Interview 7 (P7)	Senior Policy Officer	Dutch Ministry of Economic Affairs	Government
Interview 8 (P8a & P8b)	CEO & CTO	Antennex	SME
Interview 9 (P9)	Business Validation Manager*	NXP NL	Large Enterprise

Note: * = Position in FNS Core Team

Organizations involved in the consortium often only have a small team of people (compared to the organization's size) participating in 6G development within the consortium. Therefore, individuals involved in strategic decision-making regarding the consortium were selected.

The interviews were preferably held in person, but online when necessary. The duration of the interviews varied between 30 and 90 minutes. The interviews were recorded for accuracy, with the participant's consent. After the interview, participants were asked if they would like to review the transcripts to ensure the accuracy of the transcripts and to determine whether any sensitive information should be removed.

3.4 Data Analysis

Data analysis consisted of several steps. First, once the recorded interviews were transcribed, data immersion was utilized to become familiar with the content. This involves reading the transcripts multiple times to ensure a proper

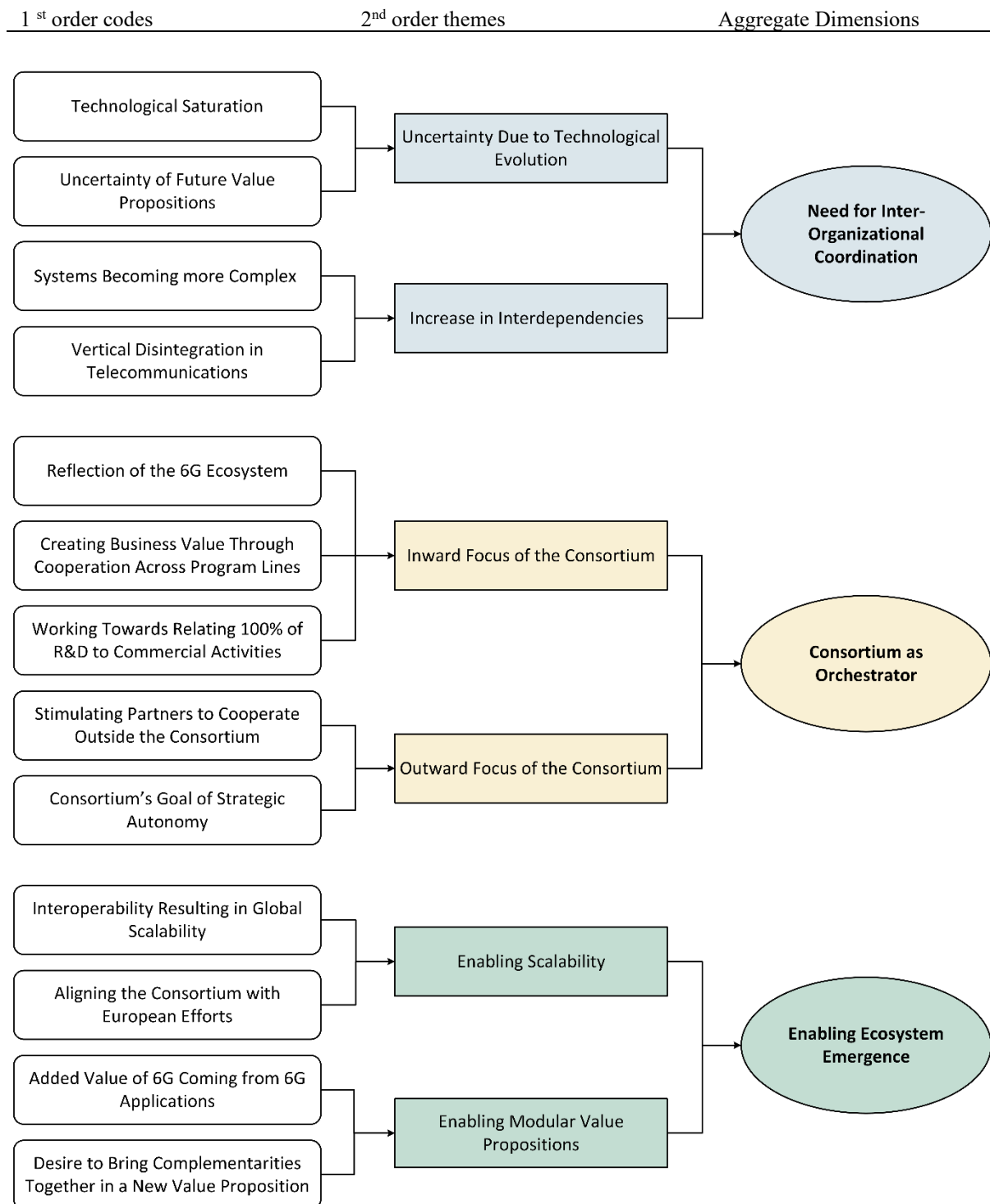
understanding. Following this, categorization was performed through a four-step process. Categorization means “identifying chunks of data (e.g., a passage of text of any length) as belonging to, representing, or being an example of some more general phenomenon” (Ghauri et al., 2020). The first step was to form initial codes through in-vivo open coding (Bell et al., 2019). First-order codes were constructed using illustrational quotes (e.g., “Reflection of the Ecosystem” as articulated by P1) and remaining close to the participants' own words. First-order codes were then consolidated into second-order themes. Linking the data to existing literature helped make sense of the first-order codes and gave way for theoretical development through second-order themes. Establishing two foci of consortia (Lavie et al., 2007), for example, resulted from a back-and-forth engagement between the data and the literature. Thirdly, the themes were synthesized into aggregate dimensions, expressing their theoretical purpose, with the research question in mind. This resulted in the data structure, presented in Figure 3.

To effectively present the findings, a data structure was created that illustrates the specific contents and affiliations of first-order codes, second-order themes, and aggregate dimensions. However, the data structure alone is limited in its explanatory power of how concepts are related to each other and in presenting the dynamic nature of concepts (Gioia et al., 2012). Hence, as the final step of data analysis, themes and aggregate dimensions were put into a model-led composition (see Figure 3), offering an integrative perspective (Berends & Deken, 2019).

3.5 Research Quality

The quality of case-study research is assessed through four criteria: construct validity, internal validity, external validity, and reliability (Yin, 2003). The following sections outline how research was undertaken to conform to these criteria.

Construct validity refers to establishing objective measures for the concepts being studied (Yin, 2003). A threat to construct validity in this study was the perception of ecosystems. In early discussions, it became clear that when discussing ecosystems, the theoretical and practical uses of the term differed significantly; in practice, the term ecosystem has become somewhat of a buzzword. Therefore, participants were not directly asked about ecosystems to prevent confusion and preserve construct validity. Instead, to make inferences about ecosystems, participants were asked about elements (e.g., modularity, complementarity) that may be used to recognize an ecosystem lens.

Figure 3. Data structure

Additionally, construct validity was enhanced by conducting two interviews with scholars who have contributed to relevant literature to explore constructs relevant in researching consortia, ecosystems, and standards, and how these can be best measured.

Internal validity refers to whether there is a good match between the researcher's observations and the theoretical inferences made from them (Bell et al., 2019). In this case study, the complexity of the case may pose a threat to internal validity, as it allows for other possible explanations. However, the prolonged engagement with a phenomenon in its real-life context makes the researcher somewhat capable of drawing coherent inferences (LeCompte & Goetz, 1982). This is done by triangulating the collected data, as the researcher engaged in informal discussions with consortium members beyond the interviews, attended multiple conferences organized by the consortium, and had access to various archival data.

External validity refers to the extent to which findings can be generalized to other contexts (Bell et al., 2019). Since this study uses a single case, the transferability of its findings may pose a limitation. However, by providing a detailed description of the data, it allows others to make their own judgements. Additionally, to preserve external validity during data analysis, themes and aggregate dimensions emerged through a dialectical process of shuttling with existing theory to generalize the findings to theory. (Yin, 2003).

Lastly, reliability refers to the degree to which a study can be replicated (Bell et al., 2019). Reliability is strived for in this paper in documenting the procedures of undertaking this research. Additionally, interview guides were included in the appendices.

Findings

In this chapter, the findings resulting from the analysis of the conducted interviews are presented and explained. Then, the relationships between the aggregate dimensions and the second-order themes that emerged from the data analysis will be outlined and visualized in a theoretical model.

4.1 Need for Inter-Organizational Coordination

4.1.1 Uncertainty Due to Technological Evolution

Technological Saturation. In prior generations of mobile networks, the consumer was central. Nevertheless, several participants concluded that mobile networks have become a commodity to consumers and that new use cases remain unclear. In prior generations of mobile networks, a technology push by firms central to the telecommunications industry was sufficient for success, noted participant 9. Now that there is a certain degree of technological saturation, firms explore new use cases that would be possible with 6G technologies beyond the usual application of mobile networks for consumers:

“With 5G, that challenge was already evident. The question was: What should we do with it, and what are the real benefits? The industry struggled to clearly demonstrate the advantages of 5G features in a way that convinced people to spend money... That is exactly what everyone is searching for right now—and what the industry is trying to figure out.” (P9)

Standardization outside the consortium happens similarly. Use cases of 6G can be admitted, and based on these use cases, the technological requirements are standardized. Participant 3 described it as follows:

“Say, we have a fantastic application for 6G, and we believe that in the standardization of 6G, in terms of frequency and these types of antennas, we should use this application to carry out the standardization. That is essentially the connection between standardization and the application...” (P3)

However, ultimately, this requires coordination between organizations enabling 6G and those facilitating use cases, as becomes clear from participant 5 describing their role in 6G:

“We are one of the stakeholders for the requirements, particularly the performance requirements. Our role is to clarify the use case and define these requirements with precision.” (P5)

Uncertainty of Future Value Propositions. In line with the previous theme, several participants have remarked that the successful adoption and deployment of 6G technologies depend as much on developing the core technology as on developing applications of 6G technologies. Therefore, the mere development of technology without coordination with downstream actors would not result in as much value creation. How these 6G applications turn out shapes how firms offering networks and infrastructure interact with firms offering their services and products for new use cases. For example, Philips is specifying a specific use case with a steep bandwidth demand (P5), which would change how network firms would have to organize their networks. Similarly, when reflecting on the organization’s future role in 6G, uncertainty remains. Partners aim to remain adaptive and continuously assess their roles in 6G:

“So that role depends somewhat on what is coming—what technology is emerging and whether we are in a position to facilitate part of it.” (P3)

On the other hand, new technological developments have enabled applications that were previously not possible. Organizations, like Philips, that are not necessarily embedded in telecommunications, could advocate for certain requirements to enable their use case:

“... it's good to keep it on the radar. Our other performance requirements are quite ambitious, but ... if you say that it's not overly ambitious, then 4G is probably sufficient.” (P5)

However, not all use cases that would be possible with more advanced mobile networks are viable for telecommunications organizations:

“For us, remote surgery was a major development. You can perform operations remotely, but the question is—how often will this actually happen? Is there a viable business case for it?” (P6a)

4.1.2 Increase in Interdependencies

Systems Becoming More Complex. The formation of the consortium occurred for multiple reasons, but a prevalent reason to bundle resources and cooperate was to make an impact on 6G development. Individual partners would not be able to make such an impact as could be achieved by a consortium:

“So the consortium is essential for pooling our strengths in a way that enables us to create meaningful impact and integrate into the international ecosystem.” (P2)

Several participants mentioned that this global involvement in 6G is a challenging aspect of making an impact on 6G. Additionally, there is an understanding that 6G cannot be fully developed within the Netherlands:

“Chips, for instance, is probably the most globally integrated industry imaginable. It’s truly a worldwide network with strong regional and national specializations. You have to operate on a global scale—otherwise, you simply won’t succeed..” (P7)

Nevertheless, compared to previous generations of mobile networks, development of 6G technology also gives rise to more opportunities:

“Networks are becoming increasingly sophisticated, enabling more and more applications. And parties are beginning to realize that it’s essential to get involved early.” (P6a)

Vertical Disintegration. Following discussions prior to the FNS interviews, a researcher pointed out the trend of vertical disintegration in the telecommunications industry. This would lead to SMEs playing a more important role in 6G. Participants generally recognize this trend as well:

“...[companies] who have their own specialty and are located in different parts of the world, meaning the entire system only functions effectively if there is a well-established ecosystem with mutual trust and solid agreements—ensuring that everyone benefits... It has indeed increased over the years—you can see that it is becoming more specialized in that area.” (P4)

From a government perspective, this is a positive development. Due to geopolitical tensions, it is beneficial to allow more competition and have less dependence on a limited number of large enterprises. Standardization could facilitate this:

“The idea is that the system can be increasingly modularized, allowing for more specific standards. This would enable companies to source individual components from different providers, fostering greater competition in the market.” (P7)

4.2 Consortium as Orchestrator

4.2.1 Inward Focus of the Consortium

Reflection of the 6G Ecosystem. In the process of setting up the consortium, all relevant telecom organizations in the Netherlands were brought together, alongside less obvious organizations that could prove complementary. Compared to other consortia, the FNS consortium is quite unique, as participant 9 pointed out:

“Many projects focus on investigating specific aspects rather than developing a full ecosystem, because building an entire system from components to applications is extremely costly. ... But now, it does happen.” (P9)

The uniqueness of the consortium’s structure is apparent in the involvement of a diverse range of organizations that are interdependent and complementary to one another. Moreover, organizations specializing in core technology, networks, and applications are all included. Various participants frame this as the consortium reflecting the ecosystem:

“So, with our program, we are a small reflection of the much larger international ecosystem.” (P1)

“I think a consortium is like a mini ecosystem. In fact, the consortium itself is also a kind of ecosystem, right? It just depends on the scale you choose. But in the Netherlands, we are the 6G ecosystem—you could put it that way.” (P2)

This way, as participants call it, an ecosystem approach emerges. It follows that this is also where the added value of this consortium lies. For some organizations, the development of 6G technology happens regardless, but specifically, the added value comes from this structure.

“If you collaborate with a company that develops drones and builds a business case, it naturally leads to entirely different insights—ones that are much more concrete, more interesting, and that also impact

technology development... I think it will also provide a competitive advantage over companies in other countries that develop things in isolation—they will be at a disadvantage.” (P4)

“That is the reason for collaboration—otherwise, if we want something, we simply buy it, right?... The ideal consortium adds exactly what you do not have yourself, but in doing so, allows you to improve.” (P9)

Creating Business Value Through Cooperation Across Program Lines. When participants were asked to reflect on the approach to technology development in previous generations of mobile networks, it became clear that, at least in the Netherlands, no cooperation on such a scale had been undertaken before. It followed that Dutch firms were not as involved as much in the development of the technology; instead, 5G got “...*handed to us on a silver platter, and we had to figure out for ourselves how to use it.*” (P2). Consequently, value appropriation opportunities were limited:

“There are many parties in Europe saying that 5G monetization has been disappointing.” (P3)

Consequently, the consortium was formed not only to utilize the technology but also to contribute to its development:

“This allows us to influence the structure of the 6G ecosystem, not just as users but also as builders. It’s comparable to a house—we won’t just live in it, we will also help construct it and determine what it will look like.” (P2)

The consortium is structured in a way that organizations focusing on components, networks, and applications are distinctly grouped into program lines to advance development effectively. But as much as this effectively ‘pushes’ technology, the consortium emphasizes creating business value by stimulating cross-pollination. Cooperation and knowledge sharing are encouraged across these program lines through the introduction of value chains:

“We examined which parties are present in which value chains and how we can strengthen collaboration within those chains. You can see that parties from PL1, PL2, and PL3 come together within a specific area to work jointly on a new functionality.” (P3)

Working Towards Relating 100% of R&D to Commercial Activities. For quite some partners, this 6G R&D initiative was initiated quite early, but the presence of the universities was, among other things, an important prerequisite for partners to join FNS. Universities and subsidy financing enabled partners to engage in pre-competitive R&D. However, as the consortium had started its first projects and activities, evaluations of its activities and outcomes revealed that too little research was undertaken that was focused on applying to commercial applications. The universities are an important prerequisite, but research had to be more directed towards commercial activities, as mentioned by the business validation managers:

“The idea is to ensure that if a university is conducting research on a particular topic, it directly contributes to commercial applications—making research more applicable in real-world scenarios.”
(P3)

4.2.2 Outward Focus of the Consortium

Stimulating Partners to Cooperate Outside the Consortium. As several participants pointed out, the development of 6G happens on a global scale. First and foremost, because of standardization, on which many actors depend. But next to that, many other countries have initiated national R&D initiatives, and globally, many organizations are engaging in R&D for 6G. The core team of FNS aims to make partners more embedded through the program:

“On one hand, we establish connections with other consortia in the Netherlands that are working on relevant technology... Additionally, we seek collaborations in Europe with countries that share the same motivations for working on 6G.” (P2)

To make an impact and achieve success in 6G, the core team of FNS emphasizes the importance of being active globally. Because, as mentioned earlier, the value chains in the telecom industry tend to be global. Some participants reported being engaged in other consortia where an aspect of 6G is the focus, while others reported they were involved in consortia related to 6G, such as those in the automotive sector. Next to that, engagement in industry coalitions was also seen as important:

“The other part of the ecosystem consists of applications. Various collaboration discussions take place, focusing on sectors like the 5G and 6G industry or 5G and 6G automotive. These discussions are more about application-sharing rather than standardization. We also engage in these conversations.” (P1)

Whereas roughly half of the partners in the consortium are involved in other collaborative agreements for 6G, some participants still see the lack of partner embeddedness as a possible challenge for this consortium to be successful:

“If the connection with the European programs lags behind in that regard, that would still be a challenge for FNS.” (P7)

Consortium’s Goal of Strategic Autonomy. Participants who have contributed to the formation of the consortium mentioned the two primary goals of the consortium: enhancing national competitiveness and achieving strategic autonomy. The former can be recognized in stimulating consortium-spanning value creation and eventually creating more business value. The latter refers to how the consortium aims to make the Netherlands as independent as possible. This was a goal from the beginning of the consortium, but became increasingly important due to geopolitical tensions.

“So, the growing awareness in Europe that greater economic independence is necessary means building up our own knowledge base and reestablishing a strong domestic industry... If you have a strong position, you can negotiate. Without it, the opportunity is simply lost.” (P1)

Naturally, becoming fully independent and autonomous regarding 6G would not be feasible. Thus, the focus was on the strengths and capabilities of the Dutch industry, as well as those of Europe:

“We structured the program lines based on the strengths we have in the Netherlands and Europe. We then assessed whether we could gather enough partners to bring these initiatives to fruition.” (P2)

4.3 Enabling Ecosystem Emergence

4.3.1 Enabling Scalability

Interoperability Resulting in Global Scalability. An important prerequisite for making FNS a success is the interoperability and scalability resulting from standardization. All participants emphasized that standardization plays an important role in the success of the program, as well as in individual interests. Especially in

telecommunications, standardization is needed for regulatory and performance reasons. At the same time, businesses recognize the economic importance of standardization.

“But also with the aim that once this standard truly becomes a global standard, you will have products and services that fully align with it. And that is essentially the reason... to ensure that your products fit as well as possible within the standard so that you have a chance to make a lot of money worldwide.”
(P2)

This makes standardization a complex globalized process with a diverse set of stakeholders and important implications. Some participants argue that standardization can determine the scale of the innovations or technologies that are developed within FNS:

“We are very aware that for some of the things being developed, if they are not standardized, they will likely have a smaller market, which in turn limits commercial opportunities... it is embedded in the program that these activities receive attention and are actively pursued. We definitely recognize the importance of this.” (P7)

The FNS consortium stimulates partners to actively engage in standardization. Altogether, the aim is that firms with patented technologies strive to standardize their technology, and additionally, other firms have developed innovations and technologies compatible with the standardized technology.

“So, once again, patents or royalties—but also ensuring that, as a company, you fully understand how everything works, know all the intricacies, and can be immediately ready to act.” (P9)

Aligning the Consortium with European Efforts. In the extension of the previous code, several participants noted that the consortium aims to align with European efforts to achieve scalability and make an impact. The consortium aligns some of its activities and focus with what happens on the European scale:

“The European Commission has established a large European research program—this is the European initiative. A significant portion of their efforts aligns with what we are doing in the Netherlands, so we actively connect to and engage with the initiatives they develop.” (P1)

To some extent, this reinforces the importance of standardization, as partners of FNS gain better insights into how the standards will be developed through alignment with European efforts. After all, participants are convinced that much of 6G development will take place in Europe:

“But these European programs, for example, contribute significantly to standardization.” (P2)

Finally, geopolitics also contributes to the motivation of aligning with European efforts. To reach strategic autonomy, the government looks at a European scale. There remains a recognition that 6G cannot be effectively developed solely within these national initiatives. Consequently, the initiatives of the European Commission as a whole, can have that impact, which FNS hitches onto:

“For the digital economy, we are not only looking at the Netherlands but at Europe as a whole. Europe is essentially our perspective—can we develop and acquire the necessary technology within Europe?” (P7)

4.3.2 Enabling Modular Value Propositions

Added Value of 6G Coming from 6G Applications. While much of 6G R&D initiatives focus on developing specific aspects of 6G technology, applications have been a key component of 6G development. Much of this, naturally, is triggered by technological saturation. Participants realize that much of the success of 6G is dependent on its applications:

“But indeed, we see that 6G will only truly provide value once it enables entirely new possibilities and applications.” (P3)

Hence, applications of 6G technology are most effective in combination with other complementary technologies, which together create a value proposition. As a result, organizations complementary to mobile network organizations have become increasingly important. This is also the reason for cooperation, as Participant 9 pointed out:

“We certainly want a device to come back where someone will at least say, “Well, if you add this and we are able to do that as well, then it will be truly great.” And that another one says “Oh, we’ll add this extra feature in software,” making it a real success.” (P9)

Desire to Bring Complementarities Together in a New Value Proposition. Finally, participants' reflection of what they ideally envision as their organization's role in 6G revealed how some participants would eventually want a value proposition to come together where multiple complementary organizations contribute to a value proposition. The example of participant 9 in the previous paragraph showcases how several complements would come together in a value proposition. Notably, participant 3 would ideally even want to set up a platform to enable such an ecosystem construct:

"...we aim to provide a platform where companies can serve a specific niche or customer group with a particular application. We establish the foundation for these applications, ensuring they can run effectively while leveraging network elements. They may utilize specific network features that we offer within the platform, enabling those companies to serve their end customers with specialized solutions."
(P3)

This exemplifies how certain organizations can contribute to the development of emerging ecosystems. However, several participants indicate that especially the mobile network operators are in such a position, as they own the spectrum licenses and directly contribute to customer-facing products and services.

4.4 Towards a Synthesis

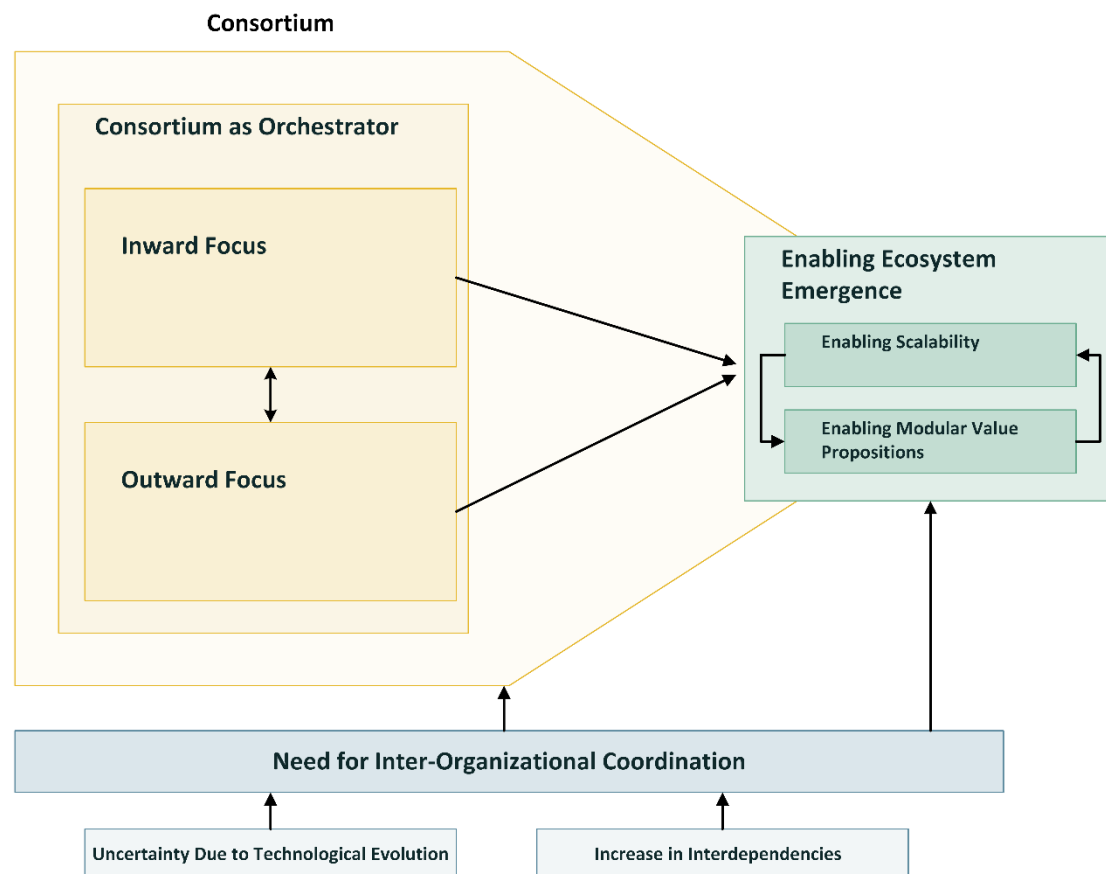
From the data analysis, it follows that technological saturation and technological evolution in telecommunications have caused uncertainty. Value appropriation in telecommunications has become uncertain as the technology has reached saturation. Hence, instead of a technology push, firms globally seek new value propositions that are enabled by mobile networks. Similarly, a new technological generation results in new standards, which, in turn, re-shuffle the roles and positions of firms in telecommunications. Additionally, telecom system offerings have become more complex, which makes firms more globally interdependent. Likewise, components of these system offerings are produced by a greater number of diverse actors due to vertical disintegration. Altogether, these dynamics increased the need for inter-organizational coordination.

In response to these dynamics, firms within the FNS consortium engage in explorative R&D to develop new value propositions and technology accordingly. The consortium's structure and partner selection enable collaboration among its partners to create joint-value through interactions among upstream and downstream component producers. Additionally, university research is guided by commercial applications to ensure

valorization. While this emphasizes an inward focus of the consortium, the consortium actively encourages partners to engage in similar inter-organizational R&D initiatives to embed them in the global ecosystem. Similarly, the consortium's goal of strategic autonomy necessitates constant consideration of its positioning in relation to other R&D initiatives.

Where the consortium serves as the vehicle for organizations to coordinate and explore new value propositions, the triggers indicating the need for inter-organizational coordination affect how value propositions are organized. Interoperability can be achieved through standardizing the underlying technologies, enabling the scalability of these value propositions. Similarly, interoperability is anticipated by aligning the consortium's efforts with European 6G efforts. Through such alignment, partners can better anticipate emerging standards and thus anticipate the complementarity of their technologies. It follows that the anticipation of complementarity can ground a firm's position in emerging ecosystems. Accordingly, telecommunication firms anticipate modular value propositions to appropriate the most value of new technologies. As a result, it enables new ecosystems to emerge. Overall, these findings are synthesized in the theoretical model visualized in Figure 4.

Figure 4. Theoretical Model



Discussion

This study sought to explore how consortia support their partners in shaping emerging innovation ecosystems during the early stages of technological evolution. Building on an in-depth case study of the FNS consortium, this study illustrates how a consortium's structure and set of partners can facilitate joint-value creation and support its partners in forming and scaling innovation ecosystems during the early phases of technological evolution. It follows that the need for inter-organizational coordination arises as a general trigger, driven by both uncertainty due to technological evolution and increasing systemic interdependencies. Both elements result in ecosystem-wide uncertainty, necessitating coordination among actors.

By serving as a vehicle for inter-organizational coordination during the early phases of technological evolution, an R&D consortium creates a structured yet flexible vehicle in which partners collectively navigate uncertainty, explore new value propositions, and position themselves for future ecosystem dynamics. Two interlocking mechanisms facilitate this process. First, an inward focus drives internal alignment: the consortium curates an 'ecosystem-like' set of partners, encourages cross-pollination across program lines, and steers toward joint-value creation. Second, an outward focus embeds partners in broader networks, promoting engagement in global standard-setting bodies, seeking relevant complementary actors, and pursuing strategic autonomy within the global ecosystem.

Together, new value propositions may emerge. Subsequently, two mechanisms can, in turn, facilitate the emergence of ecosystems by enabling the scalability and modularity of these value propositions. Scalability is achieved through direct contribution to standards and, similarly, through anticipation of emerging standards. This way, actors can anticipate complementarity during explorative R&D. Additionally, as a result of technological saturation, explorative R&D emphasizes the importance of value appropriation in its focus on enabling new value propositions. These findings have important implications for both theory and practice, which will be discussed below.

5.1 Theoretical Implications

First, recognizing the distinct innovation challenges upstream and downstream of a focal firm reveals important asymmetries in their impact on the firm's capacity to generate value from its offerings (Adner & Kapoor, 2010).

The theoretical framework of this study extends this notion by explaining how such innovation challenges are coordinated within an R&D consortium in the early phases of technological evolution and how its approach in doing so can impact the value appropriation opportunities of partner firms. This relates to how a consortium, comprising relevant upstream and downstream actors, connected by a central technology, could create fertile ground for exploring alignment among these actors in future value propositions. How these actors explore possible alignment structures lies in the extension of what Dattée et al. (2018) coin as ‘playing the ecosystem game’. Instead, in this case study, the consortium serves as the vehicle for creating and appropriating value from emerging technologies.

Second, much of the dynamics in the theoretical model can be explained as centripetal and centrifugal forces, where the former pushes for vertical integration into a single entity, and the latter pulls activities out onto the market (Holgersson et al., 2022). Technological saturation has significant implications for how value is appropriated. Additionally, to enhance global competition, standards tend to get more modularized (i.e., more specific parts of technology are standardized). Alongside the trend of vertical disintegration, it represents a shift in centrifugal forces. However, this case study demonstrates that both policymakers and managers seek complementarity in new value propositions during the development of new technologies. This extends on the notion of new ecosystems emerging from technological inventions (Dattée et al., 2018), and demonstrates how centripetal and centrifugal forces facilitate ecosystem emergence.

Third, this study’s findings contribute to the multi-partner alliance literature by nuancing the implications of firms’ external involvement for both public and private benefits (Lavie et al., 2007). Through involvement in multiple R&D consortia, firms can better influence standards (Leiponen, 2008). However, firms at the periphery can also benefit from external involvement by anticipating complementarity in relation to emerging standards. Additionally, by aligning the R&D efforts of a consortium with key standards contributors, a consortium can better anticipate emerging standards and develop technologies that complement them. This implies that, due to technological saturation, firms at the periphery, rather than merely those at the core (Jacobides et al., 2018), may play a more influential role in shaping emerging ecosystems. Overall, through external involvement, consortium partners can better navigate uncertainty and therefore shape emerging innovation ecosystems (Olk & West, 2023).

Finally, the findings of this study extend the concept of multi-tiered governance, where distinct governance mechanisms are employed based on the convergent or experimental nature of the complementor and its associated uncertainty (Reiter et al., 2024), by illustrating how, in this case, the global standardization of

telecommunications is formally coordinated and convergent, whereas the consortium operates in an informal and exploratory manner (Buchanan et al., 2025). Whereas Reiter et al. (Reiter et al., 2024) indicate that this is not generalizable to ecosystems with dispersed control, the findings of this study suggest that actors can engage in multi-tiered governance through R&D consortia. That is, in an R&D consortium involving both upstream and downstream component actors, focal firms can simultaneously address uncertainty at both the core and the periphery and coordinate them effectively.

5.2 Practical Implications

The findings of this study yield several implications for managers and policymakers. It is worth arguing that the ecosystem perspective is being progressively embraced as a framework for structuring consortia. Naturally, with the upsurge of ecosystems, more managers and policymakers are acknowledging and employing an ecosystem perspective to innovation.

First, where technological saturation and technological evolution lead to ecosystem-wide uncertainty, R&D consortia comprising upstream and downstream firms can effectively navigate this uncertainty, allowing firms to shape and coordinate emerging ecosystems effectively. This also implies that policymakers can support firms in shaping emerging innovation ecosystems by adopting an ecosystem approach to R&D consortia. Notably, this study's findings indicate an essential role of the government in supporting firms to shape innovation ecosystems, as early-phase R&D has significant implications for standard setting, and the simultaneous coordination of upstream and downstream actors can have important implications for value appropriation. Policymakers should consider this, as government funding is a crucial enabler of these initiatives.

Second, in large ecosystems with dispersed knowledge and control, partner engagement in multiple R&D consortia poses benefits for the firm and the focal R&D consortium (Lavie et al., 2007; Olk & West, 2023). In an R&D consortium where partners are complementary to each other, a focal firm engaging in multiple R&D consortia, thereby having a greater influence on standardization (Leiponen, 2008), could result in partners in the consortium benefiting by being complementary to focal firms in emerging innovation ecosystems. Managers should strategically consider their involvement in R&D consortia during the early phases of technological evolution, and policymakers should actively encourage external involvement among partners.

Finally, where technological saturation and technological evolution lead to uncertainty, managers and policymakers can view this as an opportunity to steer towards joint-value creation through ecosystem emergence. Technological evolution allows for value propositions to be organized along a modular architecture, where multilateral complementarity can arise, and thus innovation ecosystems may emerge (Jacobides et al., 2018). Managers should continuously assess these centripetal and centrifugal forces to manage their technologies and develop capabilities, thereby positioning themselves to shape emerging innovation ecosystems (Holgersson et al., 2022).

5.3 Limitations and Future Research

This study has several limitations and suggests some future research opportunities. First, some aspects of the methodology of this study present limitations. A criticism inherent to single-case study design is that its findings are often less generalizable. Whereas this case study does not provide statistical generalizability, it does aim to improve analytical generalizability by generalizing a set of findings to a broader theory (Yin, 2003). However, the limited number of interviews conducted may not ensure theoretical saturation, which is typically sought in qualitative research (Bell et al., 2019). This may impact the validity and reliability of this study. Future research could adopt longitudinal or multiple-case study designs to validate the findings of this study.

Second, as this case study employs a cross-sectional study design, it reflects intended outcomes but cannot attest to actual outcomes of the consortium. A longitudinal study that takes into account the entire process of the consortium and its outcomes would lead to more concrete theoretical and practical implications. Generally, though, it is difficult to say a single theory can truly explain or predict ecosystem outcomes in such a global and complex setting as telecom. Aspects such as geopolitics and standardization in telecommunications generally represent elements that can hardly be controlled or directed by individual actors, but do have significant implications, as stressed by several participants of this case study. On the other hand, Altogether, there lie opportunities for future research to focus on how actors can best adapt to these dynamics, and how consortia can best support actors in doing so.

Finally, as this study presents findings and implications inherent to telecommunications and, to some extent, to embedded ecosystems, the theory and its implications are mostly relevant to a context where knowledge and control are dispersed. Such ecosystems can be difficult to research as Whereas this study begins to recognize

the concurrent state of a sponsoring organization embedded in larger ecosystems, as suggested by Baldwin et al. (2024), ambiguity remains around their hierarchical relationship and their interactions. Future research could further explore this hierarchical interplay by examining how it evolves across the various stages of technological evolution.

Conclusion

How do R&D consortia support their partners in shaping emerging innovation ecosystems during the early stages of technological evolution? This central question guided this research. By conducting an in-depth case study of the FNS consortium, this study has demonstrated how a consortium's structure and set of partners can facilitate joint-value creation and support its partners in forming and scaling innovation ecosystems during the early phases of technological evolution. More specifically, a dynamic interplay of internal and external foci drives this process. Through an internal focus, a value-chain-spanning composition of partners, cross-program-line collaboration, and guided university valorization enables consortium members to steer towards joint-value creation. Through an external focus, proactive engagement in global standard-setting bodies, encouragement of external involvement, and strategic positioning of the consortium and its activities foster greater opportunities for value appropriation. Thus, an R&D consortium that blends divergent (exploratory) and convergent (coordinative) activities creates a structured yet flexible vehicle that enables partners to collectively navigate uncertainty, explore joint-value propositions, and position themselves for future ecosystem dynamics.

This result has significant implications for research at the intersection of innovation ecosystems and R&D consortia, as it illustrates the important role an R&D consortium can play in supporting its partners in shaping emerging innovation ecosystems. It adds to this literature by addressing the role of R&D consortia in supporting their partners in shaping emerging innovation ecosystems. Practically, this study shows how managers can navigate firm-level uncertainty during the early phases of technological evolution. For policymakers, this study finds that the government's role in supporting firms during technological evolution is essential.

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Appendices

Appendix A: Interview Guide FNS Core Team

Welcome

The purpose of the study, why they were selected, privacy concerns, and consent to record

If requested, the transcript of the interview will be sent to the participant, who may provide comments. The data will be changed accordingly if any comments or suggestions are made.

Introduction

1. What is your role in the team?
2. In which parts of the consortium is your organization involved in?
3. Could you describe the motivation of the organization to join the consortium?

The Consortium

4. How did the consortium start? And with whom?
5. What difficulties were there with setting up the consortium?
6. What is the common goal of the consortium?
 - a. Can this goal/objective change over time?
 - i. What dynamics influence the consortium's goal?
7. How does this common goal relate to the broader ecosystem?
8. How do you think different partners within the consortium strategize for the ecosystem?
9. How are the interests of the partners aligned within the consortium?
10. Do you experience difficulties in aligning the partners?
 - a. How so?

Partner selection

11. Could you describe the process of selecting the partners?
 - a. How do prior connections affect partner selection?
12. Could you describe how the roles within the consortium were assigned or decided?
 - a. Were there cases where the partner didn't agree with their role, or does this change over time?
13. If some organization outside the consortium is seen as increasingly important in the ecosystem, do you consider inviting that organization to the consortium?
 - a. Why, or why not?
14. How does the consortium manage relations outside the consortium?

Complementarities/interdependencies

15. Who initiates joint research projects? Leading firms, all firms?
16. What do you think causes the initiation of new research projects/directions?

Standards

17. How does the consortium approach standards? Perhaps more as a unified consortium, or encouraging individual actors to engage in standards setting?
18. Do partners strategize for standard development? How so?

Ecosystem

19. How do you identify the relevant scope of the ecosystem?
 - a. National, Europe, networks, 6G globally
20. How do you think the partners identify what scope of the ecosystem is relevant for them?
21. How do you see the ecosystem evolve, and how does the consortium anticipate this?

Closing

22. Is there any other thing you'd like to add?

Appendix B: General Interview Guide

Welcome

The purpose of the study, why they were selected, privacy concerns, and consent to record

If requested, the transcript of the interview will be sent to the participant, who may provide comments. The data will be changed accordingly if any comments or suggestions are made.

Introduction

1. What is your role in the organization?
2. Could you explain how the organization got involved in FNS?
3. What was the motivation of the organization to join the consortium?
4. How much of your organization's R&D efforts is focused on 6G?
5. Is the organization involved in other consortia? Or collaborative innovation efforts? If not, why not?

Roles

6. How would you describe your organization's role in 6G?
7. What would ideally be your organization's role in 6G? Now and in the future?
8. What challenges or barriers do you foresee in attaining that role?
9. Does the organization approach its role in 6G differently than it did during the development of 5G?
10. Do you consider yourself a leading firm in this consortium or a follower? In other words, do you set the choices and demands, or conform to the terms set by other firms with greater influence?

Interdependencies & Coopetition

11. How do you select partners to cooperate with on 6G technology (either in or outside FNS)?
12. How do you approach cooperation with competitors within the consortium? Different than outside the consortium?
13. Through this consortium, have you connected with any new organizations that could remain valuable to your firm beyond the consortium?
14. How does the increasing de-integration of value chains, resulting in more specialized companies, affect dynamics within the consortium and in 6G development overall?

Standards

15. How do you approach the standards process of 6G? Do you wish to contribute to standards setting/development? Is it different than with 5G?

Consortium

16. When is participation within this consortium successful for the organization?
17. What challenges and barriers do you foresee to make this participation successful?

End

18. Do you have any other insights that would benefit this research?

Appendix C: Data Display

Aggregate Dimensions			Second-order Themes	Exemplary Quotations
Need for organizational Coordination	Inter-	Uncertainty Due to Technological Evolution		With 5G, that challenge was already evident. The question was: What should we do with it, and what are the real benefits? The industry struggled to clearly demonstrate the advantages of 5G features in a way that convinced people to spend money... That is exactly what everyone is searching for right now—and what the industry is trying to figure out. (P9) Such a big change only makes sense if there is a real need for it. In the past, it was very clear—you had calling, right? That was a real game-changer, being able to call someone, so there was a huge market for it. Everyone wanted it, so it was worth investing in the network... Now, the question is more like—what is the next big application? (P8a) Maybe there are entirely new cases we haven't even considered yet, right? Technology is advancing at an incredible pace. AI, for example, is now appearing everywhere. But what exactly will AI's role be? We already see changes in traffic patterns—people interact differently with their smartphones because AI plays a role, whether embedded in the device or running in the cloud. (P6a) So, that role depends somewhat on what is coming next. What new technology is emerging, and can we play a part in facilitating it? To do that, we need to think ahead and actively engage in the development of new technologies—perhaps not leading the way, but certainly contributing to their evolution and conducting research. That is exactly what we are doing now. We must find a balance when looking toward the future. What is coming our way? How do we position ourselves so that we hold a certain authority in the space? How do we ensure that we can influence developments and direct some of them toward us, allowing us to generate value? That is the playing field we operate in. (P3)
			Increase in Interdependencies	I don't think [Dutch consortia on 5G] really existed, actually... Networks are becoming increasingly sophisticated, enabling more and more applications. And parties are beginning to realize that it's essential to get involved early (P5) And then you have to connect that with international companies like Ericsson and all those value chains, because these value chains are all global. Chips, for instance, is probably the most globally integrated industry imaginable. It's truly a worldwide network with strong regional and national specializations. You have to operate on a global scale—otherwise, you simply won't succeed.. (P7)

...[companies] who have their own specialty and are located in different parts of the world, meaning the entire system only functions effectively if there is a well-established ecosystem with mutual trust and solid agreements—ensuring that everyone benefits... It has indeed increased over the years—you can see that it is becoming more specialized in that area. (P4)

Well, yes, that happens on a broader scale. I know of technologies developed at Philips Research that were later spun off, though they were often more on the periphery of our focus areas. This kind of spin-off process happens all the time, and it's actually a good thing. It means that something potentially useful has been created or conceived, but as a company, you can only focus on so many things at once. So, it's important to decide where to concentrate efforts and where not to. If something has value, it's great when it finds its way forward rather than fading into obscurity. (P5)

Consortium
Orchestrator

as Inward Focus of
the Consortium

So, with our program, we are a small reflection of the larger international ecosystem. (P1)

I think such a consortium is like a mini ecosystem. In fact, a consortium itself is a kind of ecosystem, right? It just depends on the scale you choose. But in the Netherlands, we are the 6G ecosystem—you could put it that way. There isn't another 6G ecosystem in the country. (P2)

If you collaborate with a company that develops drones and builds a business case, it naturally leads to entirely different insights—ones that are much more concrete, more interesting, and that also impact technology development... I think it will also provide a competitive advantage over companies in other countries that develop things in isolation—they will be at a disadvantage. (P4)

Yes, an important reason why we invest resources here is to foster collaboration between parties—cooperation that wouldn't necessarily happen on its own. That is something we actively want to achieve.

These partnerships should emerge and grow stronger because that is, of course, a fundamental characteristic of an ecosystem. And hopefully, they will be sustainable and somewhat resilient even after the program ends. Ideally, the program runs until 2030, which is quite a long time, but the goal is to create something lasting—an ecosystem with partnerships that continue beyond its duration. (P7)

We have been added to the core team at the request of the National Growth Fund Committee to strengthen the connection between the project and the

business sector—essentially to enhance value creation. Our task is to maximize the value generated through our work. In practice, this means we have mapped out the value chains. Additionally, we have interviewed researchers and mapped their work onto these value chains. The ideal is for every research effort to contribute to value creation. We have now formalized this approach and introduced a new KPI—which didn't exist before—to measure the link between researchers' work and value creation. This includes not only PhD researchers but also those from TNO and universities, examining how value can be built from their contributions. (P9)

We have also defined a KPI stating that 100% of research conducted by universities and institutions should be linked to a commercial activity. After measuring it—through numerous interviews—we found that currently, only about 13% meets this criterion. This is a new initiative. Our goal is to bring that number to 100% within the next three years. That means ensuring that every university conducting research on a given topic is directly applying it within commercial activities. It's about shifting research toward practical applications. (P3)

Outward Focus of the Consortium It is also in our best interest to ensure people establish more connections in various places. (P1)

On one hand, we establish connections with other consortia in the Netherlands that are working on relevant technology... Additionally, we seek collaborations in Europe with countries that share the same motivations for working on 6G. We are considering Finland, Sweden, and Germany as key partners, as they also have 6G programs. Beyond Europe, we are exploring opportunities with Taiwan, Japan, and Korea, where exciting developments are taking place. We are assessing potential ways to collaborate—not necessarily as a consortium, since FNS consist of 60 parties. However, TNO, as the consortium lead, is exploring whether we can work with Taiwan to exchange knowledge in areas that are valuable to us. Likewise, we have expertise that could be beneficial to them, and together, we might develop solutions that both sides can use. (P2)

So, the growing awareness in Europe that greater economic independence is necessary means building up our own knowledge base and reestablishing a strong domestic industry... If you have a strong position, you can negotiate. Without it, the opportunity is simply lost. (P1)

Yes, we naturally take a European perspective when considering the digital economy. We don't just look at the Netherlands but at Europe as a whole. The key question is: Can we develop and acquire the necessary technology within Europe? That is the central focus of our approach. (P7)

Enabling Emergence	Ecosystem	Enabling Scalability	Yes, we play a significant role in this. We chair SA1 within 3GPP, with much of the work outsourced to TNO, whom we hire to represent us within 3GPP. In addition, we also have direct representation in some areas. Our goal is often to influence standards, but also to build a patent portfolio. By ensuring that our developments are incorporated into standards, we create opportunities to generate revenue from them. This is a strategy many players engage in, and we do the same. (P3) Yes, our technology is not currently part of the standard, but we want to change that. However, we have a system that competes with the existing standard from a purely technical perspective. Naturally, there are stakeholders who oppose this, making the process quite challenging. (P8a) You naturally try to ensure that what you develop gets integrated into the standard. That way, you can be the first—and the best—at utilizing it, or position yourself so that others have to pay to use it. (P9) The European Commission has established a large European research program—this is the European initiative. A significant portion of their efforts aligns with what we are doing in the Netherlands, so we actively connect to and engage with the initiatives they develop. (P1) It is also important to collaborate at the European level because, while we are based in the Netherlands, working together across Europe achieves more. The European 6G program is one way to do this, but there is also ETSI, a European standardization organization. Ericsson is also involved in 6G, working to bring European parties together to identify key areas for joint efforts. The goal is to determine what aspects require collective focus and to make strategic choices that maximize impact. ETSI is one of the organizations worth actively participating in, and we consider this a priority. (P7)
		Enabling Modular Value Propositions	Those applications are what determine the success of our technology. (P6a) But ultimately, it always comes down to enabling new technology or new functionalities. That is, in a way, the core reason why we participate in FNS. Our main focus is on applications, although we are also active in PL1 and PL2. However, we see that 6G will only truly provide value once it enables entirely new possibilities and applications. (P3) Ultimately, you want both parties involved in a project to grow stronger, not just to deliver a product at the cost price. That is not the goal. We certainly want a device to come back where someone will at least say, "Well, if you add this and we are able to do that as well, then it will be truly great." And that another one says "Oh, we'll add this extra feature in

software," making it a real success. We could then use that software for demonstrations. That is the essence of collaboration. Otherwise, if we need something, we simply buy it—that's rarely the issue. In a consortium, the ideal setup is one where each member contributes something the others lack, leading to collective improvement. (P9)

Networks are continuously evolving, becoming more advanced and offering an increasing number of application possibilities. (P6a)

Over the past year, we started defining use cases, and each step brings us closer to specific technologies. Ultimately, these technologies must be developed to make the use cases possible. Within 3GPP, various working groups are already engaged in this process, and in some areas, we are seeing early advancements. We also have special focus groups dedicated to accelerating these developments. (P3)

What we see is a kind of platform economy, where platforms enable new services. We aim to provide a platform where companies can serve a specific niche or customer group with a particular application. We establish the foundation for these applications, ensuring they can run effectively while leveraging network elements. They may utilize specific network features that we offer within the platform, enabling those companies to serve their end customers with specialized solutions. I believe we already play this role to some extent but still need to further solidify our position. (P3)

Appendix D: Disclosure of the Use of AI Tools

By submitting this thesis, I acknowledge that I have read and understood the requirements on the use of AI tools and agree to adhere to them. No content in this thesis is direct output of artificial intelligence. In this thesis, the following AI tools have been used for the following purposes:

Grammarly: <https://app.grammarly.com/>

To enhance English writing.

ChatGPT: <https://openai.com/>

To enhance English writing.

For initial idea development.

Consensus: <https://consensus.app/>

To assist in finding and synthesizing answers to research questions and finding relevant papers in this regard.

Perplexity: <https://www.perplexity.ai/>

To search accurately and find relevant sources of information.

Microsoft Copilot: <https://copilot.microsoft.com/>

For initial idea development.

To enhance English or Dutch writing in confidential documents.

To gather general feedback on text sections.