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A Multi-Level framework for structured innovation for Distribution System Operators

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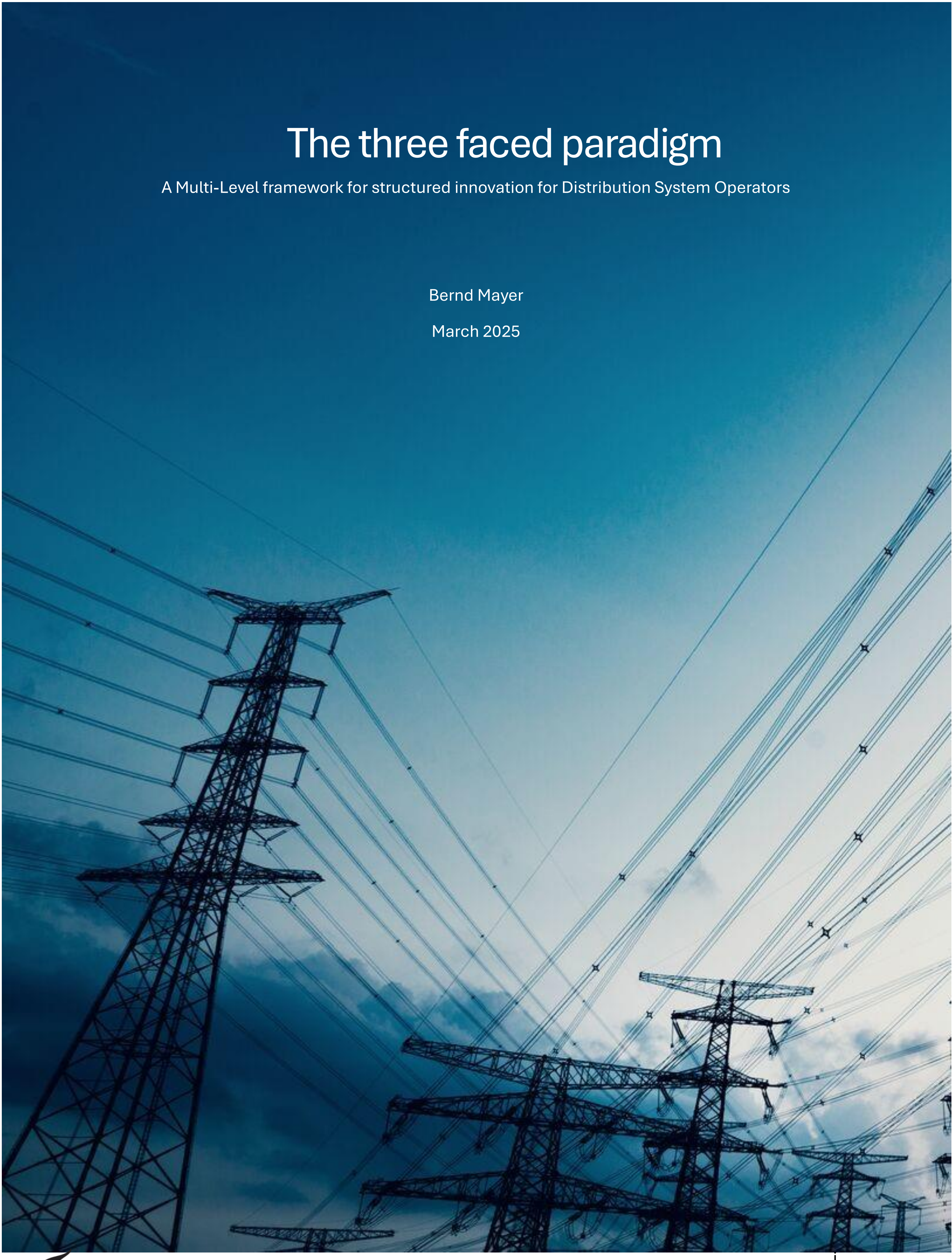

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A Multi-Level framework for structured innovation for Distribution System Operators

by

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Preface

Studying at the faculty of TBM for both my bachelors and my masters was quite the journey. It has been challenging at times, but it has also awakened a true passion for socio technical systems, and the beautiful complexity that is the energy transition. This thesis stems from my interest to accelerate the progress for DSOs.

There is a whole host of people I would like to thank. But for the sake of keeping this interesting for the reader I'll try to keep this brief.

First and foremost, I would like to thank my former first supervisor and now my external supervisor, Mark de Bruijne. Your feedback and encouragement were instrumental not just for helping to improve, but also for keeping me sane. I'm saddened to see you leave the TU Delft behind, as in my opinion it just lost a great teacher. Nevertheless, I have no doubt that the new role you are taking on, will suit you equally well. Then I would like to thank Aad Correljé, my second supervisor and chair. For providing me with my favourite course ever taken: Electricity and Gas. Furthermore, your feedback and intuitive sense for distinguishing academic rigour from generalities which helped in pushing this work forward.

I also would like to thank Joyce Kooijman not just for her apt sense of structure, but also for her commitment and subtle kindness to students. Something I got to experience through her clear, but people centric guidance throughout these last few months. It made finishing the project an actual joy.

Then one a more personal note, I want to express my heartfelt thanks to my partner, for supporting me and for her patience. I would like to thank my brilliant sister, without whom this thesis would be a lot less structured, and a lot of sentences would be left unfinished or double. I also would like to thank Marilene Zwetslood for her help and insight at crucial points of this work. I would like to thank my friends and family for supporting me and providing much appreciated distractions from time to time.

The proverb goes, "*It takes a village to raise a child,*" and in many ways, writing this thesis felt much the same. Additionally, just as any parent can attest, progress also means closing certain chapters. This thesis will likely be the pinnacle of my academic career and at least the final part of my masters.

I do sincerely hope you enjoy reading it.

"*Every new beginning comes from some other beginning's end.*" – Seneca

Bernd Mayer,

09.03.2024

Executive summary

DSOs are of vital importance for the resilience and adaptivity of the essential energy grids with continuously growing demand and consistently increasing complexity (IEA, 2020b).

DSO's face a plethora of fundamental challenges including the increase of energy consumption due to electrification, the rise of decentralized energy resources (DER) and the increasing penetration of photovoltaic (PV) systems (EU DSO Entity, 2023a). All of which pose a significant challenge on its own for distribution grids. Additionally, Energy technologies that are needed to cover over a third of the required cumulative CO_2 emission reductions are still in the demonstration or prototype phase (IEA, 2020a). Therefore, it's not just a matter of novel invention but also the upscaling of current innovations (Bossink, Blankesteijn and Hasanefendic, 2023a).

Without a guiding framework, (meaning a structured model for fostering innovation), innovation efforts may become fragmented, inefficient, and ultimately less impactful. However, many current frameworks on innovation are not up to the task of guiding DSO's effectively, or don't give the full picture to work within the complex context in which DSO's operate. Furthermore, public sector innovation in practise is strenuous, and continues to be a topic warranting further research (Kankanhalli, Zuiderwijk and Tayi, 2017). The public sector stakeholder DSO is deserving of its own relevant framework given its societal relevance. There is a need for implementable technologies in an upgraded operational framework that incorporates not just current issues like congestion management, but also enables opportunities for innovation to deal with future challenges (Tomar, Rossi and Nguyen, 2021; EU DSO Entity, 2023b). Fundamental changes to current frameworks are essential for DSOs to remain enablers of the energy transition rather than becoming bottlenecks (EU DSO Entity, 2023b).

The central research question guiding this study is:

"What framework can guide innovation for DSOs in the Netherlands?"

As this study aims to develop a framework specifically suited to the unique context of DSOs, it is classified as exploratory research, given the current limited understanding of innovation for this context. This study employs three research objectives: to develop a framework that accounts for the system context, to provide tangible and actionable output for DSOs, and to consider the regulatory environment affecting innovation.

Because there is already a plethora of innovation frameworks all with their respective strengths and limitations, starting from scratch would be excessive. Therefore, this research employs an abductive approach to framework synthesis. Consisting of five core steps. 1) Systematic Exploration of Existing Knowledge. 2) Framework synthesis. 3) Empirical Observation through Case Studies. 4) Comparison and framework refinement. 5) Contextualisation and interpretation.

The Systematic Exploration of Existing Knowledge was guided by the three research objectives. First it explores literature that describes innovation frameworks at a systems level, second literature that describes innovations using a process perspective and third of regulatory experimentation. The main frameworks chosen for the framework synthesis are four academic models and two contemporary models by two companies working on innovation management for clients, that are that have been refined through practical application.

The theoretical frameworks used for the synthesis are: The open innovation as described by De Jong (2008). Strategic Niche Management, as described by Brown and her colleagues (2012a), a framework describing key elements for the upscaling of innovations (Bossink, Blankesteijn and Hasanefendic, 2023b), and lastly, a framework on mapping regulatory experimentation (Bovera and Lo Schiavo, 2022a).

The two company-based innovation frameworks describing the innovation process are: the innovation Engine (by Cap Gemini) and the Innovation monitor (by NLMTD).

The framework synthesis resulted in an initial framework. It describes three levels of innovation that run parallel to each other: project level, company level, ecosystem level.

Subsequently cases were used for exploring how observable and applicable the theoretical components of the constructed innovation framework are within the operational context of DSOs. A multiple embedded case study was constructed as the research method in combination with a thematic analysis. The cases chosen are the Divestment of Allego by Alliander and the Klant-Sluit-Zichzelf-Aan case by Cap Gemini. The main refinements of the framework were the removal of two factors on company level and the rephrasing of a factor on the ecosystem level.

This refinement led to the final constructed framework: a diagnostic framework for stimulating innovation within the DSO context. It represents the first exploration of a framework that holistically addresses the unique complexities and demands of DSOs, offering a foundation for further refinement and application. Its differentiating features include three parallel levels in which innovation processes can be structured and its inclusion of strategy as a factor, as well as strategy alignment. Each level has a set of more detailed factors describing drivers of innovation on each level. Especially impactful factors include: “innovation topic addressed”, “organisational structure and agility” and “stimulating market forces”. The newly constructed framework meets the research objectives by integrating key elements necessary for facilitating innovation in the DSO context. However, its effectiveness in part depends on the innovation expertise with which it is applied and resource availability making it most useful for medium to large organizations.

Its application range is mostly determined by the similarity in regulatory environment of other countries (or sectors), in combination with the ownership structure of the DSOs. Likely, it is largely applicable to countries like Germany, Belgium or Denmark, and sectors such as the IT sector, mobility, water management, manufacturing, automation or biotechnology.

Furthermore, this study has identified systemic constraints including regulatory barriers, administrative burdens and public scrutiny. This work represents a first exploration of a framework that holistically addresses the unique complexities and demands of DSOs, offering a foundation for further refinement and application. Future research could refine the model through additional application, explore different structures, and expand its use for other actors or sectors. Additionally, it could dive into uncovered theoretical aspects such as the role of strategy alignment, or regulatory learning.

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Chapter 1: Introduction

This first chapter will discuss the background of this research. It will introduce the subject, its societal context, its relevance and its urgency. Subsequently this chapter discusses literature with regard to the topic, the limitations of current knowledge and the consequent knowledge gaps. It concludes by framing these challenges in a main research question.

1.1 DSOs under pressure

The Netherlands is undergoing a vast transformation of its electricity network(Elzen et al., 2004). The Distribution System Operators (DSOs) are a central pillar to the effort towards decarbonisation (Euractiv, 2023a). DSOs oversee the distribution grid and act as a liaison between end users and transmission networks, carrying the responsibility for a continuous availability of power supply to residences and commercial establishments (Euractiv, 2023a). DSOs are of vital importance for the resilience and adaptivity of the energy grids with continuously growing demand and consistently increasing complexity (IEA, 2020b).

However, one of their key responsibilities -ensuring capacity of electricity to consumers- is faltering and has led to long waiting times for adding new connections the grid (NOS, 2024a). In some areas the waiting time for transport capacity has reached 5 to 8 years (Enexis, 2024). This critical shortage comes at a point where demand is expected to continuously rise. A DSO has had to recently adjust their demand predictions, from a 30% increase in 10 years to a 50% increase in electricity consumption in 3-4 years (Kleinnijenhuis & van Hest, 2022a).

Due to critical shortage of net capacity the overseeing authority ACM has even implemented drastic regulatory measures in order for parties with high societal importance, such as hospitals, to gain priority for being connected to the grid (ACM, 2024).

This pressure to increase the capacity of electricity grids comes at the time where DSOs also need to fundamentally change their operating network, to accommodate the rise of decentralized energy resources (DER), electrification, digitalisation and cybersecurity (Broeckx et al., 2019a; Euractiv, 2023b; Tomar et al., 2021). All of these trends individually already pose a significant challenge for distribution grids. However, they all converge simultaneously, creating compounded pressure and intensifying the strain on the system. Pressure to change is further increased by nearing deadlines of environmental treaties, which increasingly seems unattainable in the Netherlands (NOS, 2024b).

Or simply put: “grid operators don’t face one singular existential transformation; it is a tsunami of changes that are integral to their way of operation and their future” says a Senior consultant Strategic Digital Innovation (2024).

1.2 Change and innovation required but difficult to realize

Clearly a lot of change is needed, However, energy technologies that are needed to cover over a third of the required cumulative CO_2 emission reductions are still in the demonstration or prototype phase (IEA, 2020a). Therefore, it’s not just a matter of novel invention but also the upscaling of current innovations (Bossink et al., 2023a).

Whether new technologies enable DSOs to achieve their goals, or whether the energy grid becomes a major bottleneck for sustainable development, depends on the ability of DSOs to innovate and scale-up innovations. This was also acknowledged by an International Energy

Agency rapport, which claimed that the acceleration of clean energy innovations is crucial to achieve net-zero emissions targets (IEA, 2020a).

However, the utility sector is historically not well known for its innovative capacity (Cinar et al., 2019a). Part of this limited innovation capability might be attributed to the sector's capital-intensive infrastructure and long investment cycles (Bocca, 2020a; Dehdarian & Tucci, 2021a). However, other scholars have also highlighted an industry wide risk averse attitude and strict regulatory oversight as potential limiting factors (Beerepoot & Beerepoot, 2007; Cinar et al., 2019b).

1.3 The value of innovation frameworks

One possible avenue for improvement would be the use of a functional framework to guide innovative efforts. Innovation often involves navigating complex systems and addressing interconnected challenges. Frameworks provide clarity and reduce uncertainty by breaking down the innovation process into manageable steps (Geels, 2002).

A structured approach is particularly valuable because innovation is an inherently chaotic process. Structure helps provide order and focus, enabling organizations to navigate its complexity more effectively (Damanpour, 2017; Markham & Lee, 2013).

This is especially important in dynamic fields, such as energy, where organizations face complex regulatory requirements and must often integrate technological advancements within short timeframes (OPSI, 2015).

Without a guiding framework, efforts to innovate risk becoming fragmented and inefficient. Such a lack of structure can lead to misaligned priorities, wasted resources, and ultimately reduced impact, as organizations struggle to navigate the inherent complexity and unpredictability of the innovation process (Stilgoe et al., 2013).

There is a need for implementable technologies in an upgraded operational framework that incorporates not just current issues like congestion management but also enables opportunities for innovation to deal with future challenges (EU DSO Entity, 2023; Tomar et al., 2021). Or put more drastically:

“More fundamental changes in the current framework are necessary to empower DSOs and ultimately customers. Only then, can DSOs remain enablers of this energy transition and not develop into bottlenecks. Without upgraded, smartened and well-equipped power grids this historic transition towards a renewable energy system will not materialize.” (EU DSO Entity, 2023).

1.4 Research gap

Now that the importance of the development of an innovation framework is stated, it becomes important to specify what constitutes an innovation framework. A relatively modern definition is the following:

“The system of resources and capabilities that a corporation would need in order to be able to innovate.” (Krasadakis, 2020)

When applying this definition to the context of DSOs in the Netherlands it becomes clear that there is a knowledge gap, as currently there exists no standalone framework to help DSOs to innovate.

1.4.1 Challenges of the system context.

One of the primary challenges lies in the specific context in which DSOs operate. As publicly owned companies, DSOs embody a unique quasi-public sector position, where both private and public sector innovation frameworks fall short of being fully applicable (Kankanhalli, Zuiderwijk, and Tayi, 2017).

Many existing frameworks, aimed at increasing the innovative capability of an organisation, are focussed on private companies (Cinar et al., 2019b). This however overlooks the crucial fact that societal goals that are central to DSOs and their functioning (Euractiv, 2023a). However, on the flip side, public sector innovation frameworks are relatively scarce, and public sector innovation remains a strenuous endeavour in practice, continuing to be a distinct research topic that warrants further exploration in its own right (Kankanhalli, Zuiderwijk, and Tayi, 2017).

This context of DSOs position as publicly owned companies, lays bare gaps in current scientific frameworks, in addressing their dual mandate of operational efficiency and public accountability. However, company ownership is not the only challenging contextual factor for DSOs.

The energy sector itself operates as a complex system in which technological, regulatory, economic, and social factors are deeply interconnected (Bocca, 2020b; Dehdarian & Tucci, 2021b; World Energy Counsil, 2024). There are few limited innovation frameworks that take the specific energy sector context into consideration. However, much of that research on energy sector specific innovation tends to focus on specific aspects of the system such as renewable energy uptake (Negro et al., 2012), or specific technologies such as smart grids (Dehdarian & Tucci, 2021a; Milchram et al., 2020a). Therefore, a fit for purpose systemic perspective for DSO energy innovation does not exist in scientific literature.

1.4.2 Challenges with the actionability

Nevertheless, there are a few established scientific models which do take into account some of the complexities of energy focussed systems.

One of these models is the Technology innovation system (TIS) which does look at the system surrounding a technology (Markard & Truffer, 2008). It can be used by policy makers to identify barriers for technological innovation. However, although it does look at the broader system, it usually only operates from the perspective of a single technology, such as smart grids or electric vehicles (Markard et al., 2015). Consequently, limiting the usefulness of the system perspective when applied to a DSO, which does not confine itself to a single technology.

Another model, the Multi-Level Perspective (MLP) introduces and conceptualizes different levels and phases of innovations, and modernised versions focus on the upscaling of new technologies (F. W. Geels, 2004). However, this perspective is mostly presented as a “mid-range” theory, and most crucially, does not stimulate agency for the stakeholders involved (F. W. Geels, 2011). Meaning, that while the MLP does well describing broad societal trends and upscaling, it does not help in providing guidance in everyday decisions for stimulating innovation.

Another renowned scientific model that does include the context well is Strategic Niche Management (SNM). In more recent, studies, it has been applied to a wide range of technology sectors, such as biogas in India, electric vehicles in China, wind in Australia, and energy communities in Finland (Healey, 2008; Ruggiero et al., 2018a; Verbong et al., 2010; Xue et al., 2016). This would also make it suitable for the DSO context. However, SNM has been used mostly for ex-post evaluations of case studies. It hasn't been applied in a manner that is used proactively for guiding future endeavours (Schot & Geels, 2008a). While some of these case studies provide policy recommendations, they don't provide tangible levers for companies to act upon, which in the case of DSOs, is crucial. Thus, within the energy sector, SNM does not seem to stimulate Agency or decision making for non-legislative stakeholders. This was also underscored by Schot and Geels, the creators of SNM themselves. As they state:

"It remains to be seen, however, if such instruments actually work in practice and have the intended effects. So far, SNM has been used primarily for ex-post evaluations of case studies. It has not been applied prescriptively in ongoing processes."(Schot & Geels, 2008a)

Lastly, even when diving into ex-post evaluations, SNM tends to describe macro trends and mechanisms. As a result, it overlooks much of the necessary detail required to provide actionable information.

1.4.3 Challenges in regulatory context

A third and final knowledge gap identified is the key challenge posed by regulation, which inhibits the application of current scientific innovation frameworks to the DSO context.

Regulation plays a significant role in fostering innovation within the energy sector (Sunila and Ekroos, 2023). Regulation, when properly designed, can drive the adoption of innovative technologies and business models, particularly as the sector transitions to renewable energy and lower carbon emissions (Euractiv, 2023b). The Dutch energy market is heavily regulated, with rules designed to ensure sustainability, fairness, and consumer protection (Bovera and Lo Schiavo, 2022a). Therefore, a framework guiding DSOs should also consider the regulatory context in which it operates. However, academic innovation frameworks that incorporate the role of regulation within energy systems are not well-established. One, potential avenue of interest are regulations for pilot projects, or regulatory sandboxes which allow for experimentation with new energy solutions in a controlled environment (Bauknecht et al., 2020). However, frameworks for describing key elements of regulatory sandboxes are limited and still require more research (Sunila & Ekroos, 2023). But recently, the Netherlands, one of the pioneers of regulatory experimentation, closed its regulatory sandbox construct for the energy sector (Schneiders, 2021a). The unclear state of regulatory sandboxes in the Netherlands highlights the absence or limited availability of functional frameworks to guide DSOs in this area.

1.5 Research question and research objective.

This last paragraph is dedicated to build upon the background information and the identified knowledge gaps, and outline the research question, the research objective and its relevance.

1.5.1 Research question

Returning to the definition of innovation framework:

"the system of resources and capabilities that a corporation would need in order to be able to innovate." (p. 59 Krasadakis, 2020)

It is clear that due to all these asterisks and limitations of existing scientific research, there is no clear framework at hand to guide DSOs' innovation in a day-to-day manner in which they can allocate resources effectively. Therefore, a new framework should be created to address the outlined limitations of current scientific frameworks.

Therefore, the main question of this study is:

"What newly constructed framework can guide innovation for DSOs in the Netherlands?"

1.5.2 Research objective

Understanding the required functionality of the newly constructed framework is vital to addressing the limitations of current frameworks. To guide the creation of this new framework, a set of goals or core requirements have been formulated. These aspects are essential to include in order to effectively address the identified knowledge gaps and define the capabilities the framework should possess.

First and foremost, the new framework should take the system context into account. DSOs cannot be regarded in isolation as an object of study. The functioning, capabilities, demands and objectives are to a large extent dependent on the context in which they operate. Therefore, a new framework should include this aspect.

The second objective of the new framework is to provide tangible and actionable output for DSOs to use. i.e. be able to provide guidance for decision-making at the day-to-day operational level.

The last objective for the newly constructed framework is the consideration of regulation. As DSOs operate in a highly regulated context. It is essential to consider the regulatory environment. More specifically regulation that systematically touches on innovation and experimentation.

In short: the focus of the research is on the interplay between innovation as a process and innovation as a system enabled through regulation.

1.5.3 Scientific and societal relevance

From the scientific perspective the main relevance comes from filling the currently identified knowledge gaps. By filling these gaps this research helps expand the scientific knowledge on applicable frameworks for the energy sector, or more specifically the DSO context. Additionally, the state and effectivity of regulatory experimentation constellations in the Netherlands is currently unclear. Addressing this aspect provides new knowledge into this area of expertise.

Regarding societal relevance, the primary focus is on supporting DSOs. As crucial stakeholders for the energy domain, thriving of DSOs is an important step toward a decarbonised society. A societal goal that seems increasingly under pressure, and unlikely if DSOs are not enabled through innovation. This research helps by supporting the expansion of DSOs innovative capabilities and through that help society at large. However, it is also relevant for consultancies who aim to progress innovative capacities in the DSO sphere or similar context. Lastly it can also provide insight for regulatory experts with the ambition to work on systemic improvement of innovation within a sector.

Link to Study Program

The proposed research delves into the complexities of organizing for innovation, where the process is no longer limited to central ideation but requires a dynamic interplay between actors, organizations, and technologies. This multi-disciplinary nature of innovation, particularly within the energy sector, aligns seamlessly with the Complex Systems Engineering and Management (CoSEM) curriculum. By addressing innovation systems, processes, and regulatory frameworks within the energy transition, this study integrates key CoSEM concepts such as system thinking, multi-actor decision making, institutional economics. This research utilises concepts from Cosem modules such as, SEN1141, SEN1131, SEN1541 and SEN1522. Moreover, it reflects the CoSEM focus on addressing complex societal challenges by combining theoretical models with real-world applications.

1.6 Conclusion.

This first chapter has set out to discuss the background of this research. One of the primary aspects of relevance are based on urgency:

DSOs are crucial stakeholders within the energy sector. However, DSOs face increasing demands to undergo fundamental transformations. The mounting pressure on DSOs to innovation and change, has given rise to the need for a new innovation framework for this context. Without a guiding framework, efforts to innovate risk becoming fragmented and inefficient. There is a need for implementable technologies in an upgraded operational framework that incorporates not just current issues like congestion management but also enables opportunities for innovation to deal with future challenges.

In order to address this main research question of this study is:

“What newly constructed framework can guide innovation for DSOs in the Netherlands?”

The primary challenges and research gaps lie in three key areas. The challenges of system context, challenges with actionability and challenges in regulatory context. These challenges have been translated into research objectives.

Having outlined the background, its scientific and societal relevance, and formulated the main research question, the next step is providing a structured manner on how to address the main research question. Therefore, the next chapter will dive into the methodology.

Chapter 2: Methodology

This chapter describes the main research structure. This structure delineates the process of the construction of a framework and will also link these steps to the sub questions. For each of the sub questions, the research methods will be discussed as well as the accompanying data collection methods.

The central research question guiding this study is:

“What newly constructed framework can guide innovation for DSOs in the Netherlands?”

The first paragraph below outlines the general research design and the following structure of this research rapport. The following paragraphs delineate the sub-questions and the methodology that used for them.

2.1 Research Design and approach

As this study aims to develop a framework specifically suited to the unique context of DSOs, it is classified as exploratory research, given the limited understanding of innovation for this context. Exploratory research is well-suited to questions that investigate new, complex, or multi-dimensional phenomena, aiming to uncover patterns, generate insights, and establish initial frameworks that can later be tested or validated (Swedberg, 2020).

This research employs an abductive approach to exploratory research, with a unique focus tailored to the specific goal of developing an innovation framework for DSOs. Abductive reasoning is particularly valuable as it enables the iterative interaction between empirical data and theoretical constructs to generate new insights. Unlike deductive reasoning, which begins with a hypothesis, or inductive reasoning, which seeks to strengthen or refine existing theories, abductive reasoning facilitates the development of new theoretical perspectives by identifying patterns and anomalies in the data (Timmermans & Tavory, 2012).

This flexible approach makes abductive reasoning suitable for the construction of frameworks, as it allows the researcher to move beyond initial assumptions and adapt to emerging insights during the research process (Tavory & Timmermans, 2014). In the context of this study, abductive reasoning is particularly useful because it bridges the gap between existing theoretical elements and the practical observations derived from the operational context of DSOs.

This research approach is combined with framework synthesis, a method that systematically integrates and refines existing frameworks to develop a context-specific model for guiding framework development (Carroll et al., 2011). Framework synthesis is particularly well-suited to this research because it enables the construction of a tailored framework that draws on validated concepts while adapting them to the unique demands of DSOs. By building on existing frameworks, it avoids the inefficiencies of developing entirely new methodologies, instead focusing on bridging practicality gaps and enhancing applicability in the DSO context.

Framework synthesis is inherently compatible with an abductive approach. Framework synthesis systematically integrates elements from existing frameworks to address specific gaps or challenges, abductive reasoning enriches this process by enabling iterative refinement. Through abductive reasoning, insights gained from empirical observations directly inform the synthesis process, ensuring the framework is tailored to the unique demands of the DSO context. This iterative interplay between theory and practice ensures that the final framework is both theoretically robust and practically applicable.

This complementary relationship between framework synthesis and abductive reasoning also aligns with the exploratory nature of this research. By integrating existing theoretical knowledge with emerging empirical insights, this approach provides the flexibility necessary for addressing and incorporating the multi-dimensional challenges faced by DSOs. Furthermore, applying an abductive research approach to the method of framework synthesis also supports the goal of providing actionable and practical guidance by grounding the framework in both theoretical understanding and real-world contexts.

2.1.1 Overview of the research process

This research broadly consists of two parts, the first being the construction of a new framework and the second focussing on the guidance through the framework. This is broadly reflected in the structure and is closely connected to the abductive research approach, the framework synthesis method, and the research sub-questions.

The research design of this research blends the research approaches for abductive research and method of framework synthesis.

The framework synthesis process follows five main steps: (1) systematic exploration of existing knowledge, (2) framework synthesis, (3) empirical observation, (4) comparison and framework refinement, (5) framework contextualisation and interpretation (Brunton et al., 2020a; Dixon-Woods, 2011a). These steps broadly align with the stages of abductive reasoning, where theoretical constructs are continually refined and tested against empirical findings, as described by Kovacs and can be seen below in figure 1. In each step, the corresponding connection between the abductive reasoning process and its related step in framework synthesis is outlined and discussed.

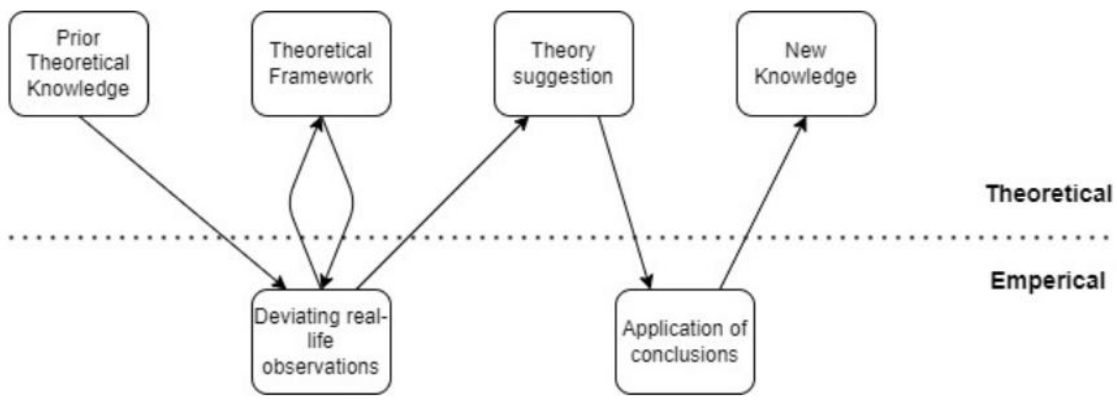

Figure 1: Abductive research method (Kovács & Spens, 2005)

1. Systematic Exploration of Existing Knowledge

This initial step corresponds to prior theoretical knowledge in the abductive framework and consists of a literature review. As the systematic exploration of knowledge results in an overview of prior theorical knowledge. To demarcate and focus of the literature search, this exploration starts of from the three goals of the framework. Firstly, literature that describe innovations frameworks at a systems level, secondly literature that in detail describes innovations using a process perspective and thirdly, of regulatory experimentation. In particular the use of regulatory sandboxes in practice.

2. Framework synthesis.

This stage aligns with theory matching in the abductive approach. Meaning the iterating between theoretical data of the prior knowledge and empirical evidence, to create a novel theoretical framework. In figure 1 this can be seen as the relation between Deviating real-life observations and theoretical framework. During this step an initial innovation framework for DSOs is constructed using insights gathered from the prior identified theoretical knowledge and though interviews. The framework synthesis is iterative, allowing refinement as theoretical constructs are evaluated against each other and are merged into a cohesive model. Resulting in a theory suggestion in the form of an initial framework for DSO innovation.

3. Empirical Observation through Case Studies

This third step in the synthesis method also aligns with deviating real-life observations in abductive research. As the construction of a new framework is iterative, a more in-depth exploration into the empirical evidence is conducted. Here the framework is more thoroughly grounded into real worlds observations. Case studies are well situated to explore real-world observations of newly synthesised frameworks (Brunton et al., 2020b). Two focused case studies of DSO innovation within the Dutch electricity infrastructure industry were chosen to provide empirical evidence. Thus, allowing real-world observations of innovation management practices. The case studies will help identify areas where empirical findings diverge from or support the initially constructed framework.

4. Comparison and Framework Refinement.

Here, the frameworks diverge in their structure and approach. As in the Synthesis, this is a separate part, while in the abductive approach this would still fall under framework refinement and therefore the theory matching. Nevertheless, this step is important in both approaches. This is parts' aim is a more thorough grounding of the framework into real world observations. It compares between the framework developed in step 2 and the empirical data obtained in step 3. The comparisons will be discussed, and the findings will be interpretated in this step with the aim of developing a newly refined innovation framework. This will culminate in theory suggestion, which aligns with the fourth step of the abductive method.

5. Contextualisation and interpretation

The final step focuses on presenting the synthesized framework and outlining both its practical application and the key barriers to DSO innovation identified during the research.

Within framework synthesis, this phase examines the frameworks' use by providing information on how to interpret and use the newly constructed framework (Carroll et al., 2011; Dixon-Woods, 2011b). For the purpose of this research, the framework serves as a practical tool, providing guidance on its use, scope, and context within existing theory while addressing identified challenges.

From an abductive reasoning perspective, this step corresponds to the Application of Conclusions, where theoretical developments are framed in relation to their practical implications. This final step translates the developed theory into practical applications, bridging the gap between theoretical constructs and real-world practice. For instance, in a case study on financial sustainability for non-profit organizations, the application of conclusions led to the development of a business model tailored to the organization's specific context (Brunton et al., 2020b). Much like this example the goal here is to tailor an innovation model to a specific context. Therefore, this step explores the contextual barriers to innovation identified during the research. In doing so, it provides a deeper contextualization of innovation challenges, offering a foundation for discussing the framework's practical usability, barriers to adoption, and potential areas for further refinement.

2.1.2 Research structure and flow diagram.

To visualize the structure of this research and its accompanying chapters, a flow diagram has been created, outlining both the research process and chapter structure. This diagram integrates the five steps of framework synthesis and the abductive approach into a single structured progression. The process culminates in answering the main research question, providing a comprehensive conclusion to the study. Additionally, for clarity, the sub-questions have been incorporated into the research flow, illustrating their connection to each phase of the study. These sub-questions are further elaborated upon in Section 2.2.

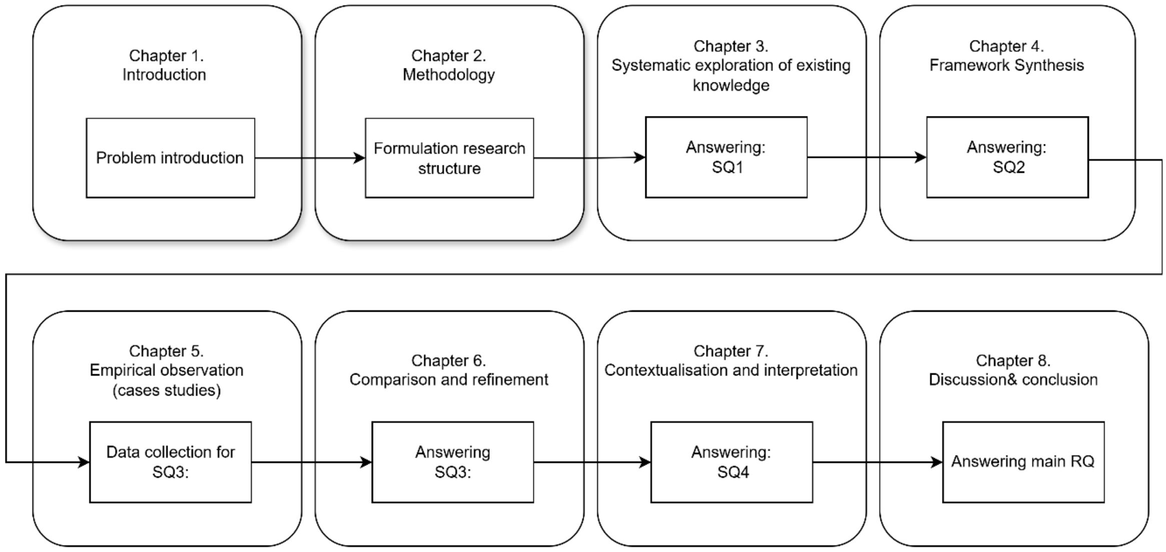

Figure 2: Research flow diagram and chapters

2.2 Sub-questions

A number of sub-questions have been formulated to answer the main research question. Below the main research question is repeated before dissecting it into smaller sub-questions:

"What newly constructed framework can guide innovation for DSOs in the Netherlands?"

The sub-questions are rooted in the need to systematically address the two key components of the main research question: First the creation of the newly constructed framework and second the guidance it should provide. The sub-questions also align with the overall research design.

The first three sub-questions are therefore dedicated to the creation of a new framework. These three questions also reflect the abductive approach closely. The first question is focussed on the exploration of prior knowledge. The second, focussed on theory matching in the form of framework synthesis. Third is a sub-question dedicated to the exploration of empirical evidence for refinement via the application of theory to a case environment.

> SQ1: What (elements of) current frameworks are suitable/well situated for framework synthesis?
>
> SQ2: How can the selected frameworks be synthesised
>
> SQ3: How observable and applicable are the theoretical components of the selected innovation framework within the operational context of DSOs?

The second part is focussed on the guiding aspect of the main question. In order to guide effectively it's important to understand how the framework can be used and interpreted. This also broadly aligns with the framework synthesis step as previously outlined. This fourth research question also reflects one of the research objectives that the newly constructed framework should provide actionable and tangible output.

Lastly, DSOs don't operate in a vacuum. They are uniquely positioned within the public domain, where they are in part also dependent from the context. Therefore, it is also important to discuss what might need to change in the context in which DSOs operate. This is also closely aligned with the goals of taking into account the systems context and the role of regulation.

Both aspects are reflected upon through the last sub-question:

> SQ4: How can the framework be used to navigate the contextual challenge(s) of DSOs?

2.2.1 Sub-question 1

The first sub-question is as follows:

> SQ1: What (elements of) current frameworks are suitable/well situated for framework synthesis?

For this sub-question, an abductive exploratory research approach will be employed, integrating thematic analysis to systematically analyse trends and themes in innovation frameworks. This includes both a focused literature review and a desk study of best-case practices, supported by expert interviews. This iterative process of moving between theoretical models and practical applications is closely aligned with the abductive approach.

Data collection methods:

1)Literature research:

The starting point of the search of current frameworks comes from the research objectives. With a focus on the system context, tangible and actionable outputs and regulatory experimentation. Translated into subjects connected to innovation three starting foci were for exploring innovation frameworks:

- innovation as a system
  - explores frameworks that describe innovation on a system level.
- innovation as a process
  - frameworks best case use of innovation process frameworks (i.e. desk research of methods used in practice). It dives into frameworks that are used in practise, thus providing tangible and actionable levers.
- regulatory experimentation.
  - Explores frameworks for regulation that systematically touches on innovation and experimentation.

2) Expert interviews:

- Pieter Paul van Oerle,
  - 11 years Accenture innovation lead NL
  - Current founder and CEO of NLMTD
- Teddy van Eijk,
  - Senior Consultant in Strategy and Innovation, with a specialisation in innovation management
- Regulatory experimentation expert (anonymous)
  - PhD in Energy Law and sustainability
  - Practical experience with regulatory sandboxes in the Netherlands
- Tineke C. van der Schoor
  - Researcher Sustainable Building & Sustainable Communities.
  - Co Author on: “Participatory Experimentation with Energy Law: Digging in a ‘Regulatory Sandbox’ for Local Energy Initiatives in the Netherlands”(van der Waal et al., 2020)
- Bram de Vogel,

    - Senior consultant Strategic Digital Innovation
- Bo-Iris Bergevoet
    - Manager at Capgemini Invent
    - With expertise in corporate governance

Data analysis method:

Thematic analysis is used within the focal lenses based on the research objectives to catch the trends and developments that have taken place over the years with regard to the stimulation of innovation.

This method was chosen because thematic analysis, as outlined by Braun and Clarke (2006), is a foundational approach in qualitative research that offers flexibility in identifying, analyzing, and reporting patterns within data. Braun and Clarke also emphasize its utility in providing a detailed account of data and allowing themes to emerge naturally, especially when exploring under-researched areas(Braun & Clarke, 2006, 2013).

2.2.2 Sub-question 2

The second, sub-question

SQ2: How can the selected frameworks be synthesised

Research approach/method

Framework synthesis. Framework synthesis itself as a method describes steps needed for combining frameworks. After previously screening and selecting the right frameworks. The next step of the framework synthesis method is focussed on the combining of the selected frameworks (Brunton et al., 2020b). This step entails the actual bundling of frameworks and their factors and pruning connections which seem redundant or irrelevant.

Data collection method:

None, the data have already been collected in the previous sub-question.

Data analysis method:

Framework synthesis, through thematically grouping factors.

The data analysis follows the principles of framework synthesis, specifically through thematic grouping and refinement of factors. This involves examining the selected frameworks, identifying overlapping or complementary elements, and integrating them into a cohesive structure. Themes are derived based on the characteristics of the included frameworks, ensuring alignment with the research question and broader theoretical context (Brunton et al., 2020b). The analysis process critically evaluates the relevance of each factor, pruning redundant connections and iterates this process for refining the framework to enhance its applicability to the DSO context.

2.2.3 Sub-question 3

Then on to the third sub-question. Which is stated below:

> SQ3: How observable and applicable are the theoretical components of the selected innovation framework within the operational context of DSOs?

Research approach/method

For providing an answer the multiple embedded case study has been chosen as the main research method. This is due to the fact that this question pertains to the study of a phenomenon in a practical setting. Case studies allow researchers to examine certain systems in their natural settings and derive theories from practical experiences (Kilani et al., 2016). Case studies also align with the framework synthesis method by providing a basis for comparing theoretical insights with empirical evidence, supporting the framework's relevance and applicability in practice(Carroll et al., 2011).

Additionally, innovation is a complex phenomenon, especially on a system level, where the boundaries between the context and the phenomenon can become blurred. Case studies are especially valuable when a phenomenon cannot be easily separated from its context, making them ideal for complex, real-world situations where understanding context is crucial (Stake, 1978; Yin, 2013).

Furthermore, this sub-question still aims to refine the theorical framework in an exploratory setting. Studying cases allows researchers to explore how individual instances connect to broader theoretical frameworks, aiding not only in refining existing theories but also in generating new ones, particularly for complex, multi-dimensional issues that benefit from close, context-sensitive examination (Ragin & Becker, 2000).

A multiple-case study approach was selected to enhance the robustness of the proposed framework and support potential generalizations, aligning with Yin's argument that multiple cases strengthen empirical substantiation and potential generalisation (Yin, 2003). An embedded case study design was chosen to address the complexity of the research focus, allowing the three focal lenses to serve as distinct units of analysis. This setup aligns with Yin's recommendation for embedded designs when examining multiple levels within a case, as it permits for sufficient depth and focus on specific aspects, whilst also providing support for possible generalisations for theory forming (Yin, 2012).

Case selection

A multiple-case study approach was chosen to capture a specific empirical spectrum, with cases selected based on three key parameters: the innovation must be radical, span organizational boundaries, and directly impact DSOs.

Radical innovation is the most challenging to accommodate within a system, yet it remains essential given the scale of change required (Joint Research Centre European Commission, 2022; Lavrijssen & Carrilo, 2017).

Cross-organizational innovation is essential for pooling resources and expertise, facilitating the upscaling of technologies, and enabling comprehensive solutions that address the complexities of modern energy systems (International Renewable Energy Agency, 2020).

Lastly, this research has already outlined the importance of DSOs, which are also the main focus actor for this study.

By selecting cases that embody these parameters, this study can provide valuable insights into how DSOs can navigate and lead the ongoing transformation in the energy sector. These selection criteria ensure the cases align with the study's focus and provide a robust foundation for examining innovation dynamics in the context.

The two cases selected are the divestment of Allego by the DSO Alliander and the "Klant Sluit Zichzelf Aan" case, which concerns the upscaling to more DSOs of a tried solution for enabling quicker connections to the grid.

Data collection methods:

Information about the cases was obtained via desk research and interviews with key players. The key players selected for the Allego case are:

- Pallas Agterberg,
  - Former board member of Alliander, who oversaw the initiation of the charging stations
- Mereille Klein Koerkamp
  - A former employee at Alliander who took part in the transition from a DSO branch to a separate company. Part of the founding set of board members of the then newly founded Allego company.
- ACM employee (anonymous)
  - With considerable knowledge on the regulatory perspective on this case.

For the Klant sluit zichzelf aan case:

- Igor Lelieveld
  - Team lead KSZA project
  - Consultant at Cap Gemini invent
  - Part of the consulting team that enabled the innovation to occur
- Bram de Vogel
  - Senior consultant Strategic Digital Innovation
  - Innovation expert with extensive knowledge on innovation in practise as well as experience with and insight into the selected case.

Data analysis method:

For the analysis method for the cases, thematic analysis was chosen. The themes in this context refer to the characteristics identified through the first sub-question and subsequently refined during the framework synthesis. The case study seeks to observe these themes and connect them to the previously identified ones for confirmation, providing insights into the extent to which, and how, these elements of the framework are being applied in practice.

2.2.4 Sub-question 4

The last, sub question is focussed on understanding the interpretation and contextualisation of the framework. In addition to ensuring that the research objectives are being met.

SQ4: How can the framework be used to navigate the contextual challenge(s) of DSOs?

This part is focussed on the guiding aspect of the main question. In order to guide effectively it's important to understand how the framework can be used and interpreted. This also broadly aligns with the framework synthesis step of contextualisation and interpretation. This forth research question also reflects one of the research objectives that the newly constructed framework should provide actionable and tangible output.

Additionally, DSOs don't operate in a vacuum, they are uniquely positioned within the public domain, where they are in part also dependent from the context. Therefore, it is also important to discuss what might need to change in the context in which they operate. This is also closely aligned with the goals of taking into account the systems context and the role of regulation.

Method: analytical reflection

In order to answer this question the dedicated chapter will provide a structured reflection on three main aspects.

1. Assessing the framework's relevance and application range

The first part focuses on assessing the framework's relevance and application range. To evaluate this, real-world challenges will be compared against the framework for relevance. This analysis aims to determine how the framework can be used in practice and under what circumstances it is most applicable. Additionally, the framework's boundaries of application will be examined by identifying where it provides actionable insights and where its utility may diminish. This includes assessing whether the framework adequately addresses key innovation challenges and identifying any gaps or limitations in its applicability.

2. Reflect on what the framework application reveals about systemic/regulatory constraints of the framework

The second part reflects on systemic and regulatory constraints revealed through the framework's application. This entails analysing regulatory barriers and other systemic barriers that may hinder innovation within DSOs. This part of the reflection contributes to answering SQ4 by illustrating how systemic factors influence the framework's applicability and its role in navigating the challenges faced by DSOs.

3. Theoretical Implications and Scientific Positioning

This third part explores the broader theoretical implications of the findings and positions the framework within existing innovation and regulatory discourse. This includes identifying how the framework aligns with or diverges from current theories and what its scientific contribution is. By clarifying these distinctions, this section will highlight the framework's added value and its relevance for both innovation studies and regulatory research.

Chapter 3: Literature review

This chapter will provide a systematic exploration of current theory on innovation frameworks. It consists of three distinct parts. Each tied to one of the foci which are based on the research objectives. Namely, innovation as a system, innovation as a process and regulatory experimentation. For each of these focus points, some of the best suited models are outlined and discussed.

This chapter will conclude with summarising the selected frameworks and their main features and therefore answering the first sub-question. Which is repeated below for the sake of clarity.

> SQ1: What (elements of) current frameworks are suitable/well situated for framework synthesis?

3.1: Innovation as a system.

The first focal point examines innovation as a system. The results for this focus can be broadly classified into two categories: internal innovation within an organization and external innovation involving its interaction with the broader environment. Meaning how an organization can interact with its surroundings in order to innovate more effectively. This paragraph will first discuss the most known internal model, and subsequently dive into models describing external innovation, then discuss crucial elements for upscaling.

3.1.1 Internal innovation

Models for how to organise innovation inside a company have been around for a considerable time. As innovation takes place within an organisation more often than in coalitions or joint ventures it is important to consider this aspect.

Funnel model

The most well-known and still predominantly used model, either in its original form or a modified version, is the Stage-Gate model developed by Robert Cooper(Cooper, 1990). The Conceptual version can be visually seen below in figure 3.

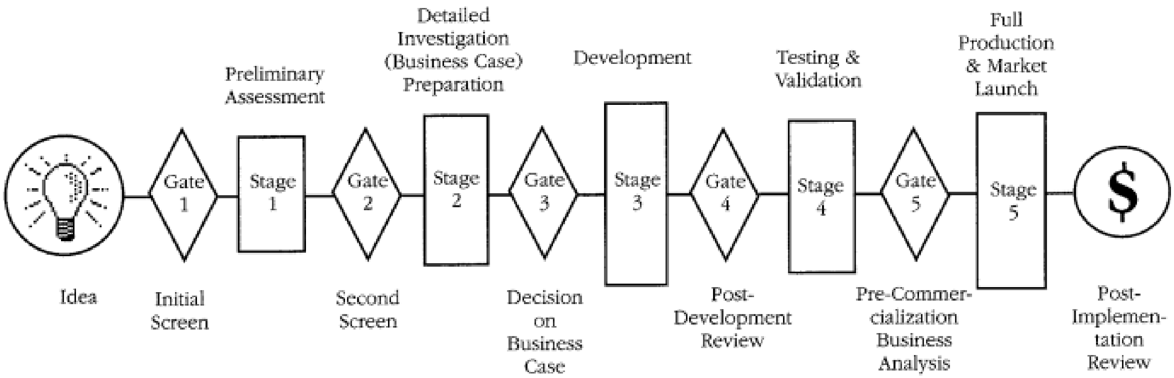

Figure 3: Overview stage gate system(Cooper, 1990)

A plethora of analyses and extensions have already been investigated. Such as multicompany perspectives, innovation service, implementations towards agile(Alam et al., 2023; Bhatia et al., 2017a). Due to the diversity and the amount of versions available it is essential to understand its principle components.

It's clear that this model works primarily from a perspective of incremental innovation, where through different steps within the process and continuous development, testing and screening a few technologies run the gauntlet, mature and are launched to market. Another name for the model is the funnel model. It already hints at the small margin of technologies that actually make it through. Additionally, while the funnel starts by looking outward, it's a process meant for internal development.

3.1.2 External innovation

To foster sustainable innovation, it's essential to look beyond the internal structure of an organization and consider the broader system, including various actors and how it functions. Transitions occur within comprehensive systems (regimes) that address basic human needs, and each regime is shaped by a combination of technologies, infrastructures, behaviours, cultural values, and policies (Elzen & Wieczorek, 2005). Understanding this broader context is crucial for driving meaningful change and innovation. Below multiple contemporary models that prescribe how this interaction should be organised are discussed.

Open innovation

The open innovation paradigm has its limitations in this field, it is still widely regarded as a modern pillar of innovation strategy (Chesbrough, 2019). Additionally, this paradigm has not only culminated in academic literature but is widely used throughout the industry and still advocated for in modern consultancy practises (BCG, 2024). Therefore, this paragraph will begin discussing some frameworks available for open innovations and their respective most essential aspects.

The rise and raison d'être of open innovation

Open innovation centres on the idea that valuable ideas can originate both inside and outside an organization, and that innovation can extend beyond its traditional boundaries (Chesbrough & Chen, 2015). In this model, companies no longer operate under the belief that successful innovation requires tight internal control. Instead, they recognize that internal ideas can be commercialized by leveraging external partners or markets, and external ideas can be brought in-house to create new pathways for bringing innovations to market that otherwise would not have come to fruition (Chesbrough, 2004; Kankanhalli et al., 2017). However, the technological innovation in the power and energy sector has traditionally been focussed on the more classical internal Research and Development methodology (Noailly & Ryfisch, 2015). External sources of ideas, such as universities, or research institutions were mostly used to fill the gaps in internal research and thus took on a more supplementary role (Greco, Locatelli and Lisi, 2017).

However, a core characteristic of modern radical innovation is that they don't stem from a single source, but rather from a complex interaction between organisations and actors(Bers et al., 2011).

External collaborators such as users, retailers, suppliers, competitors, universities, research institutions, and independent researchers are now recognized as crucial and valuable contributors to the innovation process (Dall-Orsoletta, Romero, and Ferreira, 2022). Moreover, fostering intentional collaboration between companies and other players within the innovation ecosystem is likely to enhance R&D productivity (Ili et al., 2010). Therefore, it is no longer assumed that just R&D teams are the most effective method for perpetual and disruptive innovation (Greco et al., 2017). This is coupled with the fact that a global clean energy transition to achieve net-zero emissions in the long term will require radical shifts in how we generate, distribute, and consume energy(IEA, 2020a). Considering the challenges the P&E sector has to overcome and the fundamental overhaul needed, without radical innovations these changes might not come as quickly as needed or at a significantly higher costs(Bogers et al., 2020). This among other reasons is why the open innovation paradigm has risen to prominence in the scientific community and has seen implementation in a plethora of businesses, including Dell, Procter & Gamble, ÖBB Open Innovation Platform, Unilever, InnoCentive, Atizo, Quirky (Bunk, 2018; Frey et al., 2011).

Types of open innovation

Generally, three types of open innovation can be described, inside out, outside in and collaborations.

When a company embraces external inputs and contributions, it engages in what is termed as outside-in or inbound open innovation (Bogers et al., 2018; Chesbrough & Chen, 2015). This approach involves integrating external knowledge and ideas into the firm's innovation process. Examples of inbound innovation include acquisitions, mergers, licensing-in, minority equity investments, and R&D contracts, where external resources are harnessed to enhance internal capabilities(Chesbrough, 2010).

Inside-out or outbound open innovation occurs when an organization allows its internal ideas or intellectual property to flow outward for use by external parties(Chesbrough, 2010). This approach is less common but includes practices such as licensing-out, divestments, and spinning off internal innovations into independent ventures. By doing so, companies can create additional value from their innovations by enabling others to commercialize them, even when they do not fit within the company's core business strategy(European commission, 2016a).

Lastly, strategies related to open innovation are based on collaboration, such as joint initiatives between various stakeholders or, coupled processes with private companies or value chain linking (Dall-Orsoletta et al., 2022a; European commission, 2016a).

Key characteristics.

For stimulating innovations there are two options: either support enterprises in how they organise their innovation practises or set the right conditions for open innovation to flourish (De Jong et al., 2008a).

De Jong et al. describe five characteristics for internal management of enterprises and three system factors.

Internal factors for enterprises.

1. Networking
2. Collaboration
3. Corporate entrepreneurship
4. IP management
5. R&D’

System factors

1. the availability of a substantial stock of basic knowledge,
2. a highly-educated and mobile labor force,
3. good access to finance.

However, these factors might be limited in their applicability for the energy sector specifically. As Henry Chesbrough, the architect of the open innovation paradigm said:

"Pecuniary mechanisms, which imply that knowledge flows are related to or consist of money, can be linked to the idea that a business case (i.e., the financial case) is a motivating factor for an innovation activity. However, for sustainability challenges, it is becoming increasingly apparent that nonpecuniary mechanisms are oftentimes observed as the most conspicuous *initial* motivating factor that ultimately leads to the open innovation activity."

Strategic niche management

What is it

Strategic niche management (SNM) has evolved as policy-centric framework in the Dutch socio-technical transitions tradition and also makes use of MLP. SNM advocate to pay attention to the role of visions, the development of actor networks, facilitating learning, creation of nurturing spaces for niche innovations, and strategies for up-scaling niche innovations (Twomey & Gaziulusoy, 2014).

Essential components

At the core of strategic niche management is the idea that governments can play a vital role in creating a more level playing field to the point that developing (green, or more socially favourable) technologies can challenge the regime or status quo (Ruggiero et al., 2018b). Establishing a protected area seeks to assist a certain niche in establishing guidelines, standards, and stability in order to test and assess novel opportunities, until they are ready to challenge the current regime (F. Geels & Raven, 2006; F. W. Geels, 2004; Smith & Raven, 2012).

Supporters of strategic niche management state that these protected spaces maybe created by using a "carrot and stick" strategy, combined with more conventional forms of command and control of certain market-based incentives for instance, tax breaks or rebates to affect changes in actor behaviour (Moore, 2018a). However, opponents argue that evolutionary economics play a vital part in limiting investment in lost causes, thus freeing up more funding for investing in technologies that do seem promising (Susur et al., 2019). However, getting the right mix of protection and selection proves rather difficult (Heiskanen et al., 2015). Too much protection can prevent the niche from becoming self-sustaining, while too little may stifle its growth. The challenge lies in determining how to roll back protection measures in a way that provides certainty to all actors, and how to accelerate development to effectively challenge the regime (Moore, 2018a). Exactly this ambiguity on what is needed in detail is problematic. What is the right amount of protection? What are the right mechanisms to utilise and how can governments actually nurture immature technologies for future success and sustainability? These questions remain unanswered.

In addition to protection for immature technologies, learning seems to play a critical part in SNM (Ruggiero et al., 2018b).

In order to support niche upscaling, intermediary organizations should aim to accumulate knowledge, build networks that facilitate new community energy initiatives, and advocate for niche growth (Hargreaves et al., 2013). Learning is fundamental to Strategic Niche Management

(SNM) because it allows the translation of lessons from local experiments into generalized knowledge, which can then be utilised to shape and coordinate local projects(F. Geels & Raven, 2006). Firstly, they seem to reduce uncertainty and help progress toward a dominant design, while also playing a role in the development of the broader socio-technical system by aligning emerging technologies with institutional, organizational, and technological structures, as well as raising public awareness (Brown et al., 2007a; Friedman & Hendry, 2019)

Here we see the distinction between two types of learning, namely first and second-order learning. First-order learning involves gaining insights into how to improve the design of the technology itself. In contrast, second-order learning focuses on the perceptions of consumers and regulators, where their ideas are not only considered but critically examined and challenged(Hoogma, 2000). Therefore second-order learning is crucial for radical regime shifts (Schot & Geels, 2008b). Additionally, SNM facilitate the gathering of empirical results that can advance both types of learning(Frishammar et al., 2015). Lastly, there is the factor of broadening or accumulation(Loorbach & van Raak, 2006; Naber et al., 2017a). This refers to the concept of repeating niche experimentation or pilots in different contexts and linking it to adjacent domains(Ruggiero et al., 2018b). Some authors also refer to this process as scaling up niches, where they are translated or embedded into the current regime(Hargreaves et al., 2013). This process is sometimes also referred to as the social embedding of developing niches, where they over time influence and change current socio-economic and institutional order(Kivisaari et al., 2004).

Nevertheless, what specific elements support these learnings or protections generally comes back in ambiguity or sometimes even contradictory. Smiths and Raven for instance, have identified shielding, nurturing and empowerment as the most promising, while Geels mentions, expectations&vision, learning, network, protection and niche regime interaction as the most essential(Schot & Geels, 2008b; Smith & Raven, 2012). While commonalities here seem to exist, when zooming in, either ambiguity or contradictions begin. For instance, the first factor of Geels 2008 framework, of expectations&vision the guidelines call for:

“Be flexible, engage in iterative visioning exercises; adjust visions to circumstances and take advantage of windows of opportunity" (Schot & Geels, 2008a, p. 549)

“Be persistent, stick to the vision, persist when the going gets tough” (Schot & Geels, 2008a, p. 549)

Asking for persistence and flexibility simultaneously, is like trying to steer a chariot being pulled by a lion and a swordfish. Yes, both seem potent and have a part to play in the right circumstances but wanting them both simultaneously is likely not the most efficient way forward.

Additionally, ambiguity plagues some conclusions, with a study specifically searching for what makes some SNM project become successful and other less so concluding that: “when SNM actions align with socio-technical landscape dynamics, then public sector actors have a greater chance at stimulating regime transformation.”(Moore, 2018a).

Essentially, reiterating what the model stipulates and describes instead of describing fundamental factors or what actors can do to increase the chances of furthering technologies to maturity. Another review of case studies searching for handles in practise concluded that, “none of these studies have detailed analytical processes of SNM for the analysis of eco industrial park development.”(Susur et al., 2019)

Therefore, while clear answers on what main elements can be used for maturing niches are lacking. It might be useful to look for common denominators instead.

Following a comprehensive systematic review of strategic niche management in practise, Browne et al. provided a set of suggestions that cut across their categories (Browne et al., 2012a).

1. developing a transition strategy and engaging in scenario planning with industry stakeholders;
2. identifying potential 'lead adopters' and develop a strategy for SNM
3. developing stakeholder partnerships with industry and consumer groups;
4. promoting the adoption of new sociotechnical regimes through awareness campaigns and education
5. changing the taxation structure to tax negative externalities and create positive incentives through excise relief and subsidies
6. providing long certainty through a constant mix of policy and regulatory signals.

Additionally, a systematic literature review on policy recommendations for SNM identified factors that appeared consistently across all categories. The most frequently reoccurring policy recommendations or topics focused on (Jenkins & Sovacool, 2018):

1. the appropriate financing of niche innovations.
2. mutual learning between stakeholders and across niches.
3. brokering and partnership in order to strengthen niche development.

According to this research these three core aspects seem to best cover the plethora of factors describing important elements of SNM. Nevertheless, the previously discussed framework offers a more comprehensive approach, encompassing a broader range of elements critical for addressing innovation challenges. Given the importance of thorough coverage, it is likely more effective to utilize an extensive framework with diverse factors that can be synthesized, rather than relying on fewer, more rigid elements.

3.1.3 Upscaling

Open innovation and strategic niche management highlight different important aspects of a system. An important part of stimulating innovation is to scale up the current immature technologies to the point of being functional or profitable (Naber et al., 2017b). As mentioned in the introduction, scaling up innovation is also important to DSOs as approximately one-third of the total reductions in $CO2$ emissions required to transition to a sustainable path originate from technologies that are presently in the prototype or demonstration stage (IEA, 2020a). Additionally, from the system perspective, small technological innovations and novel production ways are continuously ideated. The challenge lies not in more ideations but in scaling and commercializing those ideations.

Especially in the context of sustainable technologies scaling has recently taken the centre stage. Given the urgent need to accelerate transitions in order to address "wicked" problems like climate change (Köhler et al., 2019; Markard et al., 2020). As a result, the question of how niche innovations can be effectively scaled up and applied at broader system levels has gained increasing importance (Feser et al., 2024a). The pressing nature of these challenges, as captured by the idea that "time is running out" (Levin et al., 2012), highlights the need for developing robust instruments that not only foster niche innovation but also enable their widespread adoption and system-wide integration (Feser et al., 2024b). Or in simpler terms, it is not just enough to create a space for innovation and experimentation and communication of ideas. There is a clear need for the broad appliance of new innovation in practice.

However, scaling up pilots or initial demonstrations to fully fledged projects or functional companies is a complex issue where technological, social and societal factors interact. Due to this complexity it is also an important topic to study(Bossink et al., 2023b).

Recent researchers have delineated six factors that influence these demonstrative and transformative upscaling processes(Bossink et al., 2023b):

The factors that stimulate upscaling of sustainable energy technology in and from demonstrations are:

1. governmental support,
2. university-industry-government interaction,
3. coordinated flow of demonstrations,
4. investments in complementary technology and infrastructure,
5. presence of stimulating market forces,
6. using the economic benefits of scaling up.

Governmental support:

The first factor, governmental support, consists of a number of policy tools that governments have at their disposal such as: subsidies, taxes, legislation, regulations, plans, and actions the government implements to develop sustainable energy technology(Bossink et al., 2023b).

Part of these using these instruments is to create a level playing field. Due to high initial investments and the long lead times of infrastructure and significant entry barriers, the fossil based companies have a significant head start(Dehdarian & Tucci, 2021a). By reducing the competitive advantage of established technologies and supporting emerging sustainable technologies through effective policy measures, sustainable energy technologies can catch up and scale further through demonstrations and projects(Bossink et al., 2023b).

Additionally, governmental support should focus on active standardisation from pilots or demonstrations. Partly because it shows commitment and long-term support for upcoming technologies, which gives established actors the confidence that they should give this route serious consideration (Jenkins & Sovacool, 2018). Moreover, technology and institutions have historically co-evolved over time. However, with rapid technological advancements on the horizon, this balance is disrupted, creating an disparity in the rate of change between the two.

While technology has quite a lot of agency in its development, regulation and standards, take time to develop, when taking the backseat and waiting for interaction, its likely to fall behind and not catch up until the transition is either done, or some calamity has happened which has sprung the system into action. Active standardisation and institutionalisation of learnings after demonstration or pilots is an attempt at proactive involvement and evolving the current regulatory framework.

University-industry-government interaction

University-industry-government interaction refers to the collaborative effort where academic researchers, government officials, and industry practitioners work together over the long term to develop sustainable energy technologies. This collaboration fosters co-innovation, where academic research provides a knowledge base, governments create supportive policies, and businesses focus on commercializing the innovations. Such cooperation is vital for driving technological advancements and ensuring that new sustainable energy solutions can move from research to real-world application.

Coordinated flow of demonstrations

A coordinated flow of demonstrations can drive the development of multiple sustainable energy technologies, leading to the creation of strategic portfolios that consist of unique but complementary technologies working together (Hedeler et al., 2020). These demonstrations comprise of multiple consecutive and parallel demonstration projects, this is also referred to a "coordinated sequential approach" (Hendry et al., 2010).

Over time, through a series of demonstrations, sustainable energy technologies became more resilient, production and supply chains were established, and a niche market was developed to support the adoption of these new technologies (Brown et al., 2007a). This has historically worked for biomass, wind turbines, PV modules, CCS, solar thermal power, and waste to electricity(Bossink, 2020).

Investments in complementary technology and infrastructure

The fourth factor that drives upscaling, complementary technology and infrastructure, involves assembling the necessary technologies and engaging relevant stakeholders to ensure that sustainable energy technologies can function efficiently and effectively. This process includes the creation of value chains, where a network of supplying and collaborating companies work together to facilitate the production and market deployment of these technologies(Bossink et al., 2023b). For a new sustainable energy technology to successfully scale, it must be supported by a range of complementary technologies -such as energy storage solutions, transport and transmission systems, and smart grid infrastructure- that are developed and scaled in parallel(Lilliestam et al., 2021).

Or in other words: an invention is never singular or stand alone. Even something as revolutionary as the smartphone, was accompanied by technology advances in cameras, GPS, roaming, touchscreens, sim cards, and most importantly processors (Gold, 2017a).

Presence of stimulating market forces

Stimulating market forces involves boosting market demand, reducing production costs, and expanding production capabilities, all of which contribute to the advancement and development of sustainable energy technologies(Bossink et al., 2023b; Collins, 2020).

Think of the hydrogen market in Germany as an example. They have this chicken and egg problem, that production is not scaling up and becoming cheaper because of lagging demand, and demand is not spiking due to limited supply and relatively high costs(Huber, 2021; Dertinger et al., 2022; Riham, Alkousaa ; Christian, 2023).

Using the economic benefits of scaling up

The sixth factor driving upscaling, economies of scale, refers to the reduction in costs for renewable energy technologies as production and consumption increase(Bossink et al., 2023b).

This is crucial for more industrially driven technologies. However, I would argue that the previous factor covers most of the essential aspects already.

3.2: Innovation as a process

This paragraph concentrates on the second focus of the theoretical exploration: innovation as a process. While many innovation process models are tailored to specific companies, it is also essential to explore those designed to support innovation across multiple organizations. This paragraph examines models from two highly competitive companies, both actively operating in the high-tech sector and, most importantly, the energy sector.

However, due to the model's direct connection to competitive advantages of the company, access to these models is rare and accompanied by specific restrictions. While NLMTD (spoken as unlimited), is open in their model but restricted in the way it is used, this chapter can openly discuss each factor separately. However, for Cap Geminis "Innovation Engine" -due to a Non-disclosure Agreement- this research can only outline its fundamental aspects and some key points but won't mention all factors separately. However, while the individual factors cannot be shown directly, the relevant aspects have been carefully considered through interviews, and discussions, and have been systematically analysed and integrated into the new framework.

3.2.1 Innovation monitor.

The model of NLMTD is the result of a few decades of practical expertise. Additionally, they offer also provide a service for setting up an open innovation project. However, the main model NLMTD employs is the "innovation monitor". The innovation monitor consists of ten factors that all represent a significant piece of the puzzle to effective innovation. Or in their own words:

"The innovation monitor helps you create the conditions within your organization in which employees feel supported in their innovative activities" (NLMTD, 2020)

Figure 4: Innovation monitor by NLMTD

Watch Tower (External Analysis)

A key element of innovation management is conducting continuous environmental scanning, monitoring market conditions, technological developments, and regulatory changes(NLMTD, 2020). Organizations must remain vigilant of shifts in competitor strategies and evolving consumer behaviours (interview CEO NLMTD). This proactive approach broadens the organization's perspective, enhancing its ability to anticipate both opportunities and threats. This closely aligns with the outside-in open innovation paradigm. A paradigm that is underscored by their program to boost open innovation(nlmtd, 2020), but also in their broader innovation strategy. Especially for DSO's that are dependent on public funding bringing the outside in is essential (interview CEO NLMTD).

"it's finding the right stakeholders that agree on the concepts as they need to open up to the outside world for solutions, but also open up to their peers in the industry to share those solutions. Because there's really no clear reason for Stedin to be smarter than alliander or for an Enexis to be smarter than Stedin on certain aspects." (interview CEO NLMTD).

Purpose & Strategy

Defining the purpose and strategy of an organization is foundational to aligning innovation activities with organizational goals (interview CEO NLMTD). It's important to identify and define a "north star" (interview CEO NLMTD). Answering questions, on the position in the market, and the reason d'être and key competences, helps in crafting a strategic vision that balances the objectives of people, planet, and profit (NLMTD, 2020). Establishing a clear purpose and a coherent strategy ensures that the organization's innovative efforts are directed towards achieving long-term success (interview CEO NLMTD).

Customer Insights

Understanding customer needs is paramount in both radical and incremental innovation(Bohlmann et al., 2013). Engaging with potential customers and observing actual consumption patterns enables an organization to adopt a learning stance(NLMTD, 2020). Through continuous engagement, firms can create flexible, adaptable innovation that delivers tangible value to the market(nlmtd, 2020).

Ecosystem Collaboration

Successful innovation rarely occurs in isolation. Effective collaboration with external stakeholders—including research institutions, industry experts, startups, partners within the value chain, investors, and regulatory bodies—enhances an organization's capacity to innovate(NLMTD, 2020). These partnerships offer complementary resources, knowledge, and expertise that organizations cannot internally generate(nlmtd, 2020). This also closely aligns with the open innovation paradigm, as it aims to leverage knowdlegde that cant be used or found inside the organisation (Arsanti et al., 2024). Mapping and leveraging the innovation ecosystem is critical (interview CEO NLMTD). Organizations must engage relevant stakeholders to access external inputs that catalyze both the ideation and execution of innovative solutions (NLMTD, 2020).

Prototype & Evaluation

A structured process of prototyping allows organizations to test their innovative concepts before full-scale implementation (NLMTD, 2024). Developing a 'minimum viable product' (MVP) - whether as a mock-up, demo, prototype, or pilot- helps to materialize innovation in a tangible form (NLMTD, 2020). The evaluation of prototypes is critical for adjusting the innovation to better meet market demands, thus improving its potential success (NLMTD, 2020). Organizations must strategically decide when and how to prototype, and what tools to use to evaluate effectively (NLMTD, 2024).

Scaling

Once an innovation proves successful at the pilot level, scaling becomes a key challenge (interview CEO NLMTD). Scaling decisions significantly influence the long-term viability of the innovation (NLMTD, 2020). Many pilots "end successfully" (EQUANS, 2024). The irony being that even though the pilot was "successful" they fail to scale up afterwards. Organizations must carefully consider how to expand innovation to maximize commercial success, evaluating the scalability of both their activities and their business models (NLMTD, 2024). This step ensures that successful innovations do not remain confined to niche markets but are instead developed for broader application. Strategic planning at this stage is crucial for transitioning from prototype to profitable market offerings, i.e. preferably you have thought about the needs in later stages, to make sure that a pilot is not the end goal, but a temporary milestone, to reach to next phase for eventual exploitation (interview CEO NLMTD).

People & Culture

People and organizational culture form the foundation of any innovation framework (Mergel & Desouza, 2013). Leadership and organizational culture directly impact an organization's capacity for innovation by shaping behavior, decision-making, and risk tolerance (Agolla & Van Lill, 2016; Cinar et al., 2019b). Key cultural factors that facilitate innovation include employee autonomy, psychological safety, leadership transparency, and cross-functional collaboration (NLMTD, 2020). This cultural foundation enables the organization to harness the creative potential of its workforce. The impact that leadership and culture have on innovation cannot be overstated (interview CEO NLMTD).

Tools & Process

Innovation is an ongoing, structured process that requires continuous support through appropriate tools, resources, and methodologies (NLMTD, 2020). Organizations must design and implement innovation processes that align with their strategic objectives and operational capacities (NLMTD, 2020). These processes should integrate goal-setting, key performance indicators (KPIs), data analytics, technology platforms, and resource allocation to support innovation activities (NLMTD, 2024). The design of these processes should be flexible, allowing for learning and adaptation as new data and feedback become available (NLMTD, 2020).

Impact Assessment

In modern innovation frameworks, it is increasingly important to assess the social, environmental, and economic impacts of innovation activities (Cheah, 2016). Stakeholders—including customers, employees, investors, and government entities—place high value on organizations that demonstrate a positive societal impact (NLMTD, 2020). Organizations must therefore develop metrics to measure the effects of their innovation activities in terms of customer satisfaction, employee engagement, and environmental sustainability (NLMTD, 2020). This impact assessment helps maintain stakeholder support and aligns innovation outcomes with broader societal goals (NLMTD, 2020). The impact assessment could also be connected to the strategy or goal of the company, their "north star" if you will. Thus, operationalising purpose.

Value Creation

A critical component of any innovation framework is the capacity to create and capture value (interview CEO NLMTD). Organizations must assess the financial and intellectual value generated by their innovations, considering elements such as intellectual property, patent licensing, and new market opportunities (NLMTD, 2020). The monetization of innovation is crucial for ensuring the sustainability of future innovation activities (NLMTD, 2024). This value creation also fosters opportunities for business growth, including international expansion, strategic partnerships, and spin-offs (nlmtd, 2020). Measuring the financial returns of innovation provides the necessary support to sustain innovation investments and secure ongoing stakeholder engagement (interview CEO NLMTD).

Value also shares a connection with purpose according to the CEO of NLMTD. With central question stemming from the problem analysis: Why is this important to us? What's the cost if we don't solve it? What's the value if we do solve it? (interview CEO NLMTD). The value can be monetary, but not solving an issue could also carry social cost alternatively.

3.2.2 Innovation engine

The innovation engine in itself is a culmination and melting pot of different theoretical innovation frameworks. Subsequently, through discussion and iterations based on practical experience the current framework was formed. However, due the model directly pertaining to the competitive advantage of Cap Gemini Invent, this section will only broadly describe the model and highlight some aspects in comparison to the innovation monitor. However, the full model and all its factors have been used for the model synthesis.

The innovation engine roughly consists of four parts. The centre, with the diamond shapes. A combination of factors on strategy on the left-hand side, the six factors surrounding the diamond shapes and below and some Ancillary factors below.

At the core of the framework are the diamond shapes that stem from the double or triple diamond model (Schleith & Tsar, 2022a) for design thinking and development (interview Senior consultant Strategic Digital Innovation). These diamonds are then surrounded by the inflow of new opportunities and “sustain”, for continued support of new innovation to ensure their impact and scaling (interview Senior consultant Strategic Digital Innovation).

Adjacent are the six surrounding factors for innovation, also named innovation capabilities. The original inspiration for these factors stems from the ISO standards for innovation management (interview Senior Consultant Strategy and Innovation).

Additionally, a few central themes that were deemed important will be discussed:

One of the factors seems to align well with the value creation mentioned in the innovation monitor. It is aimed at answering question like: are we getting the value that we need from this? And how do we know? But also, as a measure of efficiency and effectiveness. How quick are we going through the double diamond? Are there a lot of fluctuations? And if so why? (interview Senior consultant Strategic Digital Innovation).

Another key influence was the nesting of the innovation process in the organisation. Which is not just making room for innovation with HR support or in the budget, but is also about traceability of choices for top management to understand variation in performance (Manager at Capgemini Invent).

Lastly, the importance of culture. Which has various interpretation depending on the context. It could describe connecting choices to top or middle management as also outlined by the CEO of NLMTD, but also as something closer to the mindset of people directly involved in the project (interview Senior consultant Strategic Digital Innovation).

3.3 Regulatory experimentation

This part is dedicated to the exploration of the third focal lens. Namely, the role of regulation and more specifically, the role of regulatory experimentation and innovation. Below, this paragraph will start by categorising the different types of regulatory experimentation. Subsequently, it will dive in deeper into the current state of regulatory experimentation in the Netherlands. Lastly, it will outline the framework that seems best suited for this context.

3.3.1 Types

Regulatory experiments are divided into two categories: the first involves governmental actors participating in and facilitating change processes through temporary exceptions within regulatory frameworks, known as regulatory sandboxes(Bauknecht et al., 2020; Bauknecht & Kubeczko, 2024). The second category involves using regulation as the experiment itself, also referred to as regulatory innovation trials (Bauknecht et al., 2020; Bauknecht & Kubeczko, 2024).

Both of these categories have different aims and functions.

Sandboxes typically involve granting a limited waiver, enabling organisations to test new business models or technologies in a regulatory environment where requirements are less stringent (Bovera & Lo Schiavo, 2022a). They are also seen as a way to level the playing field and a way to artificially create a protected space for new technologies to grow without the pressure of market forces or competition (Beckstedde et al., 2023; Sunila & Ekroos, 2023).

The second aspect stems from the fact that regulators cannot keep up with the speed of technological developments(Bauknecht & Kubeczko, 2024; Schneiders, 2021). However, with the pressure of developing sustainable technologies the guardrails to protect consumers now might impede innovation(Sunila & Ekroos, 2023). The challenge therefore now lies in finding a way to protect consumers while also enabling innovation (Schneiders, 2021). Research fields on how to solve these challenges are adaptive governance and reflexive governance (Eshuis & Gerrits, 2021; Janssen et al., 2017; Lindner et al., 2016; Schneiders, 2021).

3.3.2 Current state

Interestingly enough the current state of regulatory experimentation in the Netherlands is has become unclear. While originally one of the pioneering countries in 2015, the Netherlands as of 2020, has closed the regulatory sandbox pertaining to energy (Beckstedde et al., 2023). As of now there are no consultations to open new energy sandbox initiatives (Broeckx et al., 2019b). The context given at the time the Dutch state (Raad van State, RvS) had published a negative advice on the energy sandbox and its potential impact (Raad van Staten, 2020). It highlighted that the full responsibility for the setup and costs of the experiment, along with the associated risks, rested entirely with the experimenters (Schneiders, 2021). It was therefore closed, in order to protect consumers and argued for more detailed criteria for setting up experiments.

The minster of energy at the time disagreed with this decision stating that the energy transition is not a ‘clear and well-defined path’ (RVO, 2021). The goal of the sandbox is to explore whether the granting of derogations or waivers 'is favourable to the energy transition and whether an adjustment or repeal of those regulations is desirable' (Wiebes. E.D., 2020).

The ordeal was summed up by Schneider in his investigation of the effectiveness of regulatory sandboxes, as the following:

"The opinion of the RvS shows a misunderstanding of the fact that the sandbox is supposed to be an adaptable tool reflecting the evolution of society and new business models. Predefining exactly how an experiment should be conducted defeats the point of a sandbox." (Schneiders, 2021)

Here we also see that the current understanding of regulatory sandbox has become the blend of both categorisations. Each has its part to play. Quite a a number of countries have a form of regulatory sandboxes, including Germany, Belgium, Italy, Denmark, and the (formerly) the Netherlands (Beckstedde et al., 2023; Bovera & Lo Schiavo, 2022b; Broeckx et al., 2019b; Schittekatte et al., 2021; Schneiders, 2021). However, In the energy sector, Italy is currently the only country where experiments are explicitly aimed at developing a new regulatory framework, meaning that regulatory innovations are being implemented (Bauknecht & Kubeczko, 2024).

3.3.3 Framework:

Therefore, when looking for a functional framework it is important that both categories are included. The selected framework, for regulatory experimentation is a three-step framework, based on experimental experiences in Great Britain, and most crucially, Italy.

The framework is divided into three distinct phases—design, implementation, and evaluation—each encompassing specific dimensions that guide the regulatory experimentation process (Bovera & Lo Schiavo, 2022c):

1. Design Phase
   This phase includes five key dimensions:
   - Steering governance
   - Flanking governance
   - Actors and promoters
   - Stakeholder involvement
   - Eligibility criteria
2. Implementation Phase
   The implementation phase focuses on operationalizing the experiment and includes:
   - Topics addressed
   - Trial dimensions (spatial and temporal)
   - Derogations
   - Funding
3. Evaluation Phase
   The evaluation phase is critical for assessing outcomes and includes two dimensions:
   - Monitoring
   - Dissemination and public disclosure

The framework's focus on governance, stakeholder involvement, and eligibility criteria in the design phase facilitates the structured planning of experiments while considering contextual relevance. The inclusion of spatial and temporal dimensions, derogations, and funding in the implementation phase addresses practical aspects of experimentation. Additionally, the evaluation phase incorporates monitoring and dissemination, emphasizing accountability and the sharing of results.

By addressing these dimensions, the framework provides a structured approach to regulatory experimentation and reflects the complexities of the Dutch energy sector. Its comprehensive structure supports the examination of regulatory challenges and the exploration of innovation within highly regulated contexts.

3.4 Conclusion and framework selection

This chapter set out to provide an exploration of current theory on innovation frameworks consisting of three distinct parts. This chapter closes off with a short reflection on the first sub-question and the answers found so far.

SQ1: What (elements of) current frameworks are suitable/well situated for framework synthesis?

This research identified and analysed multiple frameworks to address the complexities of upscaling innovations for sustainable technologies at a system level. These frameworks were chosen based on the tripart research objectives which were previously outlined in this study: innovation as a system, innovation as a process, and regulatory experimentation. Each focus contributed to understanding the interplay between systemic dynamics, practical implementation, and regulatory enablers, reflecting the multifaceted nature of innovation in the energy sector.

3.4.1 Key frameworks and contributions

Innovation as a System:

Open Innovation Paradigm (De Jong et al., 2008b):

This framework highlights the critical role of external collaboration for innovation. It addresses the systemic nature of innovation by integrating external actors—such as universities, suppliers, and other stakeholders—into the innovation process. Open Innovation underscores that sustainable technologies rarely emerge in isolation and require ecosystem-level engagement to succeed.

Strategic Niche Management (Browne et al., 2012b):

SNM provides tools for creating protected environments where niche innovations can mature. It emphasizes shielding, nurturing, and empowering emerging technologies, facilitating the transition from experimental niches to mainstream applications. SNM's focus on second-order learning and systemic alignment is particularly relevant for scaling sustainable technologies.

Innovation as a Process (Company-Based Models):

Innovation Monitor (NLMTD):

Developed by NLMTD, the Innovation Monitor evaluates and addresses barriers to innovation through ten key factors, including Purpose & Strategy, Ecosystem Collaboration, and Impact Assessment. Its practical refinement ensures relevance across industries, including energy. This model helps organizations align innovation activities with strategic objectives, offering tools to navigate operational complexities effectively.

Innovation Engine (Capgemini):

Capgemini's Innovation Engine integrates elements from ISO standards for innovation management and design-thinking frameworks. It provides tools for aligning strategic priorities and embedding innovation processes within organizational structures.

Regulatory Experimentation:

The Three-Step Regulatory Experimentation Framework (Bovera & Lo Schiavo, 2022d):

This framework is structured across three phases: design, implementation, and evaluation. It emphasizes governance, stakeholder involvement, and eligibility criteria during the design phase, operational aspects like derogations and funding in implementation, and monitoring and dissemination in evaluation. This structured approach aligns well with the regulatory environment of the Netherlands, facilitating innovation within the constraints of highly regulated sectors.

3.4.2 Next steps

No single framework fully encapsulates the complexity of scaling sustainable technologies on a system level. However, synthesizing elements from these frameworks acknowledges the inherent complexity of the energy sector and offers a multi-faceted lens to guide the upscaling of sustainable technologies effectively. These frameworks collectively reflect the interplay between systemic requirements, organizational processes, and regulatory structures, offering valuable insights into the challenges and opportunities faced by DSOs in navigating innovation.

The subsequent step involves examining how these selected frameworks can be synthesized and identifying necessary modifications. Therefore, the next chapter will outline the framework synthesis.

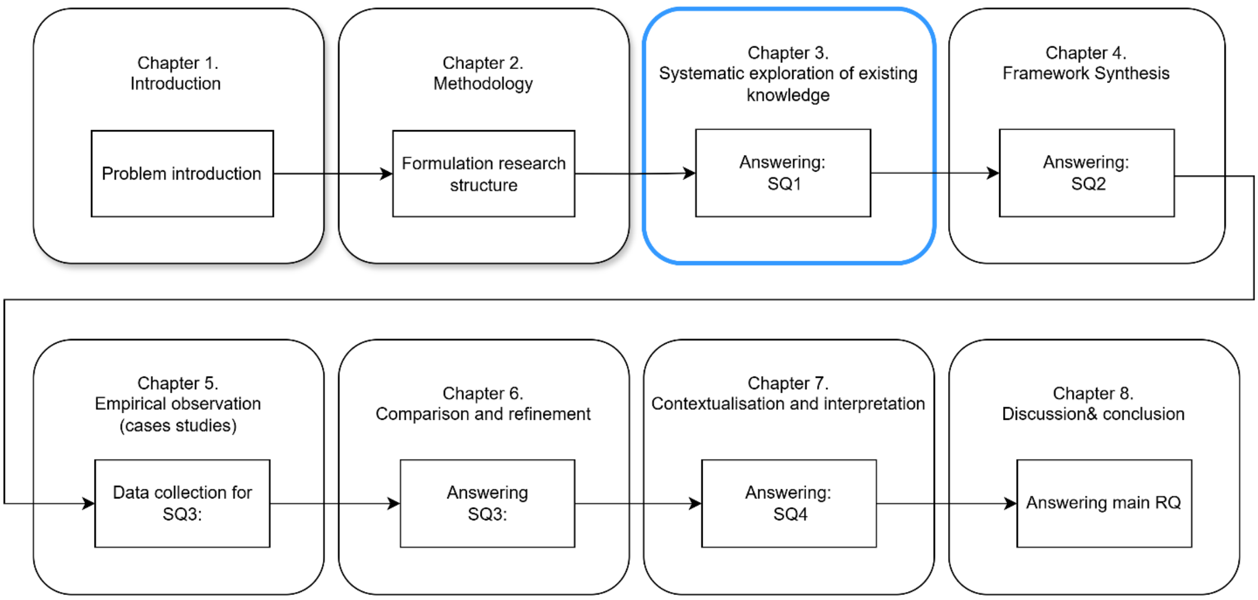

Figure 5: Overview current stage of this research

Chapter 4: Framework synthesis

This chapter outlines the crucial step of combining the important factors identified. First, the core concept underlying the newly constructed framework is outlined. Second the process of selecting, combining and pruning factors is described, to end up with an initial theoretical framework.

4.1 Three levels:

The constructed framework distinguishes between three levels of factors: ecosystem level, company level, and project level. This distinction arises from the complexities encountered when synthesizing different frameworks, particularly the challenge of similar yet distinct terminology that takes on different meanings depending on the level of analysis. By structuring factors across these three levels, the framework allows for greater clarity and nuance, ensuring that concepts remain precise while accommodating variations in scope and perspective. This structured approach provides a foundation for analysing stakeholder management, innovation strategies, and other key factors at the appropriate level.

For example, stakeholder management is frequently outlined as an integral factor for innovation. It is emphasized in frameworks such as Regulatory Experimentation (Bovera & Lo Schiavo, 2022d) and was extensively discussed in expert interviews with senior innovation consultants and corporate strategy experts (interview Senior consultant Strategic Digital Innovation interview CEO NLMTD). However, its meaning can vary depending on the context.

From a project perspective, stakeholder management can refer to engaging the right individuals within a project, as highlighted by a senior management consultant in strategic digital innovation (interview Senior consultant Strategic Digital Innovation). At the ecosystem level, it relates more closely to stakeholder partnerships across different actors in the innovation system, aligning with insights from Strategic Niche Management and perspectives from a researcher specializing in sustainable communities and regulatory experimentation (interview Researcher Sustainable Building & Sustainable Communities). Lastly, at the company level, stakeholder management can take on another meaning as outlined by the CEO of NLMTD, who emphasized the importance of involving individuals across different managerial layers to drive an effective innovation strategy (interview CEO NLMTD).

These perspectives are interconnected yet distinct. However, when analysed through the three outlined levels of innovation, their relevance becomes clearer. At the project level, the focus on people and culture is most applicable. At the company level, the emphasis on managerial engagement aligns well with innovation strategy implementation. Finally, at the ecosystem level, fostering partnerships to support the creation of niche markets resonates with both Strategic Niche Management and regulatory insights. This distinction of parallel levels ensures that each interviewee's perspective on stakeholder management is not conflicting but complementary, providing flexibility and nuance.

However, this is not just the case for stakeholder involvement. But can also been seen in other factors, such as “alignment strategy” where repeatedly by different parties it was mentioned that a project purpose and strategy needed to fit well with the company’s overall (innovation) strategy (interview Senior consultant Strategic Digital Innovation, interview CEO NLMTD). Additionally, the strategy needs to align with the state of a market (Brown et al., 2007b; Sunila & Ekroos, 2023). So, from the perspective of profitability or financial sustainability, is the market growing or shrinking? Niche market or increasingly competitive? And is there long-term financial support etc. Or put differently, a strategy on how to position the company in the ecosystem. Which leans closer to aspects of open innovation and Strategic niche managements.

Other themes which seem characterized by a multi-level structure are “processes and organisation” and “access to finance”. Below, an overview of the multi-level factors can be seen. Where the left individual box (in white) indicates the theme, and directly to the right the accompanying factors can be seen. They are ordered in descending order, i.e. at the top is ecosystem level, below that, company level, and the bottom project level. Additionally, the colours represent the origin of each of the factors. It shows from which source the factor stems.

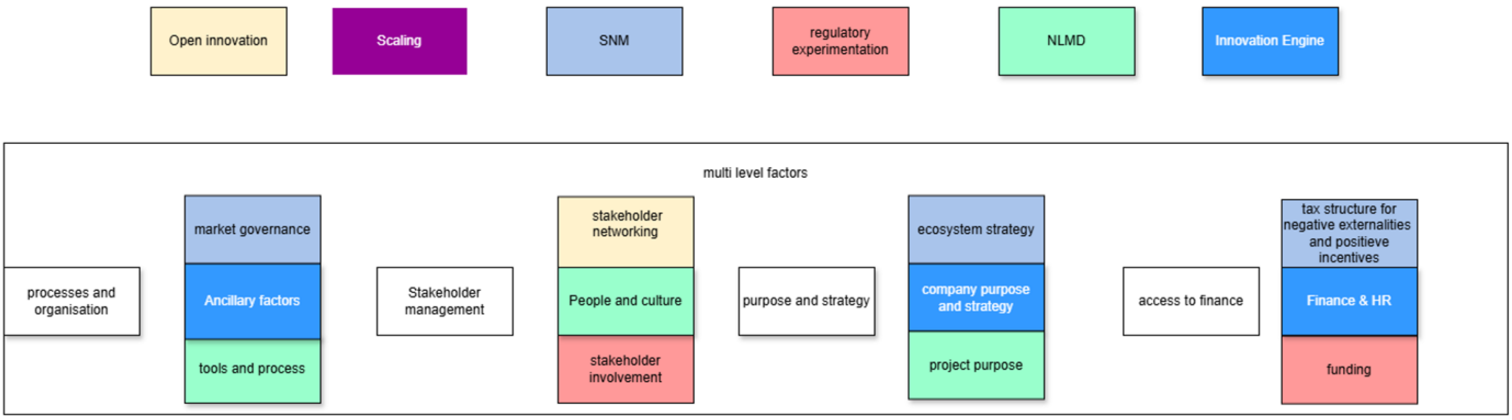

Figure 6: Themes with Multi-level factors

4.2 The model

The following section details the process of constructing the framework, ultimately unveiling its structure. The process follows a few steps. The first step is the categorisation of all factors of the selected frameworks into three categories: project level, company level, ecosystem level. Second, for each of the category's factors are removed if deemed not relevant enough, combined when they are thematically similar, or kept unaltered. The process iteratively repeats until the version for a level (e.g. ecosystem level) is optimised where the version has no thematic redundancy, or too much information/nuance is lost with further exclusion or combining. First, the categorisation is shown, along with noteworthy remarks on the information this already provides. Second, the iterative pruning process is show for each level individually. At the end a table is shown per level, of what factors were removed, combined or kept.

4.2.1 Categorisation of factors

Assigning each framework's factors to a level already provides some valuable insights. Below in figure 6 the sorted factors can be seen. The source of each of the factors can be seen by its colour. The specific factors of the innovation engine have been removed to protect their competitive advantage.

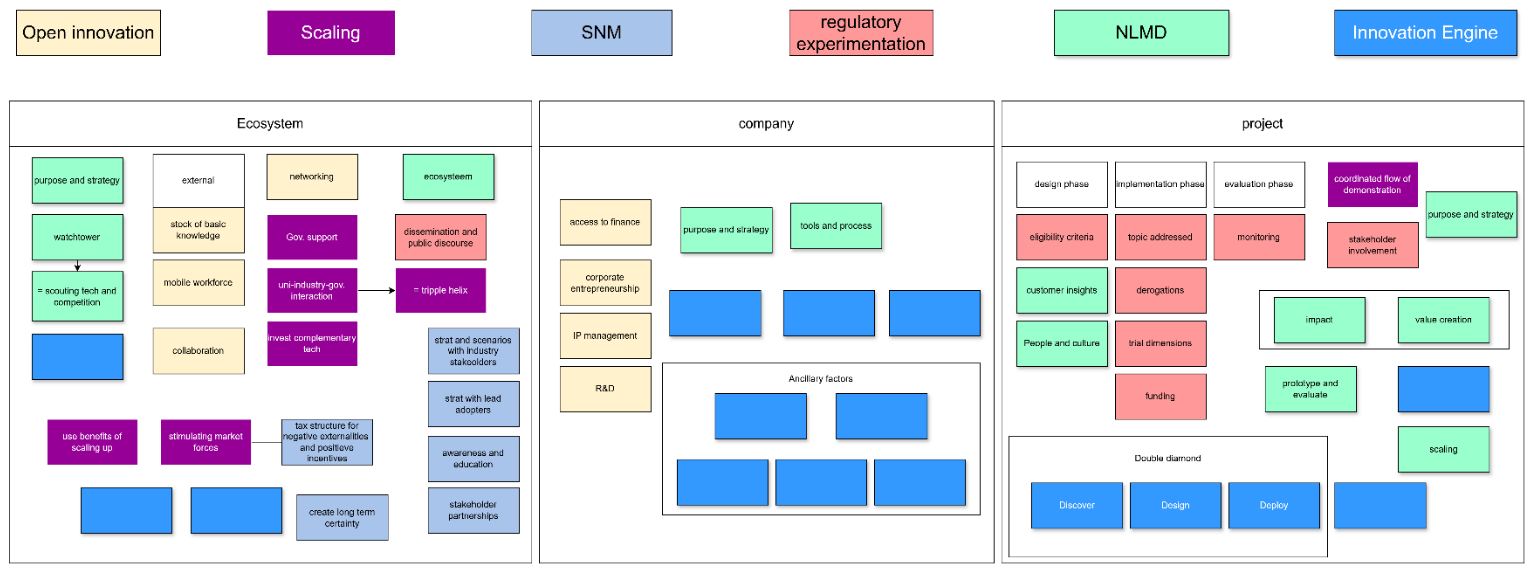

Figure 7: Framework factors categorised by the three innovation levels

It can be seen that most models have a spread of factors on different levels. So, while some models have the wide range, they all seem inconclusive as they describe different aspects of the same phenomenon. Additionally, most models seem to have a certain level where they are heavily focussed on. For instance, factors for regulatory experimentation, seem almost exclusively focussed on the project level, and it not represented at all on the company level. SNM factors seems exclusively focused on the ecosystem, which seems fully in line with previous observations on how SNM does not provide actionable details. While open innovation has an even spread on the ecosystem and company level, but not on the project level. This illustrates that the current individual frameworks often focus on specific aspects or levels of innovation, leaving gaps that hinder their ability to capture the full complexity of the process. This observation on the spread of current individual frameworks is quite in line with the notion that all these models individually have their blind spots when describing innovation.

4.2.2 Project Level

The process of getting from the categorised factors to a more refined version entails a few iterations of pruning and combining factors. First this paragraph will discuss what factors were initially on the project level and the finalised version after iterations of pruning and combining. Second, it will discuss the combined factors, on how and why they were combined. Third, the finalised version is shown, and its main characteristics are outlined. Lastly, a small table is shown to give insight into what has become of each of the factors. For the sake of confidentiality, the Innovation Engine's factors (in blue) are not detailed but can be assumed to have been merged or combined into the finalised version.

Before and after iterations of combining and pruning

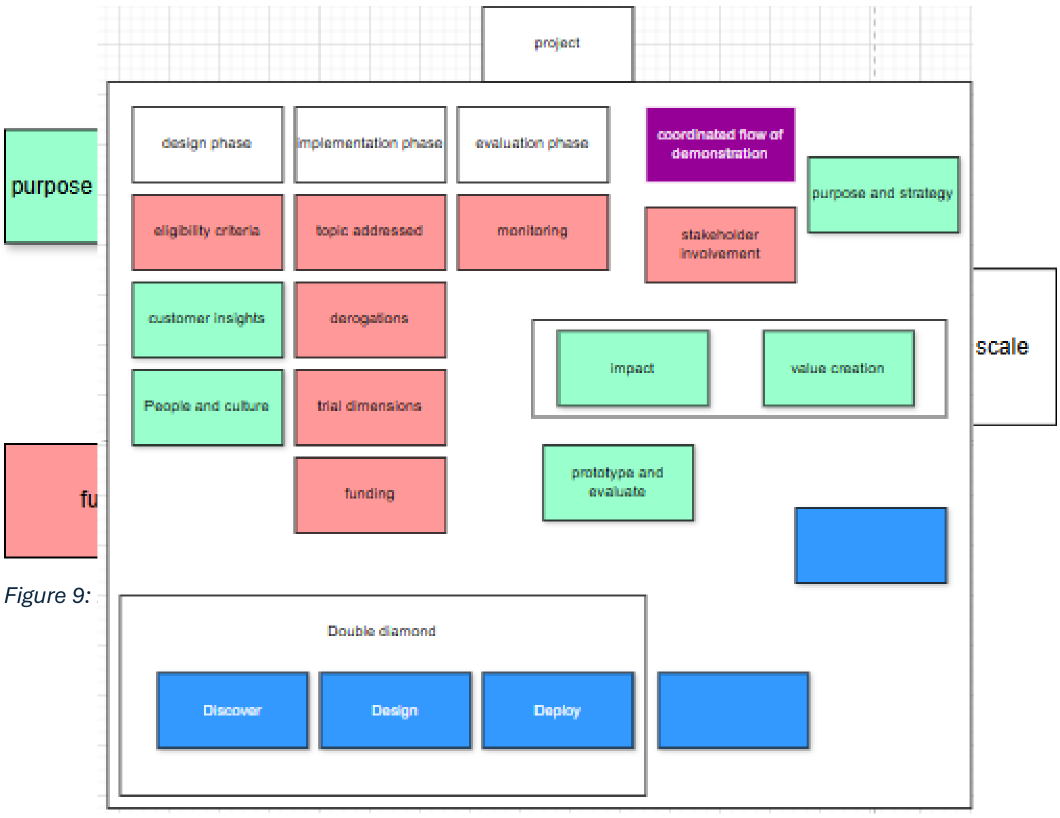

Figure 8: Project level pre-pruning

Factors removed

Quite a considerable number of factors was removed on this level. First the white indicators "design phase", "implementation phase" and "evaluation phase" were removed. They stem from the phases of the regulatory sandbox framework but are no longer relevant in as the main model categories are level of abstraction not time frames.

The factor "eligibility criteria" was removed due to its limited immediate relevance. While it may become relevant later, it is a procedural hurdle that teams might encounter, rather than a structural factor that actively guides innovation or addresses challenges. The same is also true for "derogations" and "trial dimensions" as factors. Additionally, these factor's relevance rely on the fact that the topic of innovation is contentious. If the topic of innovation is in line with regulation, then these factors become completely irrelevant.

Factors combined

Below the combined factors can be seen below in figure 9. This next paragraph details which combined factors were created along with its reasoning.

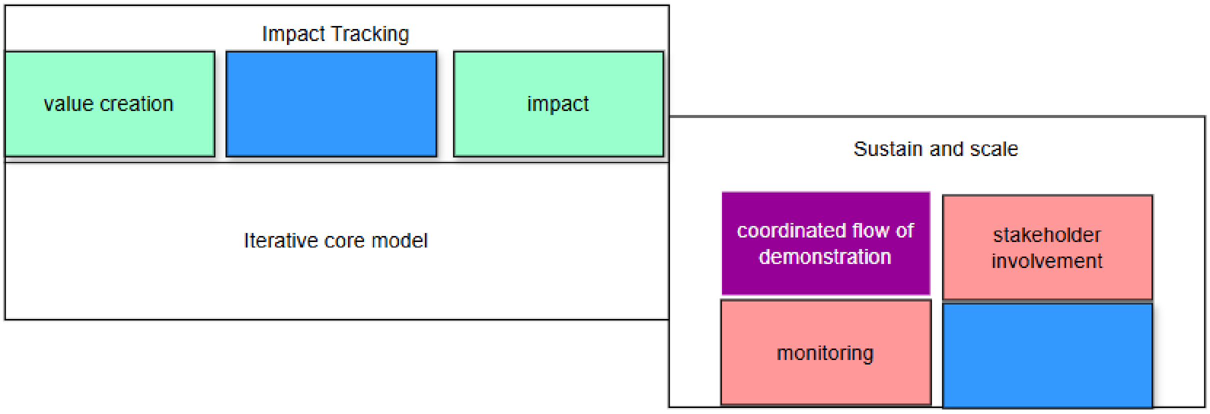

Figure 10: Combined factors at the project level

Most projects rely on a central model that outlines the creation process. This is particularly common in product- or service-driven innovation, where a structured process flow model is typically employed. For this iterative process, the double diamond, triple diamond or agile are common practises (Bhatia et al., 2017b; Schleith & Tsar, 2022b). This concept of a central iterative core model is also seen in multiple of the already outlined frameworks. While Cap Gemini, tends to focus on the double or triple diamond models, NLMTD mentions “prototype and evaluate”. Which is remarkably close the to triple diamond method (Schleith & Tsar, 2022b). Therefore, a new central factor of “iterative core model” was created, removing the specific factors from the double diamond.

Second at the project level, is the combined factor of impact tracking. There is a plethora of theory on project management that emphasize the importance of tracking progress, and how to measure during the process whether the project is on track to achieve its aim (Gries & Restrepo, 2011; Mahabir & Pun, 2022). This point was also highlighted by both Capgemini and NLMTD. A summarising factor was therefore introduced: impact tracking.

Lastly, what is to be done after a project is finished essential. As mentioned before quite a significant portion of project are discontinued even if a pilot project was successful (EQUANS, 2024). Therefore, sustaining and scaling is crucial for long term success of innovations (Naber et al., 2017b; Ruggiero et al., 2018a). This is also noticeable from the selected framework their factors. For example, monitoring from the framework on regulatory experimentation mentions the importance of checking on the effectivity after implementation. Additionally, from the scaling framework, the importance of coordinated flow of demonstrations describes how to scale up individual project with milestones to in order to prevent getting stuck after the pilot phase. The CEO of NLMTD highlighted the importance of stakeholder involvement in scaling, emphasizing that organisation don’t just need to think about who they need now, but also what stakeholder they need to engage for future phases of scaling (interview CEO NLMTD). This aligns with the concept of a coordinated flow of demonstrations, as both rely on phased scaling to ensure sustained growth and impact.

Factors on project level.

This paragraph will briefly discuss the result of the pruning and combining of factors. It will discuss the project level, its factors.

The project level operates at the micro scale, focusing on the efforts of a single project team or group. At this level, innovation centres on the development and execution of specific initiatives, products, or technologies within a clearly defined scope, timeline, and budget. It addresses localized challenges and strives to deliver tangible, actionable outcomes.

The project level has three central components in addition to a few surrounding factors. Below the finalised version can be seen. At the core are the three combined factors as outlined in the previous paragraph. It is flanked by a few additional factors.

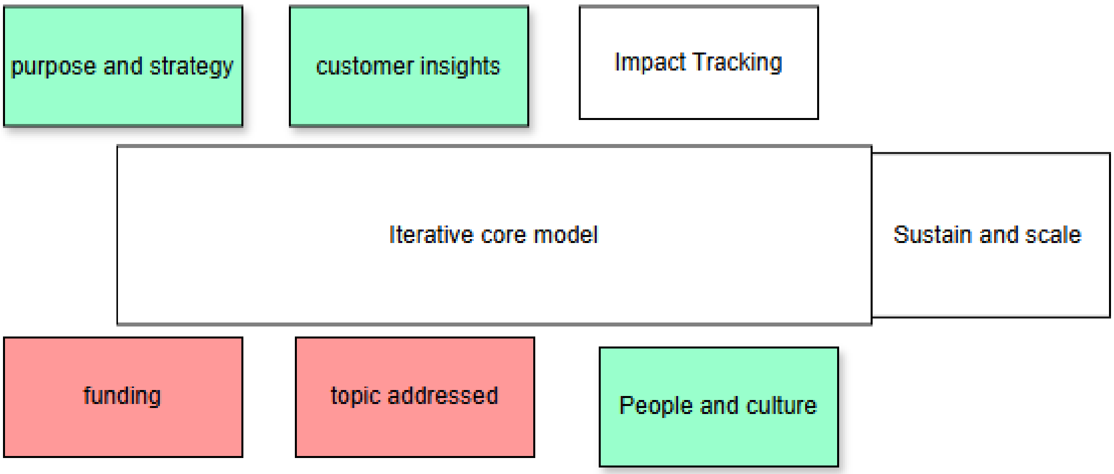

Figure 11: Finalised version project level

One aspect mentioned by both companies was the importance of purpose and strategy (interview CEO NLMTD and interview Senior consultant Strategic Digital Innovation). It is essential to have this North star and understand why the project you are doing is important and to what greater goal is aligns (interview CEO NLMTD). Additionally, a senior innovation consultant at Cap gemini mentioned that alignment of a project strategy with a bigger companywide strategy, is key for success over a prolonged period (interview Senior consultant Strategic Digital Innovation).

Second, are customer insights. This factor was chosen specifically to tailor to the DSO context. DSO's tend to struggle with understanding the needs of their customers (interview CEO NLMTD & interview Sanne Schoneveld). This also aligns well with theoretical insights found. DSOs are increasingly recognizing the need to transition from their traditional role of merely connecting customers to the grid to actively engaging with them to meet evolving demands(EDSO, 2022). Historically, DSOs focused on infrastructure and reliability, but the integration of renewable energy sources, electric vehicles, and smart technologies has necessitated a more customer-centric approach (Prettico & Vitiello, 2020).

Third funding is essential for any project. Without funding for projects, innovation stagnates (European commission, 2016b; IEA, 2020c).

Another key factor is the topic considered. This is specifically relevant for experimentation for DSO's as the topic the experimentation addresses has a big influence on the wiggle room within the law. The "omgevingswet" allows for exemptions and derogations within the physical environment, however experiments or pilots on more fundamental aspects of the energy system are difficult (interview expert regulatory experimentation). For example, with battery storage for DSOs or innovation on network tariffs handle such fundamental topics and are therefore difficult to experiment with (Hennig et al., 2022; Milchram et al., 2020b).

The last factor for consideration is people and culture. One of the key aspects consistently indicated as important by every party interviewed. While there are different interpretations, For this framework and this level, this factor details the direct involvement within a project. While for some parties it is about competences and experience, the CEO of NLMTD mentioned that finding the right people is about ownership, about finding the individuals who are personally engaged in wanting to solve those problems and wanting to implement the solutions (interview CEO NLMTD, interview Senior consultant Strategic Digital Innovation).

Overview

Table 1: Factor actions project level

Factor	Action	Reason
Coordinated flow of demonstrations	Combined	It is part of an effort to scale innovations after ideation. Therefore, it is fused with similar factors that focus on stimulating or growing innovations after ideation
Customer insights	Kept	Essential, but not integrated enough by DSOs.
Purpose and strategy	Kept	Crucial for alignment and focus.
Impact	Combined	Important but combined for impact tracking as a more continuous part instead
Value creation	Combined	Same meaning as impact, but more financial focussed. However relatively similar to impact.
People and Culture	Kept	Essential to get "the right people" on a team with a ood mindset according to CEO of NLMTD and a Senior innovation consultant.
Prototype and evaluate	Combined	Iterative process for development. Just like double or triple diamond.
Eligibility criteria	Removed	Relevance hinges on topic addressed. And even then mostly procedural.
Topic addressed	Kept	Essential. a crucial predictor for struggles down the line. Very limiting if the innovation topic

		addresses more fundamental aspect of energy system.
Derogations	Removed	Relevance hinges on topic addressed. And even then mostly procedural.
Trial dimensions	Removed	Relevance hinges on topic addressed. And even then mostly procedural.
Funding	Kept	Crucial. Without funding, not project.
Monitoring	Combined	Long-term checking up on if the goals are being met, and if it works like intended.
Stakeholder involvement	Combined	Crucial aspect of scaling up according to CEO NLMTD, however, goes hand in hand with coordinated flows of demonstrations.

4.2.3 Company level:

The process of pruning and combining factors for the company is detailed in the next paragraphs. It will take the same structure as the previous explanation on the project level. Meaning that it will start with showing the factors on company level before pruning and combining and then show the end result. Subsequently, a paragraph is dedicated to the explanation of removed factors. Followed by a paragraph on the factors combined. Lastly, this part will conclude by discussing the end result of the factors on company level and its main features. For overview a table is shown summarising this process.

Before and after iterations of combining and pruning

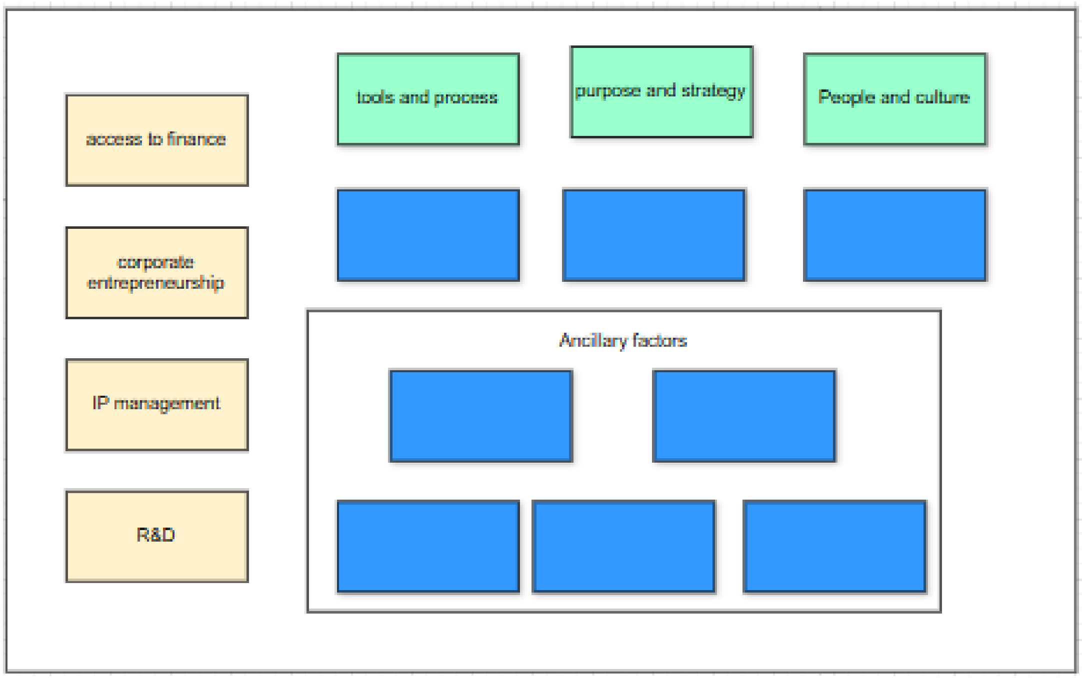

Figure 12: Company level pre-pruning

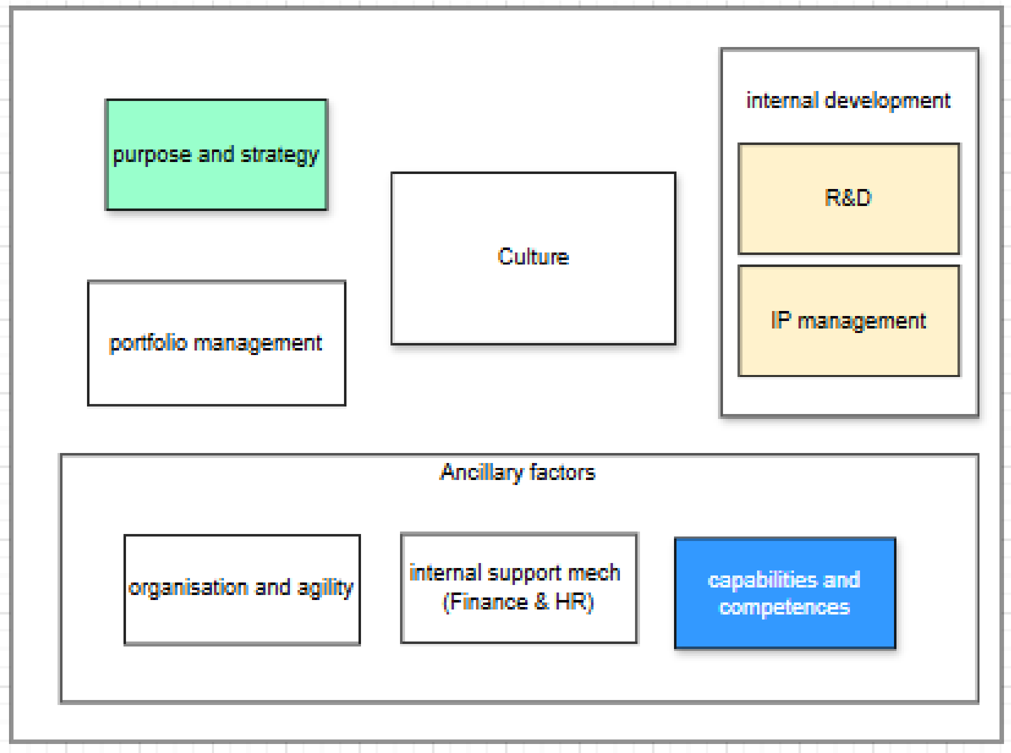

Figure 13: Finalised version company level

Factors removed

Only a few factors were removed. Two of Capgemini's innovation engines were removed as they focused on specific aspects aligned with Capgemini's operations and products, making them less suitable for broader, more generic use.

Factors combined

Quite a considerable number of factors are combined on this level. The first of which is focussed on internal support mechanisms. To reduce redundancy, they were combined.

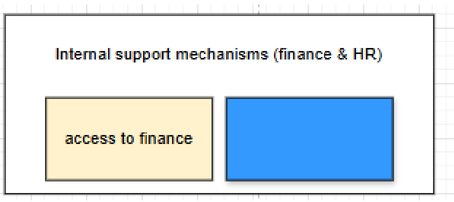

Figure 14: Combined factor company level 1

Another factor which was combined is organisational structure. Part of the reasoning for this was the joint focus on the structuring of internal processes of a company. Given their similarity, they were combined.

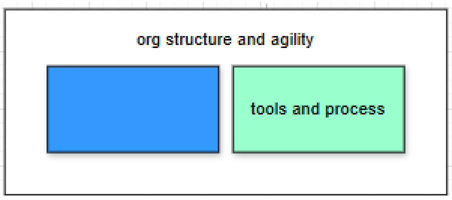

Figure 15: Combined factor company level 2

Third is the combination of two factors of the innovation engine. Both focussing on the inflow and management of projects. These were therefore combined into portfolio management.

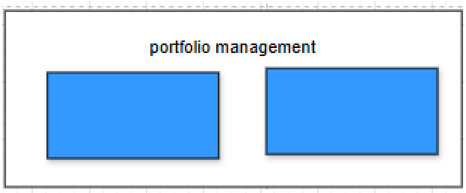

Figure 16: Combined factor company level 3

Last is the central aspect of company culture. Corporate entrepreneurship can be seen as an aspect of culture, or as a specific form of company culture. Since all three factors focus are very similar in meaning. They are combined into the factor of (company) culture.

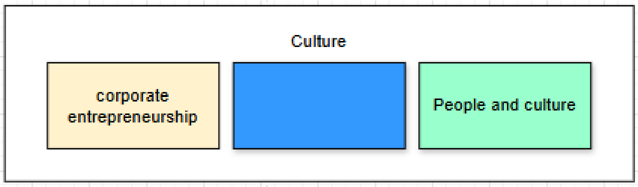

Figure 17: Combined factor company level 4

Factors on company level

This next paragraph briefly discusses the remaining factors and their relevance. Below the finalised version of the factors on company level are shown.

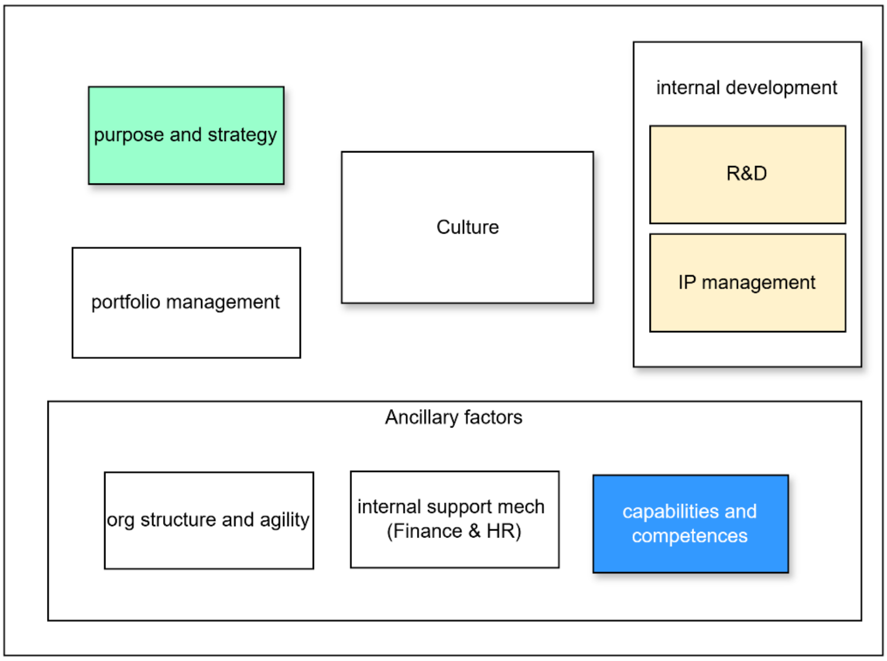

Figure 18: Finalised version company level

The company level focuses on the organization as a whole, managing multiple projects and innovation areas to align with strategic goals. At this level, innovation involves coordinating resources, overseeing diverse initiatives, and driving organizational change. By fostering a supportive culture and ensuring efforts are interconnected, the company level aims to enhance overall growth, competitiveness, and long-term success.

A central aspect here is company culture. Culture is always something intangible and often mentioned as a key reason without diving deeper into what aspects of culture are important. Even an unhealthy culture, is still a culture. Thus, the idea is fostering a company culture that stimulates innovation. Very few organisations work actively and intently at the creation of such a culture (interview CEO NLMTD). Things like, frequent collaborative learning sessions are vital for fostering an innovation culture within the organization (Interview CEO NLMTD). Additionally, innovation is about taking risks (Cinar et al., 2019b). However, in a risk averse setting such as with DSO's this should be implemented with nuance. The goal should shift from avoiding risks and novelty to managing them by reducing the scale. Fail small, and in controlled environments and celebrate pulling out early, just as much as if a project is a success (interview CEO NLMTD). This breeds the idea, that its better to try small and contained, if it works great, if not, pull out early before the stakes are increased and sunken costs fallacy can kick in.

Additionally, in public organizations, a culture of perfectionism is often prevalent, where the focus is on getting everything right before starting (interview Senior consultant Strategic Digital Innovation). To foster innovation, this culturally influenced mindset must be overcome in favour of a more agile approach that embraces failure as a valuable part of learning and progress. This is especially in connection to the earlier mentioned "fail early and contained" approach.

Additionally, decision making should support this narrative and the agility to adapt when results vary from the original plan. As is the case with most innovation, e.g. A study by the Swiss Federal Institute of Technology Lausanne (EPFL) found that up to 73% of startups change their initial idea to better fit market demands. Therefore, it is not just a matter of creating the right culture but also create the right organisational structure and agility to support a healthy innovation culture.

A second critical element is purpose and strategy. This factor remains essential on any level. However, on a company level it's about alignment. Aligning the company strategy with its innovation strategy. Ensuring that the projects executed and planned fit the grander strategy of the firm and therefore portfolio management.

As well as ensuring strategy fits with more ancillary factors, such as alignment with its key competences and capabilities. But also, with more internal mechanisms and resources for support such as sufficient budget and HR capabilities.

Lastly it is important to make sure the internal development is up to par. Internal R&D has historically been the main driver of innovation (Arsanti et al., 2024). Therefore, maintaining it in combination with good external stakeholder relations can help with knowledge spill over and information flows between actors in the energy sector(Dall-Orsoletta et al., 2022b).

Overview

Table 2: Factor actions company level

Factor	Action	Reason
Access to finance	Combined	To reduce redundancy with another factor. Mostly focussed on structural finance. And other support mechanisms such as HR.
Corporate entrepreneurship	Combined	Either part of company culture, or a specific instance of company culture. Nevertheless can be bundled with other factors on culture.
IP management	Kept	Hard to combine with other factors. And IP rights are important even for public institutions.
R&D	Kept	R&D the paradigm of open innovation still operates from the basis that accompany should have its internal development if it wants to be innovative.
Tools and processes	Combined	Combined with to include a broad point of structural support for innovation, which includes the need for structural agility.
People and culture	Combined	Combined with other factors describing culture.
Purpose and strategy	Kept	Essential on all levels especially when discussing alignment with each other.

4.2.4 Ecosystem level

The process of pruning and combining factors for the ecosystem is detailed in the next paragraphs. Following the same structure as the previous levels, the explanation begins with the factors at the ecosystem level before refining them and presenting the final result. Subsequently, a paragraph is dedicated to the explanation of removed factors. Followed by a paragraph on the factors combined. Lastly, this part will conclude by discussing the end result of the factors on ecosystem level and its main features. For overview a table is shown summarising this process.

Before and after iterations of combining and pruning

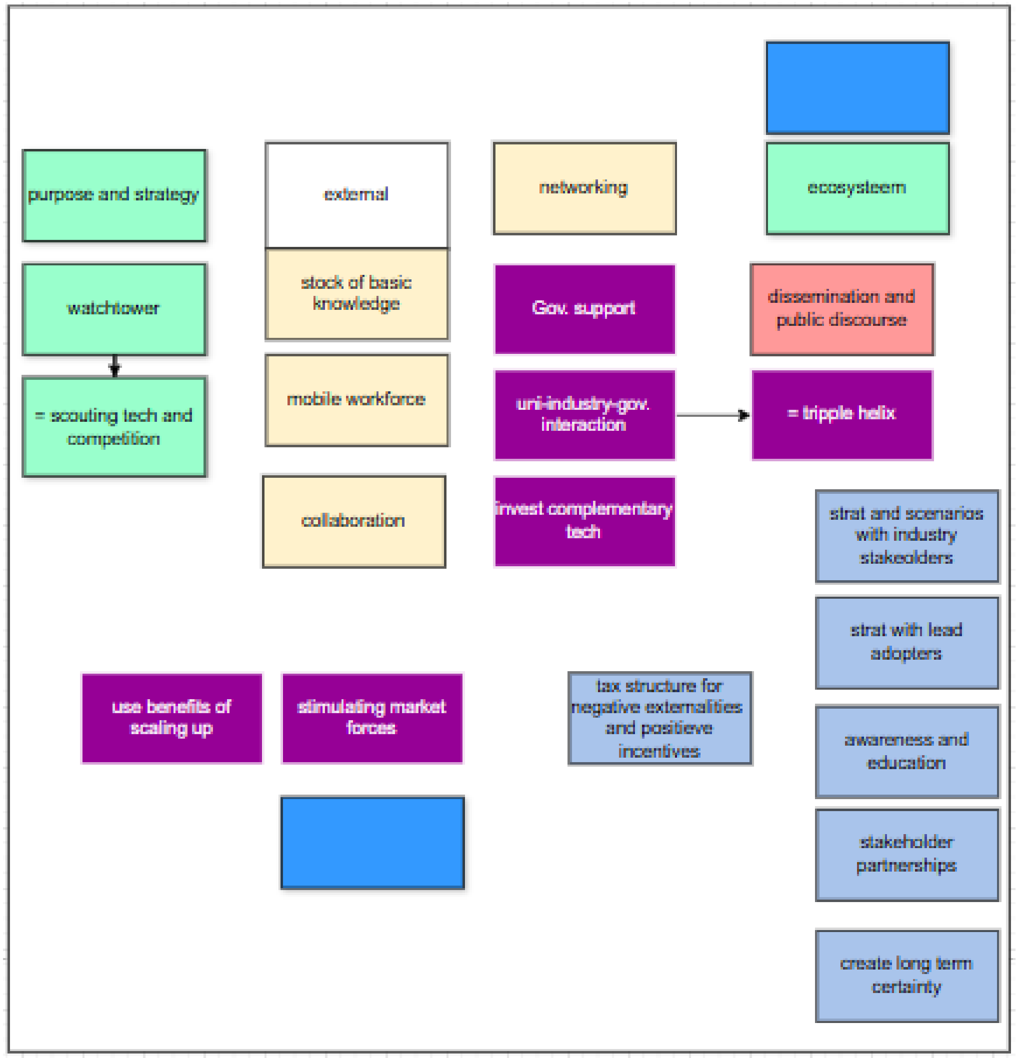

Figure 19: Ecosystem factors pre-pruning

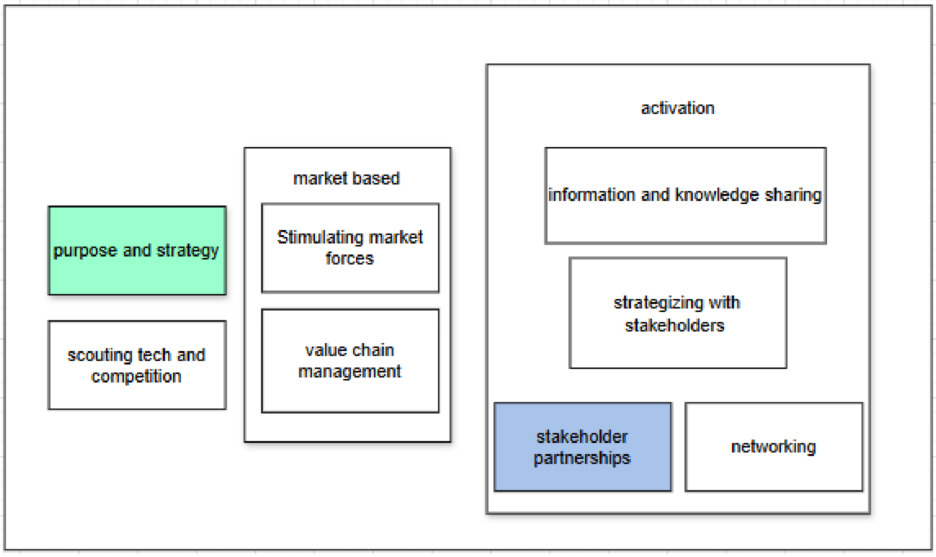

Figure 20: Finalised verion ecosystem level

Factors removed

The first factor removed was the factors of mobile workforce. While generally this might be useful for creating a flexible working force that can spread knowledge with changing employers, for DSOs this is not relevant. DSO tend to use quite specialised skill and are not product oriented. Therefore, while knowledge diffusion is important to stimulate, a mobile workforce as a means is too specific and beside the point.

Another factor that was removed is "ecosystem", along with its equivalent in Capgemini's innovation engine. The factor was too generic and lacked actionable detail, making it redundant within the ecosystem level, which already provides a structured breakdown of what the ecosystem entails. Keeping it would add no meaningful value to the framework. Lastly, the indicator "external" was removed as it referred to the nature of some of the factors below from the open innovation paradigm but is not a factor on its own.

The factor of collaboration was also removed. For understanding this, it is important to also mention a kept factor of "networking. Networking and collaboration are strikingly similar in meaning or at least in the manner in which these factors were defined in the framework for open innovation. The framework for open innovation described networking as all activities to maintain connections, including (informal) collaboration (De Jong et al., 2008b). The factor of collaborations is the other side of the coin as it represents formal collaborations between organisations. However, since "stakeholder partnerships" already captures this meaning, the collaboration factor is now redundant and has been removed.

Factors combined

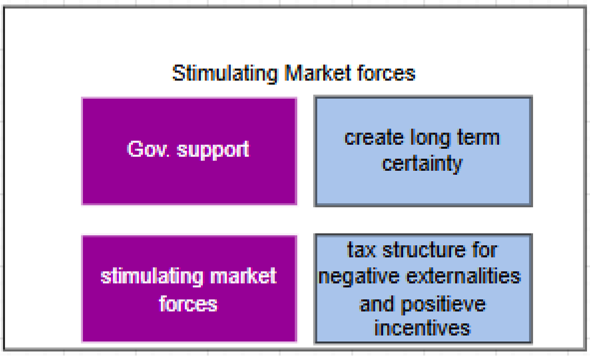

Figure 21: Combined factor ecosystem level 1

Six combined factors were created from a sizeable number of individual factors. The first of which is dedicates to "stimulating market forces". This might also be the most elaborate important and contentious factor of the bunch. Both the frameworks for scaling and Strategic niche management emphasise the importance of creating the right economic circumstances for technologies to develop. This factor is dedicated to that goal. However, there are a few overlapping themes between the factors describing this aspect. The purple factor, "Stimulating Market Forces," is already quite succinct. However, when examining what these forces entail in practice, their specifics remain unclear. In contrast, the factor "Tax Structure for Negative Externalities and Positive Incentives" provides a concrete example of how market forces are typically stimulated, making it a more practical and descriptive representation. Nevertheless, they both describe the same theme. A similar relationship exists between "Create Long-Term Certainty" and "Government Support" in conjunction with the factor of stimulating market forces. When considering how long-term certainty is established, the answer largely aligns with providing sufficient stimulating market forces and government support as key mechanisms. Therefore, these can be grouped together under the banner of Stimulating market forces, as it effectively ties together the individual factors.

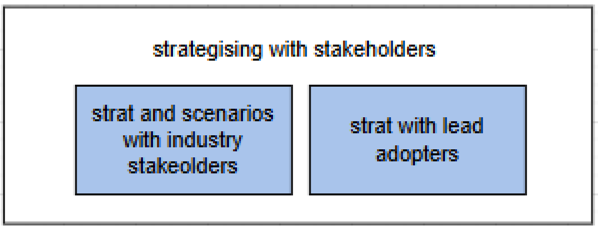

Figure 22: Combined factor ecosystem level 2

The second combined factor is the "strategizing with stakeholders". This is done because of two reasons: First, lead adopters can be seen as a type of stakeholder and secondly, lead adopters are also customers therefore their feedback is already integrated into the micro level. This double redundancy makes it worthwhile to combine them into a single factor focussed on strategising with stakeholders.

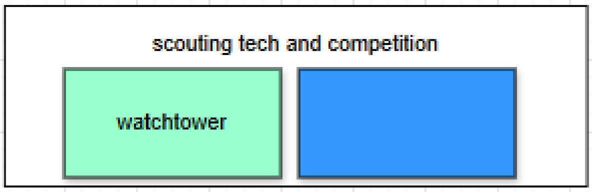

Figure 24: Combined factor ecosystem level 3

Another factor is dedicated to the exploration of opportunities beyond the horizon of organization's internal scope. Within the NLMTD innovation monitor the factor dedicated to this aspect of innovation is called the "watchtower". The meaning of the factor "watchtower" can also be stated as the scouting of the external environment. Specifically, with a focus on technologies and the competition. Therefore, the combined factor of Scouting tech and competition.

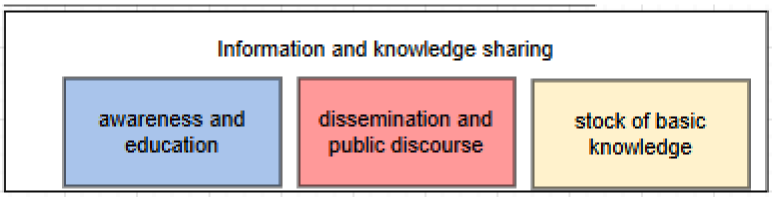

Figure 23: Combined factor ecosystem level 4

Another piece of the puzzle is the exchange of knowledge between organisations. Within the open innovation paradigm this is a central aspect. Part of this through partnerships, joint ventures, or collaboration. However, another part is the outflow of information. This closely resembles the inside-out or outbound open innovation form as described by Chesbrough (Chesbrough, 2010). However, the three factors al discuss different aspect of knowledge sharing, but the common denominator is the outflow of information. Therefore, these factors were combined into "information and knowledge sharing".

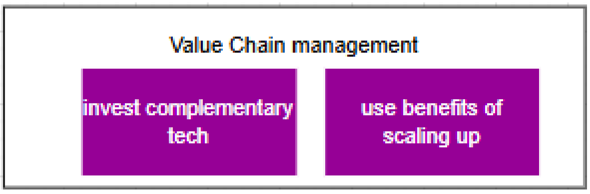

Figure 25: Combined factor ecosystem level 5

Another important part of niche market formation and especially for scaling up, is the investment of complementary technologies. Most revolutionary products are an amalgamation of smaller innovations. The prime example being the smartphone(Gold, 2017b). Additionally, for it important using scaling benefits like economies of scale or integrating companies higher or lower into the value chain (Bossink et al., 2023a). Both of these factors can be summarised as "Value chain management" as they vertically integrate value chains or invest in parallel value chains. Additionally, the factor of "using the benefits of scaling-up" does not provide a lot of valuable input standalone. As the other factors of the framework on scaling already provide a more detailed picture. Nevertheless, in order to keep some of its meaning preserved in the model the factor is combined instead of removed.

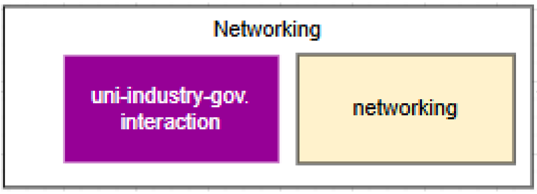

Figure 26: Combined factor ecosystem level 5

The final combined factor focuses on networking, a crucial element for strong ecosystem positioning (De Jong et al., 2008b). However, as already mentioned networking focusses on the informal side of collaboration. More specifically, in the framework for open innovation networking, is described as all activities to maintain connections, including (informal) collaboration (De Jong et al., 2008b). The two factors above largely overlap in meaning. For instance, the "university-industry-government interaction" from the scaling framework is identical to the triple helix model on collaboration. The triple helix model describes the type of organisations with whom to engage with in order to promote innovation. The relation is therefore descriptive and therefore mostly adds redundancy.

Factors on ecosystem level.

This paragraph briefly discusses the remaining factors and their relevance. Below the finalised version of the factors on ecosystem level are shown.

This level of innovation operates across interconnected organizations, industries, and stakeholders. It focuses on fostering collaboration, aligning goals, and leveraging shared resources to address systemic challenges and create value on a broader scale. This level emphasizes the interdependence of actors and the co-creation of solutions within a dynamic and evolving environment.

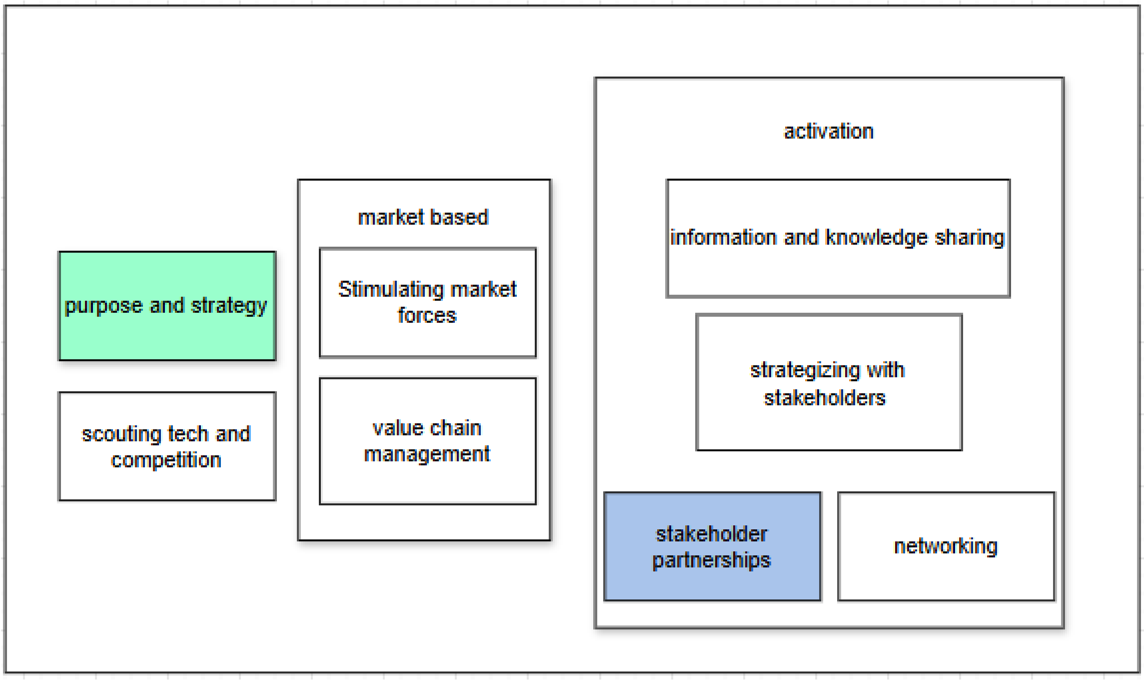

Figure 27: finalised version ecosystem level

There are two clusters of factors on this level of the framework. The first cluster on market forces, consist value chain management and stimulating market forces. Although it may seem as ‘only’ two out of the eight factors here. They represent six factors from which they were combined and are truly essential. These two factors are very closely aligned to the central idea of strategic niche management and the idea underpinning the framework of scaling: The conviction that creating the right contextual economic conditions is a crucial part of innovative success, especially with regards to sustainable technologies (Giganti & Falcone, 2022; Healey, 2008; Naber et al., 2017b).

The second cluster focusses on the activation of the stakeholder network. Fundamental to this cluster are elements of strategic niche management and the open innovation paradigm. Key is the open flow of information and the active alignment of other key stakeholders by strategizing, (informally) collaborating and creating partnerships (Arsanti et al., 2024; Browne et al., 2012b; Mergel & Desouza, 2013).

Another factor is the scouting technologies and competition. This is especially relevant considering the fact that DSO’s are risk averse, therefore scouting success stories outside the company can prove a low risk high reward strategy with regards to technological innovations. Additionally, DSO’s while they are technically companies, their competition is limited. Therefore, DSOs can learn best practices, innovative solutions, and operational strategies from one another due to the similarity of their challenges. Which can save other DSO’s resources by not having to all invent the wheel or falling for the same pitfalls (International Renewable Energy Agency, 2020). However, the effectiveness of this factor also depends on the information sharing between DSOs.

Lastly, strategy and purpose play are important as well on an ecosystem level. For DSOs, aligning their strategy and purpose with societal goals, such as decarbonisation and grid reliability, ensures they remain relevant, compliant with regulations, and able to more effectively collaborate within the energy ecosystem to drive meaningful progress(Euractiv, 2023a). In strategic niche management this is known as niche innovations aligning with societal momentum (Moore, 2018b). In addition, more generally, understanding market position and the strategy within a market with respect to other players needs to align with company strategy. In practical terms, understanding your strategy in the smart grid market—along with your own position and those of other stakeholders—needs to align with how you structure your organization and allocate resources within the company.

Overview of factors

Table 3: Factor actions ecosystem level

Factor	Action	Reason
Networking	Combined	With the triple helix model, as it has the same meaning. But can give a bit more direction on with whom to network.
Stock of basic knowledge	Combined	Part of information outflow.
Mobile workforce	Removed	
Collaboration	Removed	Meaning formal collaboration which is the same as stakeholder partnerships. The informal is networking.
Gov. support	Combined	Government support is shown through creating laong term certainty through tax incentives, and other market stimulating forces. Therefore descriptive relation and combined.
Uni-industry-gov. interaction	Combined	With networking. As they describe the same. Could also have been removed, but now it can still provide a bit more insight into with whom to network
Use benefits of scaling up	Combined	Combined with investing in complementary tech as both pertain to vertical or horizontal value chain integration.
Stimulating market forces	Combined	In a way also kept. But it's meaning a bit expanded
Invest complementary tech	Combined	Combined with benefits of scaling up as both pertain to vertical or horizontal value chain integration.
Ecosysteem	Removed	Redundant as all the other factors combined describe the ecosystem.

Watchtower	Combined	Essential but combined into scouting of technology and competition to be more clear and more precise.
Purpose and strategy	Kept	Complex, but very important factor.
Tax structure for negative externalities and positive incentives	Combined	Descriptive in nature of what stimulating market forces also mean.
Strategizing and scenarios with industry stakeholders	Combined	Rather specific, and can be generalised to overall strategizing with stakeholders.
Strategizing with lead adopters	Combined	Lead adopters are also stakeholders. Therefore can be generalised to strategizing with stakeholders.
Awareness and education	Combined	Pertains information and knowledge outflow
Stakeholder partnerships	Kept	Clear, succinct and accurate factor.
Create long term certainty	Combined	When asking, how would one do this. The answer would likely entail mentioning the other grouped factors. Therefore, a descriptive relation and too much overlap. Therefore combined.
Dissemination and public discourse	Combined	Pertains information and knowledge outflow

4.3 Conclusion

This chapter outlined the crucial step of combining the important factors identified. The chapter addresses the second sub-question:

SQ2: How can the selected frameworks be synthesised

In order to address the question: first the core concept of three parallel levels were outlined and discussed: The project level, the company level and the ecosystem level. Each of these level with their own respective factors.

Subsequently each level and their respective factors were discussed. These factors were the result of selecting combining and pruning factors. Which reduced the overall factor count from eighty-four to eight per level. For quick oversight each level their respective factors can be seen in the table below.

Table 4: Overview levels and their respective factors

Ecosystem level	Company level	Project level
Purpose and strategy	Purpose and strategy	Purpose and strategy
Scouting tech and competition	Culture	Iterative core model
Stimulating market forces	Portfolio management	Sustain and scale
Value chain management	Organisation and agility	Customer insights
Information and knowledge sharing	Internal support mechanism	Impact tracking
Strategizing with stakeholders	Capabilities and competences	Funding
Stakeholder partnerships	R&D	Topic address
Networking	IP management	People and culture

Now that the initial theoretical framework is constructed the next step would be to investigate its application through case studies in order to see which of these factors are observable in a real-world setting. The next chapter dives into the case studies and the empirical evidence gathered.

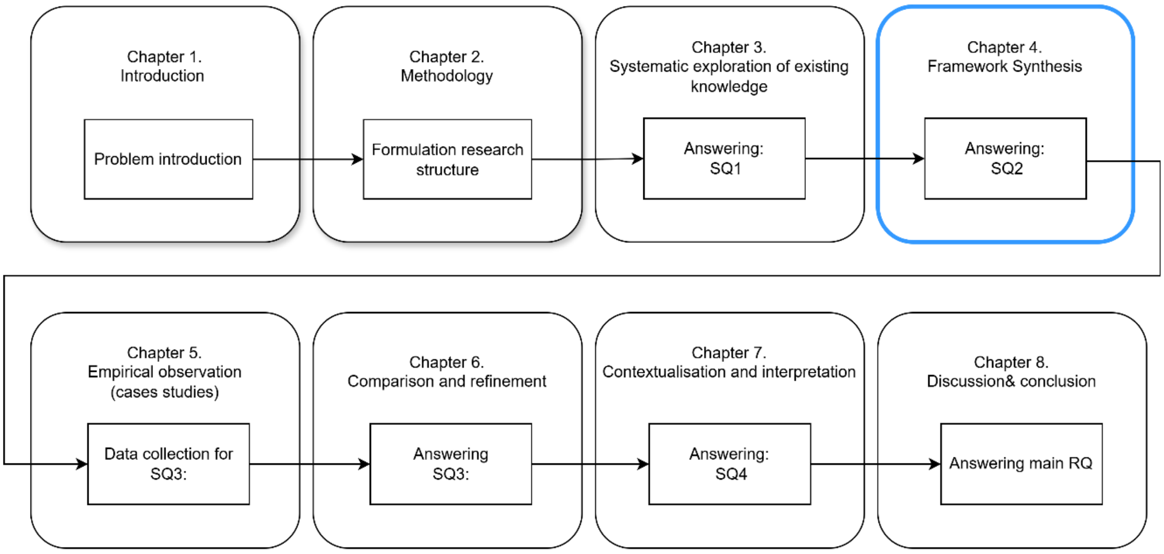

Figure 28: Overview current stage of this research

Chapter 5: Case studies

This chapter will outline descriptions of the case studies. Due to the embedded nature of the case study, this chapter will detail only the relevant information with regards to the framework factors identified. First this chapter will discuss the Allego case, second the "klant sluit zichzelf aan". Each of the case studies will first provide the general outline of the case for context. Subsequently, certain aspects that stood out or were expected but not observed, are discussed. Lastly, each case will end with a short overview of the factors that were observed for clarity.

5.1 Allego case:

5.1.1 General timeline:

The official documents show a few main periods of importance that seem at the core of this case. First there is the ideation of the charging station idea with Alliander that eventually led to the creation of Allego in 2013 (interview Former board member Alliander). Second was the scaling which led to an investigation from the Autoriteit Consument & Markt (ACM) into the charging station in starting in 2015 and concluding in februari 2016 (ACM, 2016) Third, is litigation against Alliander in september 2016 (Vattenval, 2018). Last is the choice to divestment the entire charging station branch of Alliander to become independent in 2018 (Algemeen Nederlands Persbureau, 2018).

5.1.2 Themes identified

By breaking these moments open and looking into what themes correspond with the factors identified in the framework it becomes clear how observable and applicable the theoretical components are.

Ideation

When looking at the ideation it is important to highlight that the idea of charging stations was one of many other ideas (interview Former board member Alliander and interview founding board member Allego). It started with about ten teams, some of which mergered and stopped. Subsequently about 5 ideas were granted a small fund to pursue a proper business plan. The initial ideations came form a collaborative day, where the board member for strategy and innovation at the time (Pallas Agterberg) had gathered about a hundred employees and also connected with a firm in London that were know for being good with the creation of a so called "value system" (interview Former board member Alliander).

Value system refers to understanding the broader context of an innovation, including the stakeholder map and identifying where the innovation can create the most significant impact (interview Former board member Alliander). This closely resembles looking at the ecosystem perspective first and top-down start ideation. Specifically, the strategizing with stakeholders as they brought in a partner company. Additionally, the Amsterdam municipality had put pressure on Liander to (co) invest in charging infrastructure as they saw a rise in unconnected individual charging stations and felt like they were losing control over the infrastructure if they did not enter the market now (interview Founding board member Allego). Therefore, Liander knew there was sufficient backing from partners on the ground as well.

Additionally, the market-based forces seems to be included through value chain management, as eventually these ecosyetem events nudged them to investing into the complementary technology of charging stations. Additionally, with the focus of looking at where the biggest impact can be made, can be interpreted as looking at stimulating market forces. Given the explanation of the Former board member for strategy at Alliander:

"There were some prerequisites for the business models, for instance, enough paying customers and a long-term perspective on how you think you can make a difference in the ecosystem" (interview Former board member Alliander).

Additionally, it can be argued that a long-term perspective for making a difference in the ecosystem, is as close as we can get to an ecosystem-strategy without using the word strategy. Additionally, this borders closely to exploring the market conditions to understand already. the Former board member for strategy at Alliander emphasized the importance of market structure and profitability within the system, noting that while collaboration and support from the municipality were crucial, the market conditions still needed to be explored for long-term viability (interview Former board member Alliander). This was also confirmed by a founding board member Allego, who mentioned that the fact there we no viable alternatives in the market for sustainable mobility was a large part of their success (interview Founding board member Allego).

Interestingly enough, the factor of scouting technology was considered, but the viability of potential technologies seemed to mostly have been taken into account through iterations of the business plans. As Founding board member Allego noted that the success of the charging station spin-off, was in part because it was a complementary technology that had already shown its viability due to batteries being a proven concept and being relatively ubiquitous (interview Founding board member Allego). Combined with the dramatic success of Tesla, showed the promise and potential of electric vehicles and therefore, charging stations (interview Founding board member Allego). Lastly, the fact that there we a number of different potential projects in their portfolio, some of them becoming successful others dropped after it showed it was not worthwhile pursuing shows the importance of portfolio management.

Scaling and investigation ACM

The Allego, branch inside was managed according to the Ambidextrous management paradigm (interview Former board member Alliander). This paradigm works according to creating an alternative decision-making structure within a company. The central idea being that many companies have quite rigorous decision-making structures which hinders development. Innovation (radical especially) needs room to breath to change as many of the initial ideas are disregarded and evolve to a new product which might be more fruitful. This can be seen back in figures like that the fact that roughly 73% of startups pivot away from their original idea to better fit the market and consumer's needs (Omar Rabbolini, 2022). Alliander created branches within their own company which work independently and were encouraged to ensure their own HR and finances (interview Former board member Alliander). In way Alliander had a branch of the company that functioned as an incubator for internal start-ups. The Former board member for strategy at Alliander also mentioned her extensive dislike for pilots specifically as they limit scalability:

"I believe pilots are the worst nightmare for innovation. .... The word pilot means that you do something, you learn, and then it stops." (Former board member Alliander).

She continued elaborating on that decision makers are often the bottleneck with progress through pilots (interview Former board member Alliander). Innovation is volatile, and upfront knowing how you are going to judge success can set up an innovation for failure. And even if pilots do succeed, they rarely stay within the budget (interview Former board member Alliander). Involving decision-makers who bear responsibility for outcomes can stifle early-stage innovation, shifting the focus of developing an innovation from learning and experimentation to an excessive fixation on KPIs and fiscal accountability (interview Former board member Alliander).

Being an ambidextrous organisation, creates space for innovation to grow through the right support mechanisms, like internal decision making, and own HR and finances. This aligns well with the identified factors of organisational agility, and internal support mechanisms (HR and Finance). Additionally, ambidexterity addresses cultural challenges by enabling different company cultures to coexist within a nested yet independent organizational structure. For instance, while the DSO itself remains risk-averse and focused on rigorously calculated decisions, its independent branches can adopt a more flexible structure and decision-making approach, fostering agility and a learning-oriented culture.

The success of scaling however did not go unnoticed. After having received multiple complaints from parties involved in the charging station market the ACM opened an investigation into Allander's conduct in 2015 (ACM, 2016). Some parties suspected that Alliander would have an unfair advantage compared to its competitors. This eventually culminated in a lawsuit from Nuon.

Litigation

Third is the litigation from Nuon against Alliander. This was made especially interesting by the fact that before 2009 Nuon and Alliander were part of the same company (Alliander, n.d.).

Nuon's main objection to Alliander's involvement in charging stations stems from the regulatory separation of production and distribution in the energy sector. This regulation, designed to limit market power, was the same reason for the original separation of Nuon and Alliander (Alliander, n.d.; Vattenval, 2018). The idea being that having control over the distribution gave them an unfair advantage compared to competitors (de Rechtspraak, 2016). Therefore, by both supplying the infrastructure for charging stations and also billing customers for the energy used, Alliander was in breach on this fundamental separation within the energy system and was abusing their market position.

The court agreed with Nuon and ruled that Allego could not simultaneously install charging stations and supply electricity to end-users, as this contravened the Electricity Act (de Rechtspraak, 2016). The court emphasized that Allego, being part of a group that includes a network operator, must avoid commercial energy supply activities to maintain market integrity (de Rechtspraak, 2016). Consequently, Allego was required to adjust its operations to comply with these regulatory requirements, ensuring a clear separation between network management and energy supply functions (interview Former board member Alliander).

As a result Liander changed its procedure to ensure that they no longer bought or sold electricity of charging cars (ACM, 2016).

Divestment

The final part of this case is the decision to divest the Allego branch. After the lawsuit, Alliander made some procedural changes to their operating model for the charging stations and the ACM eventuall closed their investigation into Allego (ACM, 2016). With the conclusion reading as follows:

“The investigation did not reveal that Allianders’ subsidiary Allego violated the group prohibition or engaged in prohibited ancillary activities. Nor was there any evidence that network operator Liander gave Allego preferential treatment over its competitors.” (ACM, 2016)

Nevertheless, with the ACM “breathing down their neck” and having already lost a lawsuit, some people within the organisation felt that Allego posed too big of a risk to the organisation (interview Former board member Alliander). Thus, the decision was made to sell the Allego branch to ensure that they could be seen as fully independent not the quasi-independent structure that ambidexterity offered (interview founding board member Allego). This would provide an influx of funds, as well as protect them from future regulatory ambivalence.

The views on whether the divestment could be seen as success story is a complicated story. On one hand, the innovation itself was scaled up successfully, matured and eventually entered a competitive market independently. In that sense it was a clear success (interview Former board member Alliander). However, there is a flipside to this coin. The divestment was mostly a result of regulatory uncertainty and scrutiny by the regulator. A regulatory who does not have an internal division for innovation, nor does it have any KPI within their organisation for innovation (Interview expert market regulation Netherlands). Additionally, this divestment had implication for the industry that we now outside the scope of the DSO. Originally, electric vehicles were seen as a risk for congestion but also as a potential solution if they could manage the charging effectively(Hu et al., 2014). However, with the divestment, the goals of the organisation shifted away from societal benefit to more narrow profit focus (interview Former board member Alliander). The culture shift was so pronounced Founding board member Allego eventually left because the company had changed significantly at heart:

“in 2019 AlLego got sold to a French investment party (Milence). I stayed another year. And then decided to leave because a lot was happening and changing. And I thought, OK, this is no longer the company which I was part of from day one.” (interview founding board member Allego).

Due to the full privatisation the societal goals were no longer pursued. Therefore, the grid operating cost have likely increased for the consumer due to this privatisation (interview Former board member Alliander). The irony here is that by wanting to protect consumers from market power in the short term, the ACM has indirectly hurt the consumer in the long term.

5.1.3 Short overview

Table 5: Short overview factors observed Allego case project level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Project	yes	The goal of the project gradually evolved and was iteratively expanded.
Customer insights	Project	yes	the subject was identified from the fact that increasingly more charging stations popped up in the municipality of Amsterdam.
Impact tracking	Project	Yes	Value tracking and functionality was at the heart of the ideation from day 1.
Iterative core model	Project	Yes	No specific model was used to guide progress; instead, the branch grew iteratively over time.

Funding	Project	Yes	Funding was provided after progressing to the remaining 5 ideas after day 1.
Topic addressed	Project	Yes	This was eventually the reason why it was divested. As the subject was too close to some core aspects. unbundling in this case.
People and culture	Project	Yes	Both interviewees at the Liander at the time mentioned the importance of getting the right people on board with the right mindset. Founding board member Allego even mentioning a certain willingness to operate under uncertainty and flexibility whilst also needing stubbornness.
Sustain and scale	Project	Yes	The ambition was always to scale up in phases. With gradual milestones. They included stakeholders and monitored the installations for feedback.

Table 6: Short overview factors observed Allego case company level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Company	Yes	A founding board member Allego mentioned the fact that some boardmembers had the drive to focus on sustainability this project had full support, because it aligned with their vision and strategy for the company itself.
Portfolio management	Company	Yes	Multiple ideas were explored simultaneously. Some of them making it into a success others were abandoned
Culture	Company	Yes	Culture was essential, it was (together with organisational agility) the reason for implementing an ambidextrous structure.
R&D	Company	No	It is to expensive and high risk. They externalise R&D to other parties until a technology has proven itself enough (interview Founding board member Allego). Thus, likely enhancing the importance of scouting technology and communication with other partners.
IP management	Company	No	For the same reasons as above.
Organisation and agility	Company	Yes	Organisational agility was crucial to the success, as their idea shifted radically in the beginning. ambidexterity was instrumental in facilitating this organisational agility.
Internal support mechanisms (HR and Finance)	Company	Yes	These are actually the exact points the Former board member Alliander emphasised as important for their semi-independent branches to develop themselves. But with sufficient back up if needed.
Capabilities and competences	Company	Yes	The reason Allego was set up, was because it was already very closely related to their main operations. By using that expertise and the capabilities of their internal staff they were able to scale up effectively.

Table 7: Short overview factors observed Allego case Ecosystem level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Ecosystem	Yes	The idea to invest in charging stations was partly pushed by the municipality of Amsterdam. Who is the main shareholder of Alliander as well. Additionally at the time there was a clear alignment between the goal of decarbonisation by board members and the societal goal of decarbonisation as well.
Scouting Tech and competition	Ecosystem	Yes	Part of the reason why chargingstations seemed promising was based on the success of Tesla (interview Founding board member Allego). Additionally, the former board member Alliander mentioned that for a while DSO's gave out a trophy of sort for "the best stolen idea" to stimulate learning from each other.
Stimulating market forces	Ecosystem	Yes	It was mentioned that for a while providing a subsidy for buying new electric cars was part of the consideration to invest(RVO, 2016). This subsidy stimulated the electric car market and subsequently the market for charging stations. Additionally, the general understand that there was no viable alternative ensured a long term certainty that charging stations were a future proof investment (interview founding board member Allego).
Value chain management	Ecosystem	No	The value chain within the energy system are by law unbundled. Even in the nieuwe energiewet batteries are not an option, let alone production (interview expert regulatory experimentation). However, investment into complementary technology, a factor behind value chain management can be recognised.
Information and knowledge sharing	Ecosystem	Yes	Not directly. They were constantly in conversation with their peer DSOs but it did not have a relevant impact on the course of the project.
Strategizing with stakeholders	Ecosystem	Yes	As the municipality of Amsterdam strategised with Alliander to collaboratively invest in charging infrastructure.
Stakeholder partnerships	Ecosystem	No	while there was collaboration between stakeholders, and they were helping each other out at time. Partnerships in the sense of joint investment was not observed.
Networking	Ecosystem	Yes	Between the municipality and Alliander. As well as having partners for helping construct the business model more effectively. And the development of the first few charging stations with Nuon.

5.2 Klant Sluit Zichzelf Aan (KSZA) case.

5.2.1 General timeline

This project focusses on outsourcing installation capacity to third parties to connect parties to the grid. The labour shortage for installations, combined with the immense challenge for DSOs to expand grid capacity simultaneously, caused this project to scale up drastically.

Only two clear phases can be seen. The first part was the initial project setup within Alliander. This part will mostly describe the initial challenge situation and the solution to the conundrum. second is the scaling up of the project. Scaling eventually beyond company boundaries.

While exact starting dates are contracting information and thus not available for publishing in the public the domain. An indication is that the project itself is roughly two years old. For the second phase the beginning of 2024 can be used as a reference. This project therefore reflects recent developments and aligns with current industry practices.

5.2.2 Themes identified

Initial project setup

The Klant Sluit Zichzelf Aan (KSZA) project originated from challenges of network congestion and labour shortages. While DSOs have the legal obligation to connect parties to the grid(Hu et al., 2014), with the network currently operating on maximum capacity often means that even when connections were made, they could not be fully operational (Team lead KSZA project). At the same time, a labour shortage strained resources needed for both grid expansion and new connections, creating a significant conundrum (Euractiv, 2023a). This is where KSZA comes into play—allowing Liander to focus on reinforcing electrical networks while installers and contractors handle connection work (Exter, 2024).

For the ideation there were a few constraints that set the solution space. “We had to ensure any solution stayed within the boundaries of the DSO's legal responsibility, as the law mandates, we remain accountable for the regulated part of a client connection “(team lead KSZA project). It was clear that, due to high pressure from the ACM to maintain a level playing field in the private (free) domain, outsourcing installation capacity through a tender was not a viable option (team lead KSZA project).

To understand these constraints, it is essential to differentiate between the "free domain" and regulated activities. The "free domain" includes activities not regulated by law and can be carried out by any certified company (CMS, 2015). This typically involves installing equipment, such as charging stations or factory systems, on the customer’s private property. These installations fall outside the jurisdiction of regulated DSOs and are considered the customer’s responsibility (team lead KSZA project). Conversely, connecting to the medium-voltage grid is regulated and falls exclusively under the responsibility of DSOs. This distinction exists because the medium-voltage grid forms part of the national energy infrastructure, which is tightly controlled to ensure fair access, safety, and reliability (De Boer, 2024).

Outsourcing regulated activities through tenders presented additional challenges. Allowing a single party to handle the regulated connection to the medium-voltage grid could provide them with an unfair competitive advantage in the free domain (team lead KSZA project). This is because regulated and free domain installations are often interconnected, and performing both simultaneously offers operational synergies. However, these synergies would only be accessible to the party managing the regulated connection, disrupting the competitive balance in the free market. This closely resembles how the topic of the innovation is tied to the regulatory context and how important it is to the success of an innovation project.

The success of the initial KSZA project lies in the introduction of certification for medium-voltage connection work. By allowing companies operating in the private (free) domain to obtain licenses for KSZA-related tasks, competition is maintained. Licensing ensures that multiple companies can qualify by meeting specific requirements, preventing any single entity from gaining an unfair advantage in the regulated domain (team lead KSZA project). "By having the licencing, it remains the responsibility of the DSO, whilst the labour itself can be outsourced, just like you would outsource tasks for renovating a home to some extend" (team lead KSZA project).

Another aspect which is still ongoing is the aspect of profit for new installations. The working model now is to accepts that on some installations they will simply lose money. This is mostly due to the fact that the network tariffs are set by regulation, therefore even if the costs are higher there is still a limit on how much DSOs are allowed to charge (Hennig et al., 2022). However, freeing up capacity for other projects and other new connections that might make a profit could offset the loss to the point where it is likely worthwhile anyway (team lead KSZA project).

Scaling up beyond company boundaries.

When asked about why the project was successful in its scaling a number of interesting things came to light:

First and foremost, the thing mentioned as the greatest driver was "absolute necessity" (team lead KSZA project). Societal demands for increased capacity and new connections forced a plethora of investigations into net congestion along with a search for bottlenecks within processes for grid expansion (Kleinnijenhuis & van Hest, 2022b). This too was the initial spark for the project as mentioned in the previous paragraph. Therefore, alignment of the societal goals with company goals was instrumental.

At the project level, the purpose and strategy were clearly focused on increasing capacity and productivity by outsourcing work to external partners. This approach allowed DSOs to manage more projects effectively and "increase the overall capacity" (team lead KSZA project). The success of the project also relied on having "a group of very enthusiastic people" within the organization working on the project, whose dedication was critical for overcoming challenges and driving progress (team lead KSZA project).

Additionally, the way milestones were set up was piece-meal (team lead KSZA project). A bit like consecutive parts of a puzzle that still needed to find its form. This in combination with a focus on the added benefit (value) for the DSO in freeing up labour capacity to work on grid expansion gradually grew the project.

At the company level, strong executive sponsorship emerged as crucial. Several COOs from different DSOs acted as senior sponsors, providing leadership and ensuring alignment with organizational priorities (team lead KSZA project). This leadership not only "helped with convincing people in the organizations to help and support in realizing the project" but also ensured the necessary investments were made to avoid budget constraints (team lead KSZA project). Successfully outsourcing connection work required the DSO to leverage and expand its core competencies, such as managing external partnerships and navigating regulatory compliance. Since installations were already part of their portfolio, Liander already had a good understanding of the requirements for such work. This familiarity helped in creating the certification criteria for contractors and ensured alignment with the regulatory environment, further enabling the effective implementation and scaling of the initiative

Finally, at the ecosystem level, early involvement of key stakeholders in the system, -in this case with contractors and installation companies- were essential to the project's success (team lead KSZA project). With Igor stating clearly:

"In a quite early stage we found a group of partners in the market: ("Aannemers"), contractors and installation companies that were very enthusiastic and got on board quite early. So, they also keep the pressure to scale it up." (team lead KSZA project).

As can be understood from this quote, early involvement and clear partnerships with key players in the ecosystem helped scale up this innovation project. The collaboration expanded after the initial project turned into a success. Multiple DSOs adopted this the KSZA certification strategy.

Additionally, through effective communication the project scaled up beyond company boundaries by introducing the other DSOs to the concepts of KSZA(Exter, 2024). Part of this is also a product called, "chief of thievery" where the best ideas within Liander are shared with other DSOs in order to move away from the "not invented here"- mentality (Exter, 2024). This aligns well with what the former board member for strategy of Alliander mentioned about the trophy of the best stolen idea (interview Former board member Alliander).

Furthermore, from the KSZA project also sprang regular "collaboration sessions". With people from Enexis, Stedin, and WestlandInfra to explore how they can implement KSZA within their organizations(Exter, 2024).

"During these sessions, we look at questions like: How are things going on your end? What challenges are you facing? What can we learn from each other? What can we work on together? This (KSZA) was the only way we could truly introduce these formal collaboration structures." (team lead KSZA project)

5.2.3 Short overview

Table 8: Short overview factors observed KSZA project level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Project	yes	The initial goal was clear and aligned well with the company goal and strategy.
Customer insights	Project	Yes	Part of the call for action came from customers struggling with long waiting list for the mid-voltage connections
Impact tracking	Project	Yes	By consciously focussing on the added value of labour capacity reduction. The impact was tracked even after the original project scaled up to other DSOs
Iterative core model	Project	Yes	The term used specifically "continuously evolving solutions and problems" (team lead KSZA project).
Funding	Project	Yes	It was not specifically mentioned. However, I can assure you without funding Cap Gemini would not be putting consultants on the task.
Topic addressed	Project	Yes	The legal boundaries of responsibility of the DSOs for new connections defined the solution space. Anything beyond would likely be strenuous, or simply not possible. The same was true for the profitability of some connections.
People and culture	Project	Yes	This was explicitly mentioned by the Team lead KSZA project as one of the key drivers.
Sustain and scale	Project	Yes	The ambition was always to scale up in phases. With gradual milestones. Additionally, they also checked regularly on progress and feedback on ongoing KSZA projects within a collaborative setting between DSOs. Additionally formal structures were introduced to sustain and ensure that other DSOs might replicate its success.

Table 9: Short overview factors observed KSZA company level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Company	Yes	The purpose of the company was clearly focussed on maximising capacity as quickly as possible, which matched well with the project and was also aligned with societal goals.
Portfolio management	Company	No	Within this case nothing specific points to the importance of portfolio management. Arguably the scaling to other DSOs can be seen as portfolio management of different projects.
Culture	Company	No	While the manner in which the project was done can be seen as indicative of culture. The team lead KSZA project did mention what constitutes to “the right mindset” which might be culturally influenced, but that would be rather indirect.
R&D	Company	No	No mention, nor deemed relevant for DSOs
IP management	Company	No	Same as above.
Organisation and agility	Company	Yes	With regulation being quite tight, there was a lot of uncertainty, especially in early phases. However, they were able to make quick iteration and eventually even form formal structures, which demonstrates a certain degree of organisational agility.
Internal support mechanisms (HR and Finance)	Company	Yes	This project has two examples of those being instrumental. The HR aspect of labour for installation capacity being outsourced. The project itself was to some extend formed from the fact that they had a labour shortage. Secondly, the outsourced organisational capacity. the fact that Cap Gemini was hired to bring in brainpower to solve this conundrum also illustrates how much resources they were willing to commit, and how much internal HR capacity they had available for solving the issue.
Capabilities and competences	Company	Yes	Its core competencies, such as managing external partnerships and navigating regulatory compliance, contributed significantly to the successful execution of the project.

Table 10: Short overview factors observed KSZA ecosystem level

Factor	Level	Observed	Additional explanation
Purpose and strategy	Ecosystem	Yes	The societal goals seemed very well aligned with the strategy of the company. The strategy at hand became, we don’t have the labour capacity, thus we aim for outsourcing as much as possible in order to reduce waiting times for new connections and increase grid capacity.

Scouting Tech and competition	Ecosystem	Yes	Can clearly be seen by the regulator meeting between DSOs on KSZA projects.
Stimulating market forces	Ecosystem	Yes	The concept of using a market structure for bidding with certification shows the understanding of market stimulating forces.
Value chain management	Ecosystem	No	Technology was not at the heart of this solution. Additionally, they can't invest in other parts of the value chain. Complementary technology has been discussed, such as VR goggles to see where cables are in the ground to help with the installation. But was not at the centre of this case.
Information and knowledge sharing	Ecosystem	Yes	The regular meetings on sharing best practises and challenges is a clear example of this.
Strategizing with stakeholders	Ecosystem	Yes	The extensive collaboration with other stakeholders to move the project forward. As well as adhering to the wishes of the ACM and strategizing with the contractor shows this factors contribution.
Stakeholder partnerships	Ecosystem	Yes	The constellation with the contractors were a clear partnership, even being directly named as such by the team lead KSZA project
Networking	Ecosystem	Yes	The contact with the ACM but also the discussions with the other DSOs and the contractors all show a certain informal collaboration, even if not all of them became a formal partnership over time.

5.3 Conclusion

This chapter set out to outline the empirical evidence gathered from the embedded case study for further analysis. This corresponds to the empirical observation step of the framework synthesis framework. First this chapter outlined the Allego case, second the KSZA case was discussed. Both cases are first discussed chronologically with the overall timeline and secondly more in-depth narratively/causally, discussing drivers of successful scaling and additional important factors or relations.

With the empirical evidence gathered and presented the next step is a more thorough analysis. The goal is to compare the evidence gathered and refine the framework if possible. This is done in the next chapter.

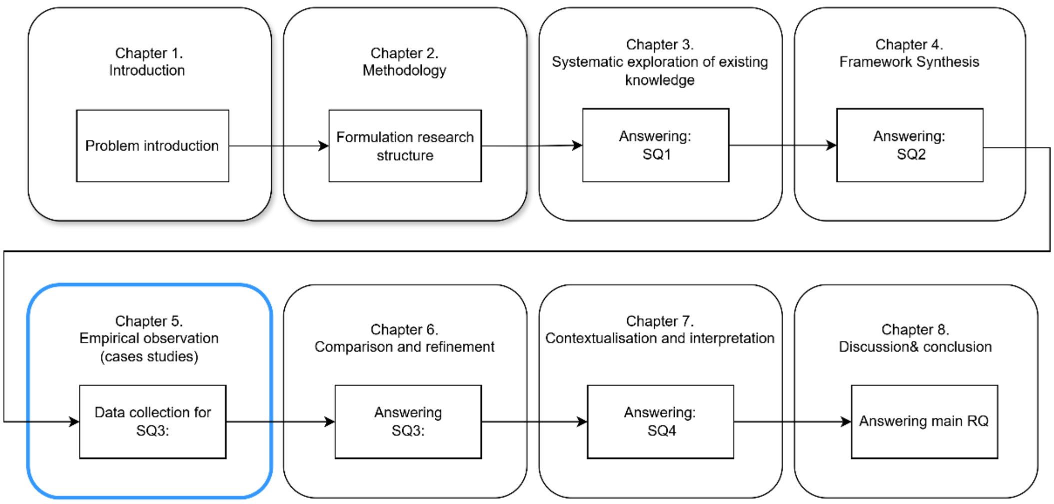

Figure 29: Overview current stage of this research

Chapter 6: Comparison and refinement

This chapter will dive into the details of what factors were actually observed and what this might mean for a revised framework. Additionally, this chapter will analyse the empirical evidence by evaluating factors based on the impact they had. This chapter will answer the third sub-question that can be seen below.

SQ3: How observable and applicable are the theoretical components of the selected innovation framework within the operational context of DSOs?

In order to answer this fully, this chapter will first discuss observability of the three levels as a concept and then dive into each of the three levels and discuss the results separately. Starting with the project level, then the company level and lastly the ecosystem level. The factors will be discussed in a side-by-side comparison between the cases. The discussion will detail if factors were observed, and possible explanations for unobserved or dubious factors. A second part focusses on the applicability, by discussing on each level how the most impactful factors were structured, their relevance in practice, and their consequences.

6.1 Observability of the three levels.

One of the central aspects of the newly constructed framework is the concept that innovation happens on three different level simultaneously. These levels were ideated in order to harmonise different definitions of similar wording and to fully capture the complexity, breadth, and nuances of innovation in reality. The ideated model in theory also showed that no current framework seems to offer a wide enough range to cover the spectrum of factors necessary. This of course begs the question to what extend were these levels observed?

The simplest answer comes in the direct form from Founding board member Allego, who stated:

“I at least recognize that there are those 3 levels. And that they are important. Because you can always do an innovation project. .... But such a project you can only do if the companies believe: OK, this innovation is going to help in our future. .... And then you need to have a feeling on what's happening at the ecosystem. .... You need to somehow believe in an ecosystem and also be able to influence it to a certain extent.” (Interview Founding board member Allego).

This is a clear indication that the levels are functional. However, as an outside observer its sometimes easier to distinguish structures then for people who are in the middle of it.

Being an outside observer can be a bit like overseeing a maze. While for the observer it might be clear that the maze is circular or a square. When you are in it, trying to find the shortest way out, these structures might be overlooked.

As a result, it is unlikely that these conceptual structures would be identified by many participants within the case. However, the main reasoning for the creation of the levels was to harmonise definitions and simultaneously capture complexity within the newly constructed model. Therefore, when looking at the case from this perspective do the three levels actually facilitate this?

From this perspective, the three levels do appear to facilitate the intended goals. When looking at the broad range of factors that were deemed influential for the cases, no single framework in isolation could have properly explained why the projects went the way they did. Furthermore, the three levels did allow for a more nuanced understanding of why particular parties or individuals played certain pivotal roles and how they influenced outcomes, moving beyond a broad and vague concept like "stakeholder management" as an umbrella term. A similar dynamic can be seen with factors such as impact/value tracking, stimulating market forces, and finances and funding. While these factors all relate to the economics of innovation, the model more effectively captures the complexity by separating them on three levels. Thus, distinguishing their unique aspects, illustrating how they are similar yet address fundamentally different challenges.

Additionally, while there were occasional omissions or unobserved factors, there was never a sense that something essential to the project's success was entirely missing or unaccounted for. This indicates that the levels effectively captured the complexity of the case by providing a structured, comprehensive lens through which to analyse influential factors, avoiding oversimplification and ensuring clarity in identifying key contributors.

6.2 Comparison project level.

6.2.1 Side by side comparison factors

When looking at the identified factors below it becomes clear that on a project level all factors were observed. However, there is still some nuance to be found. For instance, the factor of impact tracking could be defined more sharply. In both cases, it specifically focussed on the added value, not necessarily on a broader understanding of impact. With the Allego case, the value proposition and business model were central aspects for continued development. For the KSZA case the focus on added value did not come the pure form of direct profit, but from the value of freeing up labour capacity for other projects. Therefore, changing the factor form impact tracking to value tracking would likely be a better fit.

Table 11: Factor comparison project level

Factor	Observed Allego Case	Observed KSZA Case
Purpose and strategy	yes	yes
Customer insights	yes	Yes
Impact tracking	Yes	Yes
Iterative core model	Yes	Yes
Funding	Yes	Yes
Topic addressed	Yes	Yes
People and culture	Yes	Yes
Sustain and scale	Yes	Yes

Additionally, sustain and scale, might be a bit too much of a simplification. As scaling effectively is a very sensitive endeavour. With having the right stakeholder involved, having the right way of setting milestones, i.e. no pilot project but consecutive projects towards a bigger goal and many more nuances that now might get lost.

The team lead of the KSZA project for example, was asked what he would have done differently if he could start over with the knowledge he has now. His response was that they should have set more aggressive targets. Initially, they were cautious, but after seeing positive results early on, he felt they could have aimed for more ambitious goals and milestones. While this reflects a fundamental understanding of scaling the project, simply labelling it as "sustain and scale" might not fully capture the nuance of his statement.

6.2.2 Factor impact

The first factor of great significance is the contextual factor of topic addressed. In the Allego case, the topic was contentious. Charging stations innovated on a topic close to the fundamental regulation on unbundling. Leading to increased pressure which eventually build up and led to the divestment. In the case of KSZA the topic was not a bottleneck, however as also mentioned the topic on experimentation was important. When looking at what might be possible for profitability through tariffs, the team of Cap Gemini invent hit a wall. Although, there was no impact on the project, it is precisely because they worked around the brick wall of regulation regarding fundamental aspects of the energy grid, like network tariffs.

Another factor which had a profound impact was the sustain and scale. Within the Allego team, it was the continues scaling which eventually led to its success. By always having a next step ready at hand and bringing in the right stakeholders for the next step, the development/scaling advanced. Thus, avoiding what could be described as "pilot syndrome," where initiatives remain isolated one-off efforts without follow-up. The same was true of KSZA. Continuous milestones followed by learning and scaled steps.

Lastly, people and culture can be considered. In the Allego case, there was abundant support from management which paved the way for the project team to continue scaling. The same was true for the KSZA project. Having senior support for project was mentioned as a key driver for scaling. Therefore, who to involve, especially who of senior management, can be seen as instrumental.

6.3 Comparison company level.

6.3.1 Side by side comparison factors

With regards to the company level less factors were observed.

Table 12: Factor comparison company level

Factor	Observed Allego Case	Observed KSZA Case
Purpose and strategy	Yes	Yes
Portfolio management	Yes	No
Culture	Yes	No
R&D	No	No
IP management	No	No
Organisation and agility	Yes	Yes
Internal support mechanisms (HR and Finance)	Yes	Yes
Capabilities and competences	Yes	Yes

In the first case, the people who were open for an interview were often part of a board that oversaw an entire company, such as Pallas Agterberg (former board member Alliander), Mereille Klein Koerkamp (founding board member Allego) or Anja van Niersen (CEO Milence).

In contrast, the individuals interviewed for the second case were more involved at an operational level, making them more likely to focus on the project level. Given that the nature of the problems aligned closely with ecosystem elements, it is unsurprising that factors at the company level might be underrepresented, as the interviewees were less involved at that level.

Additionally, since the company in question is the same in both cases, factors at the company level—such as culture—that were observed in the first case are likely also present in the second case. However, these factors may not have been mentioned simply because of the focus of the interviewees.

This shifts the question of observability to a comparison of likelihood: is it more probable that there is a false positive for company-level factors in the first case, or an underrepresentation of these factors in the second case due to the focus of the interviewees? Personally, I lean toward the latter being more likely, though the answer is not entirely black and white.

6.3.2 Factor impact

For the Allego case organisation and agility was key. It allowed for the ambidexterity and reinforced a structure which stimulated (small scale) risk taking and development. Without this structure to get rid of middle management decision makers the project would not have come to fruition according to a former board member of Liander. However, it can be argued that ambidexterity is a manifestation of organisation and agility, in combination with company culture.

It can be argued that this was also the case for the KSZA. I.e. if the organisation did not provide the flexibility to work with consultants in conjunction with internal staff, the solution would not have been ideated in the manner in which it had now.

Additionally, on company level the impact of strategy alignment can be seen. Having the project goal, in line with the overall company strategy, that in itself has to be in line with ecosystem positioning and overall societal goals was crucial. As the team lead of the KSZA project mentioned that one of the biggest drivers was necessity (team lead KSZA project). Therefore, without this alignment top to bottom, likely the project would have been considerably more strenuous. The same was true for the Allego project, as it was suggested by the municipality of Amsterdam and alignment with decarbonisation efforts it was easier to get different parties aligned on the project.

6.4 Comparison ecosystem level.

6.4.1 Side by side comparison factors

Table 13: Factor comparison ecosystem level

Factor	Observed Allego Case	Observed KSZA Case
Purpose and strategy	Yes	Yes
Scouting Tech and competition	Yes	Yes
Stimulating market forces	Yes	Yes
Value chain management	No	No
Information and knowledge sharing	Yes	Yes
Strategizing with stakeholders	Yes	Yes
Stakeholder partnerships	No	Yes
Networking	Yes	Yes

Most factors on this level were observed in both cases. However, there were a few exceptions. The first being value chain management. While value chain integration, whether horizontal or vertical, can be beneficial in many industries, this is not the case for DSOs, as such integration is explicitly prohibited (European Commission, 2019). However, this factor was created out of two other factors. Scaling benefits, and investment in complementary technology. When asked about these factors the consensus was that investment in complementary technologies was relevant (interview founding board member Allego, team lead KSZA project). From the perspective of the Allego case, this seems natural, as the company itself originated from investments in such a technology. With regards to the KSZA, it is less self-explanatory. This might be because Capgemini, being heavily involved in IT, recognizes the value of investing in complementary technologies, even if it did not directly contribute to the KSZA project specifically. Thus swapping “value chain management” for the factor of “investing in complementary technologies” seems more fitting.

The second factor under scrutiny for this level is on stakeholder partnerships. Within the KSZA case those were explicitly mentioned as a key driver of success. However, within the Allego case this was not the case. This might be explained by the definition, where it is joined investment which at the time was less accepted. This is evident in the municipality of Amsterdam's earlier push for Alliander to invest in charging infrastructure, where collaboration occurred without joint investment which eventually led to Allego. However, Liander and Equans recently announced that they are partnering to expand the number of public charging points in Amsterdam from 60 to 1,000 (Liander, 2024). Additionally, in the Allego case collaboration with partners was essential. Such as with the municipality of Amsterdam, Nuon for the first charging pole, and partner company to help with a value-based proposal for new innovation projects. Therefore, while partnerships in the Allego case did not materialise at the time, later we do see partnerships as being an integral factor. Even within the same industry of charging stations.

6.4.2 Factor impact

An essential factor to consider is the factor of stimulating market forces. Even when to some extend it can be seen as contextual, it has a tremendous impact of the feasibility of projects. having the economic context factors are not in your favour on an ecosystem level, would be the equivalent of sailing against a headwind. It would require considerable effort, and progress would be not straightforward.

This also aligns with findings from SNM, which emphasize that aligning innovation efforts with broader socio-technical landscape dynamics enhances the likelihood of influencing and transforming existing regimes. Specifically, when SNM actions are in harmony with societal trends, public sector actors have a greater chance of stimulating regime transformation, making it a key driver for niche innovations to become part of the regime later on (Moore, 2018b).

6.5 Conclusion

This chapter was dedicated to answering the third sub-question:

SQ3: How observable and applicable are the theoretical components of the selected innovation framework within the operational context of DSOs?

First this chapter established that the three levels were observed in practise. Second it dove into which of the factors on each level were observed. In general, most factors were observed, however “IP management”, and “R&D” as factors were removed as they were not observed. Additionally, the factor of “value chain management” was changed to “investing in complementary technology” to capture the underlaying dynamics.

Additionally, the framework gave insight into how certain factors impacted the success and challenges of the projects. A few factors stood out due to their substantial impact in the cases: the context factors of stimulating market forces (ecosystem level), and innovation topic (project level). On a company level organisation and agility played a vital role in providing internal structure for the scaling of the innovation in each case.

After finalizing the comparison and refinement step in this chapter, the framework reached its final iteration for this study. The next and final step is to interpret the framework and situate it within the relevant DSO and academic context.

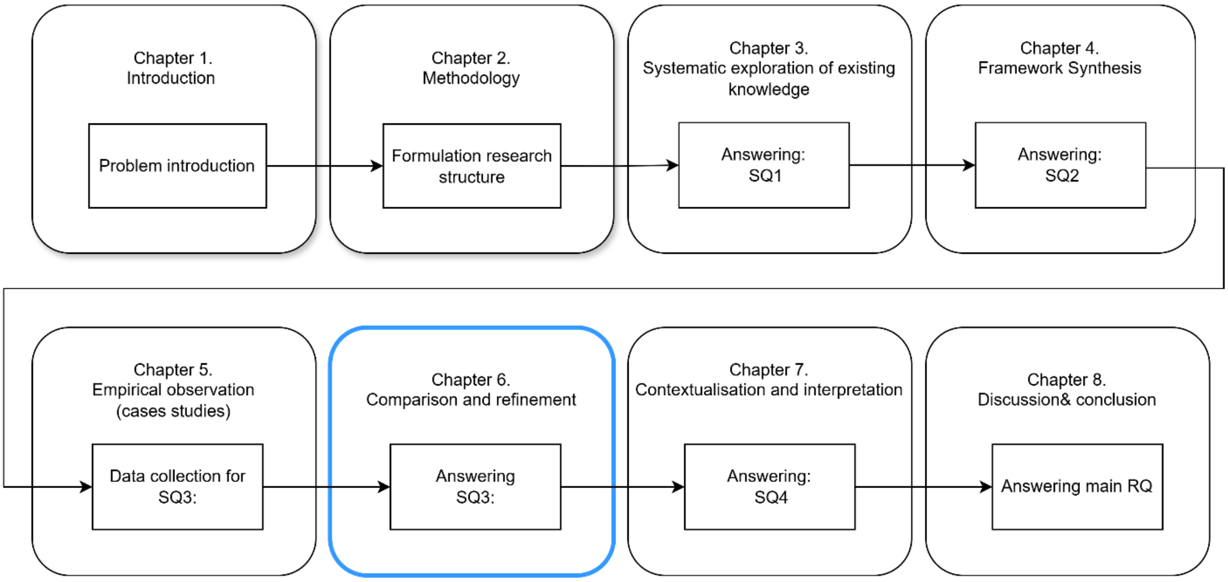

Figure 30: Overview current stage of this research

Chapter 7: Contextualisation and interpretation.

This chapter is dedicated to the fifth step of the framework synthesis methodology and to answering the fourth research question.

SQ4: How can the framework be used to navigate the contextual challenge(s) of DSOs?

This chapter is a structured analytical reflection in order to address this question. The reflection focusses on three distinct parts. The first focussed on assessing the frameworks relevance and its application range. This will describe the how the framework can be used and under what circumstances the framework is relevant.

A second part will reflect on the systemic on and regulatory barriers that were identified throughout the process of constructing and applying the framework in chapter 6.

The third part of the structured reflection examines the positioning of the newly created framework within its scientific context.

7.1 Framework practical relevance and application range

This first part of this chapter will assess the practical relevance and application range. This section will reflect on what can already be concluded about how the framework should be used and where its application is most effective. Second it will discuss how far its application range might stretch, and where it might end. By examining whether the framework adequately addresses key issues, and when it falls short in certain areas, this analysis will help define its practical scope and boundaries.

7.1.1 Practical relevance and usage

Difference in utilisation of frameworks

In order to assess the practical relevance first it is important to provide information on how the newly constructed framework is intended to be used in order to get the most out of it. One important thing to note is the apparent difference in usage between the theoretical models and the models used by companies in practice.

One noteworthy aspect is how innovation models, such as those of NLMTD and Capgemini, are applied in practice. Rather than serving as prescriptive guides for how to innovate, they are more often used as diagnostic tools to analyse and understand the innovation processes at an organisation. The innovation model is used as a communication tool to identify bottlenecks in the innovation process. To then subsequently focus on the areas which require most attention.

This is interesting as the academic models from the classic innovation literature (e.g. SNM open innovation etc.) tend to be more prescriptive in nature. Meaning that they describe how in a best-case scenario a certain process, system or *should* look like. However, this often clashes with the complex reality found in practise.

Since the framework is designed to provide actionable output, a diagnostic approach aligns better with its objective. Therefore, in contrast to the current academic frameworks, the constructed framework should be used as a diagnostic tool.

Unpacking Innovation, from Identified Problems to Systemic Alignment

This fundamentally changes how the framework is best utilized, altering how the process of improvement should begin. In practical settings, innovation efforts are typically initiated in response to a clearly identified problem or need. Stakeholders rarely engage in solving issues that have not been explicitly recognized or brought to their attention. For instance, the KLZA case originated from challenges of network congestion and labour shortages as problems. Problems don't arise in isolation, therefore when looking at innovation there is usually already a certain initial purpose attached. However, frequently, the initial stated problem is not the root issue or has multiple parallel causes. Therefore, a relevant framework should practically dive into the search of root issues. The newly constructed framework facilitates this by using the initial problem statement to determine the starting level before assessing its alignment with other levels. Through this, it accepts reality as it is by engaging the initial problem, whilst encouraging to dig deeper through systemic exploration.

Let's say the initial problem presented seems to be on a project level. For example, a concrete project diving into local flexibility constellations. Projects like the InterFlex Project in Eindhoven by Enexis, or Alliander's Delvi Project, would fit that description. Given that both projects explore low voltage experimental solutions including charging infrastructure, for reducing local grid load (LF Energy, 2024; Sympower, 2021). The constructed framework would first engage on a project level: wat is our ideation structure? Is the main topic contentious? Is there a plan for sustaining and scaling afterwards? Subsequently it would allow for zooming out. What is the purpose/goal of je project, how is it aligned with company goals? After then looking at the company level the next step would be to examine ecosystem level factors. Are there stimulating market forces we can impact? What other parties are out there, what is our relationship with them? How do we communicate with them? Is there a potential for partnerships? In short, the exploration began at a project level as an initial entry point but expanded structurally to include other relevant levels and factors.

In this example the entry point would have been on the micro level, but other levels could also act as starting points to a root cause exploration. For instance, if the objective is to enhance a company's overall capacity for innovation, the company level is likely the appropriate entry point. Projects for parties like the E.DSO's Innovation & Research Committee (IRCO) would be relevant. The E.DSO represent leading European DSOs, engaging in research and innovation projects to integrate new technologies and solutions into the energy system ('Innovation & Research - E.DSO', n.d.).

If the goal is to advance an entire sector or technological market, likely ecosystem is the right place to start. The European Union's Grid Action Plan would fall under such a scenario (Europian Commission, 2023). Or the Heat4Cool and LIFE iTS4ZEB Projects which aim to mature heating technologies in a manner that could reduce grid load (4zeb, 2023; cooling post, 2024).

These initial starting points were also observed in both of the cases. The Allego case focussed on the ecosystem and company, level, as it was borne from the desire to make the company more innovative and to give shape to the new market of charging infrastructure. The KSZA was more centred on the project level as it was set up the specific purpose of increasing labour capacity. However, in both cases, the project benefited from managing factors on other levels, than the entry level for which the purpose was formulated.

Given these hypothetical applications and the observed application in the cases of the framework, it seems fitting and relevant for providing insight into the root causes and providing first actionable steps for DSO related issues. Nevertheless, this framework like any, has its limitations of where the application is relevant. The next paragraph is dedicated to exploring the potential limitations.

Application limitations

One limitation would focus on the expertise needed for applying the framework effectively. Simply put, it would likely still require an innovation expert to navigate this framework. This limitation could limit the usefulness for smaller Dutch DSOs such as Coteq Netbeheer, Rendo, or Westland Infra as these smaller DSOs might not have access to an innovation expert of the resources to acquire one. Additionally, the framework has the underlaying assumption of having sufficient resources to manage innovation projects. The framework might prove to be too resource-intensive for smaller DSOs or those with limited innovation capacity. Therefore, while the newly constructed framework does provide more tangible advice for DSOs, it is not a ready-to-go kit for boosting innovative capacity. For instance, "sustain and scale" as a factor, has a lot of nuances and requires careful planning and execution. Beneath this factor are aspects like milestones, the importance of engaging (external) stakeholders with consecutive phases, planning for growth, fail quick and contained mentality etc. Despite its actionability, the framework still requires an innovation expert for effective application. However, it primarily serves to prompt the right questions rather than provide all the answers instantly.

A another limiting aspect is that the framework is organisation focussed. If the objective is to promote a specific technology within society, a central coordinating entity—whether a government body or a company specializing in the technology—would likely be required. Meaning that a question like, improve hydrogen innovation in the Netherlands, would necessitate some degree of customization of the framework to structure it effectively at the project or company level. While it might be possible, it would require more time and resources. Therefore, academically, the framework may be less suited for questions that do not have an organization as a protagonist or that focus on more decentralised or polycentric structures.

7.1.2 Application range

As mentioned earlier, the newly constructed framework appears well-suited to the Dutch DSO context, addressing a wide range of challenges. This is expected, as its design aimed to synthesize existing frameworks to cover their blind spots, resulting in a more comprehensive approach tailored to the DSO environment. However, the usefulness of the framework might extend beyond the pure Dutch DSO context. At the same time its application range also knows its limits. This paragraph will discuss the potential application range of the newly constructed framework.

Countries

Starting with the most obvious boundary, national borders. It highly likely that the framework remains relevant beyond Dutch borders. The first prerequisite for application would be its similarity with the Netherlands. Therefore, likely only democratic market-based economies would be compatible. However, even in Western countries the applicability would depend on two things: the similarity of the regulatory environment, and the type of ownership.

With the similarity of regulatory environment countries like Germany and Belgium come to mind, as well as some Nordic countries. By contrast the UK and US are fundamentally different regulatory systems. With the EU following the civil law system, while the UK and US follow the common law system (The World Bank, 2006). Given that the constructed framework is tailored to the Dutch context with its roots in the civil law system the UK and US would likely fall outside its applicability range. For other European countries like France or Spain it would highly depend on how similar their regulatory environment is to that of the Netherlands.

Another important distinction would be based on ownership type of DSOs. The newly constructed framework was specifically tailored to a publicly owned context of DSOs. However, this type of ownership isn't as consistent throughout Europe. France, Belgium, Denmark, Iceland and Norway predominantly use publicly owned DSOs (Council of European Energy Regulators, 2024; CSM LAW, 2015; The World Bank, 2006). In contrast, Italy, the UK, and Spain, have mostly private ownership constructions for DSOs (Council of European Energy Regulators, 2024; E.ON, 2018; Weisman, 2025). Lastly, there are a few with a mix of both versions, like Germany, Sweden or Finland (Collan, 2024; Marhewka et al., 2024; Söderberg & Vesterberg, 2022). It is reasonable to assume that for western countries with a public ownership structure the newly constructed framework seems more applicable. For privately owned DSOs, some aspects may still apply, but the framework loses relevance as it is not tailored to that context. For the mixed countries it would likely depend on which specific DSO and their ownership structure.

Other actors or sectors

Although designed for DSOs, the framework may have broader applicability. It raises interesting questions: What would remain of its relevance when applied to other sectors or other types of organisations within the sector?

First with regards to other organisations within the energy sector. It would for a large part stay similar. Especially for public organisations, most factors would stay the same. This is due to the framework being explicitly constructed and adapted for a specific context. These contextual aspects, such as the regulatory environment, the adherence to public goals or values and the main economic drivers/incentives, would stay the same. Thus, making the framework likely very relevant and needing little adaptations.

For private organisations, a few key alterations would need to be made, for instance the removed factors of R&D and IP management would likely need to be reintegrated. Additionally, with profitability as the main overarching goal, this would likely need to be more pronounced. With regards to the underlying mechanisms, either on a project level, or company level this aspect would need to be more distinct. For instance, it is likely that the factors of value tracking on the project level would be expanded upon into versions that are more similar to ensure increased value, in combination of value tracking. This would be close to what NLMTD offers within their innovation model. On a company level, certain aspects on funding which are now part of supporting mechanism could become a standalone factor. However, the natural monopoly position of DSOs makes the ecosystem interactions very different compared to private companies. Less focussed on collaboration and more competition. Therefore, strategizing with stakeholders would be more difficult and the factor of investing in complementary technology would likely focus again on vertical and parallel value chains and potential integration of companies in those areas. However, the factors on an eco-system would remain the same and relevant. Additionally, as a diagnostic tool it could still provide useful guidance to find root causes or bottlenecks.

With regards to other sectors the framework may still offer insights, but other frameworks might be better suited to other specific sectors. Its relevance likely depends on a few things. The first is similarity in context. Advanced technological sectors therefore seem most likely suitable. Being similar in its institutional environment and their economic model with high capital cost. Additionally advanced technology sectors are often highly specialised, knowledge based and require a network of dedicated specialist to function. Making the understanding of macro context more important compared to other sectors. Sectors that fall under this category are, the IT sector, mobility, water management, manufacturing, automation or biotechnology.

Another key aspect is the focus of innovation. The split here is in product focused innovation and process focused innovation (Kraft, 1990; Xie et al., 2019).

In industrial sectors, process innovation is often prioritised. Focussing on enhancing manufacturing processes, optimizing supply chains, and improving operational efficiencies to drive value. Process focussed industries usually have limited difference in the end product and price a biggest differentiator (Xie et al., 2019). The energy sector or internet companies would be good examples. Product focussed innovation sectors are -unsurprisingly- more product oriented, fixated innovation with regards to features and attribute differences between products to create value. A clear example of a high-tech product focussed sector would be the smartphone industry (Cecere et al., 2015).

Therefore, given the previous relevant advanced technological sectors, these can now be divided for applicability on another axis of product vs process focussed industries. Making the framework more applicable, water management, automation, and some IT sectors. Compared to mobility, manufacturing or biotechnology.

Beyond those sectors it would require a significant amount of tailoring in order to provide meaningful insight as these sectors would significantly differ from the original context in which the framework was developed. Differences in institutional environment, economic operational model, and innovation model -meaning knowledge-based vs resource-based and products vs process focused- would require a plethora of fundamental aspects of the framework to be overhauled.

7.2 Systemic and regulatory constraints identified

This second part will reflect on the systemic and regulatory barriers identified throughout the process of constructing and applying the framework in Chapter 6. Even if the framework were theoretically perfect, its effectiveness would still be impacted by systemic hurdles, such as regulatory constraints. By identifying these barriers, this section helps position the framework within its real-world context, clarifying considerations or limitations on operational relevance given existing structural limitations. This reflection contributes to answering SQ4 by illustrating how systemic factors influence the framework's applicability and its role in navigating the challenges faced by DSOs.

7.2.1 Regulatory sandboxes in practise

Part of this research was the exploration into the state of regulatory experimentation in the Netherlands. Gathered from experts in the field it has become clear that options for regulatory exemptions or derogations are still possible. However, the ACM only approves individual projects on a case-by-case basis. Meaning that even a continuation or the upscaling of a proven concept project, still needs to reapply for each individual project. Additionally, through the "omgevingswet", some derogations are possible with regards to more minor aspects that focus on the building environment. However, there is no mechanism for regulatory experimentation that focusses on more fundamental aspects of the energy network, such as networks tariffs or forms battery storage (interview expert regulatory experimentation). This was also observed in the KSZA case. Additionally, the set up for exemptions on singular pilot projects comes with inherent drawbacks. Statically speaking pilot projects tend to die out, even if they are "successful" by their own metrics. This was reinforced by the Former board member for strategy at Alliander, who expressed her dislike for such pilot programs explicitly:

"I believe pilots are the worst nightmare for innovation. .... The word pilot means that you do something, you learn, and then it stops." (interview Former board member Alliander).

Therefore, it seems that the way regulatory sandboxes are set up in the Netherlands is highly impractical and does not stimulate the development innovation effectively.

This becomes more understandable when considering that the ACM is solely focused on its primary task of regulating markets and managing market power. Nevertheless, the lack of any consideration for either stimulating or stifling innovation in its tracks for (emerging) markets remains striking. This is due to the insight that the ACM apparently has no in-house expertise, innovation-focused projects, or KPIs related to innovation (Interview expert market regulation Netherlands). This systemic barrier of underwhelming regulation for regulatory experimentation hinders innovation efforts for DSOs and other actors in the energy sector.

Additionally, the potential of regulatory learning, i.e. regulation adapting through learning by doing through pilot programs seems potent but under researched. As articulated in conversation with the regulatory experimentation expert and the Researcher of Sustainable Building & Sustainable Communities (Researcher Sustainable Building & Sustainable Communities).

7.2.2 Administrative burden of tech startups.

This (lack of) development on regulatory sandboxes also comes at an interesting time, where countries in Europe are forced to rethink their regulatory efforts towards existing and emerging industry practises to boost innovation in tech sectors such as energy. The Netherlands is exception here, as Dutch tech entrepreneurs recently expressed their concerns about the decline in new start-ups and the limited number that grow into successful companies. They point to "absurd regulations" as a major obstacle to innovation and growth(NOS, 2025). Additionally, the Netherlands Bureau for Economic Policy Analysis (CPB) has highlighted that Europe is increasingly lagging behind the United States and China in advanced technological sectors, a concern echoed by European Union key figure and former president of the ECB, Mario Draghi (NL-Times, 2024). Draghi has emphasized the need to "profoundly refocus efforts on closing the innovation gap with the US and China"(Hasan Chowdhury, 2024) .

To address this, Draghi has proposed several measures, namely establishing an EU-wide legal status for innovative start-ups, incorporating innovation criteria for public procurement, and creating a system for evaluating and minimising regulatory costs across Europe, particularly for tech sectors (alliedforstartups, 2024; Hasan Chowdhury, 2024). These concerns highlight the significant systemic barrier posed by administrative burdens resulting from regulation.

However, it also shows the potential existence of a broader societal trend to adapt regulation as a catalyst for innovation rather than a barrier for the tech markets. This broader trend aligns well with the findings of this research on the state of regulatory experimentation in the Netherlands: while it does exist to some extent, it does not provide a sound basis for thriving innovation within the energy sector.

7.2.3 Public scrutiny and media influence

The innovation challenges faced by DSOs closely resemble those encountered in public sector innovation. Their critical role in energy infrastructure makes them subject to a ‘too important to fail’ mindset, resulting in a highly risk-averse approach. Public discourse further reinforces this dynamic, as DSOs operate under intense scrutiny. For instance, media portrayals such as an article depicting Liander as ‘reckless cowboys’ misrepresent their actions, framing them as unaccountable entities misusing taxpayer funds (van Mersbergen, 2016). In reality, their decisions were a direct response to municipal requests, illustrating how public perception can distort the narrative around DSO decision-making. This heightened level of scrutiny constrains their ability to take bold innovation steps, as any perceived misstep can lead to significant reputational and political consequences.

7.3 Theoretical implications and scientific positioning

This final part of this chapter will explore the broader theoretical implications of the findings and position the framework within existing innovation and regulatory discourse. This includes identifying how the framework aligns with or diverges from current theories and what its scientific contribution is. By clarifying these distinctions, this section will highlight the framework’s added value and its relevance for both innovation studies and regulatory research.

7.3.1 Overall positioning

The constructed framework falls under the category system innovation frameworks. Along with its peers that aim to understand innovation as a phenomenon within a codependent context. Additionally, due to its multi levelled nature it would be quite closely positioned next to the MLP and Strategic niche management given the system focus. Lastly given its regulatory considerations, it could be seen as an innovation framework tailored to the regulated energy sector.

7.3.2 Purpose and strategy

One surprising result of this study is the observed importance of alignment of purpose and strategy. Across interviews, this aspect has emerged as a recurrent theme in various forms, with multiple professionals mentioning its importance. Additionally, “alignment of strategy” was mentioned as well. This is surprising as purpose was never mentioned in the academic models in the classic innovation literature such as SNM, open innovation, those on scaling or regulatory experimentation. Neither was strategy alignment mentioned. It is noteworthy that a factor with significant influence from a practical standpoint, as highlighted by professionals actively working in the field, has not been identified in common academic models on innovation.

The constructed model as proposed in this research, reflects the importance of the factor of purpose and strategy by including it across the three levels of project, company and ecosystem. With the factor having a different interpretation on each level based on its context. By making these differences explicit, the framework provides a tool for analysing whether and how strategic objectives align across levels. Recognizing and examining these differences in strategy on different levels allows the model to clarify if and how strategies align across levels. It highlights how strategies across levels can reinforce or contradict each other, therefore aiding in identifying areas that might need more attention.

Therefore, one of the contributions of this research is the introduction of strategic alignment as a systemic factor in innovation in the literature. Based on the complexity of the topic and its interwoven nature, further advances into a more explicit integration of strategic alignment might be worth exploring in the future. However, as this research does not specifically focus on innovation strategy, this aspect falls beyond its scope and may warrant further investigation in future research.

7.3.3 Observed difference in utilisation of innovation models

Another noteworthy aspect is how innovation models, such as those of NLMTD and Capgemini, are applied in practice. Rather than serving as prescriptive guides for how to innovate, they are more often used as diagnostic tools to analyse and understand the innovation processes at an organisation. The innovation model is used as a communication tool to identify bottlenecks in the innovation process. Subsequently focussing on the areas which require most attention.

This is remarkable given that the academic models from the classic innovation literature (e.g. SNM, open innovation etc.) tend to be more prescriptive in nature. They tend to focus on what aspects there *should* be in order to get a certain outcome.

Metaphorically, if innovation was the creation of a cake, the academic models are the recipe. They describe what aspects are important and how they should be used for a desired result.

The practical models from Cap Gemini and NLMTD both describe ingredients. They have a list of items they think are important and look what is on the table and discuss what cake they want to make. Subsequently they try to discuss differences in what they find and where they want to focus on. Another way to understand the differences in the utilization of innovation models is to view academic models as descriptions of how elements should ideally be structured for innovation. In contrast to the practical models where innovation always serves a purpose. With academic models, innovation seems to be the end goal, in practise innovation is a tool to achieve something else. The case studies also reinforce this view.

In the Allego case innovation was used as an accelerator to boost the company to achieve decarbonisation and (financial) sustainability. In the KSZA the goal was to free up capacity in an innovative way in order to do expand grid capacity in the long run.

This distinction is relevant as it shows clear categorical difference between the newly constructed model and the current scientific discourse. This research emphasises the practical need from academic models to incorporate a more diagnostic approach to innovation by recognizing that innovation serves context-dependent purpose rather than existing as an end in itself.

7.3.4 Comprehensiveness and specificity

A last defining aspect of the newly constructed framework is it comprehensiveness compared to current literature. The framework was ideated in order to address the blind spots of the individual innovation models. This was done through integrating aspects of multiple frameworks in order to provide broad and systemic perspective on innovation for the DSO context. This research synthesised aspects of system, process and regulatory innovation to ensure wide coverage on factors important to innovation. Current scientific frameworks typically focus on specialised domains. This study represents the first exploration of a framework that holistically addresses the complexities and demands of the DSO context, offering a foundation for further refinement and application. However, this comes at the cost of a certain specificity of the individual frameworks. By ensuring broad reach, some of the details from the 84 individual factors stemming from the five initial frameworks are lost.

7.4 Conclusion

This chapter is dedication to the fifth step of the framework synthesis methodology and answering the fourth research question. Which can be seen below:

> SQ4: How can the framework be used to navigate the contextual challenge(s) of DSOs?

The framework proves highly relevant for DSOs by serving as a diagnostic tool that structures innovation efforts across project, company, and ecosystem levels. While broadly applicable within the Dutch DSO context, its effectiveness in part depends on the innovation expertise with which it is applied and resource availability making it most useful for organizations with sufficient innovation capacity.

Unlike traditional prescriptive models, the newly constructed model engages the initial problem as presented and encourages to dig deeper into root causes on three levels, in order to identify and address bottlenecks in a structured manner. Thus, it serves as a problem-driven tool rather than a predefined blueprint for innovation, unlike current academic models. Another contrast with its contemporary academic models is that the framework operates from the perception that innovation is a tool to serve some other purpose, rather than a goal on its own.

Its application range is mostly determined by the similarity in regulatory environment of other countries (or sectors), in combination with the ownership structure of the DSOs. Likely, it is largely applicable to countries like Germany, Belgium or Denmark, and sectors such as the IT sector, mobility, water management, manufacturing, automation or biotechnology.

While the framework is broadly applicable within the Dutch DSO context, its effectiveness is influenced by systemic constraints such as the ineffectiveness of the current state of regulatory experimentation, administrative burdens on tech startups, or public scrutiny and media influence.

With the contextualisation and interpretation complete the last step would be to answer the main research question in a final conclusion and discussion.

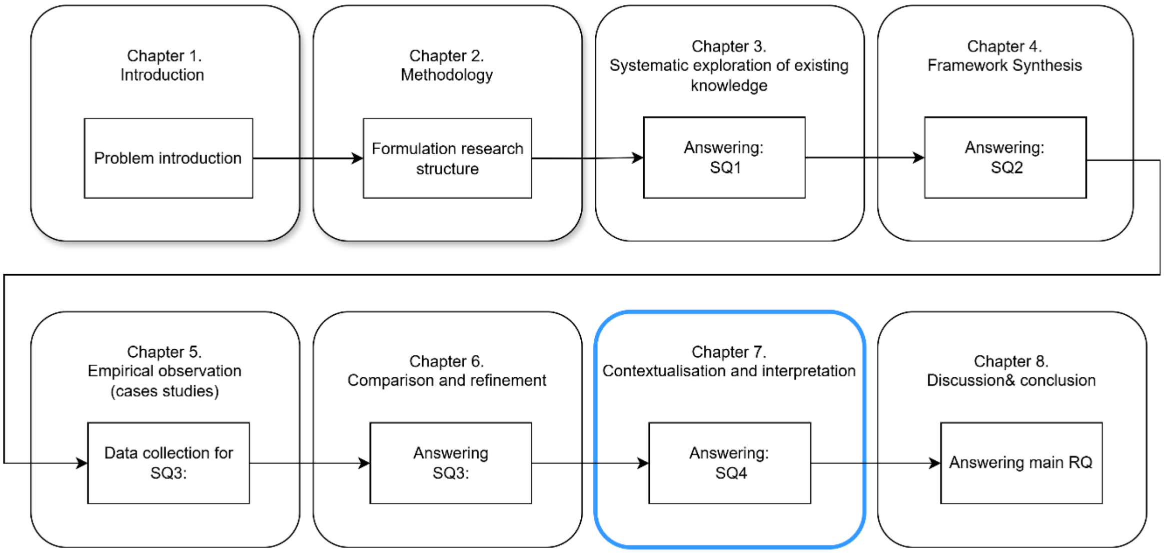

Figure 31: Overview current stage of this research

Chapter 8: Discussion and conclusion

This chapter has two distinct parts. The first part is the discussion. It reflects on the research process and its findings, offering a critical examination of the taken approach. Additionally, it reflects on methodological limitations and set out recommendation on areas for future research that warrant further exploration or that could further develop the framework and its applications.

The second part is the conclusion of this research. It will go over the answers to the research sub-questions and subsequently answer the main research question. It will end with a final brief reflection on the research objectives.

8.1 Discussion

The first part is structured into 3 sections. The first section reflects on methodological limitations. The second section explores some unexpected findings that emerged from the research which did not translate to direct contribution in answering specific research questions. The third section discusses some of the potential avenues for future research.

8.1.1 Limitations

More cases for additional refinement

This research is exploratory in nature. Therefore, it is a first attempt at such a comprehensive framework. There are of course opportunities to further advance the research. The first opportunity being expanding upon the limited number of cases used for this research. While these two cases provided valuable insights, incorporating additional cases could enhance the framework further. Given the specificity of the research, finding cases with the right characteristics and sufficient data is challenging. Nevertheless, the framework would benefit from more cases for comparison and refinement of the factors.

Interview bias

Another area for enhancement stems from the type of information sources used. As interviews were a primary source of information for this research, interview bias naturally played a role in shaping the findings. The perspectives of interviewees often reflected the level at which they operated, influencing their assessment of which factors were most important. While this bias is impossible to fully eradicate, and is therefore to some extend to be expected, it was still evident in the KSZA case, where access to company-level insights was more limited than in the Allego case. Which translated into some company factors not being observed even though they were likely present, as discussed in chapter 6. Given the exploratory nature of this research, it was not initially clear that the framework would result in three levels. Consequently, the selection of interviewees focused on their expertise and knowledge of the cases, rather than applying a specific criterion for diversification based on organizational levels.

Nevertheless, in studies with a small number of cases, such as this one, the impact of interview bias can become more pronounced. Future research could address this by including a broader range of cases, diversifying the interview pool across organizational levels, or further diversifying additional data sources to mitigate reliance on individual perspectives.

Other input frameworks.

The choice on which framework to use as input significantly influences the outcome. Given the vast number of available frameworks on innovation, selection ultimately relies to some extend on personal judgment. Different input frameworks would inevitably lead to a different synthesis into the newly constructed framework. However, given the aim of comprehensiveness it's likely that many core themes would still emerge similarly.

8.1.2 Anomalies and conceptual tensions

The irony of the factor on scaling

When speaking on the ambition of scaling, usually people tend to refer to aspects on the micro level. Thinking of how organisations can create more products or sell more goods. However, when examining how the factors on the scaling framework were integrated, it becomes clear that most of the factors were on a macro or ecosystem level. While at the same time having a factor of "sustain and scale" at the micro level. This seeming irony is better explained through a conceptual tension. Meaning that there is a duality to the factor of scaling which tends to be overlooked. Mostly, for scaling people focus on aspects such as increased product production since its tangible. But in order for those products to be relevant the right circumstances at the ecosystem level need to be present. This irony can also be seen in the model as sustain and scale is a factor on micro level, whilst the factors responsible from creating the right circumstance to scale are integrated into the macro level.

Contextual factors essential

The duality of the factor of scaling also echoes in the fact that contextual factors seem essential. Contextual factors meaning factors that are largely predetermined by the given context, e.g. which topics are contentious, and what stimulating market forces are already in play. Given one of the research objectives was ensuring actionability it remarkable to see that some of the most important factors identified from the cases are contextual factors. Think of the importance of stimulating market forces on an ecosystem level, or the impact of the topic on the innovation of the long-term feasibility of an innovation. While these can be influenced, lobbied for or worked around to some extend they are quite rigid factors and are not easily changed overnight.

However this is in line with observations from SNM, which emphasize that aligning innovation efforts with broader socio-technical landscape dynamics enhances the likelihood of influencing and transforming existing regimes. Specifically, when SNM actions are in harmony with societal trends, public sector actors have a greater chance of stimulating regime transformation, making it a key driver for niche innovations to become part of the regime later on (Moore, 2018b).

Cut-of-point.

One aspect which remains contentious for synthesising concepts is determining the cutoff-point for when to stop reducing factors to preserve a certain level of detail. With framework synthesis, the complexity does not arise in providing coverage, since combining 5 frameworks with a combined number of 80+ factors ensures a wide net to cast. The challenge isn't expressing complex phenomena, in a complex manner. It's the reduction of complexity through concepts in a model that is the challenge of framework construction. However, with bundling factors based on common themes, where the exact cut-of-point lies, when to stop reduction, is not as clear cut. Ultimately, there is an inherent element of interpretive judgment in the process of theory creation. Decisions on where to draw boundaries are shaped not just by analytical rigor but are also formed by the researcher's perspective, much like any act of structured creation. However, additional refinement through the application of cases might help finetune the cut-of-point.

8.1.3 Future research

Refinement for generalisation

As mentioned, future research could focus on the refinement of the current framework or its factors. The addition of more case studies to refine the framework could greatly benefit the frameworks robustness given its current limited application through cases. It could also shed additional light on the exact cut-of-point for when to stop the reduction of factors. The inclusion of cases with the involvement of smaller DSOs to include their perspective into the framework would be an interesting avenue to pursue. This could enhance the generalisation of the model for DSOs in the Netherlands.

Increase specificity by exploring certain factors

Additionally certain factors could be explored in more detail to provide a more specialised focus for the model. For example, the sustain and scale factor could be elaborated upon in order to provide more tangible guidelines for this aspect of the innovation project. Along with the duality of scaling as a concept being expressed on both the project and the ecosystem level.

The concept of strategic alignment is implicitly in the model. However, as mentioned earlier, more extensive research could be undertaken into the effects and forms that strategy alignment on different levels could have. With strategy not at the core of this research diving deeper into the topic falls outside the scope of the research. But the complexity of the new factor found might warrant further in-depth endeavours into that area of research in the future. Such research could also include the positioning with the term "innovation strategy" as an avenue worth investigating.

Exploration into different framework structures.

Another interesting aspect to explore is different core structures of the constructed framework. For instance, one area of interest for potential improvement in the framework is the positioning of the layers relative to each other. The current framework has the levels positions parallel to each other. One of the interviewees mentioned that it could be possible that the levels have a nested structure. Meaning that within an ecosystem is a company, and within a company there are projects. Which would put all factors on equal footing. A first draft has been attempted in addition to identifying connected factors on different levels. This first draft can be found in the appendix. However as became clear quickly, a thorough investigating into this nested nature and its precise structure would necessitate significant additional efforts and would go far beyond this initial exploratory research. Therefore, falls beyond the scope of this research but would be an interesting avenue for further exploration.

Another interesting exploration could be a weighted factor structure for the framework. This could provide a more quantitative approach to framework refinement and would also open up easier avenues for expansion beyond Dutch borders.

Expansion of organisations or sectors

Next to further refinement of current factors, the framework could also be expanded beyond the use for DSOs. Expanding the framework beyond its application for DSOs could provide several valuable insights and opportunities. First, it would allow for the exploration of its adaptability across diverse industries, particularly those operating in similarly regulated and complex environments, such as telecommunications, water management, or public transportation. The three layers of the framework, are likely to remain relevant in these contexts due to the scale of operations in addition to its similarity in regulated environment. Testing the framework in these contexts would allow for the exploration of its adaptability, robustness, and capacity to address innovation challenges beyond the energy sector.

Regulatory learning

Another potential aspect of interest that might warrant further examination is the concept of regulatory learning. In the potential came up in conversation with the regulatory experimentation expert and the Researcher Sustainable Building & Sustainable Communities (interview Researcher Sustainable Building & Sustainable Communities). Regulatory learning, i.e. regulation adapting through learning by doing utilising pilot programs seem under researched as of now. Regulatory learning, how it can be more formally institutionalised in pilot projects, or what might be a better constellation for stimulating innovation in the Netherlands than the status quo, could be further explored in future research.

Chapter 8.2: Conclusion

This last part of the final chapter has three distinct sections. The first section will briefly go over the main conclusions throughout this study and go through the answers to the sub-questions. The second section will focus on answering the main research question and briefly reiterate some avenues for future research. The third section will reflect back on the research objectives.

8.2.1 Answering the research sub-questions

This first section will go through the sub-questions chronologically.

> SQ1: What (elements of) current frameworks are suitable/well situated for framework synthesis?

Guided by the three research objectives an exploration was conducted in the current theoretical framework would be suitable for synthesis. The three research objectives led to the exploration of framework on innovation as a system, innovation as a practical process and regulatory experimentation. Form each of these three domains a few relevant frameworks were selected:

- Innovation as system
  - Open Innovation Paradigm (De Jong et al., 2008b)
  - Strategic Niche Management (Browne et al., 2012b)
- Innovation as a process
  - Innovation Monitor (NLMTD)
  - Innovation Engine (Cap Gemini Invent)
- Regulatory experimentation
  - The Three-Step Regulatory Experimentation Framework by (Bovera & Lo Schiavo, 2022d)

> SQ2: How can the selected frameworks be synthesised

These frameworks were subsequently synthesised. First the general structure was ideated. This main structure consists of three parallel levels for innovation: The project level, the company level, and the ecosystem level. These levels were used for a categorisation of the individual factors of the input frameworks. On each level the categorised factors were either removed, combined or kept based on thematic similarities. This led to an initial framework that could be applied to cases for refinement.

> SQ3: How observable and applicable are the theoretical components of the selected innovation framework within the operational context of DSOs?

The main structure was confirmed and did allow for capturing a broad scope of important factors whilst also allowing for specificity. The model did explain well the impact that certain factors had on the progress of projects and their challenges. With the context factors of stimulating market forces (ecosystem level), and innovation topic (project level) being highly influential. On a company level organisation and agility played a vital role in providing internal structure for the scaling of the innovation in each case. In general, most factors were observed, however “IP management”, and “R&D” as factors were removed as they were not observed. Additionally, the factor of “value chain management” was changed to “investing in complementary technology”.

> SQ4: How can the framework be used to navigate the contextual challenge(s) of DSOs?

The framework proves highly relevant for DSOs by serving as a diagnostic tool that structures innovation efforts across project, company, and ecosystem levels. While broadly applicable within the Dutch DSO context, its effectiveness in part depends on the innovation expertise with which it is applied and resource availability making it most useful for organizations with sufficient innovation capacity.

Unlike traditional prescriptive models, the newly constructed model engages the initial problem as presented and encourages to dig deeper into root causes on three levels, in order to identify and address bottlenecks in a structured manner. Thus, it serves as a problem-driven tool rather than a predefined blueprint for innovation, unlike current academic models. Another contrast with its contemporary academic models is that the framework operates from the perception that innovation is a tool to serve some other purpose, rather than a goal on its own.

Its application range is mostly determined by the similarity in regulatory environment of other countries (or sectors), in combination with the ownership structure of the DSOs. Likely, it is largely applicable to countries like Germany, Belgium or Denmark, and sectors such as the IT sector, mobility, water management, manufacturing, automation or biotechnology.

While the framework is broadly applicable within the Dutch DSO context, its effectiveness is influenced by systemic constraints such as the ineffectiveness of the current state of regulatory experimentation, administrative burdens on tech startups, or public scrutiny and media influence.

8.2.2 Answering the main research question

This paragraph details answering the main research question which is repeated below.

"What newly constructed framework can guide innovation for DSOs in the Netherlands?"

This research has developed a diagnostic framework for stimulating innovation within the DSO context. It represents the first exploration of a framework that holistically addresses the unique complexities and demands of DSOs, offering a foundation for further refinement and application. Its differentiating features include three parallel levels in which innovation processes can be structured and its inclusion of strategy as a factor, as well as strategy alignment. Each level has a set of more detailed factors describing drivers of innovation on each level. Especially impact factors include: "innovation topic addressed", "organisational structure and agility" and "stimulating market forces". The final model can be seen below.

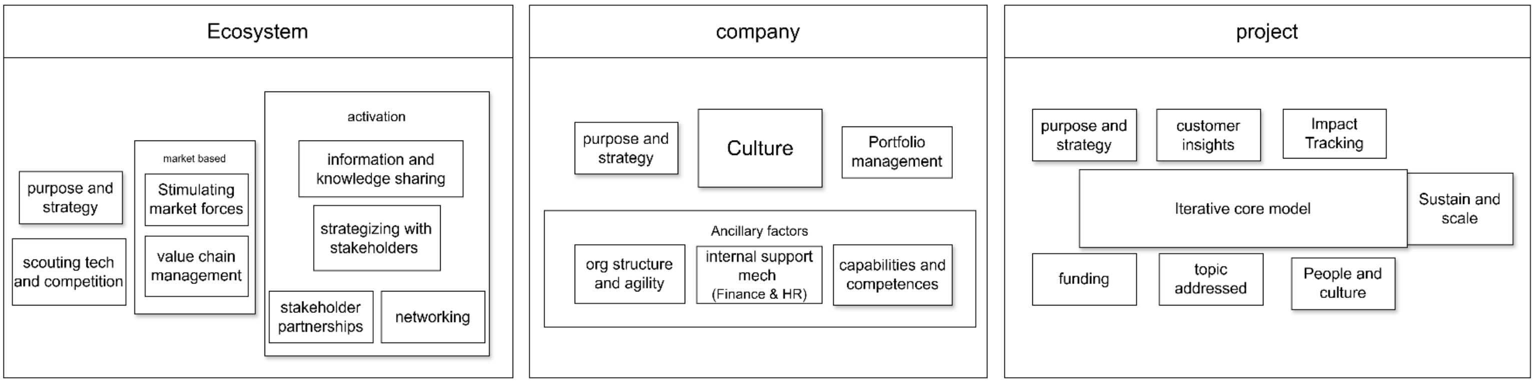

Figure 32: the newly constructed: "three faced" framework.

The framework engages with presently identified challenges as entry points to structurally find root causes and identify bottlenecks, helping in day-to-day decision making. The model presumes innovation to be a tool for obtaining another purpose. It incorporates this through the purpose and strategy factor, helping to maintain effectiveness by keeping underlying goals in focus throughout the framework's application.

Although it helps DSOs identify actionable steps, it is not a ready-to-go solution as the framework does require innovation expertise to navigate. Additionally, through application to cases it has become clear that there are systemic constraints including regulatory barriers, administrative burdens and public scrutiny. Therefore, its successful application in part depends on expertise practitioner and the ability to work within systemic constraints. The framework's application range likely extends beyond the Dutch DSO context, though its effectiveness is dependent on similarity of regulatory structures and ownership models.

8.2.3 Reviewing the research objectives

This study set out to create a new framework to guide DSOs. It set out to accomplish three key research objectives with the newly constructed framework.

1. The new framework should take the system context into account. The functioning, capabilities, demands and objectives are to a large extend dependent on the context in which the operate.
2. The framework should provide tangible and actionable output for DSOs to use. i.e. be able to provide guidance for decision-making at the day-to-day operational level.
3. The newly constructed framework is the consideration of regulation. Specifically, regulation that systematically touches on innovation and experimentation.

The newly constructed framework successfully meets these research objectives by integrating key elements necessary for facilitating innovation in the DSO context.

First, it integrates the ecosystem level as an integral part of the framework. Thus, ensuring an innovation query is analysed within a broader system context. The ecosystem level describes key systemic drivers including, technological developments, market forces and stakeholder interactions. Therefore, the ecosystem level allows for DSOs to position their efforts within a larger landscape of systemic dependencies.

Second, by engaging with presently identified challenges as entry points, the framework helping in day-to-day decision making. Additionally, its diagnostic approach helps to structurally find root causes and identify bottlenecks. The comprehensiveness of the framework and the level of practical detail provided by the project level ensures sufficient depth for practical application.

Finally, the framework explicitly accounts for the complexity of the regulatory context by structurally integrating regulatory experimentation factors into the newly constructed framework. Additionally, this study identifies systemic constraints including regulatory barriers currently present.

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Appendix

A first rough draft on a what the framework with a nested structure could look like. In addition identifying connected factors on different levels.