Institutionalization of durable multi-stakeholder collaborations:

An approach to stimulate durable collaboration in multi-stakeholder projects

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Institutionalization of Durable Multi-Stakeholder Collaborations

An Approach to Stimulate Durable Collaboration in Multi-Stakeholder Projects

April 8, 2024

Master Thesis
Complex Systems Engineering and Management
By:
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5652537

in partial fulfilment of the requirements for the degree of
Master of Science
in Applied Physics

at the Delft University of Technology (TU Delft), Melkweg 5, 2628 CD Delft, Netherlands,
to be defended publicly on Friday April 12, 2024 at 15:45.

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Preface

Throughout my academic career, I have encountered various opportunities to delve into practical applications of my learning. For instance, during my bachelor's degree, I had the opportunity to explore an efficient method to improve the sustainability of a military base. During my master's degree, I participated in an offshore wind project for Shell. These experiences have fueled my motivation as I am inspired by the prospect of making a tangible impact. For this thesis, I desired the same source of motivation.

Fortunately, I had the opportunity to join an ongoing project to research the durability of the collaboration among the stakeholders involved in this project. This project (the MMvIB project) is adopted as a case study. The scarcity of knowledge surrounding the research subject and approach posed an intriguing challenge, albeit occasionally daunting. However, the close association of this research with the case study ensures that the findings are poised to have practical applications. This practical relevance has been a significant source of motivation. Hopefully, this study will inspire further research and contribute to the existing body of knowledge.

I would like to take this space to express my gratitude to those who have contributed to making this research possible, more enjoyable, or both. First, I want to thank Igor and Mark for providing me with the opportunity, the tools, and the support to conduct this research. Second, I want to thank everyone who took the time to talk to me: Evert Jan, Christian, Rosa, Ewoud, Nihit, Linda, Gregor, Charlotte, and Vincent, thank you for all the interviews and meetings we have had. I also want to thank Floris for often joining me to the library. I think we can safely conclude that our mutual support has been indispensable. The support of my friends at TU Delft should also not go unnoticed. Mick, Siemen, and Tycho in particular: thank you for making my time in Delft even more fun and memorable. Thanks as well to my family for occasionally checking in on me to see how I was doing. Furthermore, I would like to thank Frederique for all the support. You always knew to ask the right questions and motivate me. At last, thank you TU Delft for providing me with the opportunity to pursue my studies.

Finally, I hope that you, the reader, will enjoy reading this thesis. I hope that this study will resonate with your interests, inform you, and potentially spark further exploration and discussion on enhancing the durability of multi-stakeholder collaborations.

Sjoerd Blom
Delft, April 2024

Table of contents

Preface 4
List of Illustrations 7
Acronyms 8
Executive Summary 9
1. Introduction 11
1.1 Knowledge Gap 12
1.2 Research Approach 13
1.3 Research Questions 14
1.4 Alignment with CoSEM 15
1.5 Research Structure 16
2. Theoretical Background 17
2.1 Multi-Stakeholder Collaboration (MSC) 17
2.2 Stakeholder Theory 18
2.3 Strategic Management 19
2.4 Conclusion Chapter Two 20
3. Methodology 21
3.1 Data Collection 22
3.1.1 Research Approach 22
3.1.2 Literature Review 22
3.1.3 Interviews 25
3.2 Data Analysis 26
3.2.1 Inductive Reasoning 26
3.2.2 BOMOS 27
3.2.3 Clustering Methods 27
3.3 Implementation of Results 29
4. Results 1: Research Findings 31
4.1 Factors 31
4.2 BOMOS Comparison 33
4.3 Requirements of the Clustering Process 34
4.4 Collaborative Form 35
4.4.1 Comparative Analysis 35
4.4.2 Abductive Approach - the Collaborative Form 37
4.5 Supplementary Results 40
4.5.1 Relative Significance of Clusters 40
4.5.2 Temporal Relevance 43
4.6 Collaborative Guide 46
5. Results 2: Case Study Application 47
5.1 COOP Approach 48

5.1.1 Consult Stakeholder Perspective 49
5.1.2 Observe Temporal Sequence 50
5.1.3 Organize Factors Based on Significance 50
5.1.4 Periodic Reassessment 51
5.1.5 Conclusion and Discussion 51
5.2 Future Management 52
6. Discussion and Conclusion 55
6.1 Main Findings 55
6.2 Discussion 56
6.3 Limitations and Further Research 57
Bibliography 60
Appendices 72
A: Literature Review 1 72
B: Literature Review 2 75
C: Search Query 78
D: Visualization Map 80
E: Factor Definitions 81
F: Inductive Clustering Approach 89
G: Abductive Clustering Approach 94
H: Deductive Clustering Approach 98
I: Article Categories and corresponding Clusters 104
J1: Interview Summary Christian (Hanze university) 105
J2: Interview Summary Rosa (Hanze university) 107
J3: Interview summary Ewoud (Hanze university) 109
J4: Interview Summary Linda (TNO) 110
J5: Meeting Nihit (TU Delft) 112
J6: Interview Layout Stakeholders 113
J7: Interview Summary Gregor (Quo Mare) 114
J8: Interview Summary Evert Jan (Hanze university) 116
J9: Interview Summary Charlotte (Quintel) 118
J10: Interview Summary Vincent (TNO) 120
K: Elaboration of Table 3 122

List of Illustrations

Figure 1.1: Schematic overview of research design. 14
Figure 1.2: Research structure 16
Figure 3.1: Research Flow Diagram (RFD) 21
Figure 3.2: Screening of literature 24
Figure 4.1: Overview of mentions per factor 32
Table 4.1: Comparative analysis of the clustering techniques 37
Figure 4.2: Collaborative form 39
Table 4.2: Significance of clusters based on impediments for MSCs 41
Table 4.3: Aggregated ordinal ranking of the cluster's hierarchy 43
Figure 5.1: COOP approach 48
Table 5.1: Factors and scores influencing MMvIB management 53
Figure 6.1: Increasing number of factors per article 58
Figure A.1: Schematic overview of the screening and selection phase 72
Table A.1: Overview of selected literature from first literature review 74
Table A.2: Sources, content, and search terms of second literature review 77
Table A.3: Iterative optimization process of search query 79
Figure A.2: Visualization map of the AI approach conducted with "Researchrabbit" 80
Table A.4: Definitions of factors 81
Figure A.3: Inductive clusters 89
Figure A.4: Deductive clusters 98

Acronyms

BOMOS: Beheer- en OntwikkelModel voor Open Standaarden (original Dutch version) "Management and Development Model for Open Standards" (English translation)
COOP: Approach entailing the Consult, Observe, Organize, and Perpetual development phases
CoP: Community of Practice
CoSEM: Complex Systems Engineering and Management
EIA: Environmental Impact Assessment
MSC: Multi-Stakeholder Collaboration
MSI: Multi-Stakeholder Initiative
MSP: Multi-Stakeholder Partnership
MVP: Minimum Viable Product
MMvIB: Multi-Model voor Integrale Besluitvorming (original Dutch version) "Multi-Model for Integral Decision-making" (English translation)
RFD: Research Flow Diagram
SDGs: Sustainable Development Goals
SQ: Sub-Question
WP: Work Package

Executive Summary

Problem Statement The Dutch energy landscape is becoming increasingly complex. The energy sector is characterized by many interacting factors and uncertainties, requiring integrated approaches and collaborative efforts to address the challenges and opportunities it presents. The term “wicked problems” encapsulates these intricate societal challenges that defy easy resolution and necessitate collaboration among various individuals, institutions, or stakeholders. A structured and effective approach to explore complex socio-technical systems is the use of multi-models. Multi-models are often operated by various stakeholders to facilitate the interaction of various models and datasets, each addressing specific aspects of the analyzed subject. This approach capitalizes on the combined expertise of individual models, contributing to a nuanced and more comprehensive analysis of wicked problems. MMvIB is such a multi-stakeholder project with the objective to develop and implement a multi-model infrastructure to provide a consistent and transparent foundation to guide the decision-making process related to the Dutch energy transition. This project serves as a case study for this thesis to provide a detailed, real-world context that contributes to a deep understanding of the wicked problem. Subsequently, the MMvIB project provides a practical knowledge gap, highlighting the need of an approach to stimulate durable collaboration within the Community of Practice (CoP). Additionally, a scientific knowledge gap is established as literature inadequately addresses institutional arrangements within Multi-Stakeholder Collaborations (MSCs) and lacks a robust model for establishing durable MSCs.

Research Question To address the identified knowledge gaps, this research sets out to develop an approach to foster durable collaboration among multiple stakeholders within an MSC. The research is structured along three sub-questions, all converging towards the following main research question:

"What are the key design considerations and components of a collaborative guide that facilitates the durable organization of a Multi-Stakeholder Collaboration?"

Results The collaborative guide is formulated through a series of methodological steps employed throughout the study. To commence, a literature review is combined with several semi-structured interviews to identify conceptual factors influencing the durability of MSCs. A total of 69 distinct factors are identified and compared with an empirical model called BOMOS to identify the relative inclusiveness of the factors. Subsequently, three distinct clustering methodologies are invented to enhance the comprehensiveness of these factors. A comparative analysis of these three techniques results in the establishment of one uniform collaborative form. This form is designed by an agglomerative hierarchical clustering process resulting in the establishment of a dendrogram. The dendrogram provides an overview of the factors and the clustering process. Additionally, the relative significance of clusters and a temporal sequence of clusters and factors is established. The former indicates which clusters are usually deemed to be more influential in establishing durable MSCs. These results are based upon interviews with stakeholders of the MMvIB project, a qualitative analysis of the literature review and literature. The temporal sequence of clusters and factors is based on reasoning and can aid in pinpointing relevant clusters and factors to be improved during a specific phase of maturity of the MSC. Together, the collaborative form, relative significance, and temporal sequence constitute the collaborative guide. This guide can be used for stakeholders to improve the durability of their MSC.

Case Study Application Consequently, the collaborative guide is applied to the MMvIB case study to establish a tailored approach to enhance the durability of collaboration within the CoP. As a result, the COOP approach is formulated to implement the collaborative guide systematically. This approach functions as a universal tool for structuring the process of stimulating durable MSCs. The COOP approach entails four phases: the Consult, Observe, Organize, and Perpetual development phases. The initial "consult" phase entails gathering stakeholder perspectives to identify factors necessitating improvement to stimulate durability within the MSC, according to the stakeholders. This phase is followed by observing the temporal sequence of clusters and factors and comparing these to the MSC's phase of maturity to identify relevant clusters and factors. The subsequent "organize" phase prioritizes the identified factors based on the potential influence these factors possess on enhancing the MSC's durability. Finally, continuous monitoring and adjustment of factors are advocated in the "perpetual development" phase to adapt to evolving project dynamics.

Relevance The outcomes of this research offer valuable insights destined for a broad spectrum of CoPs seeking to bolster the durability of their MSC. The establishment of an approach to stimulate durability within MSCs is novel. There are some articles that mention multiple factors. However, none of these articles have the intention to establish an exhaustive list of these factors. While this research does not imply to be comprehensive, it does intend to be more exhaustive than preceding studies in establishing an overview of factors influencing the durability of MSCs. Moreover, the findings are applied to the context of the MMvIB project. This application not only provides recommendations for the CoP to enhance their durability, but it also functions as an example of how to implement the strategy. At last, the implementation of a case study approach has resulted in a combination of empirical and theoretical knowledge, providing a more nuanced and complete perspective. Future research can examine the following three key areas to further advance the understanding and implementation of durable MSCs:

1. Change the research perspective from "what" to "how": Future studies could explore methods and tools to understand how the established factors can be improved to bolster the durability of collaborative partnerships. It is essential to consider the diversity of potential MSCs to ensure the broad applicability of the approach.
2. Assess the effectiveness of the approach and identify potential improvements: Long-term studies in diverse settings could establish shortcomings of the approach. Quantifying the impact of the COOP approach by comparing MSC durability before and after implementation could provide valuable insights into the effectiveness of the approach. Furthermore, qualitative assessments from practitioners could identify potential improvements.
3. Investigate the universality of applying the approach across diverse collaborative contexts: To guarantee universal implementation of the approach, research could examine potential MSC environments and the implications of diverse contexts. In accordance with these implications, several adjustments might be needed to incorporate all aspects of MSCs.

Conclusion It is argued that MSCs are an effective tool to address complex societal challenges such as the establishment of a multi-model. The stakeholders of the MMvIB project have demanded a strategy to enhance the durability of their MSC. Therefore, this research has developed a collaborative guide to stimulate durable collaboration among stakeholders within MSCs. The COOP approach provides a structured strategy to identify relevant and influential factors to achieve this prolonged cooperation within the CoP of MSCs. The functioning of the approach has been demonstrated by the implementation of the MMvIB as a case study. Future research should focus on refining and implementing the COOP approach across diverse collaborative contexts to further advance the understanding of durable MSCs and identify methods to improve the identified factors.

1. Introduction

Problem Statement The Dutch energy landscape is undergoing a substantial transformation. This transformation mainly originates from several objectives of the Paris climate agreement (Van Vuuren et al., 2017). To commit to the goals defined in the Paris agreement and several other National and European documents, a so-called energy transition is required. The driver of the energy transition is the imperative to address several challenges, such as energy security, climate change, and sustainable development (Bogdanov et al., 2021).

To tackle these challenges, a transition from the conventional fossil fuel-based energy infrastructure towards a renewable energy system should be established. Despite the availability of various sustainable alternatives, such as wind, solar, and hydropower, a definitive nationwide solution remains elusive. A reason for this is the complex and dynamic nature of the energy infrastructure (De Bruijne, 2006). There is not a one-size-fits-all approach, as different regions face different challenges. Moreover, these challenges are dynamic and depend on various factors, including resource endowments, socio-economic contexts, and technological opportunities (Clarke et al., 2012). The energy system is influenced by several interconnected factors, such as technological, economic, political/institutional, socio-cultural, and environmental factors (Cherp et al., 2011). The interconnectivity of these influences further complicates the energy system.

The complexity of this challenge is often referred to as a "Wicked problem" (Vayaliparampil et al., 2021). Wicked problems refer to intricate societal challenges that defy easy resolution and necessitate collaboration among various individuals, institutions, or stakeholders (Dentoni et al., 2018). As conceptualized by Rittel and Webber (1973), these problems are challenging to address and are characterized by an array of challenges, which, among others, include the absence of a definitive problem formulation, the absence of a singular correct solution, the inability to easily test hypotheses, and the multiplicity of causes. In 2001, the Dutch government adopted their fourth National Environmental Policy Plan (NMP4) as an attempt to address the complexity. This approach emphasized the need for system thinking.

Energy Modeling In order to efficiently navigate the intricacies of the energy transition and facilitate instruments to enable this system thinking, decision-makers and researchers currently employ computer models of energy systems. Energy modeling provides a structured framework for exploring different energy scenarios and stimulating the sustainable progress of a nation (Suganthi & Samuel, 2012). There are multiple functions to these models. For example, a model can calculate or optimize the required size and design of a specific aspect of the energy infrastructure. Furthermore, models can simulate real-world interactions between energy supply and energy demand to provide insights on climate policy, energy security, economic development concerns etcetera (Pfenninger et al., 2014). Besides providing insights, the models enable the formalization of scattered knowledge about complex interactions in the energy sector. Factors such as costs, emissions, resource availability, and technological advancements can be mapped and optimized. Modeling energy scenarios offers a valuable tool for exploring, designing, and optimizing energy systems, providing a cost-effective and efficient means of assessing feasibility, identifying risks, and informing decision-makers before real-world implementation (Mendes et al., 2011).

However, the myriad of available models suggests the inherent complexity of modeling the energy transition (Pfenninger et al., 2014). According to Box (1976), "all models are wrong, and some are useful" (p. 792). Models incorporate their own methodologies, characteristics, and focal points to simplify reality according to their individual perspectives.

Multi-Modeling Recently, the implementation of a multi-model approach has gained momentum in the search for a structured and supportive process to explore complex socio-technical systems (Del Granado et al., 2018). A multi-model constitutes a collection of interacting models and datasets, each addressing specific aspects of the analyzed subject (Bollinger et al., 2018). This approach capitalizes on the expertise of individual models, contributing to a nuanced and comprehensive analysis of wicked problems. The different models communicate and co-evolve with one another within the context of a dynamic socio-technical environment (Cuppen et al., 2021).

Multi-models address the complexities of large socio-technical systems more effectively than single models by reducing uncertainties associated with multifaceted problems. (Drent, 2020; Tebaldi & Knutti, 2007). In relation to the previous quote by Box (1976), Nikolic et al. (2019) advocate for the use of multiple models, stating, "All models are biased, therefore we need more of them" (p. 2). Therefore, the adopting a multi-model approach represents a promising stride in tackling the intricate dynamics of modern socio-technical systems.

MMvIB An example of such a multi-model approach is the MMvIB project. MMvIB is the Dutch abbreviation for a project called “Multi-Model Infrastructure for Integral Decision-making in the energy transition”. This two-year project has the objective to design and implement a Minimum Viable Product (MVP) for a multi-model infrastructure to provide a consistent and transparent foundation to guide the decision-making process related to the Dutch energy transition (TU Delft, 2021a). The project’s principal aim is to develop knowledge on specific tools and methods to establish a generic open-data platform facilitating the interoperability of existing models (between 5 and 18). These models should collaborate and transparently share data utilizing a shared language to generate insights to inform decision-making processes concerning socio-technical systems.

The resulting multi-model will, theoretically, establish a more extensive examination of the complex socio-technical energy system than separate models could have done. Foundational to the MMvIB is the facilitation of cooperation between actors and stimulation of further research on the energy transition. Collaboration between actors is important since multi-models are typically constructed by multiple stakeholders. This type of modeling is called participatory multi-modeling which is more complex due to the influence of more uncertainties and a higher need for communication (Cuppen et al., 2021). While participatory multi-modeling has several benefits (e.g., fused expertise), the main challenge is bridging various social worlds.

1.1 Knowledge Gap

Two distinct knowledge gaps have emerged concerning the utilization of multi-models. The first knowledge gap is pragmatic and stems from practical insights gained through the above-mentioned MMvIB project. The second knowledge gap is established during a literature review.

Practical Gap The first knowledge gap stems from the MMvIB project. While finalizing this thesis, the MMvIB project has reached its deadline. Nevertheless, the full potential of the project has yet to be achieved. The Community of Practice (CoP) mentioned during several interviews that follow-up research is required. Without further research of the CoP, the multi-model will deteriorate and become irrelevant. Furthermore, the project's structure dictates that upon a stakeholder's departure from the consortium, associated model(s) and knowledge regarding the multi-model will likely become unusable. In conclusion, the practical knowledge gap demands the exploration of strategies to maintain stakeholder engagement and foster the ongoing advancement of the project.

Scientific Gap The second knowledge gap originates from literature. An initial literature review, conducted to identify underexplored themes concerning multi-models, has revealed a knowledge gap concerning the institutional arrangements within Multi-Stakeholder Collaborations (MSCs) (Appendix A). The term "institutional" refers to the organizational, structural, and regulatory features of a system, organization, or society. An MSC refers to a consortium of stakeholders who collaborate in an interactive process in which actors share resources, risks, and responsibilities to achieve a common goal (Ayala-Orozco et al., 2018). The demand of the MMvIB project to research durable collaboration among stakeholders within an MSC, in combination with this initial literature review, prompted a subsequent literature review. This time, the research focused specifically on the durability of MSCs, pertaining to the specific demand of the MMvIB project. During this research, various articles mentioned the durability aspect of MSCs (Appendix B). However, none of the identified articles provides a robust model to establish durable multi-stakeholder collaboration.

1.2 Research Approach

To fill the above-mentioned knowledge gaps, this research aims to establish an approach to stimulate durable collaboration between stakeholders within an MSC. This guide provides a structured approach for MSCs to stimulate durable collaboration. The impetus for this research stems from the request by the MMvIB project to improve durable collaboration between the stakeholders. Consequently, this study aims to offer counsel to the MMvIB consortium for enhancing their collaborative endeavors. However, the scope of this research extends beyond advisory. The collaborative guide will be applicable to a wide range of MSCs. The aim of this research is as follows:

"To develop an approach tailored for Multi-Stakeholder Collaborations aimed at fostering durable collaboration among multiple stakeholders within the MSC."

Research Design As the current literature lacks a comprehensive overview of factors influencing the durability of MSCs, this research aims to collect factors derived from both theoretical frameworks and practical contexts.

Figure 1 provides a schematic overview of the terminology describing this research. The outer layer denotes that the research has a qualitative and exploratory nature (Bryman, 2006). These approaches are characterized by their emphasis on investigating, understanding, and generating detailed insights and substantiated solutions to the research question (Hunter et al., 2019). The exploratory aspect is supported by inductive reasoning. This type of reasoning identifies patterns or themes from data and generalizes these findings to broader themes (Punch, 2013). Furthermore, several aspects of design science have been incorporated. Design science covers the aspect of this research which deals with the scientific study and creation of “artifacts”, constructing the collaborative guide (Johannesson & Perjons, 2014). The aim of design science is to not just understand a phenomenon but to develop a design or framework to solve the actual problem.

This framework is based upon a literature review and the results of a case study. First, a literature review is performed to collect and analyze theoretical data from said research. The data should discover factors influencing the durability of MSCs. This type of research approach requires desk research. Second, the MMvIB project serves as a case study, providing practical knowledge on durable collaboration within the MSC of the MMvIB project (Swanborn, 2010). This practical knowledge is established through conducting interviews with relevant stakeholders.

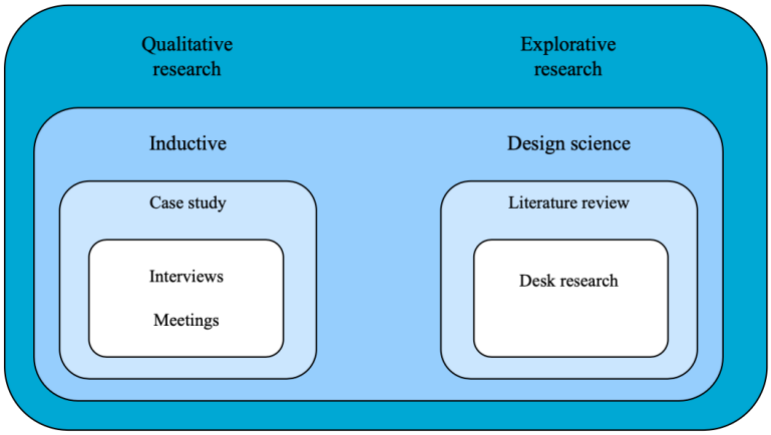


Figure 1.1: Schematic overview of research design.

1.3 Research Questions

The main objective of this research is to answer the following main research question:

"What are the key design considerations and components of a collaborative guide that facilitates the durable organization of a Multi-Stakeholder Collaboration?"

The process of answering this main research question is structured by three sub-questions (SQ). Each sub-question aims to establish a different output and is categorized by its own methodology. This section discusses the sub-questions in chronological order.

Factors To commence the research, a literature review will be conducted. The aim of this review is to discern and describe the factors exerting influence on the durability of multi-stakeholder projects. These factors and themes will be cataloged in a database to delineate the current literature landscape in the field. Currently, the identified knowledge gaps highlight the inability to comprehend the intricacies of sustained collaboration within MSCs. This limitation arises from the absence of research to understand the entire system. By synthesizing existing knowledge, a more exhaustive understanding of the factors influencing the sustainability of MSCs can be achieved. Moreover, various interviews will be conducted with stakeholders of the case study to potentially extract additional factors. Finally, the factors will be compared to the BOMOS model. This model encapsulates factors that guide organizations in developing and managing standards and is used to test the exhaustiveness of the identified factors (Folmer, 2023). The first sub-question accompanies the process of establishing these factors:

SQ.1: "What are the themes and concepts influencing the durability of Multi-Stakeholder Collaborations?"

Collaborative Guide The second sub-question initially delves into the methodology of structuring the factors to enhance the interpretability of the results. This inquiry will manifest in the formulation of a collaborative form, synthesizing the identified components. The requirements of the collaborative form are extracted from specific articles that were identified during the literature review. To structure the collaborative form, the factors are categorized as overarching themes or clusters. This process entails a novel interpretation of three theories to organize the data. These approaches are derived from literature on inductive-, abductive-, and deductive reasoning and theorizing (Okoli, 2023).

The collaborative form will be accompanied by an overview of the relative importance of clusters and a temporal sequence of clusters and factors. The latter is based on reasoning and can aid in pinpointing relevant clusters and factors to be improved during a specific phase of maturity of the MSC. The importance of clusters indicates which clusters are usually deemed to be more important in establishing durable MSCs. Combined, the collaborative form, relative significance, and temporal sequence constitute the collaborative guide. This guide can be used by stakeholders to structure the process of identifying relevant factors to improve the durability of their MSC. The development of the collaborative guide serves as a response to the second sub-question:

SQ.2: "How can the requirements for a durable Multi-Stakeholder Collaboration be composed into a collaborative guide?"

Case Study Advice At last, the third sub-question investigates the practical application and relevance of the collaborative guide within the specific context of the adopted case study. During this phase, the suggested guide is utilized to establish recommendations to the stakeholders of the MMvIB project. This section will not only serve as explicit guidance for the MMvIB consortium on fostering enduring collaboration, but it can also be construed as an illustrative model for other MSCs aiming to enhance the sustainability of their collaborative endeavors. The advice is based upon the collaborative guide and information obtained during the interviews with stakeholders of the MMvIB project. The application of the collaborative guide in relation to the case study aims to address the third and last sub-question:

SQ.3: "How can the collaborative guide be applied to the case study?"

1.4 Alignment with CoSEM

To explore and answer the above-mentioned research questions, several levels of expertise are required. As a master's student at TU Delft, studying Complex Systems of Engineering and Management (CoSEM), I have acquired a wide range of interdisciplinary knowledge related to complex systems and the management thereof. First of all, the MSc program has equipped me with systems thinking. This means that I can analyze and understand the interactions, behaviors, and interdependencies of various components within a system. Moreover, CoSEM has equipped me with the capability to grasp the intricacies inherent in complex systems, exemplified by the energy system. Themes such as emergence, networks, and nonlinear dynamics are essential components for comprehending complex systems. At last, the program has established a certain proficiency in modeling complex systems and analyzing data using computational tools and techniques. These competencies contribute to an enhanced comprehension of the MMvIB project. The essential qualities mentioned above accommodate an environment which is very suitable, if not destined, to be studied from a context of the CoSEM MSc program.

1.5 Research Structure

The remainder of this thesis is organized as visualized in Figure 2. This figure presents the chronological steps and the associated research questions of this study. The overview should be interpreted sequentially from top to bottom following the direction of the arrows. Chapter two, entitled "Theoretical Background," expounds upon the theoretical underpinnings surrounding multi-stakeholder collaboration, elucidating several concepts and frameworks. Following this theoretical foundation, the third chapter delineates the methodological progression. The description of this methodology provides a systematic and transparent account of how the research was conducted, ensuring the rigor and reproducibility of the study's findings. The fourth chapter presents the results of the research leading to the establishment of the collaborative guide. Subsequently, the fifth chapter applies this collaborative guide in the context of the MMvIB case study. This chapter provides specific recommendations to the consortium of the MMvIB project and functions as an illustration of how to utilize the approach. The final chapter summarizes and discusses the findings to provide a clear understanding of the study's outcomes and their broader implications.

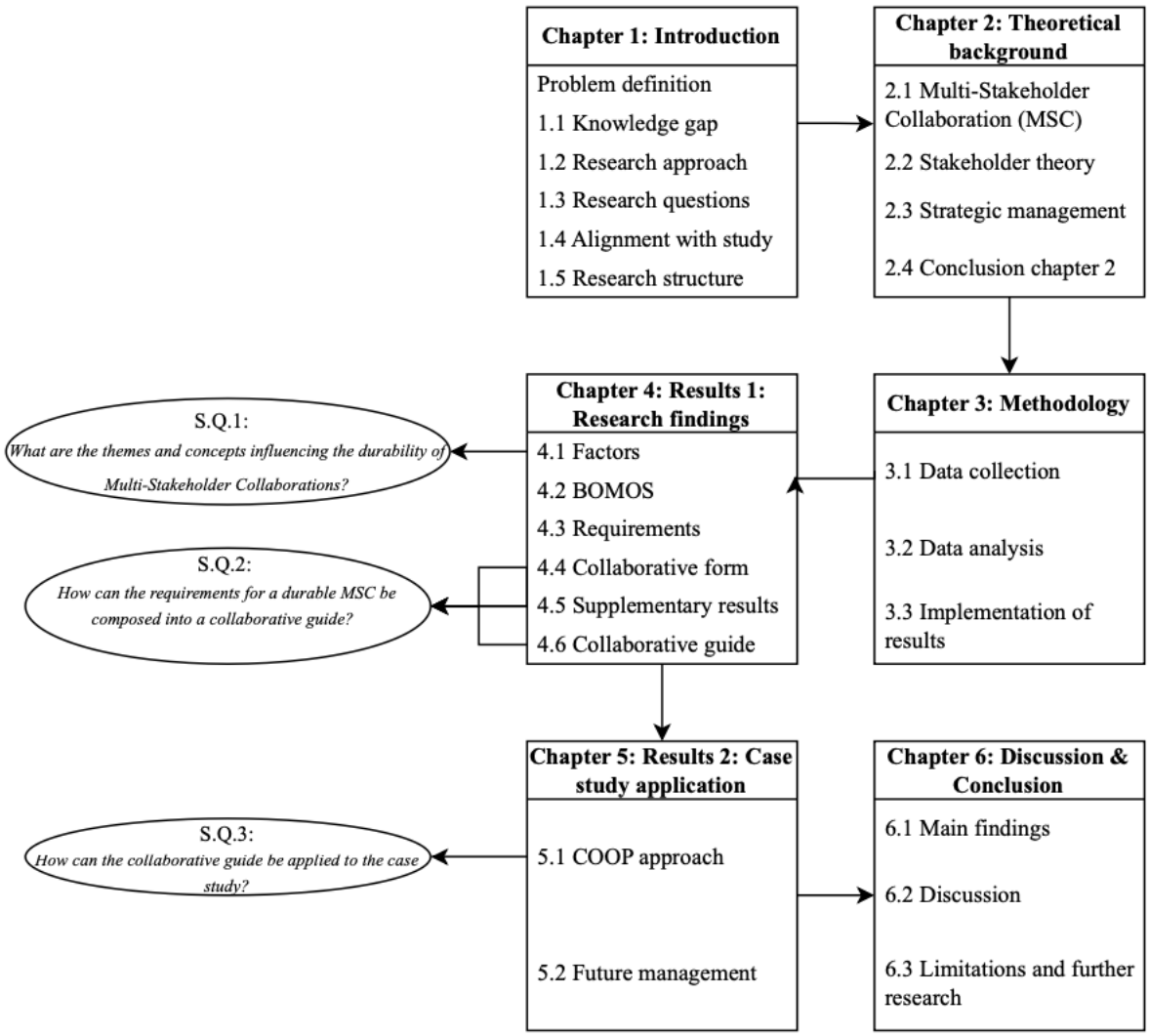


Figure 1.2: Research structure

2. Theoretical Background

Throughout this thesis, three literature reviews have been undertaken to discern knowledge gaps, explore theories related to the subject of MSCs, and discern factors which influence the durability of these MSCs. This chapter discusses relevant concepts derived from these literature reviews to establish a theoretical foundation for this research. First, the concept of multi-stakeholder collaboration is elaborated upon. Thereafter, two prevalent theoretical concepts which are frequently utilized in literature to explicate MSCs are described and correlated with the concept of multi-stakeholder collaboration. The differences and commonalities between these theories demarcates the research domain and furnishes contextual background information.

2.1 Multi-Stakeholder Collaboration (MSC)

Terminology The term “Multi-Stakeholder Collaboration” is often used interchangeably with the terms “Multi-Stakeholder Partnership” (MSP), “Multi-Stakeholder Initiative” (MSI), Multi-Stakeholder Cooperatives, or Multi-Stakeholder Projects (Eweje et al., 2021). All terms refer to a situation where various stakeholders (often referring to companies) work together to bundle their strengths and solve complex problems. For this thesis, the term Multi-Stakeholder Collaboration is preferred as it amplifies the significance of mutual benefit by including collaboration.

Definition Eweje et al. (2021) define an MSC as “a temporary social arrangement in which two or more social actors work together toward a single common end requiring the transmutation of materials, ideas, and/or social relations to achieve that end” (p. 192). The connection between MSC and multi-modeling resides in their collective pursuit of tackling intricate challenges through interdisciplinary collaboration and the amalgamation of diverse knowledge. Multi-models, comprising distinct models, typically originate from various stakeholders, each possessing a unique expertise and focus.

Configuration and Functionality Various authors argue that MSCs are an effective mechanism for addressing wicked problems (Foley et al., 2017). The ability of MSCs to consolidate resources and capabilities enhances the competencies to tackle the complexities of such problems. However, the configuration of these MSCs requires further research. In his article, Kar (2014) describes the configuration of an MSC as follows: "A successful partnership requires common goals, complementarity, convergence and mutual self-help. It needs a clearly defined role, horizontal integration, equal power relations and capacity of the community to bargain collectively. The public sector needs to provide an enabling environment in terms of investment opportunity, policies, and legislation. The businesses can contribute innovative approaches and create economic opportunities for the poor. The community can be an active participant in the entire process" (p. 21). Pérez Perdomo et al., (2016) add to this configuration by describing the required roles of stakeholders within an MSC. The roles should be complementary, exhaustive, and ambidextrous to both explore and exploit activities. Kaumbata et al. (2020), suggest that MSCs can perform a stakeholder analysis to identify and recruit partners to provide context-specific technical knowledge, influence, and marketing-related needs. Bulmer and Yáñez-Araque (2023) analyze how collaboration can be promoted between stakeholders as varied as governments, scientists, and NGOs. In conclusion, the organization of an MSC entails a complex and multifaceted challenge. Various authors describe components of the configuration of an MSC.

Durability However, none of the identified articles delve into the methods for maintaining these collaborations over an extended duration. Corsaro and Engel (2020), along with a limited number of other authors, have touched upon the significance of a long-term partnerships in their work. Nevertheless, their discussion is limited to highlighting the importance of durable collaborations and specifying a timeframe for achieving sustainability (at least 18 months). How to achieve durability is not discussed. Corsaro and Engel (2020) label the durability of MSCs as the “sustainability” of collaborative partnerships. During this thesis, various terms will be employed interchangeably to characterize the enduring aspect of MSCs. The terms "sustainability", "durability", "longevity", and "long-term continuation" will be utilized synonymously to articulate the required steadfast and enduring aspect of MSCs.

Challenges Petersilia (2008), determined that stakeholders often lack time, ability, or will to sustain their MSC. A combination of these three factors might provide an explanation for why a framework for durable partnerships has never been established. Another explanation for the lack of research could be the complexity of the case. An example of this complexity is provided by Elbakidze et al. (2010) who identify differences among MSCs attributed to their environmental contexts. In their article, a comparison is made between Sweden and Russia where the social-ecological system imposes distinct driving factors for the establishing MSCs and requires contrasting configurations. Beisheim and Simon (2016) supplement this statement of complexity by discussing the differences in scope and typology among MSCs. The scope of an MSC refers to the objective and magnitude of a certain project. The typology describes the core function of a partnership and is defined by three distinct types. The first distinction is made between an MSC for sharing knowledge, providing services, or setting standards. A further distinction can be made between traditional cooperatives and new generation cooperatives which mainly differ in their economic motivation, philosophy, and ownership characteristics (Lund & Novkovic, 2023).

The requirements differ significantly depending on the type, scope, or other elements of an MSC. For example, an MSC for sharing knowledge is typically more open to including all stakeholders, while an MSC that provides services often targets a specific group of stakeholders. Therefore, not one single specific outline of a durable or effective MSC can be provided. The collaborative form established during this study aims to provide a comprehensive overview of all the requirements for a durable collaboration.

2.2 Stakeholder Theory

Stakeholder theory is a management philosophy suggesting that “if we adopt as a unit of analysis the relationship between a business and the groups and individuals who can effect or are affected by it, then we have a better chance to deal with these three problems” (Freeman et al., 2010, pp. 5, 6). The problems relate to the problem of value creation and trade, the problem of the ethics of capitalism, and the problem of managerial mindset. The theory suggests that recognizing and balancing the interests of various stakeholders optimizes value creation and enables an effective business management strategy to achieve long-term sustainable success for the organization.

Commonalities Stakeholders are defined as any group or individual capable of exerting influence on, or being influenced by, the achievement of business objectives (Freeman, 1984). Stakeholder theory, as formulated by Edward Freeman, underscores the consideration of multiple stakeholders in organizational decision-making. MSCs align with this theory by incorporating stakeholders from different sectors to bundle resources, risks, and responsibilities to achieve common goals. MSCs represent a practical application of stakeholder theory as varied stakeholders are engaged to address complex issues. Furthermore, stakeholder theory encourages long-term thinking and emphasizes the importance of sustainable practices that stimulate collaboration. This long-term sustainability aspect is also to be researched for MSCs.

Differences Stakeholder theory differs from the concept of MSCs in two aspects. First, the scope of the two concepts varies. Stakeholder theory describes a theoretical framework that is used to exclusively analyze and improve relationships between stakeholders from the organization's perspective (Friedman & Miles, 2002). Contradictory, theory on MSCs encourages to analyze the characteristics of stakeholders to establish heterogeneous collaborations aimed at collectively addressing complex problems (Morsink et al., 2011). Second, the application of the two concepts differs. Stakeholder theory typically offers insights into how established relationships can be improved. MSCs, however, strategically select partners with whom they desire to collaborate to innovate and solve wicked problems. In summary, while stakeholder theory focuses on analyzing and enhancing relationships from the organization's viewpoint, MSCs advocate for examining stakeholders independently to foster heterogeneous collaborations aimed at collectively addressing complex issues.

2.3 Strategic Management

Most studies on partnerships have traditionally aligned with strategic management literature, emphasizing the pursuit of economic value (Galan & Zuñiga-Vicente, 2023). However, recent observations indicate a notable shift, with an increasing number of ventures prioritizing the engagement of multiple stakeholders to address environmental and social objectives. This evolution underscores the dynamic interplay between strategic management principles and the emerging landscape of collaborative initiatives.

Definition The definition of strategic management is fragmented and context dependent. Strategic management focuses on the significant actions and plans implemented by top managers to improve a company's performance within its external surroundings. It involves utilizing resources effectively to pursue both planned and unexpected opportunities in alignment with the firm's goals and the interests of its stakeholders (Nag et al., 2007). In essence, strategic management encompasses the formulation, execution, and assessment of the overarching objectives and initiatives established by an organization's management. During this process, the management ensures that the organization's resources are aligned with its objectives in a dynamic and competitive business environment.

Stakeholder Theory Freeman et al. (2010) refer in their article to the application of stakeholder theory in strategic management. The link between stakeholder theory and strategic management is recognizing stakeholders as an integral aspect of the decision-making process. Stakeholder theory informs strategic management by emphasizing that organizations should consider the interests and concerns of a broader set of stakeholders, beyond just shareholders. This approach contends that strategic decisions should align with the needs and expectations of relevant stakeholders, contributing

to long-term organizational success and sustainability. The integration of stakeholder considerations into strategic management enhances the overall effectiveness and ethical foundation of organizational strategies. Literature on strategic partnerships first developed in the 1990s and corresponded to strategic management literature. This body of literature primarily addressed the achievement of economic value through strategic partnerships originating from voluntary collaborations between organizations with shared interests (Galan & Zuñiga-Vicente, 2023).

Collaborative Networks However, more recent literature supports the broader approach of stakeholder theory and the more recent interpretation of strategic management (Lusch & Nambisan, 2015). They argue that value is no longer created within the confines of an organization. Instead, the notion is accepted that value is created as a product of complex collaborative processes within networks of diverse stakeholders. Ndubisi et al. (2020) observe that the overall emphasis on competition between stakeholders has diminished, with cooperation among stakeholders becoming more prevalent. Knowledge, resources, and capabilities are shared, bundled, and capitalized to innovate. A main initiator for this transformation towards collaborative networks has been the increasing complexity of technologies and society. Bundling forces is essential to respond to the rapid pace of innovation and globalization (Barrane et al., 2021).

MSCs Literature on Multi-Stakeholder Collaborations depicts great similarities to the concepts of strategic management. The trend, identified by Galan and Zuñiga-Vicente (2023), where an increasing number of organizations prioritize the engagement of multiple stakeholders to address mutual objectives, mirrors the essence of MSCs. Strategic management endeavors to establish and attain objectives within an increasingly complex and interdependently oriented environment. The increase of collaborations between stakeholders necessitates the presence of a clear management structure to bundle forces and utilize resources effectively. Therefore, the surge in popularity and complexity of MSCs demands a comprehensive understanding and a potentially revitalized application of strategic management principles.

2.4 Conclusion Chapter Two

Chapter two elucidates the meaning of Multi-Stakeholder Collaborations. Additionally, this chapter establishes a concise overview of associated theories surrounding the concept of MSC. Galan and Zuñiga-Vicente (2023) describe that literature on strategic management and stakeholder theory provide building blocks to understand the meaning of MSCs. First, stakeholder theory suggests that partnerships should be viewed as “aggregates of different types of organizations that join forces to deal with ‘messy challenges’ that cannot normally be solved by any organization acting alone” (Galan & Zuñiga-Vicente, 2023, p. 832). Second, strategic management suggests that successful business is constructed by members who draw upon a heterogeneous knowledge base. At the same time, these diverse community members appear to be interconnected by a fundamental implicit consensus that facilitates the cohesion and identity maintenance of the field (Nag et al., 2007). Combined, these two concepts form the building blocks of the MSC literature, underpinning the collaborative dynamics and strategic orientation necessary for addressing complex challenges through collective action.

3. Methodology

This chapter outlines the methodology implemented to achieve the objective of this thesis. The methodology chapter is divided in three main sections which collectively describe the process of obtaining and processing the required data. A schematic representation of the methodology is presented in Figure 3. This figure presents the Research Flow Diagram (RFD) which serves as a visualization of the sequential steps which have been taken to conduct this research. The rounded rectangles represent processes while the regular rectangles represent the results of these processes. The remaining of this chapter establishes a description of this methodology along a subdivision of three distinct phases: Data Collection, Data Analysis, and the Implementation of Results.

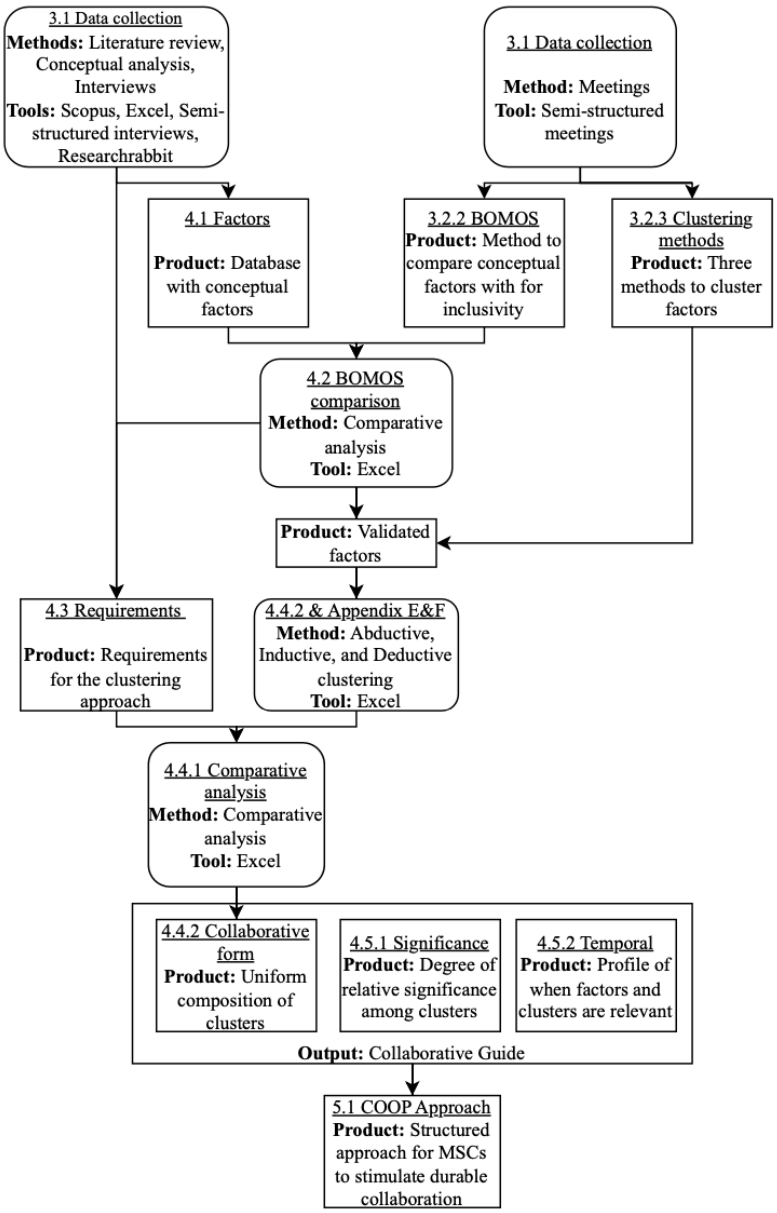


Figure 3.1: Research Flow Diagram (RFD)

3.1 Data Collection

This section outlines the methodology employed to identify the factors impacting the durability of MSCs. Initially, a literature review was conducted to delineate the factors influencing MSC durability. Subsequently, the most relevant sources from this review served as the foundation for leveraging an artificial intelligence tool to augment the search for related articles. Additionally, semi-structured interviews were conducted with stakeholders of the MMvIB project, complemented by expert consultations on multi-models and sustainable collaboration. The interviews served to align the research with practical implications and facilitate the formulation of recommendations to enhance durable collaboration among MMvIB stakeholders.

3.1.1 Research Approach

Qualitative Qualitative research is preferred for this study to delve into the complex and multifaceted nature of multi-stakeholder collaborations (MSCs) and to understand the underlying reasons behind phenomena (Creswell, 2009). By employing qualitative methods such as literature review, interviews, and meetings, this research aims to explore and identify factors influencing the sustainability of MSCs (Bryman, 2006). Qualitative research can provide insights into the different factors that influence the sustainability of MSCs while quantitative research would focus more on which factors influence the process more than others. This thesis aims to establish an overview of the relevant factors and therefore fits better the design of a qualitative research approach. It is particularly valuable to have a qualitative procedure when the research question is exploratory or when the research topic is complex and multifaceted.

Exploratory The purpose of exploratory research is to investigate unidentified, unfamiliar, or complex problems (Stevens & Wrenn, 2013). The focus is on generating new insights and hypotheses through open-ended questions, in-depth data collection and an overall embedding in the research area. This study primarily adopts an exploratory approach and follows a sequential design (Cameron, 2009; Sreejesh et al., 2014). Initially, exploratory research unveils the complexities of the MSC landscape and identifies potential factors contributing to sustainable MSCs through a literature review. Subsequently, descriptive research aims to elucidate the meaning and characteristics of these factors. At last, explanatory research will establish causal relationships between the factors resulting in the identification of overarching clusters.

3.1.2 Literature Review

The description of the literature review is organized into four distinct sub-sections. First, the process of obtaining reliable and relevant articles is discussed. Conducting a literature review is an effective method for understanding the factors impacting the durability of MSCs (Snyder, 2019). A literature review offers insights into the myriad of factors identified by researchers. Subsequently, the methodology for distinguishing key concepts from the literature is elucidated. Thereafter, an overview of the article selection process is presented. At last, the structure and content of the database resulting from the literature review are outlined.

Article Identification In pursuit of identifying a diverse range of relevant and reliable sources, the Scopus database has been consulted. Scopus boasts a substantial interdisciplinary repository, encompassing a wide scope while upholding stringent quality standards for peer-reviewed literature. Furthermore, Scopus provides an advanced search engine with features such as keyword search, wildcard search, and affiliation search. While other databases could also be utilized for the required

research purposes, the advanced search capabilities, and the implementation of rigorous quality control measures for the articles included in Scopus caused a marginal preference for the latter database. Alternatives could be Web of Science or Google Scholar. However, Web of Science has a smaller database and Scholar has many non-peer-reviewed sources. Moreover, the literature review conducted in Appendix B yielded slightly better results for Scopus in comparison to Scholar. Further research could identify additional articles through subsequent databases.

Considering the findings described in Appendix C, aimed at the refinement of the search query, it is determined that the search query should exclusively incorporate "Multi-Stakeholder Collaboration" along with its synonymous terminology. Furthermore, a wildcard search should be integrated along with a filter to exclusively examine article titles. This measure ensures that the primary focus of the retrieved articles pertains specifically to MSCs. This search query obtains a comprehensive coverage while avoiding overly narrowing the search parameters. Limiting searches to the article title increases the likelihood of relevance in retrieved sources.

Conceptual Analysis To discern concepts from literature, several approaches can be implemented. The approach enacted during this literature review aligns with the characteristics of a conceptual framework, a theoretical framework, and a framework of standards. Combined, these concepts describe the process of a conceptual analysis.

A conceptual framework approach is implemented to determine and define the key concepts or factors that are relevant to MSCs and their longevity (Jabareen, 2008). Conceptual frameworks provide understanding through gathering and interpreting relevant concepts (Saunila, 2016). In this case the concepts are extracted from literature and/or other sources after which these concepts are defined and organized. To extract the factors from literature, the factor's influence on the durability of MSCs needs to be explicitly mentioned. This influence can be either positively or negatively correlated to the durability aspect. If a factor is distinguished, it must be extracted, labeled, and cataloged. Subsequently, a theoretical framework describes a set of concepts which are developed from one or more theories that are connected (Varpio et al., 2020). To establish a theoretical framework from these concepts, the researcher defines the identified concepts, clusters them through logical connections, and relates these concepts to the relevant study so that conclusions can be drawn. At last, a framework of standards refers to the resultant set of standards that an organization should meet in a particular situation for this organization to be successful (Ingvarson, 2002). The standards provide a benchmark for quality, consistency, and reliability. The combined definition of these three frameworks is labeled “conceptual analysis” and summarizes the intention and process of establishing a collaborative form.

In summary, factors influencing the longevity of MSCs will be identified and examined for potential interconnections. These interconnections form the backbone of clusters which represent the basis for a collaborative form. The process of clustering is described during Section 3.2.3.

Article Selection The conceptual analysis commenced with an analysis of 128 articles, identified through Scopus. Figure 3.2 provides an illustration of the implemented “Searching”, “Screening”, and “Selection” phases of the literature review. The diagram exhibits the systematic approach which has been undertaken to identify and select pertinent articles. During the screening phase, these articles were analyzed to discern the conceptual factors influencing the durability of MSCs. Three articles were duplicates from each other and 11 articles were inaccessible. Therefore, in total, 13 articles were excluded from the reading process. From the remaining 115 articles, 15 articles did not address the topic of MSCs and 58 failed to introduce any novel factors. Consequently, 42 articles were deemed useful, contributing new factors to the research.

Prior to the literature review, a saturation of results was anticipated characterized by the cessation of new findings. However, additional factors persisted to emerge until the conclusion of the review process. Consequently, a supplementary literature review was conducted using the AI tool “Researchrabbit”. The results of this additional literature review are visualized in Appendix D. The input for the AI tool is a selection of the most valuable articles from the primary literature review to discern similar articles. The “most valuable" articles represent articles which mention more than 15 factors. In total, eight articles were utilized as input for Researchrabbit (Galan & Zuñiga-Vicente, 2023; Jansen & Kalas, 2020; Karimova & Lee, 2022; Loban et al., 2021; Pathak et al., 2022; Sanderink & Nasiritousi, 2020; Vayaliparampil et al., 2021; Wood Jr & de Morais, 2022). As a result, the supplementary literature review identified 51 associated papers. Of these papers several articles had already been reviewed as part of the primary literature search conducted via Scopus, while other articles were excluded due to a perceived misalignment with the study’s focus based on the title and abstract of the article. This incongruity was often based on the absence of any reference to MSCs or related terminology. From the 51 articles, six articles have been analyzed to discern additional factors. Four of these articles did not provide any additional value. Therefore, only two articles from the additional literature review offered valuable findings, bringing the total to 44 useful articles.

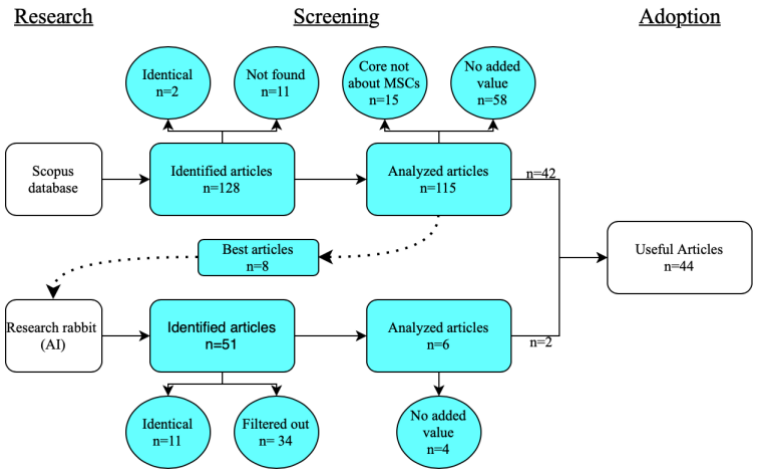


Figure 3.2: Screening of literature

Database To store the identified factors and other results, a database is established (see attached Excel file: tab “Database”). The constructed database tabulates the identified articles in the vertical rows of the Excel sheet. The following headers categorize the horizontal columns:

- Useful: This category assesses whether articles introduced novel factors pertinent to the study. Articles delineating new factors received a "YES" label, while those reiterating factors from prior articles were labeled "NO added value." "Identical source" denotes sources previously cited. Articles not primarily focused on MSCs were labeled "No, core is about...". "Not found" indicates articles inaccessible for retrieval.
- Category: This section summarizes the articles’ subjects with a word or short phrase to provide an organized overview and potentially identify patterns.
- Summary: This column presents a synopsis of each article, facilitating efficient review and aiding in the recall of its content.
- Effects: These columns offer an overview of the impacts that MSCs may exert on stakeholders. An "x" in a row beneath an effect signifies the article addressing this effect.
- Factors: This category enlists the factors that influence the sustainability of MSCs. An "x" in a row below a specific factor means that this factor is mentioned in the corresponding article.

- # of factors per source: The last column sums up the “x”s or mentions of factors per article, providing an overview of the number of factors mentioned per article.

In summary, the Excel sheet serves as a database consolidating all factors identified from both the literature review and the AI search that influence the durability of MSCs. The results of the interviews are not included in this database.

3.1.3 Interviews

Besides the inclusion of literature, data is obtained through three types of interviews. Initially, a series of exploratory interviews have been conducted with professors at Hanze University to obtain a global understanding of the multi-stakeholder environment and the complexity of multi-models (Appendices J1-J3). Thereafter, two meetings were convened to explore suitable methodologies to enhance data comprehensibility and to verify the comprehensiveness of factors. One of these meetings was held with an expert on standardization within organizations (Appendix J4), the other meeting involved an expert on computational text analysis (Appendix J5). The third category involves semi-structured interviews with stakeholders of the MMvIB project. The synopses of these interviews are provided in Appendices J1 through J10.

Exploratory At the beginning of this research, three exploratory interviews were conducted with professors at Hanze University in Groningen. All interviewees are associated with (multi-)modeling. These interviews were semi-structured and conducted in an exploratory manner to obtain a global understanding of multi-modeling. The open-ended nature of semi-structured interviews allows for the emergence of unidentified themes or patterns (Adams, 2015). This approach permits researchers to explore unanticipated areas that may not have been initially considered, contributing to the discovery of novel insights. Exploratory interviews, as a form of qualitative research method, are designed to study a certain topic in-depth while maintaining flexibility to explore diversions. These interviews aim to generate insights, and gather rich and detailed information (Cobbledick, 1996).

Meetings Additionally, two informal semi-structured meetings were convened to elicit targeted insights from experts on two specific domains. The first meeting involved a professor at TU Delft and was centered on the exploration of clustering techniques to simplify the interpretability of the data. The second meeting was conducted with a consultant in knowledge and data at TNO. This meeting was held to discuss several findings of the BOMOS comparison. Both meetings were semi-structured to facilitate in-depth examination of specific topics while affording flexibility to explore tangents and alternative perspectives offered by the experts.

MMvIB At last, several interviews were organized with stakeholders of the MMvIB case study project. These semi-structured interviews had three main objectives. First, the interviews aimed to elucidate the stakeholders' perspectives on the most critical factors influencing the sustainability of MSCs. Second, the stakeholders were presented with the latest iteration of the collaborative model for their evaluation and feedback. At last, the interviewees were asked about their visions or opinions regarding the prospective application and implementation of the MMvIB project.

The consortium comprises 11 stakeholders that can be divided into four distinct categories. TU Delft, Leiden University and Hanze University of Applied Sciences are categorized as educational and research institutions. TNO is a Dutch independent applied research organization and identifies as a research and advisory organization. The energy companies and grid operators are represented by Alliander, Gasunie and Stedin. The last category consists of Kalavasta, Quintel, Quo Mare and DNV and entail consulting and advisory companies.

The presence of multiple stakeholders requires a certain degree of structure to prevent inefficiencies. Therefore, the project is divided into several sections. First, a division is made within the project organization. This division is organized along four distinct Work Packages (WP), each describing a set of related activities along with an accountable stakeholder to ensure satisfactory completion of these activities. This research is part of WP1 which concentrates on social processes within the multi-stakeholder environment (TU Delft, 2021b). These processes focused on creating, engaging, and analyzing social networks that underpin project activities within the broader domain of energy transition. One of the key activities would be the extraction of needs and requirements for the multi-model infrastructure.

Initially, a workshop was considered to extract the opinions of stakeholders, facilitating group interaction and time efficiency. However, semi-structured interviews were preferred for their ability to elicit individual insights more thoroughly and confidentially. Moreover, conducting interviews individually minimized potential bias from group dynamics that could occur in a workshop setting. In total, four interviews were conducted with distinct stakeholders representing diverse backgrounds. Energy companies were not included in the interview process as they were not yet involved in the project. Hence, it is anticipated that their affiliation with the project is uncertain. The interviewed stakeholders comprise Quo Mare, Hanze University, Quintel, and TNO.

3.2 Data Analysis

The analysis of data encompasses two distinct phases. First, the inclusiveness of the conceptual factors obtained from the literature review is assessed by comparing these factors with the factors of a model on standardization (BOMOS model). Thereafter, the process of clustering, designed to enhance the comprehensibility of the results, is delineated. This chapter starts off with an elucidation of the overarching line of reasoning.

3.2.1 Inductive Reasoning

This study entails an inductive reasoning approach to support the exploratory nature of this research. Inductive research involves collecting and analyzing data to identify patterns and derive general principles (Punch, 2013). Researchers build generalizations and theories based on the exploration of specific cases or phenomena. These observations relate to the collection of data through the exploratory approach. During this research the findings of the MMvIB case study and the literature review will be generalized to fit all Multi-Stakeholder Collaborations.

According to Creswell (2009), the inductive approach consists of five stages. First the researcher gathers information from interviews, literature and/or observations. This phase relates to the first sub-question as it identifies the themes and concepts influencing the durability of MSCs. The second phase entails several interviews with the participants. These interviews relate to the adopted case study and incorporate a practical aspect to the knowledge base. The researcher then aims to identify broad patterns from these themes or categories. In other words, the requirements for a durable MSC are assessed to fit the collaborative form. The establishment of these patterns relates to the second sub-question. At last, the researcher generalizes or derives theories from the obtained insights to establish a solution for the real-world problems. This last phase discusses how the collaborative form relates to the case study and refers to the third sub-question. These phases of inductive reasoning are analogous to the methodology implemented during this thesis.

3.2.2 BOMOS

To start the data analysis, the conceptual factors are compared to the factors of the BOMOS model. BOMOS is a model that guides organizations to develop and manage standards (Folmer, 2023). The model is experience-based, serving as a guide for navigating discussions on structural standards management (Appendix J4). This empirical foundation stems from the contribution of numerous respected stakeholders such as Logius, TNO and the University of Twente (Folmer, 2023). Often, the the BOMOS model is adopted to optimize and formalize relationships among heterogeneous stakeholders (Geonovum, n.d.). Given that the envisioned collaborative framework embodies a standardized approach for cultivating and managing these relationships, a comparative analysis between the two models ensues. This comparative analysis elucidates the congruences and disparities between the two frameworks, providing insights into the inclusivity of the collaborative model. To discuss these findings, a meeting has been organized with an employee at TNO who is affiliated with BOMOS. Additionally, the comparison between the BOMOS factors and the conceptual factors has resulted in the identification of several requirements of the collaborative form.

3.2.3 Clustering Methods

This section delineates the methodology which has been employed to organize and scrutinize the data. Following the identification of factors, efforts are directed towards enhancing the comprehensibility of the results. Various articles and a meeting with a professor of the TU Delft (see Appendix J5) suggested the clustering of data. In essence, this entailed categorizing factors based on their meaning and relevance to the durability of MSCs (Varpio et al., 2020). This clustering process corresponds to the composition of the collaborative form and is addressed by the second sub-question of this thesis. The clustering process entails the translation of factors to overarching themes or clusters, providing overarching building blocks of clusters to the collaborative form. During this study, three distinct clustering methods have been constructed and employed to enhance the reliability of the analysis and mitigate ambiguities. A distinction is made between the abductive-, inductive-, and deductive methodologies. It is important to note that the interpretation of these approaches is based on existing theories such as reasoning or theorizing (Okoli, 2023). The application and interpretation of these theories presents an innovative methodological approach to clustering factors. Consequently, the methodology of this thesis contributes a novel framework for clustering factors, enhancing the analytical depth and applicability of existing theories in qualitative research.

Inductive Clustering First, the inductive approach or thematic clustering method has been employed. Inductive methods are exploratory and aim to generate new theories or insights (Azungah, 2018). Inductive reasoning moves from specific observations to general principles (Reid & Knipping, 2010). With inductive research, the categories or clusters emerge from the data without any pre-existing theories or frameworks. Therefore, this method was consulted before the abductive and deductive approaches to mitigate influences from identified theories. The process involves the identification, interpretation, and analysis of patterns between the qualitative meanings of the factors. These patterns are then categorized or clustered according to the overarching themes. In the context of this study, the initial step involves compiling all identified factors. Subsequently, these factors were allocated to an overarching theme. Hereby, the specific observations relate to the factors, which were identified through literature. These observations are then generalized to the clusters. If a factor cannot be allocated to an existing cluster, clusters may be slightly altered, or a new cluster is established. This process has an iterative nature so that clusters can be adjusted to better fit the new configuration of factors.

Abductive Clustering Second, the abductive approach has been implemented. Eastwood et al. (2014) presented a theory on "explanatory theory building" which combined "emergent" (inductive) and "confirmatory" (deductive) approaches to establish an abductive strategy. Therefore, this approach involves a combination of deductive and inductive reasoning and aims to provide the most plausible explanation for the observed facts (Okoli, 2023). Peirce et al. (2017) originally described abductive reasoning as a mechanism for explaining a very curious circumstance which would be explained by the supposition that it was a case of a certain general rule. Reid and Knipping (2010), described the process of abductive reasoning as the opposite of deductive reasoning. Abductive reasoning aims to establish the most plausible hypothesis, even if uncertainties are present. The researcher consults its prior knowledge and creativity to make educated guesses and establishes categories or clusters that make the most sense of the data.

During the abductive clustering method implemented in this study, the researcher commences with the set of factors and aims to incrementally cluster the factors towards the most reasonable composition. This incremental process stimulates the researcher to be more concise than the inductive approach and provides insight into the rationale behind the categorization. Unlike the inductive approach, the abductive method provides a more systematic explanation of the process, as Peirce et al. (2017) suggested. Rokach and Maimon (2005) define this method as bottom-up clustering or agglomerative hierarchical clustering. This means that initially all data points form their own cluster. These clusters are then successively merged based on overarching themes. The process continues until all data points are allocated to the clusters and the desired cluster structure is obtained. The process can be displayed using a dendrogram, envisioning the steps or levels resulting in the final clusters.

Deductive Clustering At last, the deductive approach. Here, the researcher starts with a pre-existing theory or framework and utilizes these findings to categorize or cluster the factors (Azungah, 2018). This approach is more structured than the preceding approaches as the initial phase is derived from existing data. Deductive methods are typically used when research aims to test a specific hypothesis or theory. Deductive reasoning aims to arrive at a conclusion with certainty. Toulmin (2003) suggests that the input of a deductive approach is different to the input of the inductive and abductive approaches.

The interpretation of this rule has translated to an additional data gathering process. During this study the deductive approach tests several theories from identified frameworks. These frameworks entail an overview of clusters which influence the longevity of MSCs. The established frameworks are extracted from several articles identified during the literature review which exhibited an agglomeration of clusters suggesting the formation of a framework. The frameworks were then listed and assessed. In total six frameworks have been identified as useful frameworks. A useful framework should include several clusters of factors stimulating the durability aspect of MSCs. Furthermore, the clusters should not be too specific nor too broad. All clusters which were mentioned within these successful frameworks were listed and potentially merged if they had a similar meaning. As a result, an overview of distinct clusters was established. Additionally, this list of identified clusters was compared to the ascertained factors from the conceptual analysis. If certain factors did not fit under the identified clusters, new clusters were classified. This process is described as top-down clustering by Rokach and Maimon (2005). This means that the approach commences with an understanding of the entire system before delving into the details.

Comparison The outcomes of these clustering methodologies generate three distinct sets of organized clusters, each encapsulating the major themes or concepts inherent in the dataset. The clusters derived from the inductive, abductive, and deductive approaches are juxtaposed during a

comparative analysis (see Section 4.4.1) to discern their respective strengths and weaknesses. By combining these strengths, a unified composition of clusters is culminated. The configuration and content of this design represents the collaborative form, establishing an overview of the clusters and their constituent factors.

Design Science This study adopts design science as a research approach to construct the collaborative form. Design science is intended to develop and evaluate solutions to complex problems which are of general interest (Johannesson & Perjons, 2014). In this case a knowledge base is generated to guide stakeholders in stimulating the durability of their MSC. Design science is defined as: "a method that establishes and operationalizes research when the desired goal is an artifact or a recommendation" (Dresch et al., 2015, p. 67). The classical perception of an artifact or design, as imposed by Johannesson and Perjons (2014), is loosely interpreted during this research. Other authors also incorporate this broader perception of artifacts that are constructed by design science research. Identified outputs include constructs, models, methods, instantiations, or other means to an end (Hevner & Chatterjee, 2010; Holmström et al., 2009; March & Smith, 1995; Venable, 2006). In this research, a definition of design science is adopted that emphasizes the process of exploration through design. Design science is defined as research that seeks (i) to explore a solution to solve a specific problem, (ii) to explain this explorative process, and (iii) to establish a design, in the broad sense of the word, to solve a complex problem (Holmström et al., 2009).

3.3 Implementation of Results

The objective of this thesis is twofold. The main objective of this research is to develop an approach for MSCs designed to stimulate durable collaboration among the stakeholders within this MSC. The second objective entails the application of this approach to the MMvIB case study. As visualized in Figure 3.1, three outputs are required to formulate the collaborative guide and provide recommendations for the MMvIB project. This section discusses the amalgamation and implementation of these findings.

Collaborative Form To answer the main objective of this thesis, a collaborative form will be constructed as explained during Section 3.2.3. This form provides an overview of all the identified clusters and their constituent factors. Consequently, the output will synthesize the research findings, establishing a clear overview for MSCs about the factors which influence the durability of the collaborative. The content and design of the collaborative form will partially be influenced by several requirements. These requirements are based upon findings from the literature review and are discussed in Section 4.3. The collaborative form itself is provided in Section 4.4.

Collaborative Guide The collaborative form lacks a systematic strategy for enhancing durability within MSCs. To address this deficiency, two supplementary results are introduced. First, a temporal sequence of clusters and factors is established to highlight the relevance of factors at different developmental stages of an MSC. Second, clusters are differentiated based on the potential impact the constituent factors have on improving the durability of MSCs. Collectively, these three components comprise the foundational framework for identifying relevant factors to bolster MSC durability. This artifact, termed the "collaborative guide", underscores the presence of an approach to stimulate collaboration. This guide cis operationalized through a four-step process called the COOP approach (see Section 5.1).

Temporal Sequence The chronological arrangement of factors and clusters provides structure to the process of determining how to stimulate durability within MSCs. By identifying factors which are relevant to the specific MSC's developmental stage, attention can be focused on the most relevant factors. This sequencing is guided by logical reasoning and enables the identification of factors typically significant at specific stages of MSC development. Moreover, this approach aids in assessing the maturity level of the MSC. The first cluster containing a significant number of underdeveloped factors indicates the current phase of the MSC. To enhance the MSC's durability, stakeholders must address and improve these underdeveloped factors. The outcomes of this analysis are detailed in Section 4.5.2.

Relative Significance The hierarchical arrangement of clusters introduces a degree of relative importance within the collaborative form. Including this aspect to the collaborative form incorporates structure to the process of determining an efficient strategy on how to stimulate durability within MSCs. The gradation within clusters may indicate which factors will generally have a greater impact on the sustainability of MSCs. The ranking is determined through interviews with stakeholders from the MMvIB project, a quantification of factor mentions per cluster during the literature review, and an analysis of an article on factors impeding the efficacy of place-based MSCs (Ayala-Orozco et al., 2018). The results of this analysis are provided in Section 4.5.1.

Case Study Application At last, the collaborative guide is applied to provide recommendations on what factors need to be improved in order to enhance the durability of collaboration among the stakeholders of the MMvIB project. This application of the collaborative guide addresses the third research question and functions as an example for other MSCs, illustrating the utilization of the approach and the anticipated outcomes. During this phase of the research the COOP approach has been devised as a four-step procedure to utilize the collaborative guide.

4. Results 1: Research Findings

This chapter presents the individual research findings which are intended to apply to all MSCs. First, the identified factors are addressed. Second, the results of the comparison between these factors and the factors of the BOMOS model are provided. Subsequently, the key requirements for the clustering process are delineated. Thereafter, the three clustering methodologies are discussed, and one uniform composition of the collaborative form is established. At last, the relative importance of clusters and the typical temporal sequence of factors and clusters are determined. Combined, these results constitute the collaborative guide and answer the second sub-question. Chapter 5 combines these results to establish an approach to structurally identify relevant factors to improve the durability of MSCs. This approach is applied to the MMvIB case study to answer the third sub-question and to provide an example for other MSCs.

4.1 Factors

This section delineates the themes and concepts influencing the sustainability of MSCs. A total of 69 factors are identified from the literature review and the additional search using artificial intelligence. Although the interviews did not yield novel factors, they did offer valuable insights for the second part of the results: the case study application. All conceptual factors, along with their respective meanings, are listed in Appendix E. The definitions are derived directly from the sources in which they originated to mitigate potential biases stemming from personal interpretation. Establishing these meanings is crucial for subsequent clustering phases. Additionally, this section addresses the first sub-question:

SQ.1: What are the themes and concepts influencing the durability of multi-stakeholder collaborations?

Database An overview of all identified factors and their respective articles is established in the attached Excel sheet. The literature review, amounting to 128 articles, resulted in the identification of 64 factors. The remaining five factors are derived through an additional literature review using an artificial intelligence tool called researchrabbit. Appendix D provides a visualization of the identified factors through researchrabbit. The Excel sheet “Database” exhibits that six of these articles were adopted, leading to the identification of five additional factors. Examining Figure 4.1 indicates notable variations in the frequency of factor mentions, implying varying degrees of significance, relevance, or influence within the studied context (Alhassan et al., 2016). Remarkably, factors identified earlier in the research process tend to be more frequently mentioned, suggesting a potential correlation that warrants discussion in the concluding remarks.

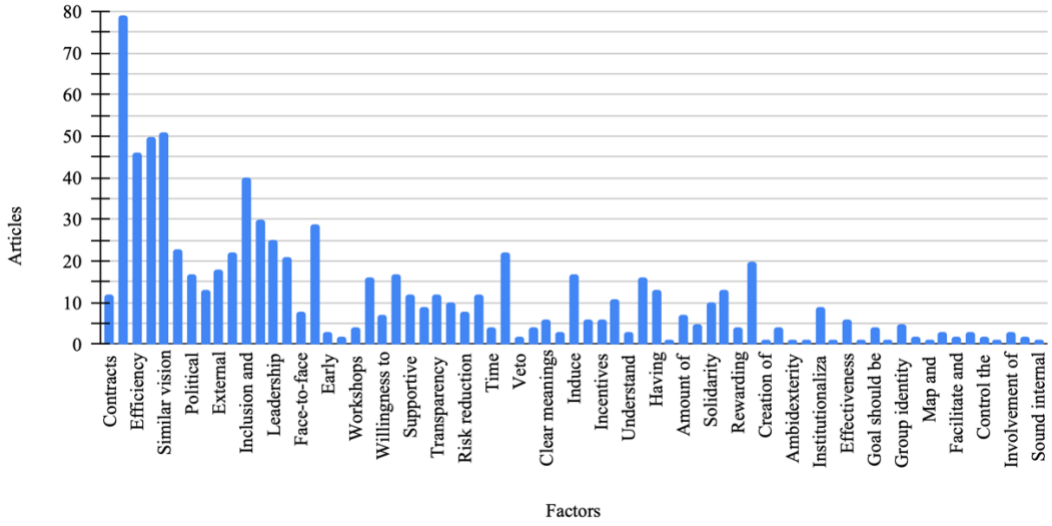


Figure 4.1: Overview of mentions per factor

Frequency Analysis To address the first sub-question, the four most prevalent factors of the literature reviews are examined in greater depth. Figure 4.1 juxtaposes the factors against the number of articles in which these factors are mentioned. The factors are presented in the same sequence as they were identified during the literature review. The four most prevalent factors are listed in descending order:

- Resources (79 Mentions): This factor describes the collective accessibility of fundamental assets for an MSC. This encompasses diverse inputs, such as tacit and explicit knowledge, physical and financial resources, and human capital. It is important that the resources are complementary, establishing additional value for the collaboration. The durability of MSCs is enhanced by the availability of these complementary resources, which creates a competitive advantage and an incentive to collaborate within the MSC (Eweje et al., 2021).
- Similar vision (51 Mentions): A congruent vision is critical for MSC durability as divergent visions, goals, or interests pose significant challenges (Ayala-Orozco et al., 2018). For example, divergent visions complicate communication and decision-making processes. As a result, the MSC becomes less efficient and transaction costs increase. Ensuring alignment in vision and mission is essential to create unity between the stakeholders of an MSC (Vayaliparampil et al., 2021). Unity enhances the cooperative capacity within an MSC, leading to a more durable collaboration.
- Clear communication (50 Mentions): Clear communication involves mutual understanding during collaborative processes. Stakeholders should be able to communicate freely and without complications (Kuenkel & Aitken, 2015). Addressing the impact of language barriers, jargon and contextual nuances is crucial for effective communication within an MSC (Toso et al., 2023). Clear communication is often associated with the organization of meetings to articulate feelings or updates about projects and to make collaborative decisions. The factor stimulates the overall collaboration within the MSC and enhances the cooperative capacity (Ayala-Orozco et al., 2018).
- Efficiency (46 Mentions): Efficiency underscores the notion that an MSC seeks complementary collaboration, recognizing that diversity in perspectives and capabilities can enhance overall team performance and outcomes (Clegg, 1996). This characteristic enables the MSC to pursue objectives more efficiently. Stakeholders collaborate to surpass individual capacities. Being more efficient than competitors creates a competitive advantage and can stimulate stakeholders to join the collaborative.

4.2 BOMOS Comparison

After having established the relevant themes and concepts influencing the durability of MSCs, the subsequent task is to validate their inclusivity. This section aims to juxtapose the 69 identified factors with the 21 factors delineated within the BOMOS model. The comprehensiveness of the conceptual factors from this study is analyzed along the factors of the BOMOS model (Folmer, 2023).

Results The results of this comparison revealed that 31 out of the 69 factors did not directly align with the factors of the BOMOS framework. These non-aligned factors are highlighted in bold in the provided Excel file under the "BOMOS comparison" tab. Subsequently, an interview was conducted with an employee of TNO. The interviewee, being an expert on the BOMOS model was asked to address these misalignments (see Appendix J4). The interviewee clarified that "BOMOS is experience-based, serving as a guide for discussions on structural standards management. Differences may arise due to the specificity of each domain, but BOMOS offers a comprehensive foundation. It is possible to come up with additional sub-categories, but that wouldn't be the foundation you need to fall back on". It transpired that the meaning of several factors from the BOMOS model are purposefully ambiguous to fit the broad interpretation of standards. Consequently, a broad interpretation is warranted for many factors delineated within the BOMOS framework. After these new interpretations were incorporated, all factors could be categorized under the factors of the BOMOS model.

Discussion It appears that the conceptual factors examined in this research operate at a higher level of granularity, necessitating a more intricate categorization process. This heightened level of detail requires a deeper understanding of the nuances inherent in each factor, posing challenges for straightforward classification. For example, the factor “Resources” identified in this study could only be categorized under the BOMOS factor “finance”. Finance is defined by BOMOS as having a long-term financial model that ensures returns in accordance with the need (Folmer, 2023). However, the meaning of resources extends beyond the availability of finance. The factor called resources, encompass a wide array of inputs to an MSC, including tacit knowledge, explicit knowledge, physical resources, financial resources, human capital, and others (Sanderink & Nasiritousi, 2020).

During the interview, it was argued that the subdivision of categories is unnecessary as “that would not be the foundation you need to fall back on”. This study holds a different perspective as it is argued that the subdivision of categories mitigates ambiguities, providing more structure for the user. Moreover, a subdivision of categories provides a backbone for the researcher to structure and label the categories to establish a comprehensive overview of the factors. An example of such an ambiguous meaning of a BOMOS factor is “Community”. The provided definition refers to the management and support of forums and stakeholders (Folmer, 2023). This definition originally fitted with 11 conceptual factors from this research. However, during the interview, a broader meaning of community was established to encompass the relationships and characteristics of stakeholders. Due to this broader interpretation, another 12 factors could be linked to the BOMOS factors. A subdivision of this category could have established a broader meaning of this category incorporating multiple constituent factors and forming a more comprehensive terminology.

Contradictory to the previous statement, another shortcoming of the BOMOS model pertains to the specificity of the factors. An example is the use of the terminology “Helpdesk” as a factor. This factor is defined as the “provision of support to various user groups, for instance, via telephone or email in accordance with a service level agreement (e.g., responding to inquiries within 24 hours)” (Folmer, 2023). The definition of helpdesk implies a broader interpretation than the word helpdesk. While it is argued that the BOMOS model offers a comprehensive foundation, this specific

terminology does not relate to all potential stakeholders. For instance, not all stakeholders necessitate assistance from a helpdesk. Instead, the terminology "Support" could have been utilized to better encapsulate the broader spectrum of assistance mechanisms required by various stakeholders, thus enhancing the model's applicability and comprehensiveness.

A potential reason for the mentioned limitations of the BOMOS model is the sole empirical origin of the data. The collaborative form discussed in this research is grounded in theoretical findings from a literature review in combination with a practical validation from the BOMOS model and relevant stakeholders of the MMvIB project. This perspective establishes a more nuanced and comprehensive understanding of the factors influencing the durability of MSCs, addressing the limitations associated with relying solely on empirical data. The BOMOS model is developed by several experts which might be biased about the application of the model.

Conclusion The principal outcome of this comparison underscores that all 21 factors of the BOMOS framework are embedded within the 69 conceptual factors. This implies the inclusiveness of the conceptual factors when compared to the BOMOS model. Furthermore, it is argued that the factors established during this study are more detailed while obtaining a more general application. Notably, the greater number of factors in the collaborative form suggest a potentially more specific or comprehensive model. Moreover, the collaborative form, which is underpinned by theoretical foundations, supplements the empirical foundation of BOMOS. At last, it is argued that a sub-division of the BOMOS factors could have enhanced the comprehensiveness and usability of the model. The collaborative form developed in this research integrates these insights by incorporating them as specific requirements.

4.3 Requirements of the Clustering Process

To structure the collaborative form, several key requirements need to be set. These requirements are identified during the comparison with the BOMOS model and during the literature review. During the literature review, 17 articles exhibited agglomerations of clusters influencing the durability of MSCs (see Excel sheet “Frameworks from literature”). These clusters are at a higher aggregation level than the factors and are used as input for the deductive approach. These clusters exhibit the same aggregation level intended for the clustering of factors during this research. By analyzing the strengths and weaknesses of these collections of frameworks, valuable lessons can be learned for the establishment of the collaborative form.

Of the 17 clusters, 11 clusters were irrelevant due to their scope being either too specific or too broad (see Excel sheet “Frameworks from literature”). The remaining six articles imposed satisfactory representations of clusters. During this process of identifying frameworks of clusters, three findings have been derived. These findings relate to the requirements of the clustering approach and are listed below:

1. Clusters should be balanced between specificity and generality. A clear demarcation of clusters enhances the clarity of the framework and mitigates ambiguities (Beisheim & Simon, 2016). If clusters are too specific, they cannot effectively encapsulate a group of factors, resulting in many slightly distinct clusters (Ayala-Orozco et al., 2018; Halliday et al., 2004). Conversely, an overlap of research areas across clusters due to overly broad clusters may encompass numerous distinct factors, inducing ambiguity in the clusters (Permatasari et al., 2021).

2. When clustering factors, it is beneficial to incorporate various subcategories or hierarchical levels into the clustering process (Loban et al., 2021). These subcategories should become less and less detailed when moving from factors to clusters. This allows for a more granular and structured representation. The hierarchical structuring enhances the interpretability of the clusters and provides an incremental step-by-step process of clustering.
3. The clusters should not be linked to a specific case. MSCs can operate in various business areas. Obtaining a generic perspective enhances the applicability of the framework (Costello & Zumla, 2000).

4.4 Collaborative Form

To establish the collaborative form, the factors influencing the durability of MSCs had to be made more comprehensible. During this section, the results of the three distinct clustering techniques are elucidated. These results are compared with each other to validate the consistency and determine a uniform composition of the collaborative form.

4.4.1 Comparative Analysis

This section conducts a comparative analysis of the three clustering methodologies. First, the results of each technique are succinctly discussed. More elaborate explanations of these approaches are provided in Appendices F,G, and H. Subsequently, the resulting clusters are compared to each other. The objective of this comparative analysis is twofold. The first objective is to compare the resultant clusters of each method with each other to identify potential shortcomings. This examination determines whether variations in data or methodology have contributed to inconsistencies in the results. The second objective aims to establish a uniform composition of clusters, involving the identification of distinct clusters while eliminating overlapping clusters. The end result is a comprehensive compilation of all distinct clusters: the collaborative form.

Inductive The inductive clusters are extracted from the data without any pre-existing theories or frameworks. The process involves the identification, interpretation, and analysis of patterns between the qualitative meanings of the factors. These patterns have been categorized or clustered according to the overarching themes. In relation to this study, all identified factors were juxtaposed and systematically linked to broader categories one by one. Through an iterative process, the overarching categories were incrementally adjusted to reflect the overarching meaning of the constituent factors. Throughout this process, eight distinct clusters have been extracted from the 69 conceptual factors identified during the literature review.

Abductive During the abductive clustering method, the same set of 69 conceptual factors is utilized as input data. However, these factors are clustered with the help of an incremental process involving multiple steps. This process encourages the researcher to be more precise than during the inductive approach and offers insights into the thought process, guiding the categorization. The resulting clustering steps are described as bottom-up clustering or agglomerative hierarchical clustering. The process can be visualized by means of a dendrogram, envisioning the steps or levels of clustering. As a result, four levels of clusters are derived with varying levels of granularity. The fourth level encompasses five distinct clusters.

Deductive The deductive approach differs from the inductive- and abductive approaches by initiating from a pre-existing theory or framework (Toulmin, 2003). This pre-existing theory must describe collections of clusters which are at a similar aggregation level as the clusters which are intended to be obtained through the clustering process. These clusters are the same as the ones described in Section 4.3, describing the key requirements of the clustering process. The agglomerations of clusters are listed in the Excel file “Frameworks from literature” and have been evaluated. In total, six collections of clusters were incorporated in the study, providing 39 individual clusters (see Excel sheet “Deductive clustering approach”). These clusters have been categorized under overarching categories to unravel distinct clusters. Ten distinct clusters emerged during this process. Additionally, these clusters haven been compared to the 69 conceptual factors. A total of 13 conceptual factors could not be categorized under one of the deductive clusters. These factors were clustered using the inductive approach, resulting in four additional clusters. Consequently, the deductive approach yielded a total of 14 clusters.

Comparison Combined, the three methodologies amount to a total of 27 clusters. However, given their identical data sources, it is hypothesized that these clusters exhibit significant similarities. Therefore, this section conducts a comparative analysis between these clusters. During the comparative analysis, the inductive- and deductive- clusters are categorized under the clusters of the abductive approach. This setup facilitates a method to detect inconsistencies in the clustering processes while obtaining the minimum number of clusters to encompass all factors.

Table 4.1 provides a visual overview of the alignment between the inductive- and deductive clusters within the scope of the abductive clusters. The abductive clusters are underlined to signify their status as overarching categories. Presented in columns beneath these abductive clusters, the inductive and deductive clusters share analogous meanings with the overarching abductive clusters. The comparison of the three distinct clustering methodologies is indicated by the different colors. The clusters in Italics denote the four additional clusters obtained through the comparison between the deductive clusters and the 69 conceptual factors (see Appendix H). These additional clusters were initially not identified by the deductive approach. To briefly elucidate the figure below, the abductive cluster "Cooperative capacity" is represented by the inductive cluster "Organizational culture" and by the deductive clusters "Collaborative capacity," "Cultural and behavioral," and "Communication."

Discussion The table below offers several valuable insights. First, it is notable that the inductive clusters encompass all the content of the abductive clusters. This observation suggests that the difference in methodologies did not induce any significant differences other than minor variations in terminology and the number of identified clusters. Remarkably, the deductive approach exhibits several interesting differences. The first noteworthy discrepancy is the number of clusters. The deductive approach has yielded more than twice the number of abductive clusters. This variance likely arises from differences in methodologies, as the deductive approach did not entail as many clustering phases as the abductive approach (see Excel sheets 8 & 10). The second remarkable conclusion is that without the inclusion of the four additional clusters, obtained through the comparison of the deductive clusters with the 69 factors, the “incentive” cluster would not have been identified by the deductive approach. This can be concluded from the figure below as the deductive clusters under the incentives cluster are both in italics. In other words, both clusters are obtained through the additional comparison between the deductive clusters and the conceptual factors. This observation indicates a significant disparity in input data since the methodology did not vary significantly from that of the inductive approach.

Table 4.1: Comparative analysis of the clustering techniques

<table>
<tr><th>Abductive</th><th>Cooperative capacity</th><th>Incentives</th><th>Management</th><th>Institutional</th><th>Conditions</th></tr>
<tr><td rowspan="2">Inductive</td><td rowspan="2">Organizational culture</td><td>Additional value</td><td rowspan="2">Management</td><td>Legal</td><td>External</td></tr>
<tr><td>Objective</td><td>Power distribution</td><td>Preconditions</td></tr>
<tr><td rowspan="4">Deductive</td><td>Collaborative capacity</td><td>Incentive</td><td>Management</td><td>Leadership</td><td>Resources</td></tr>
<tr><td>Cultural and behavioral</td><td rowspan="3">Goal</td><td rowspan="3">Evaluate, monitor and improve</td><td>Institutional design</td><td>Starting conditions</td></tr>
<tr><td rowspan="2">Communication</td><td rowspan="2">Clarity</td><td>External environment</td></tr>
<tr><td>Fairness</td></tr>
</table>

Conclusion The results derived from the abductive approach reflect a systematic and comprehensive method. Serving as a robust benchmark, this approach substantiates its effectiveness by encapsulating the clustering outcomes from both the inductive- and deductive approaches, thus validating its exhaustive character. Additionally, the abductive clustering approach excels in the establishment of structure. This structure is established through a funnel of incremental clustering steps. A funnel is typical to agglomerative hierarchical clustering and has resulted in the establishment of a dendrogram (see Figure 4.2). This dendrogram, depicting the abductive approach, exhibits the most detailed representation of the clustering process. Furthermore, the incremental characteristic complies with the second requirement of the clustering approach of establishing subcategories to incorporate structure within the collaborative form. Consequently, the abductive approach embodies the content and layout of the collaborative form.

4.4.2 Abductive Approach - the Collaborative Form

This section aims to elucidate the composition of the collaborative form. The preceding section has argued that the collaborative form is best represented by the abductive approach. Therefore, this section will describe the results of the abductive clustering approach. The inductive- and deductive approaches are presented in Appendices F and H, respectively. As the collaborative guide comprises three components, with the collaborative form being one of them, this section seeks to address a segment of the second sub-question:

SQ.2: How can the requirements for a durable Multi-Stakeholder Collaboration be composed into a collaborative guide?

Requirements Two types of requirements are relevant to the composition of the collaborative form. First, the four requirements discussed in Section 4.3 must be incorporated. The clusters should, therefore, not be too specific nor too general, clearly demarcated, consist of subcategories, and not linked to a specific case. Moreover, the collaborative form should encompass all the identified conceptual factors.

Description The abductive approach employs an agglomerative hierarchical clustering process consisting of four hierarchical levels that form a funnel of incremental clustering steps (Rokach & Maimon, 2005). These levels serve as distinct stages within the framework, each contributing to the refinement and consolidation of conceptual factors. Level one encompasses all 69 conceptual factors. Level two comprises 22 sub-clusters, offering a less detailed but more consolidated perspective. Progressing, level three features ten sub-clusters, each characterized by a reduction in granularity in comparison to the preceding levels. Ultimately, level four encapsulates the final five clusters. The fourth and final level cannot be logically clustered further. A visual representation of the abductive approach is presented below (see Figure 4.2). The figure depicts the structured iterative process. From left to right the levels exhibit an escalating degree of granularity, delineating the clusters that impact the durability of MSCs and enumerating the factors contributing to this durability. This left-to-right progression visualizes the composition of clusters and their constituent factors more clearly. However, the identification of the clusters was from right to left. The intensity of the blue color indicates the relative importance of the clusters; darker blue corresponds to a higher hierarchy of significance. Section 4.5.1 elaborates on this division of clusters according to their significance. Figure 4.2, also referred to as the collaborative form, represents the most optimal and structured approach among the identified clustering methodologies.

Clusters A further explanation of the abductive clustering process is provided in Appendix G. This appendix elaborates upon the composition of the level four clusters. These clusters are elucidated per paragraph which function as a narrative to figure 4.2 and as rationale for assigning the factors to specific clusters. This paragraph concisely elucidates these identified clusters:

1. Cooperative capacity: The collective ability to effectively collaborate towards mutually defined objectives by fostering collaboration, unity, and engagement among stakeholders.
2. Incentives: Factors that motivate stakeholders' participation in MSCs, including tangible and intangible rewards or benefits, as well as the overarching project objectives.
3. Management: Overseeing and coordinating MSCs through organizational management (managing risks and organizing decision-making processes) and performance management (monitoring, evaluating, and improving the CoP).
4. Conditions: The fundamental prerequisites for the success and enduring vitality of MSCs encompassing external conditions (political stability and resource availability) and the composition of the MSC (number and heterogeneity of stakeholders).
5. Institutional: Establishes clarity through agreements and power distribution while enhancing the durability of MSCs by formalizing decisions and facilitating leadership to adhere to the established principles and plans.

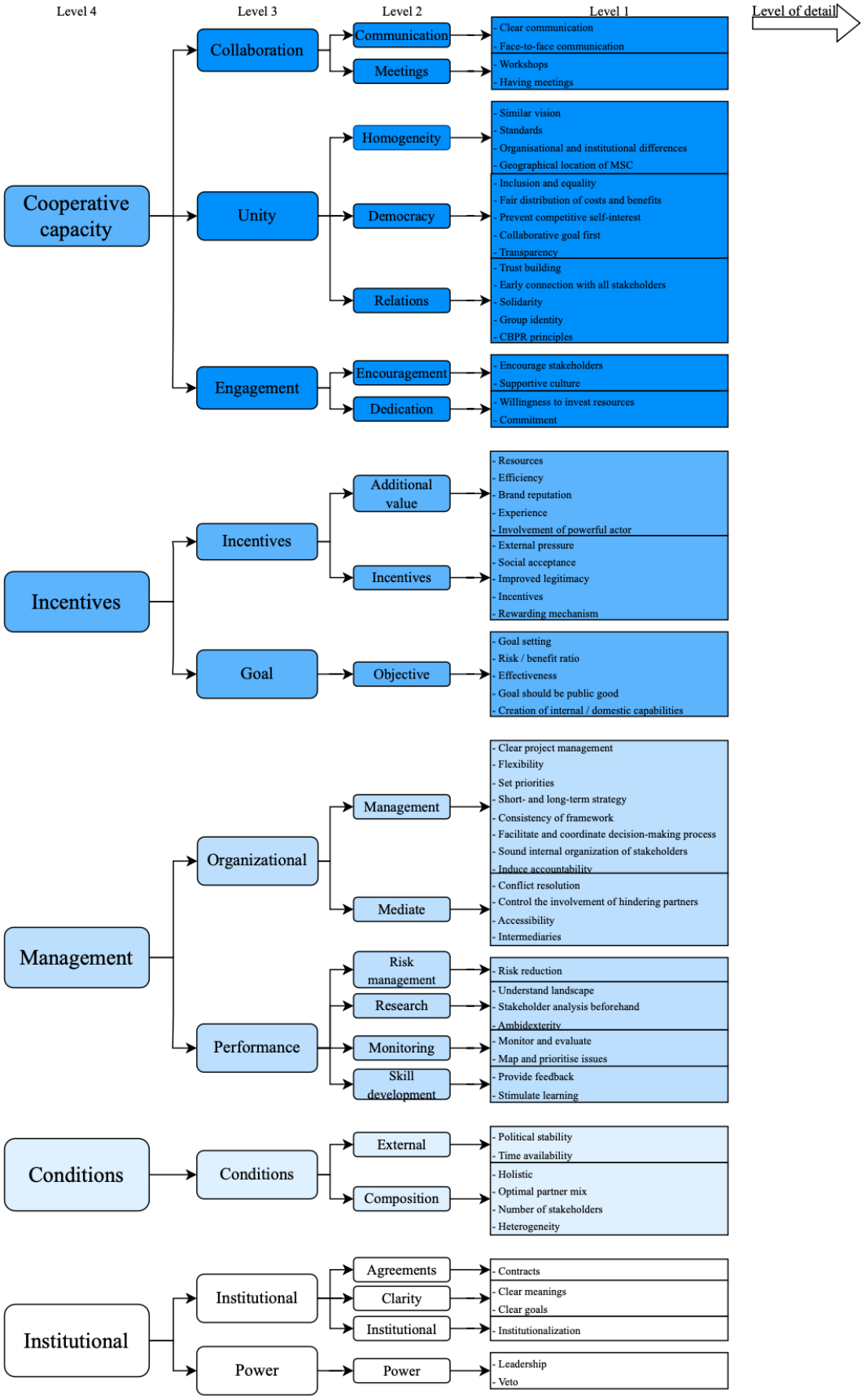


Figure 4.2: Collaborative form

4.5 Supplementary Results

This section presents the relative significance of clusters and the chronological sequence of both the clusters and their constituting factors. The relative significance indicates which clusters are usually deemed to be more important in establishing durable MSCs. These results are based upon interviews with stakeholders of the MMvIB project, a quantitative analysis of the literature review, and an additional article on impeding clusters. The temporal sequence of clusters and factors is based on reasoning and can assist in determining relevant clusters and factors to be improved during a specific phase of maturity of the MSC. The forthcoming discussion will encompass results which are distinct from the direct outcomes of the data analysis. These supplementary results entail the second and third components of the collaborative guide, addressing the second sub-question:

SQ.2: How can the requirements for a durable Multi-Stakeholder Collaboration be composed into a collaborative guide?

4.5.1 Relative Significance of Clusters

This section integrates theoretical and empirical insights to establish a ranking of importance among the clusters in relation to their influence on the durability of MSCs. This ranking serves as a component of the collaborative guide, indicating which factors typically have a greater chance to stimulate the durability of MSCs. It should be noted that the influence of factors is dependent on the content and characteristics of the MSC. The prioritization outlined in this section can only be used as general guidance, as individual circumstances may alter the relative importance of the clusters. The theoretical findings stem from two distinct analyses. The first order is based on the quantity of factor mentions per cluster during the literature review. The second theoretical sequence of clusters is derived from the article by Ayala-Orozco et al. (2018). The empirical findings are derived from the perceptions of the stakeholders engaged in the MMvIB project through several semi-structured interviews. The synthesis of these three perspectives has resulted in the following prioritization of clusters:

1. Cooperative capacity
2. Incentives
3. Management
4. Conditions
5. Institutional

Literature Review To commence, a hierarchical distinction is formulated based upon the percentage of mentions per cluster. This method is derived from the database containing all 69 factors. For this process, the factors were aggregated per cluster, enabling a quantification of each cluster's representation in the literature. The summation of these factors is provided in the Excel sheet labeled "Prioritization of clusters". The outcome establishes the cumulative mentions associated with each cluster and is provided as a doughnut chart (see Figure 4.3). The underlying assumption is that the prominence of the clusters identified during the literature review correlates with its perceived significance. According to this analysis, the classification in descending order is as follows: Cooperative capacity, Incentives, Management, Conditions, and Institutional. According to this analysis, improving the cooperative capacity of an MSC has the highest impact on enhancing the durability of this MSC.

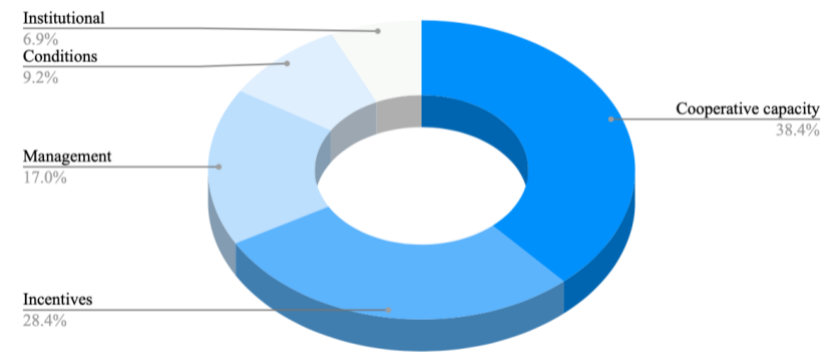


Figure 4.3: Doughnut chart illustrating the percentage of mentions per cluster

Article An additional analysis to determine the theoretical hierarchy is derived from a study conducted by Ayala-Orozco et al. (2018). Incorporating this second analysis provides a more nuanced perspective to the theoretical prioritization. The article identifies five challenges that hinder MSCs from overall strengthening. These categories are further disaggregated into eight distinct sub-categories, each representing a potential challenge for MSCs (see Table 4.2). The percentages pertaining to these sub-categories elucidate the allocated influence of these challenges in hindering MSCs. An underlying assumption posits that an enhanced hindrance correlates to a greater importance attributed to that specific category. Explanations of the categories and the linkage to the corresponding cluster is established in Appendix I.

The total percentages per cluster represent the relative importance delineated by Ayala-Orozco et al. (2018). An overview of the results is presented in the table below. It can be concluded that the cooperative capacity imposes the biggest hindrance in strengthening an MSC as almost 47% of the challenges hindering MSCs derive from this cluster. Therefore, it is argued that this cluster holds the highest potential to improve the durability of MSCs. The hierarchy of clusters in descending order of influence is as follows: Cooperative capacity, Management, Incentives, Conditions, Institutional. In relation to the ranking based upon the quantification of mentions per cluster, the clusters “Incentives” and “Management” have swapped positions.

Table 4.2: Significance of clusters based on impediments for MSCs

Category	**Percentage**	**Corresponding cluster**	**Total percentage**
Divergent visions	16.3%	Cooperative capacity	46.5%
Tensions within and between sectors	16.3%		
Problems of communication and lack of information	13.9%		
Different timeframes and lack of project continuity	15.8%	Management	29.7%
Limited participation and inadequate organization among stakeholders	13.9%		
Insufficient funding and personnel	10.5%	Incentives	10.5%
Structural conditions	8.6%	Conditions	8.6%
Inadequate institutional organization	6.2%	Institutional	6.2%

Empirical At last, the practical findings are discussed. These results stem from interviews conducted with four of the stakeholders involved in the MMvIB project. The summaries of these interviews are provided in Appendices J1 through J10. During these interviews, stakeholders were asked to discern an order of significance among the established clusters. This order determines which clusters are most effective in influencing the durability of MSCs. The stakeholders were specifically asked to align the importance of clusters in relation to the MMvIB project, ensuring that the sequence of clusters mirrored the potential influence of clusters on the durability of the MSC of the MMvIB project.

Figure 4.4 provides an overview of the hierarchies articulated per respondent. This chart exhibits the relative importance of the identified clusters according to the stakeholders. What should be noted is that TNO concluded that the organization of clusters posed a challenge due to the presence of conditional requirements in each cluster. Therefore, this stakeholder decided to score three clusters with three points.

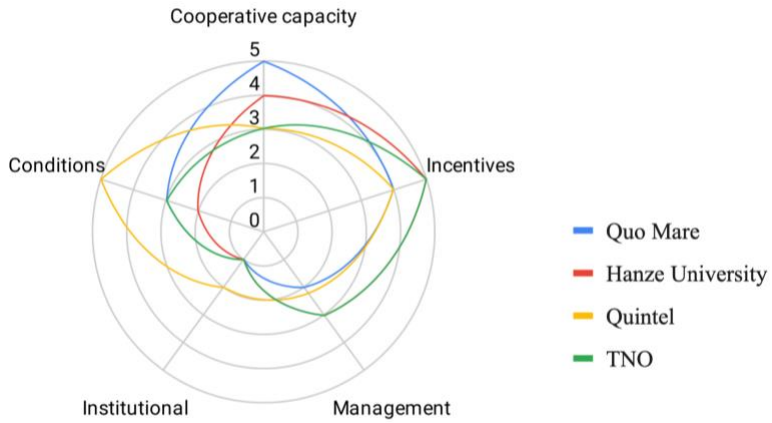


Figure 4.4: Radar chart depicting the relative significance of clusters according to individual stakeholders

The radar chart provided in Figure 4.5 serves as a cumulative synthesis of the responses of the four interviewees. This synthesis is established by adding all the individual scores from Figure 4.4. Consequently, this figure provides a visual compendium to discern the overall classification of clusters according to the interviewed stakeholders of the MMvIB project. The established order in clusters according to the four stakeholders in descending order is structured as follows: Incentives, Cooperative capacity, Conditions, Management, and Institutional.

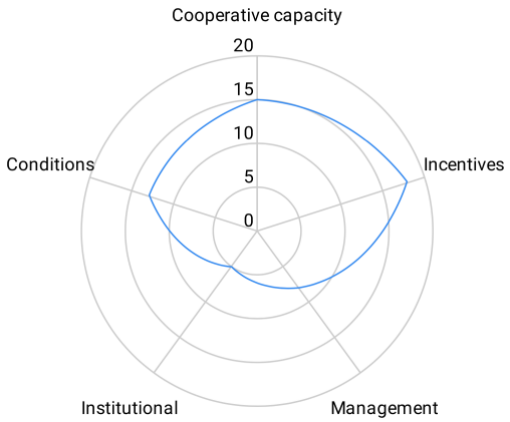


Figure 4.5: Radar chart depicting the cumulative relative significance of clusters according to the stakeholders

Discussion There are several explanations for the observed differences. First, the interviews are focused on the MMvIB project and might, therefore, contain project-specific biases or individual experiences. Second, the assumption that more mentions correspond to a higher significance might be flawed. However, combining insights from these three methods can offer a more nuanced and comprehensive understanding of the prioritization of clusters influencing MSCs.

Conclusion Overall, the three classifications established above display remarkable similarities. A uniform order is established by adding all the ordinal rankings of the clusters. The cluster with the lowest aggregated ranking is perceived as the most important cluster. This ranking can be obtained from Table 4.3. The collective examination of the cluster's hierarchies through interviews, mentions, and percentage-based challenges reveals consistent acknowledgment of the significance of Cooperative capacity. Another cluster that consistently occupies high positions is Incentives. Thereafter, subtle changes emerge in the order of Management and Conditions. Overall, the Management cluster exhibits a greater significance. Notably, the Institutional cluster is unanimously ranked as least important. This underscores its comparatively diminished importance in influencing the durability of MSCs.

Table 4.3: Aggregated ordinal ranking of the cluster's hierarchy

	Cooperative capacity	Incentives	Management	Conditions	Institutional
Literature review	1	2	3	4	5
Article	1	3	2	4	5
Empirical	2	1	4	3	5
	4	6	9	11	15

4.5.2 Temporal Relevance

In addition to the relative significance of clusters, a chronological sequence of clusters and factors is determined. This temporal order is based on reasoning to determine which clusters and factors are relevant to which phase of the MSC. The findings serve as a component of the collaborative guide, aiding stakeholders in identifying relevant clusters corresponding to the specific phase of maturity of their MSC. The phase of maturity refers to the developmental stage or level of advancement that the MSC has reached. The sequence of clusters and factors can assist stakeholders in determining which factors are typically of greater importance in which phase of development of the MSC. Figure 4.6 provides a visual representation of the chronological order, represented by the respective numbering. The intensity of the blue color signifies the relative significance of the clusters; darker blue corresponds to a higher rank in significance. Furthermore, a chronological order of factors is reasoned for. This section will function as a narrative to describe both findings.

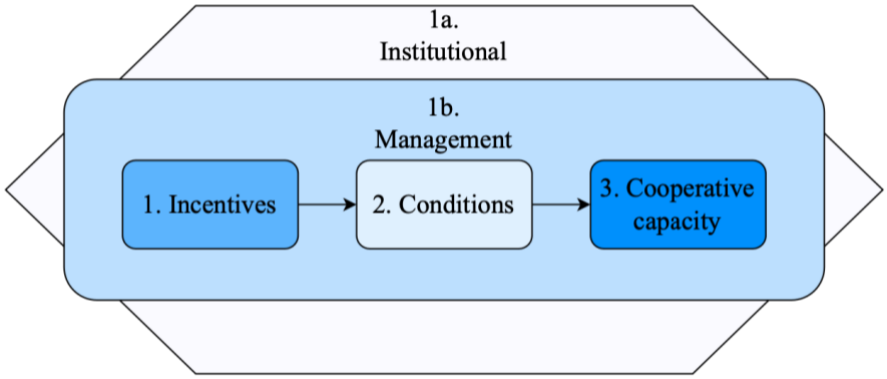


Figure 4.6: Overview of the chronological sequence of clusters

Clusters The initial phase of the temporal order revolves around the cluster "Incentives". This phase focuses on the establishment of a stimulus for stakeholders to engage in the MSC. These incentives encompass various motivations such as an increased efficiency, access to essential resources, financial gains, or knowledge development. Once the incentives are defined, the focus shifts to ensuring favorable "Conditions" for the emergence of the MSC. This involves curating a heterogeneous stakeholder composition with complementary skills, an optimal number of participants, a conducive political environment, and the availability of sufficient time. Following these conditions, the emphasis turns to enabling operational effectiveness of the composed MSC through the development of a "Cooperative capacity". This involves the stimulation of collaboration through effective meetings, fostering unity by building relationships among stakeholders, and engaging participants by cultivating a positive atmosphere.

The clusters "Management" and “Institutional” span across the three preceding clusters. Therefore, these clusters are labeled with an additional marking to denote a distinction from the regular successive order. The management cluster occupies both an organizational role to steer the project effectively and a performance aspect to ensure the consortium's efficiency. The overarching "Institutional" cluster influences the entire collaborative process. It is noteworthy that the institutional domain does not entirely overlay the structure. At the corners there is an interplay between the management cluster and the institutional cluster, suggesting a partial regulatory influence exerted by the management on the institutional aspect. In essence, this means that the institutional aspect not only influences the management cluster but is also influenced by the management cluster. It is imperative to emphasize that the sequencing of the clusters expounded in this section does not connote a hierarchy of importance; rather, it delineates a chronological progression of the clusters. The darkness of the blue color indicates the hierarchy of the clusters; the darker the color, the higher the position in the hierarchy.

Factors An additional analysis has established a chronological order of relevance within the factors. This sequence can help in determine which factors are relevant to which phases of the MSC. Although the sequence of factors largely corresponds to the order of clusters established in Figure 4.7, this analysis offers a more detailed overview. The categorization is not set in stone, meaning that certain factors can also be relevant during other phases. Nevertheless, this classification provides a backbone for stakeholders to determine relevant factors to improve the durability of their MSC. The chronological order is divided into six categories which are provided in Figure 4.7.

The first category delineates the incentives to participate in MSCs. This phase encompasses causal factors pertinent to the pre-formation of an MSC. The second- and third-time frames are labeled Establishment 1 and 2, respectively. This name suggests that all factors within these

categories are relevant during the formation of the MSC. A subdivision is introduced to account for subtle differences in the scope of the factors; Establishment 1 pertains to factors that are challenging, if not impossible, to be influenced by stakeholders (similar to the "Conditions" cluster), whereas Establishment 2 pertains to factors delineating stakeholders' characteristics (similar to the "Collaborative capacity" cluster). The subsequent categories encompass factors that are most relevant during the MSC. Again, a distinction is made between During 1 and During 2 since the latter category describes factors that impose solutions to the activities described under During 1. The final category pertains to the objectives or effects of the MSC.

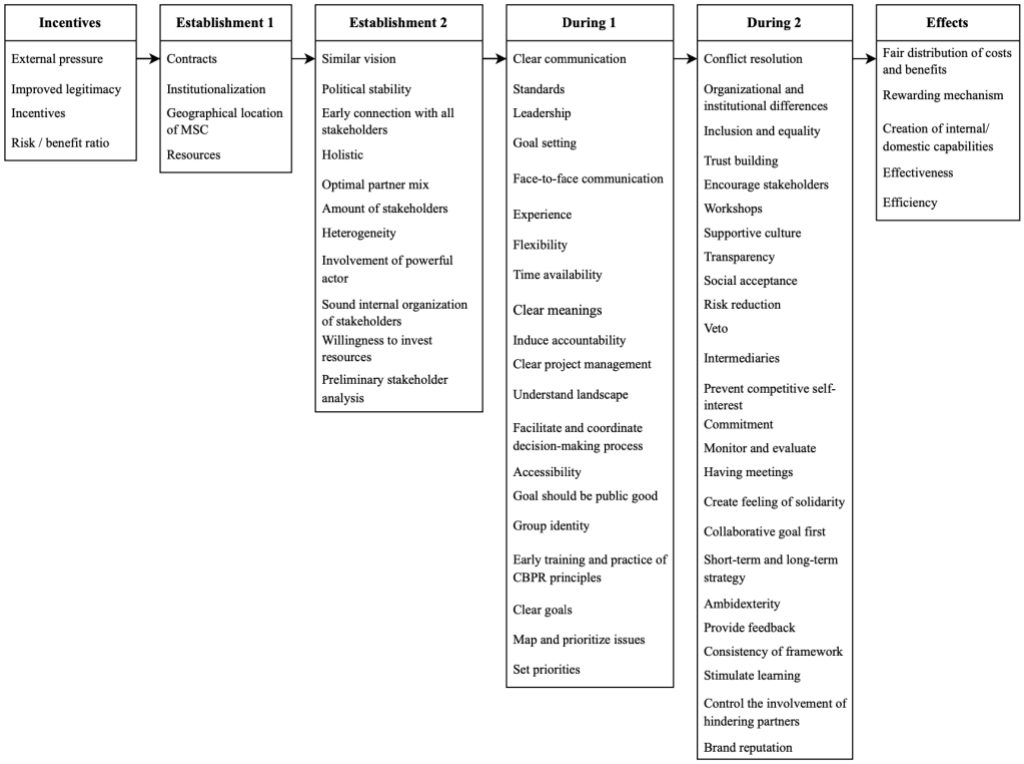


Figure 4.7: Overview of the chronological sequence of factors

Discussion and Conclusion The derivation of a temporal sequence of clusters and factors from logical reasoning represents a novel contribution within the field of MSCs. While existing research did not directly inform this sequence, knowledge obtained during this study obtained a solid basis to reason for the obtained temporal orders. This resulting sequence aids stakeholders in identifying relevant clusters and factors corresponding to specific phases of MSC maturity, facilitating a more defined approach to fostering durable collaborations.

In conclusion, the structured nature of this sequence provides a framework for understanding the developmental trajectory of MSCs, highlighting the importance of incentives, conditions, and cooperative capacity at distinct stages. The visual representations provided in Figures 4.6 and 4.7 offer stakeholders a comprehensive overview of this progression, guiding decision-making on the relevance of factors.

4.6 Collaborative Guide

The collaborative guide represents a culmination of three distinct outcomes: the collaborative form, the relative importance of clusters, and the temporal sequence of clusters and factors. These components provide essential information to identify and prioritize factors for enhancing the durability of MSCs. The collaborative form offers a structured overview of the identified factors to foster durable collaboration within MSCs, while the relative cluster importance and temporal sequence establish a degree of relevance and variation in importance among these factors. The latter two results facilitate a distinction within the clusters to select key factors pertinent to the specific circumstances of the MSC under investigation. Together, these insights form a systematic guide to assist stakeholders in improving the sustainability of their collaborative efforts, addressing the second sub-question. The subsequent chapter will apply this collaborative guide.

5. Results 2: Case Study Application

This section utilizes the collaborative guide to advise the MMvIB consortium regarding strategies to enhance the durability of their Multi-Stakeholder Collaboration (MSC). To formulate these recommendations, theoretical and practical findings from this study are synthesized, collectively forming the collaborative guide. This section serves a dual purpose. First, the collaborative guide is applied serving as an example for other MSCs. Second, the collaborative guide is applied to the case study, offering advice to stakeholders of the MMvIB project on stimulating durable collaboration within their consortium. The latter objective corresponds to the overarching aim of this chapter, which is to address the third and final sub-question:

SQ3: *How does the collaborative form relate to the case study?*

Purpose of the Advice This advice is constructed as an element of the first Work Package (WP) of the MMvIB project - Community of Practice. The results of WP1 have functioned as input for the other WPs to feed the interactions between modelers and users, and to build a community that can persist in the development of the multi-model infrastructure (TU Delft, 2021b). Currently, the MMvIB project has resulted in a multi-model ecology enabling computational models to interact in a uniform and structured way (Nikolic et al., 2019). The research has been a first step in the development of an interactive multi-model ecology. However, as all four stakeholders mentioned during the interviews (see Appendices J7 through J10), long-term collaboration is required to establish a validated prototype of the multi-model. Therefore, this study has established a framework to stimulate durable collaboration within MSCs.

Approach To foster enduring collaboration within MSCs, 69 factors have been identified through a literature review. These factors serve to incentivize stakeholders to engage in sustained cooperative endeavors. To ensure their comprehensiveness, these factors were compared to the BOMOS model. The BOMOS model is based on empirical data and provides a structured approach for developing and managing organizational standards. The factors were assessed as being exhaustive in comparison to the factors of the BOMOS model. Subsequently, these factors were clustered by three different techniques: the inductive-, abductive-, and deductive approach. These techniques have been invented as part of this research to enhance the comprehensibility of the data and mitigate potential biases within the clustering process. The mitigation of potential biases is achieved through a comparative analysis between the results of the clustering outcomes. By comparing the three methods, one uniform overview of five clusters has been established, encompassing all 69 factors. This overview is called the collaborative form as it structurally exhibits all factors influencing the durability of collaboratives. Additionally, a ranking of the clusters' potential influence has been established to prioritize clusters that are deemed most effective in stimulating durable collaboration. At last, a temporal sequence of both clusters and factors has been determined to illustrate which factors are typically relevant to a specific developmental stage of an MSC. The following section combines the collaborative form, relative significance of the clusters, and the chronological sequence to form a collaborative guide. This guide provides a structured approach for stakeholders to improve the durability of MSCs.

5.1 COOP Approach

The methodology employed in this section, referred to as the COOP approach, aims to identify factors that contribute to the longevity of MSCs. This approach is structured into four consecutive steps, which are derived from the collaborative guide. This research is unique in offering such a structured approach to enhance the durability of MSCs. This section not only outlines the methodology but also demonstrates its application within the context of the MMvIB project. Figure 5.1 offers a visual overview of the steps (ellipses) and results (rectangles) of the COOP approach. This detailed exposition of the approach is intended to facilitate stakeholders in collectively exposing potential bottlenecks in their collaboration. The figure will be discussed along the four phases of the COOP approach:

1. **C**onsult stakeholder perspective: Based on the stakeholders' input identify factors that need improvement to stimulate durability within the MSC.
2. **O**bserve chronological sequence of clusters and factors: To discern factors and clusters pertinent to the specific phase of maturity of the MSC, stakeholders may consult the sequential lists of factors and clusters.
3. **O**rganize factors based on the relative significance: When needed, prioritize the identified factors based on the significance of clusters. Factors which reside in clusters with a higher significance generally have a higher potential on influencing the durability of MSCs. Consult the collaborative form to identify the relevant factors per cluster along with the hierarchy.
4. **P**eriodic reassessment: Regularly revisit and reassess factors to adapt to evolving project dynamics.

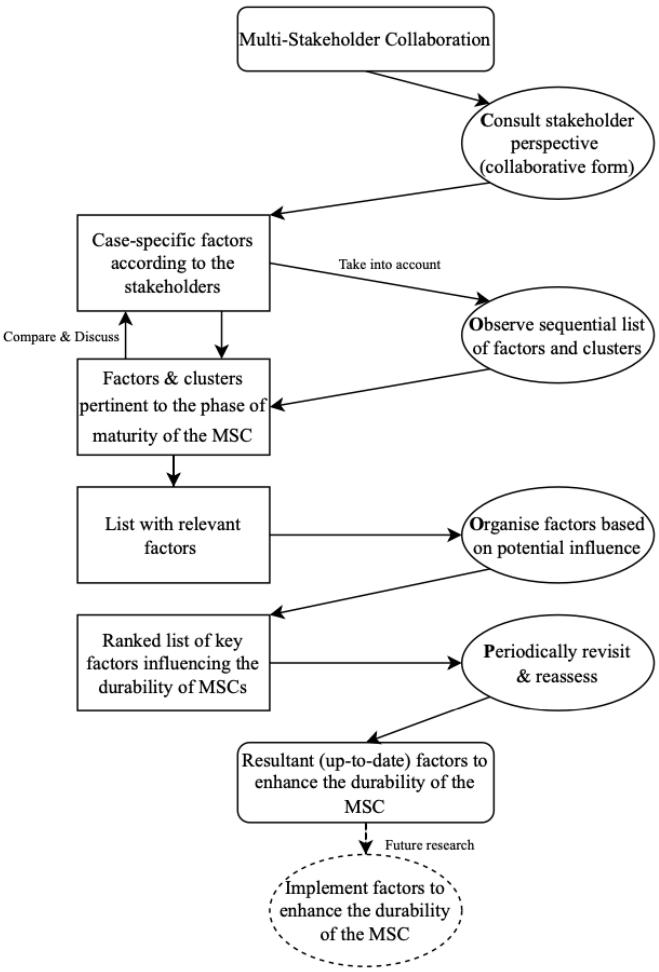


Figure 5.1: COOP approach

5.1.1 Consult Stakeholder Perspective

To initiate the process of identifying factors to stimulate the durability of an MSC, relevant stakeholders can be consulted. The practical and case-specific input can be considered to obtain an overview of factors which are relevant to the specific MSC according to the stakeholders. The perspectives of the stakeholders can be obtained during group meetings, interviews, or surveys. When extracting information from stakeholders, it is important to maintain confidentiality, a balanced representation of stakeholders, and a guaranteed freedom of speech (Bryson, 2004). Furthermore, the collaborative form can be used as a source of inspiration to start the discussion.

MMvIB During the interviews with the stakeholders of the MMvIB project, several interesting suggestions were made to stimulate the durable continuation of the CoP:

- Follow-up project: Quo Mare seeks to transition from academic research to real-world applications, emphasizing the commercialization of the multi-model and the need for additional research and financial resources. Hanze University and Quintel advocate for ongoing research to improve the multi-model, stressing the importance of increased financial incentives to maintain stakeholder engagement. TNO emphasizes the activation of market demand and suggests the further engagement of energy companies to enhance project viability. The proposal for a follow-up project reflects recognition of the project's evolving landscape.
- Quo Mare: It is important to foster a positive attitude among stakeholders and have clear leadership structures, delineating roles to expedite project initiation, and presenting a comprehensible project proposal. This underscores the idea that a conducive collaborative environment is catalyzed by proactive and optimistic stakeholder engagement, along with a well-defined project framework and leadership hierarchy.
- Hanze University: MSCs should establish a long-term goal, obtain resources, and have a structured division of roles among stakeholders. The emphasis on a strategic vision and resource allocation further solidifies the idea that sustained collaboration requires foresight and resource management.
- Quintel: Factors such as face-to-face communication, clear goals and project proposals, effective leadership, adequate financial resources, and having a practical usability of the project are mentioned. These factors underscore the intricate nature of collaboration, wherein interpersonal dynamics, project clarity, and financial stability play crucial roles in ensuring longevity of the project.
- TNO: It is important to have a shared vision, a clearly defined common goal, incentives for collaboration, and mutual benefits such as knowledge development. The emphasis on shared vision and mutual benefits aligns with the overarching theme that enduring collaborations are nurtured through collective aspirations and reciprocal advantages.

Conclusion The initial step of the COOP approach aims to identify factors which can be improved to enhance the durability of MSCs through consultation with consortium stakeholders. The collaborative form may serve as a reference during these discussions, providing examples of potential factors and initiate a discussion. For the MMvIB project, the interviewees collectively envision the future trajectory of the project as being reliant on continued research. The transition towards practical applications requires the activation of market demand and the active involvement of a broader spectrum of stakeholders. The interviewees collectively emphasized the importance of fostering positive attitudes, ensuring clear communication and leadership, delineating roles, having well-defined goals and project proposals, securing (financial) resources, and prioritizing mutual benefits. These factors can be considered when executing the subsequent steps.

5.1.2 Observe Temporal Sequence

In theory, all factors outlined in the collaborative form contribute to the durability of an MSC. In practice, often not all factors can be considered. Figures 4.6 and 4.7 delineate the temporal sequence of clusters and factors, respectively, providing stakeholders with a framework to identify relevant factors to the specific developmental stage of the MSC. This step of the COOP approach facilitates a targeted focus on relevant factors requiring immediate attention. As a result, a list of factors pertinent to the phase of development of the MSC is established. This list can be compared with the established list from the preceding step and discussed to determine whether these factors should be prioritized. It is important to acknowledge that factors categorized in preceding or subsequent developmental stages can also be relevant to the MSC due to different contexts. Furthermore, the overview is merely intended to inspire stakeholders and start the dialogue.

MMvIB According to the developed phase of the MMvIB consortium, the clusters "Management" and "Institutional", as well as categories "During 1", "During 2", and "Effects" harbor the most pertinent factors. It could be argued that certain factors residing in the “Cooperative capacity” cluster, or the “Establishment 2” category are also underdeveloped. However, most of these factors have already been addressed. Adding the factors from these categories to the factors obtained during the interviews with the stakeholders yields a more comprehensive list and initiates discussion. The following factors are identified by the stakeholders: follow-up project, resources, market demand, long-term goal, clear leadership, face-to-face communication, clear goals, project proposals.

Conclusion The second step of the COOP approach determines the temporal relevance of the factors. In other words, the consortium of stakeholders is tasked to consult the chronological sequence of factors and determine factors relevant to their phase of development. This list is compared to the preceding list of factors leading to a discussion. The discussion results in a list with relevant factors to enhance the durability of MSCs. Combining the input of stakeholders with the chronological lists of factors and clusters provides an identification of the following conceptual factors: Standards, Face-to-face communication, Clear goals, Clear project management, Time availability, Supportive culture, Risk reduction, Short-term and long-term strategy, Resources, and Rewarding mechanism.

5.1.3 Organize Factors Based on Significance

Subsequently, the list with relevant factors resulting from the second step is categorized according to the potential influence of the clusters. This categorization prioritizes factors which are expected to have a greater effect. Section 4.5.1 has established a ranking of significance between the clusters. Generally, factors residing in clusters higher in the hierarchy hold greater significance than factors in lower clusters. This hierarchical classification in clusters is also illustrated in the collaborative form in descending order from top to bottom. By comparing the list of relevant factors to these classes of significance, the factors can be organized according to the potential influence the factors might have on enhancing the durability of MSCs. The potential influence of factors is contingent upon the specific case and context, thus necessitating a nuanced approach. However, in instances where stakeholders encounter difficulty in assessing the potential impact of certain factors, this ordered classification can serve as a useful guideline. The ranking of clusters is structured as follows:

1. Cooperative capacity
2. Incentives
3. Management
4. Conditions
5. Institutional

MMvIB In relation to the MMvIB project, the identified key factors can be listed and classified according to their potential influence on MSC durability. In compliance with the classification, improving factors that reside in the cooperative capacity cluster is preferred. First, the cooperative capacity cluster can be enhanced through the stimulation of face-to-face communication and a standardization of the process. Face-to-face communication improves the collaborative process, while setting standards creates unity and enables the transferability of tasks. This transferability is essential for the management of the multi-model ecology and commercializing the product by enhancing the usability. Second, incentives to collaborate should be enhanced. This can be established through setting a new objective of the project and establishing the required resources. According to the interviews, a new objective should encapsulate the follow-up project and the most important resource entails subsidies. Third, clear project management involves identifying a short-and long-term strategy along with a clear division of roles. Furthermore, the risks of the follow-up project must be analyzed and mitigated. The conditions can be primarily influenced by establishing time and demanding clear politics to prevent last-minute adjustments to the budget or other agreements. At last, the institutional aspect requires clear agreements on the division of accountabilities, compensations, and goals.

Conclusion The third step of the COOP approach categorizes the identified based on their potential influence. This classification aids in organizing factors by their potential influence on MSC durability, serving as a guideline for stakeholders. For the MMvIB project, focusing on improving factors within the cooperative capacity cluster is recommended as this cluster is determined to possess the highest potential to enhance the durability of MSCs. The relevant factors include the stimulation of face-to-face communication and the standardization of processes.

5.1.4 Periodic Reassessment

It is important to emphasize that the factors mentioned above are to be improved. This does not imply that the other factors can be disregarded. Moreover, MSCs operate within complex and dynamic environments. Consequently, continuous learning and adaptation of strategies is pivotal to adapt to these changing settings. This process requires sustained communication, monitoring, and evaluation to gauge the efficacy of the implemented strategies. Regular meetings should be convened to review the process and reassess decisions. These meetings can be structured using the collaborative guide. For instance, the collaborative guide provides a systematic approach to discuss the phase of maturity, determine relevant factors, and stimulate the discussion on prospective steps. As a result, the dynamic nature of MSCs is accounted for and the resultant relevant factors are up to date.

5.1.5 Conclusion and Discussion

Discussion It should be mentioned that there is a disagreement between the temporal relevance and potential impact. Temporal relevance suggests, in the case of the MMvIB project, that the "Management" and "Institutional" clusters should be strengthened. Potential impact suggests that factors within the “Cooperative capacity” cluster should be improved. In practice, a decision must be made balancing these choices. The most effective approach is to facilitate a thorough discussion among stakeholders to determine where the greatest gains can be achieved. Again, these classifications serve merely to provide an initial idea and initiate discussion. Therefore, the discrepancy does not detract from the integrity of the COOP approach.

Conclusion In summary, the COOP approach has demonstrated its efficacy in furnishing an approach to structure the identification of factors influencing the durability of an MSC. The approach has established a concise set of factors which are expected to prolong the collaborative efforts within the CoP of the MMvIB project. Considering the perspectives of the stakeholders, the temporal relevance of clusters, and the potential impact of the factors, improving the following three factors is expected to enhance the durability of the MSC: face-to-face communication, standardization, and availability of resources. Depending on the ambition and available resources of the MSC, stakeholders may identify additional factors in an attempt to fortify its longevity and resilience. Moreover, the analysis facilitates a nuanced understanding of the MSC's evolving phases and specific characteristics. At last, the approach underscores the importance of continuous adaptation and refinement, ensuring that stakeholders remain engaged and committed to the MSC over time.

5.2 Future Management

An additional result of this study has investigated the potential future management of the multi-model developed within the MMvIB project. This study was conducted as a separate component of this thesis and was initiated in response to a specific inquiry from stakeholders within the MMvIB consortium. Managing the multi-model imposes several responsibilities such as ensuring accessibility, accuracy, operationality, and security. During a consultation with a professor, who is employed at TU Delft and who is affiliated with the MMvIB's organizational framework, four entities which are deemed suitable for managing the multi-model were identified: TNO or a subsidiary thereof, a (conglomerate of) commercial enterprise(s), TU Delft, or EZK (a governmental organization).

Table 5.1 presents a structured method for assessing potential organizations capable of managing the multi-model. The table offers a synopsis of potential factors influencing the prospective management of the multi-model. The factors and scores are based on insights gathered from interviews and existing knowledge. Appendix K offers a concise explanation of these factors. The table serves as an initial exploration. It is important to note that the table's scores are indicative, and further research is required to ascertain the exhaustiveness of factors and the accuracy of the associated scoring. Therefore, this table does not yield definitive conclusions.

The four columns represent the stakeholders which are identified to potentially manage the multi-model. The rows delineate various factors that influence the decision on which stakeholder is the most suitable to fulfill this task. Additionally, the symbol "++" indicates the highest suitability, whereas "--" denotes the lowest suitability of the stakeholder for the associated factor. An "X" indicates that the organization cannot fulfill the specified factor.

Table 5.1: Factors and scores influencing MMvIB management

	TNO	Commercial company / group of stakeholders	TU Delft	EZK
Commercial interests	--	+-	+	++
Conflicting interests	+-	--	+	++
Innovation	++	+-	++	--
Expertise	++	+-	+	--
Data access	+	+-	+	++
Transparency / accessibility	+-	-	+	++
Independence	+-	++	+	--
Flexibility	+-	++	+	--
Regulations	+	+-	+-	++
Resources	+	+-	-	++
Organizational structure	+-	+-	x	+-
Security	+	+-	+-	++

Interviews During the identification of the most suitable stakeholder to manage the multi-model, interviewees offered distinct perspectives. The main topics of the interviews are summarized by considerations of the project's nature, expertise, and goal setting. The following results are obtained through semi-structured interviews which are summarized in Appendices J7 through J10:

- Quo Mare posited that an important determinant in management lies in the project's characterization, distinguishing between a commercial venture and a research initiative. For commercial applications, TNO emerged as the favored option, while EZK was deemed suitable for research-focused projects.
- Hanze University underscored the significance of experience, knowledge, and the capability to safeguard the multi-model in managerial decisions. The maturity of the multi-model further influences this choice. TNO was endorsed for commercial readiness, whereas TU Delft is proposed as the best option for research-centric endeavors.
- Quintel advocated for TNO's adeptness in overseeing the entire structure of the multi-model. This refers to their ability to manage the entire multi-model rather than specific components. Quintel also expressed its concerns about EZK's potential lack of multi-model expertise. They also cautioned against potential conflicts of interest in scenarios involving the management by a commercial company or an agglomeration of companies.
- TNO contributed a set of criteria for the selection of a managing entity. These factors include independence, competence in diverse areas, ICT expertise, administrative proficiency, and capacity management. TNO acknowledges its leading role during the current research phase. However, TNO expressed a preference to collaborate and provide assistance during the innovation phase rather than a sustained project management role.

Suggestion While the study has shed light on potential entities capable of managing the multi-model within the MMvIB project, a definitive answer remains elusive. Further research is warranted to determine the relative importance of the factors, to evaluate the exhaustiveness of the factors, and examine the scoring of these factors. Nevertheless, an indicative recommendation can be provided. As can be derived from Table 5.1, TU Delft cannot fulfill the role of managing the multi-model due to a perceived misalignment with the stakeholder's organizational structure. TNO scored second highest, demonstrating competence and expertise, particularly in overseeing the entire multi-model structure. However, uncertainties persist, warranting further research to confirm the relative importance and exhaustiveness of factors, as well as the accuracy of associated scoring. Subsequent steps should involve consultation with stakeholders to clarify perspectives, refine selection criteria, and inform decision-making. Additionally, efforts should focus on addressing potential conflicts of interest and ensuring the suitability of the chosen entity for the management of the multi-model.

6. Discussion and Conclusion

This research has aimed to delineate an approach to stimulate durable collaboration within MSCs. Initially, the individual components of this approach were expounded upon. Subsequently, these findings have been combined to form a collaborative guide. Finally, the guide has been operationalized through a four-step process labeled the COOP approach, which has been applied to the specific context of the MMvIB case study. This concluding chapter will discuss the results and employed methodologies to draw conclusions and elucidate the broader implications of the study. Additionally, the study's limitations and constraints are discussed along with recommendations for future research endeavors.

6.1 Main Findings

Rationale The rationale for conducting this research stems from the increasing complexity associated with MSCs, particularly evident within the energy sector. Many pressing challenges in the energy sector defy straightforward resolutions, necessitating cooperative efforts among diverse stakeholders. These predicaments are commonly labeled in literature as "wicked problems". An example of such complexity emerged during the MMvIB project, aiming to develop a multi-model infrastructure. This multi-model, orchestrated by a consortium of stakeholders, aims to combine various models into a cohesive infrastructure. The resulting multi-model seeks to establish a coherent and transparent basis for guiding decision-making processes pertinent to the Dutch energy transition. One of the challenges encountered during this project is establishing durable collaborations that enable the consortium to work together effectively for an extended period. In addition to this practical challenge, there exists a theoretical knowledge gap in understanding durable collaboration. This research has aimed to cover both knowledge gaps.

Objective This research has had the objective to integrate theoretical and practical insights to devise an approach that stimulates the durable organization of MSCs. To achieve this objective, the following main research question is addressed:

"What are the key design considerations and components of a collaborative guide that facilitates the durable organization of a Multi-Stakeholder Collaboration?"

Approach As can be derived from this research question, the collaborative guide consists of multiple components. First, a literature review identified 69 factors influencing the durability of MSCs. Thereafter, these conceptual factors were compared to the BOMOS model to assess the inclusiveness of the enlisted factors. This model is used to guide organizations in developing and managing standards. The comparison concluded that all factors within the BOMOS model were encapsulated by the identified conceptual factors identified in this research. Moreover, the established conceptual factors offer a higher level of detail while maintaining a more general perspective. Additionally, three distinct clustering techniques have been developed and implemented to structure the factors and enhance the comprehensibility of the factors. The three methodologies were compared with each other to mitigate biases and determine the best result. The abductive approach yielded the most promising results, leading to its adoption as the collaborative form. In addition to the collaborative form, this research established a relative significance of clusters and a temporal sequence of clusters and factors. The relative significance indicates which clusters are usually considered to be more effective for establishing durable MSCs. The temporal sequence of clusters and

factors assists in determining relevant factors to be improved based on the developmental phase of the MSC. Combined, these findings constitute the collaborative guide. This guide has been applied to the case study to demonstrate the application of the collaborative guide and provide recommendations to stakeholders of the MMvIB project on stimulating durable collaboration within their consortium. The application of the collaborative guide is structured into four consecutive steps named the COOP approach.

Key Findings The primary findings of this research have resulted in the establishment of the COOP approach, a structured method to enhance the sustainability of collaborations. This approach incorporates the collaborative form, relative influence of factors, and a temporal sequence of factors. The collaborative form consolidates a wide array of theoretical and practical findings to provide a more nuanced and comprehensive overview of factors influencing the durability of collaborative endeavors. Not only can this overview be utilized by consortia of stakeholders to enhance the longevity of their MSC, also this overview provides a solid knowledge base for further research.

Furthermore, this study introduces an innovative clustering methodology aimed at enhancing the organization and comprehensibility of concepts. Three distinct methodologies are designed to combine associated factors, facilitating a more coherent representation of the data. Additionally, a comparative analysis is conducted to identify the most effective visual representation of the process and the most comprehensive composition of clusters, further enhancing the utility and applicability of the approach. These clustering techniques can be used in other conceptual analyses as a tool to structure concepts into overarching categories. This process aims to enhance the comprehensibility of the data while mitigating the potential biases associated with this process.

A solitary answer to the research question cannot be provided due to the multifaceted nature, comprising several deliverables. The main research question is answered through a process of answering the three sub-questions. Initially, a conceptual analysis of 134 articles has established the provision of themes and concepts influencing the durability of MSCs, answering the first sub-question. Subsequently, the requirements and components of the collaborative guide were established and amalgamated as an attempt to address the second sub-question. Finally, the collaborative guide has been applied to the case study with the help of a four-step approach, answering the third sub-question. Collectively, these sub-questions establish the key design considerations and components of the collaborative guide, facilitating the durable organization of MSCs.

6.2 Discussion

This section discusses the implications of the research findings within the broader context of previous studies and highlights the contribution of this research to existing knowledge.

Implications This study has contributed to the understanding of factors influencing the durability of MSCs. The literature review unearthed a dearth of knowledge in this domain. Existing literature failed to obtain a comprehensive overview of the durability aspect. A limited number of scholarly articles addressed factors dedicated to enhancing the efficacy of MSCs, with an even more constrained subset explicitly acknowledging the durability aspect of these collaborations.

However, this research has aimed to consolidate the existing knowledge to establish an overview of relevant factors that can enhance the durability of collaborations within multi-stakeholder projects. The broader implication of this research extends to the applicability of the developed framework to a wide array of MSCs, providing them with a systematic means to enhance their durability. The results are amalgamated and provided in the form of a generic method that can be

applied by many MSCs. Moreover, the method has been tested, serving as an example on the application and as an initial assessment of the feasibility of the approach. Additionally, the results function as a synopsis of existing literature on the durability of MSCs. Therefore, this study can be used as a foundation for future research.

Relevance The relevance of multi-stakeholder collaborations has significantly increased in recent years (Ndubisi et al., 2020). This trend is driven by the need to address complex societal challenges, requiring the bundling of knowledge, resources, and capabilities (Barrane et al., 2021). Multi-stakeholder collaborations enable the integration of heterogeneous knowledge to tackle these issues effectively. The MMvIB project encountered the complexities of modeling the energy sector due to its multifaceted nature.

However, the relevance of MSCs extends beyond the energy sector. The approach to enhance the durability of MSCs identified during this study, has the potential for significant impact across various sectors. The literature review on MSC durability highlighted recurring industries such as environmental sustainability, healthcare, agriculture, and water management. Partnerships within MSCs were found to be instrumental in achieving Sustainable Development Goals and addressing complex societal challenges. Environmental sustainability emerged prominently in the context of MSCs (Norman & MacDonald, 2004). Articles on environmental sustainability argued that MSCs were more effective in addressing the associated complexities. Healthcare emerged as another prevalent category in MSC literature, demanding efficient collaboratives to do research and improve the health sector (Loban et al., 2021). The establishment of an approach to enhance the durability of MSCs among a wide variety of collaboratives underscores the potential for cross-sector impact and relevance.

6.3 Limitations and Further Research

This section addresses various potential limitations or constraints associated with this research. A discussion is provided on several factors that may have influenced the results or could have impacted the validity or reliability of the findings. Moreover, suggestions are provided to mitigate these limitations in future studies.

Saturation First of all, the research is constrained by limitations in time and resources. Despite an exhaustive examination of 134 articles and numerous interviews, the emergence of new factors persisted. The ongoing identification of new factors suggests that complete data saturation is not achieved. Due to these restrictions the database mainly relies on articles identified through Scopus. As a result, other potentially valuable databases such as Google Scholar are not consulted. This constraint may have narrowed the scope of analysis, potentially resulting in the omission of relevant literature and, thereby, the exclusion of additional factors. While more time and resources could have facilitated a more comprehensive review, it is unlikely that new clusters of factors would have been identified. In other words, additional factors would most likely not have been of significant importance.

However, future research should consider exploring databases beyond Scopus, such as Google Scholar and Web of Science, to enhance the comprehensive of the literature review. Moreover, a longitudinal study could be conducted to ascertain data saturation over a more extended period. By experimenting with the approach, a more robust understanding of the factors influencing MSC durability is provided. This approach would offer valuable insights into the dynamic nature of MSCs and contribute to the ongoing advancement of knowledge in this field.

Bias Another potential limitation of this study originates from human error in identifying factors related to MSC durability. Factors were only selected if the article mentioned the explicit correlation to MSC durability. Since many articles had to be examined, there is a possibility of oversight or personal biases. Figure 6.1 provides an overview of the identified factors per article in chronological order. Article number 1 was consulted first while the last article corresponds to number 134. The trendline indicates that articles consulted later in the process tend to encompass a greater number of factors than articles examined at the beginning. This phenomenon may indicate the researcher's growing familiarity with the factors, facilitating their extraction from the text. Potentially, factors might have been overlooked at the beginning or have remained unidentified completely.

Considering this potential bias, further research might address potential biases and oversights in factor identification. Future studies could employ stricter criteria and measures to minimize researcher bias. For example, a second researcher could be included to validate the findings. Comparative analyses and longitudinal studies could provide deeper insights into MSC dynamics and the role of human error. By addressing these limitations, future research can enhance the validity and reliability of findings.

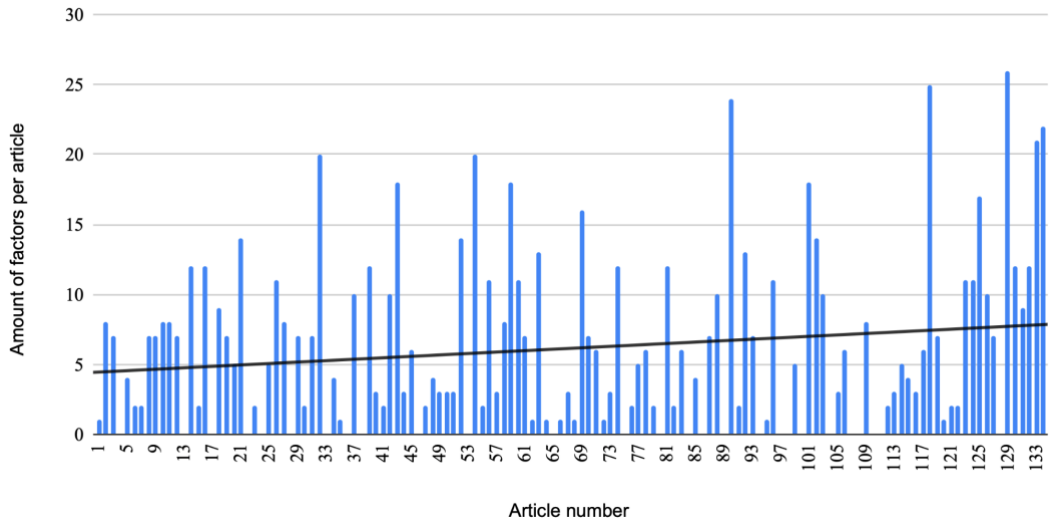


Figure 6.1: Increasing number of factors per article

Implementation Additionally, further research is needed to explore the implementation of the collaborative guide developed in this study. A limitation of this research is that it has primarily addressed the "what", neglecting the "how." Specifically, the study has identified the factors conducive to durable collaboration across MSCs. However, to effectively enhance durability, it is essential to delve into how these factors can be improved in diverse settings.

Therefore, future research should concentrate on refining specific tools and methods associated with the conceptual factors identified in this study. By doing so, researchers can advance the understanding of how these factors can be optimized to enhance the durability of MSCs. This entails exploring practical strategies and interventions to operationalize the identified factors within different collaborative contexts. Such research endeavors will not only deepen our comprehension of the mechanisms underlying durable collaboration but also provide actionable insights for stakeholders seeking to enhance the longevity of their collaborative endeavors.

Applicability The significance of this research lies in its potential to offer practical guidance for real-world cases of MSCs. While the study has adopted a broad perspective to accumulate relevant information applicable to various MSCs, its motivation is intricately linked to the case study of the MMvIB project.

Additional research is warranted to evaluate the universal applicability of the COOP approach for enhancing MSC durability across diverse collaborative contexts. It is crucial to investigate the influence of project-specific characteristics on the practical implementation of the framework. The influence of these contexts can be identified by interviewing relevant stakeholders or hypothesizing about different settings.

Effectiveness At last, future research is kindly invited to evaluate the effectiveness, shortcomings, and robustness of the collaborative guide across diverse settings. Long-term studies are needed to assess the practical application of the framework, quantifying its impact on MSC durability relative to pre-implementation scenarios. Employing action research methodologies can facilitate a participatory and democratic evaluation process, ensuring that the framework aligns with the needs of the users.

Conclusion To conclude, this research contributes to the existing body of literature by consolidating the diverse array of factors influencing the sustainability of MSCs. Additionally, this study has operationalized these findings into a pragmatic approach to apply theoretical knowledge in real-world scenarios. Notably, the efficacy of this approach has been empirically validated through successful testing, underscoring its potential to facilitate enduring collaboration and achieve sustainable outcomes within MSCs.

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Appendices

A: Literature Review 1

This literature review aimed to research which aspects of multi-models are underdeveloped in relation to the energy transition. Ten articles were consulted to discover these themes and identify whether they were researched. The objective of this preliminary research is to identify a knowledge gap.

Selection and screening process

For this literature review, Google Scholar and Scopus were adopted as databases. Google Scholar was consulted with "multi-model energy transition" as a search term. The consequent sources were filtered to exclusively mention developed countries, with a publication date after 2015 and with multi-models as the main subject. The explicit filtering out of developing countries is effectuated since the literature on multi-models in developing countries tends to focus on different topics, such as policy uncertainties and the remarkable absence of data (Bhattacharyya & Timilsina, 2010). Hereby, articles on developing countries are less content related regarding the multi-model approach. This primary search resulted in an initial n=44 sources which was scoped down to n=8. Additionally, Scopus has been consulted with the search query: "multi-model" AND "energy" AND "transition". In addition, the same filters as with Google Scholar were implemented. The search on Scopus resulted in an initial n=31 sources, of which 2 were of additional value. A detailed schematic overview of this selection and screening process is provided in Figure A1.

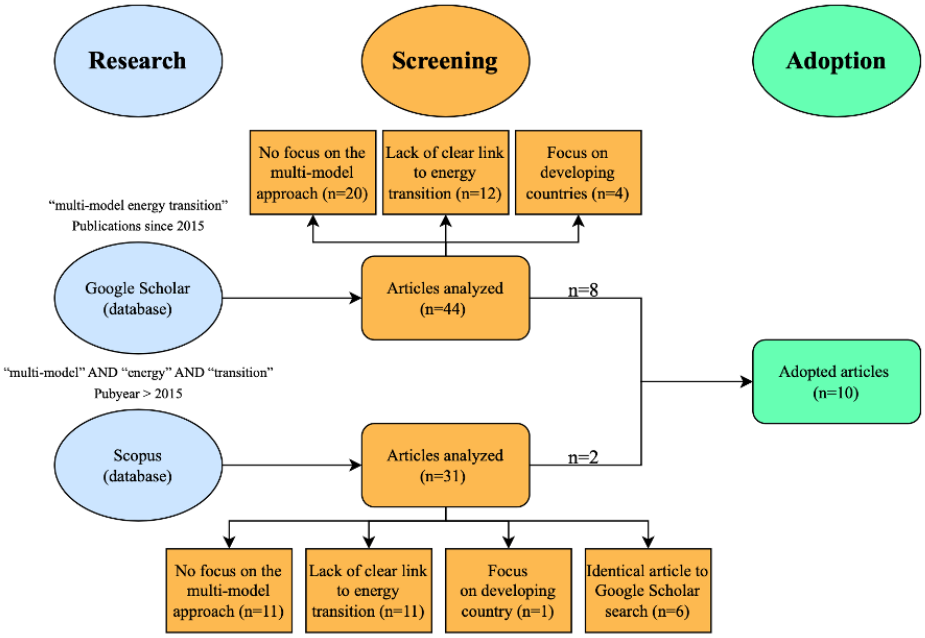


Figure A0.1: Schematic overview of the screening and selection phase

Exploration and discussion of literature

According to all sources that have been identified during this literature review, local governments are facing one of their biggest challenges. The origin of this challenge is established in agreements such as the Paris Agreement and European Green Deal (Bollinger et al., 2018; Henrich et al., 2021). The adopted articles implement a multi-model approach to interconnect models and endeavor a holistic understanding of the growing complexity associated with socio-technical energy systems (Bollinger et al., 2018; Collins et al., 2017). Along with the methodological requirements, imposed by the socio-technical energy transition (STET) framework, five categories (see Table A) have been established which models should possess to analyze the complex socio-technical energy transition (Li et al., 2015).

Table A provides an overview of the adopted literature and the extent to which these articles represent the five categories. As can be concluded, all articles acknowledge the influence of politics and the environment. Politics has been made an independent category since the multi-model ecology should contribute to the policy decision-making process in the energy transition. Mulholland et al. (2017) state that multi-modelling facilitates improved understanding of the technology pathways to decarbonize the society. According to the article this technological facet can be modeled alongside the social infrastructure to establish policy roadmaps. From the table below it can also be concluded that all reviewed articles have a positive notion of the environment in relation to multi-models. Therefore, it can be concluded that multi-models have the potential to provide policy support in relation to a national energy transition.

An additional component of modeling for the energy transition is the relevance of (innovative) technologies. The portfolio and development of energy technologies should be central in emission reduction modeling (Landis et al., 2019). However, two out of ten articles did not mention the contribution of technologies (Bollinger et al., 2018; Vrontisi et al., 2018). Furthermore, various articles neglect the inclusion of future developments in the configuration and performance of energy sources while identifying future scenarios.

A fourth characteristic of the multi-model framework is uncertainties. During the literature review, eight out of ten articles mentioned the importance of acknowledging the presence and influence of uncertainties in the multi-model ecology. In this case, uncertainty relates to the dynamic nature of policies, competing and developing technologies, energy demand growth, and inherent modeling uncertainties. While many articles mention the presence of these uncertainties in modeling, Sugiyama et al., (2019) conclude that only a few studies have explored the inter-model uncertainty and robustness of the results. However, recent research has partly filled this knowledge gap by analyzing the ability to apply existing methodologies to assess the impact of uncertainties on the multi-model ecology (Drent, 2020).

In order to conceptualize a socio-technical system, a ‘wider system view’ should be adopted to encompass all relevant sectors (Li et al., 2015). A last analyzed characteristic of the multi-model framework is, therefore, the institutional aspect. The institutional aspect is defined as the paradigm of needs, wants, and regulations of relevant actors and models. These requirements relate to the formal and informal agreements between stakeholders. These agreements could streamline the collaboration processes and make the collaboration more durable. Questions arise, such as “What happens if a model or stakeholder withdraws from the configuration?”. Bollinger et al. (2018) conclude that multi-model ecologies currently hold a lack of knowledge concerning how the frameworks should be

designed to facilitate an adequate understanding of the complexity and consequences of such withdrawals. Nikas et al. (2021) augment this statement by identifying that not all required information is available and homogeneous. This lack in coherency and availability hampers collaboration between stakeholders and their models. Both articles mention the need of a more structured organization of stakeholders within multi-model ecologies. However, neither article provides suggestions on the "how". The remaining eight articles fail to mention the relevance of institutional requirements as can be derived from Table A1. This table provides an overview of the selected literature of the first literature review.

Table A1: Overview of selected literature from first literature review

Article	Politics	Environment	Technologies	Uncertainties	Institutional
Gardumi et al., 2022	✓	✓	✓	✓	✘
Nikas et al., 2021	✓	✓	✓	✓	-
Mulholland et al., 2017	✓	✓	✓	✘	✘
Vrontisi et al., 2018	✓	✓	✘	✓	✘
Collins et al., 2017	✓	✓	✓	✘	✘
Landis et al., 2019	✓	✓	✓	✓	✘
Mai et al., 2018	✓	✓	✓	✓	✘
Bollinger et al., 2018	✓	✓	✘	✓	-
Henrich et al., 2021	✓	✓	✓	✓	✘
Sugiyama et al., 2019	✓	✓	✓	✓	✘

✓ = Mentioned in a positive way

✘ = Not mentioned in the article

- = Mentioned in a negative way

The literature review, as summarized above, has established a clear knowledge gap. Implementation of the multi-model ecology to establish a broad picture of complex socio-technical systems, requires more research regarding the institutional aspect. Eight out of ten articles did not mention the relevance of this facet while the other two sources concluded that not all required information is available and homogeneous.

B: Literature Review 2

This appendix summarizes a conducted literature review. This literature review was conducted after the review discussed in Appendix A and aims to obtain a global understanding of the existing research and to identify a knowledge gap regarding designs or theories on durable collaboration between stakeholders in MSCs. Literature review 1 (see Appendix A) has concluded that, prior to the implementation of a multi-model, more research is required regarding the institutional aspect. In this case, the institutional aspect entails the influence of regulations and stakeholders on the performance of multi-models. During several meetings regarding the exigencies of the MMvIB project, a more specific research gap has been established. This knowledge gap describes the absence of knowledge on the robustness and durability of collaboration between stakeholders in MSCs. The existence of this knowledge gap will be motivated during this chapter.

For this second, more in-depth literature review, the same two databases have been consulted. First of all, Scopus has been consulted with the search terms [“multi-stakeholder” AND “collaboration” AND “approach”]. This search query resulted in the identification of five useful sources. Secondly, Scholar was consulted with two different search terms “long-term collaboration of stakeholders” and “durable collaboration of stakeholders” which in total resulted in another six articles. Table A2 presents an overview of the sources, content, and search terms of the second literature review.

Complex projects often must be performed by multiple companies or organizations. This approach is more effective in obtaining the required knowledge and other resources. However, various negative externalities arise from collaborations. For example, transaction costs increase, and decisions are made less efficiently (Kusters et al., 2018). This second literature review aims to identify frameworks or designs which stimulate durable collaboration within multi-stakeholder projects. This review builds upon the first literature review which identified a deficiency of research being done regarding the institutional aspect of multi-models. The term ‘durable’ refers to the longer-term continuation of the project which is established through formal and informal rules. Humphreys et al. (2017), defines durable as being able to transform or overcome the impeding variables and interact productively with the enabling intervening variables to generate the desired outcomes. For many projects this longer-term is essential to guarantee the further development of the end-product and prevent the end-product from becoming outdated. However, projects are often terminated directly after or even before the predetermined period due to conflicting business models, financing, divergent visions, different interests, ineffective project management, or other problems such as miscommunication (Ayala-Orozco et al., 2018).

Weber (2012) argues that institutional durability cannot, and should not, be detached from the concept of problem-solving capacity since this is a primary reason for adopting collaboratives in the first place. Institutional durability is based upon trust and credibility as could be concluded from the Blackfoot Challenge (Weber, 2012). However, in his article, Edward Weber, admits that “the general lack of successful collaborative governance arrangements fitting the robust durability outcome suggests the opposite-new, more robust models to guide collaborative decision makers are clearly needed”. Hereby, the demand for more robust models for durable multi-stakeholder collaboration is declared. Another article addresses a similar knowledge gap. Kusters et al. (2018), argue that there is a need for adequate methods to aid the planning, monitoring, and evaluation of multi-stakeholder platforms. Both articles acknowledge a lack of research on the durability of multi-stakeholder projects. Various articles address this knowledge gap without directly mentioning it. These articles

explore building blocks or categories which should be considered to improve collaboration in multi-stakeholder projects. Several examples are provided below.

De Bruijn and Ten Heuvelhof (2010), identify four general core elements of a process design. According to them, a good process design can only exist when: the initiator has an open attitude towards other participants in the decision-making process; the core values are protected; the process has momentum and progress so that decisions can be made; and the process has a sufficient number of substantive elements (De Bruijn & Ten Heuvelhof, 2010). Other elements to consider stimulating multi-stakeholder collaboration originate from lessons learnt during projects. For example, Ayala-Orozco et al (2018), analyzed 38 multi-stakeholder collaboration projects where certain challenges hindered the collaboration between the relevant stakeholders. As a result, five main categories of challenges were identified. Most of the inefficiencies were caused by divergent visions and interests among stakeholders. Other inefficiencies described challenges in the structural conditions, such as discrimination and public insecurity (Ayala-Orozco et al., 2018). Another article derived elements of collaboration while analyzing an environmental impact assessment. This article found that characteristics such as commitment, legitimacy and a face-to-face deliberation process improved the collaboration between stakeholders during the project (Woldesenbet, 2020).

Additional literature identified several proceedings or methods to reduce the presence of the above-mentioned inefficiencies. These articles aimed to provide a more structured process to stimulate collaboration between stakeholders. Barrane et al. (2021), established ten principles to create trustful multi-stakeholder collaboration in a digital environment. The principles vary from selecting appropriate partners to enhancing informal conversations outside the purview of the project. The MSP (Multi-Stakeholder Partnership) guide by Brouwer et al. (2019), also describes a structured approach to analyze a multi-stakeholder partnership. Various phases, principles, and tools to facilitate and improve multi-stakeholder partnerships are discussed. Other articles provide checklists to determine if partnerships are likely to become successful (Dodds, 2015). Hereby, practical questions are asked such as “Are there adequate resources (including financing, staff and technical expertise, and in-kind contributions) for the initiative to deliver its target?”.

However, none of the identified articles provides a robust model to establish durable multi-stakeholder collaboration. Durable collaboration between stakeholders cannot be guaranteed by merely having and maintaining favorable antecedent conditions and factors. Weber (2012) noticed that in many cases, while the conditions (e.g., strong social capital, entrepreneurial leadership, and sufficient knowledge) and other factors (e.g., stable politics and economics) remained the same, the problem-solving capacity of the MSC declined or collapsed. In the light of these findings, the above-mentioned methods and building blocks to stimulate collaboration and preserve the CoP do not provide a robust model for durable collaboration. Past research merely functions as food for thought while analyzing collaboratives. To truly stimulate MSC, decisions will need to be made and laid down in formal and informal agreements. The process towards establishing these agreements is more complex than the building blocks discussed above. Perhaps researchers are hesitant towards the establishment of a specific design as every partnership is different. However, the identification of a more holistic, yet generalizable design process for a robust model to establish durable multi-stakeholder collaboration is highly valuable for the increasingly complex collaborations between companies.

Table A2: Sources, content, and search terms of second literature review

#	Source	Building blocks/method	Search terms + Database
1	De Bruijn & Ten Heuvelhof (2010)	Building blocks	Process management
2	Humphreys et al. (2017)	Method	Scopus:process AND management AND collaboration AND stakeholders AND durable
3	Ayala-Orozco et al., (2018)	Building blocks and Method	Scopus:multi-stakeholder AND collaboration AND approach
4	Woldesenbet, W. G. (2020)	Building blocks	Scopus:multi-stakeholder AND collaboration AND approach
5	Kusters et al., (2018)	Building blocks	Scopus:multi-stakeholder AND collaboration AND approach
6	Pathak et al., (2022)	Building blocks	Scopus: multi-stakeholder AND collaboration AND approach
7	Brouwer et al.,. (2019)	Building blocks	Google Scholar: multi-stakeholder collaboration bottleneck
8	Dodds (2015)	Building blocks	Google Scholar: multi-stakeholder collaboration bottleneck
9	Savage et al., (2010)	Food for thought	Google Scholar: long-term collaboration of stakeholders
10	Barrane et al., (2021)	Building blocks	Google Scholar: long-term collaboration of stakeholders
11	Weber (2012)	Knowledge gap	Google Scholar: durable collaboration of stakeholders

C: Search Query

To identify an effective search query, iterative optimization was employed. Table A3 provides an overview of some of the steps taken during the iterative optimization process of the search query. Moreover, this optimization attempt involved the establishment of the required terms. These terms are derived from relevant literature which had already been examined during the exploratory phase of this thesis. Since the review attempts to indicate factors that influence the sustainability of MSCs, synonyms for sustainability and MSCs were incorporated into a brainstorming session. During this brainstorming session a list with synonyms for MSCs and sustainability were incorporated as potential search terms. Following a trial-and-error process, four key conclusions were drawn:

1. Abbreviations such as MSC can yield numerous unrelated results due to their varying interpretations. For example, the tenth search query in Table C1 resulted in various sources that interpreted the abbreviation for Multi-Stakeholder Partnership (MSP) for "Melamine-Styrene based Polymer" (Karabayir et al., 2021).
2. Utilizing wildcard searches includes all variations of a word. A wildcard search is triggered by identifying the root of a word and adding an asterisk at the end (e.g., multi-stakeholder collaborat* could refer to multi-stakeholder collaboration, multi-stakeholder collaboratives etcetera). This can be beneficial for ensuring a comprehensive search as it captures a wider range of related terms and variations, thereby maximizing the retrieval of pertinent information from the database.
3. The inclusion of terms signifying the durability or sustainability of MSCs should be prevented to avoid overly narrowing the search parameters. This narrowing, as experimented with between search queries one and two in comparison to search queries four and five (see Table C1), exhibits an exclusion of more than half of the results.
4. If the search query is limited to searches within the "Article title", results have a higher chance to discuss the required subject as its main topic. Including the abstract offers a higher number of sources but also with a weaker association with the required outputs.

Table A3: Iterative optimization process of search query

#	Search query:	Identified documents:
1	(TITLE ("multi-stakeholder collaborat*" OR "multi-stakeholder partner*" OR "multi-stakeholder cooperati*" OR "multi-stakeholder project*")	128
2	(TITLE ("multi-stakeholder collaborat*" OR "multi-stakeholder partner*" OR "multi-stakeholder cooperati*" OR "multi-stakeholder project*") AND ALL (("establish*" OR "formation" OR "creation" OR "develop*" OR "acqui*")))	114
3	TITLE ("multi-stakeholder collaboration" OR "multi-stakeholder partnership" OR "multi-stakeholder cooperation" OR "multi-stakeholder project")	108
4	(TITLE ("multi-stakeholder collaboration" OR "multi-stakeholder partnership" OR "multi-stakeholder cooperation" OR "multi-stakeholder project") AND ALL (("establish*" OR "formation" OR "creation")) AND ALL (("sustain*" OR "maintain*" OR "continu*" OR "durab*")))	49
5	(TITLE ("multi-stakeholder collaboration" OR "multi-stakeholder partnership" OR "multi-stakeholder cooperation" OR "multi-stakeholder project") AND TITLE-ABS-KEY (("establish*" OR "formation" OR "creation")) AND ALL (("sustain*" OR "maintain*" OR "continu*" OR "durab*")))	21
6	(TITLE-ABS-KEY ("multi-stakeholder collaboration" OR "multi-stakeholder partnership" OR "multi-stakeholder cooperation" OR "multi-stakeholder project") AND TITLE-ABS-KEY (("establish*" OR "formation" OR "creation")))	130
7	(TITLE-ABS-KEY ("multi-stakeholder collaboration" OR "multi-stakeholder partnership" OR "multi-stakeholder cooperation" OR "multi-stakeholder project") AND TITLE-ABS-KEY (("establish*" OR "formation" OR "creation")) AND TITLE-ABS-KEY (("sustain*" OR "maintain*" OR "continu*" OR "durab*")))	76
8	(TITLE-ABS-KEY (("multi-stakeholder collaborat*" OR "multi-stakeholder partner*" OR "multi-stakeholder cooperati*" OR "multi-stakeholder project*")) AND ALL (("establish*" OR "formation" OR "creation" OR "develop*" OR "acqui*")) AND ALL (("sustain*" OR "maintain*" OR "continu*" OR "durab*")) AND ALL (("company" OR "companies" OR "organization*" OR "management*"))	519
9	TITLE-ABS-KEY (("multi-stakeholder collaborat*" OR "multi-stakeholder partner*" OR "multi-stakeholder cooperati*" OR "multi-stakeholder project*"))	730
10	TITLE (("multi-stakeholder collaboration" OR "MSC" OR "multi-stakeholder partnership" OR "MSP" OR "multi-stakeholder cooperation" OR "multi-stakeholder project"))	3466

D: Visualization Map

This figure represents the visualization map of the AI approach conducted with “Researchrabbit”. Input sources are represented by green nodes, while the output sources are represented by blue nodes. A darker shade of the node denotes a more recent publication. The lines between the nodes represent the interconnectedness of the sources.

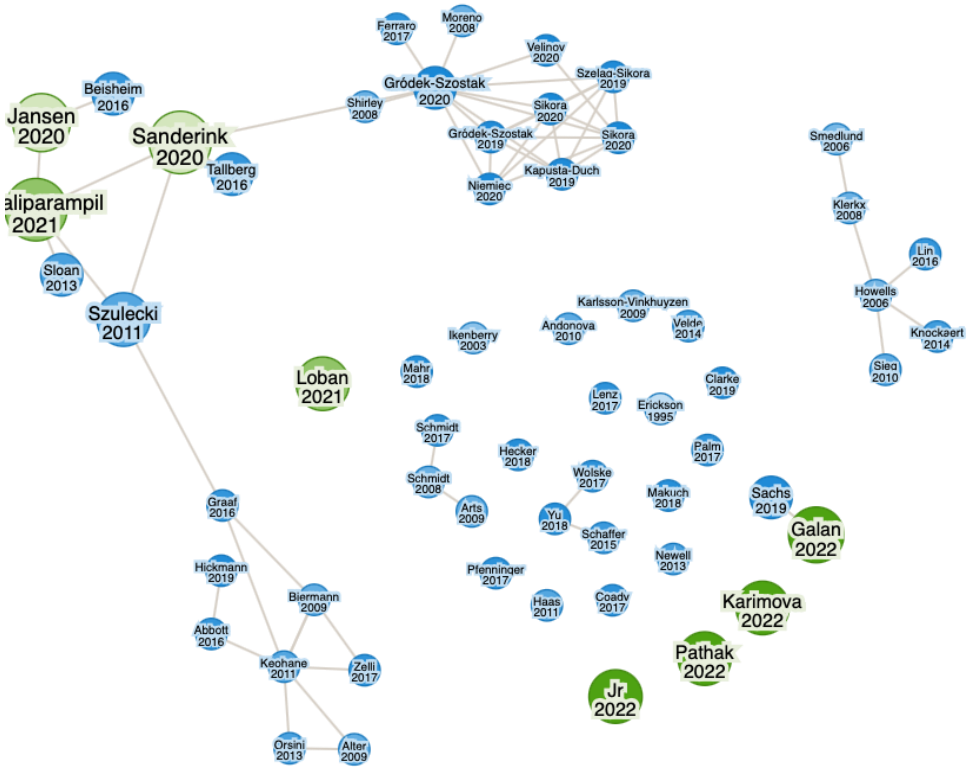


Figure A0.2: Visualization map of the AI approach conducted with “Researchrabbit”

E: Factor Definitions

This table establishes the meaning of all 69 factors. The meanings are based on the meanings provided in the articles from the literature review.

Table A4: Definitions of factors

Factor name	**Factor meaning**
Contracts	Galan and Zuñiga-Vicente (2023) argue that "partnerships usually involve a wide variety of arrangements—some of them evolving into more formal contractual agreements in the long run, while others may be less durable over time." Consequently, the establishment of agreements within contracts serves to enhance durability. A contract is conceptualized as a configuration of agreements, either written or oral, between stakeholders that possess a legally binding nature.
Resources	The availability of resources refers to the joint accessibility of essential foundations for an MSC. Eweje et al. (2021) explain in their article that "MSPs should involve sharing knowledge, consolidating resources and balancing competencies of multiple sectors, which is expected to create synergies resulting in unexpected positive sustainable outcomes." The term resources cover a broad group of inputs to an MSC consisting of tacit knowledge, explicit knowledge, physical resources, financial resources, human capital etcetera (Sanderink & Nasiritousi, 2020).
Efficiency	Clegg (1996) argues that an MSC "should not serve any stakeholder group to the exclusion of any others but should serve all of them to increase their ability to pursue their objectives more efficiently and effectively." The fact that goals might differ is considered but countered by suggesting the appointment of representatives. Thereby, stakeholders can work together as a whole in a more efficient manner than the parts alone.
Clear communication	Clear communication refers solely to the understanding of what is being said. Part of clear communication therefore relates to speaking the same language (Kuenkel & Aitken, 2015; Toso et al., 2023). Another aspect is understanding the context of what is being said and the influence of jargon (Ayala-Orozco et al., 2018).
Similar vision	Ayala-Orozco et al. (2018) have identified that having divergent visions, goals, values, or interests is the biggest challenge hindering MSC. Vayaliparampil et al. (2021) adds to this point by referring to an experiment where "10 out of 11 consortiums experienced poor governance, often due to their desire to be extremely inclusive, resulting in a failure to agree on vision and mission." This led to many partners working to advance their own agendas. In all 10 cases, restructuring of the consortium was highly advised.
Conflict resolution	Conflict resolution refers to the essential process of resolving or confronting potential conflicts. Various articles mention the importance of dealing with conflicts to collaborate. Andersen and Mosleh (2021) complement this statement by stating that participants either avoid conflicts or become paralyzed by them – missing an opportunity to utilize stakeholders' diverse perspectives, skills, and competencies to produce new meaning.
Political stability	Political stability relates to the clearness and similarity of the political environment over time. Many articles suggest that clear regulation provides more support and certainty for MSC's. However, literature also suggests that corporate motives for engagement in MSC also derive from the absence of traditional command-and-control regulations and the lack of political willingness among governments to address certain problems as a consortium might have a stronger stance than being alone (Airike et al., 2016).
Standards	Standards are argued to be essential for partnerships to operate efficiently (Buckup, 2012). Standards can be broadly interpreted but are here defined as a consistent and approved form or method of operating certain tasks. The factor is different from clear communication as it (among other tasks) describes the processes which enable clear communication. If standards are used, then all stakeholders use or do the same method or activity which creates homogeneity.
External pressure	External pressure refers to pressure, induced through goals or sanctions, from stakeholders from outside the MSC to form a consortium or deliver a certain result. Bitzer and Schouten

	(2022) describe tensions between certain regions which resulted in geographical agglomeration of partners. Furthermore, in many articles on agriculture, the influence of harsh regulations functioned as an external (political) pressure to form MSC's (Bhattacharya and Fayezi, 2021).
Organizational and institutional differences	Organizational and institutional differences is a factor which hints to the homogeneity of stakeholders. While a certain level of heterogeneity is beneficial for creativity etcetera institutional differences should be limited. Vikstedt and Rajala (2023) label this factor as institutional hybridity or the alignment of organizational structures. For MSC's to operate efficiently, they should therefore have at least congruent organizational structures.
Inclusion and equality	For MSC's to become more attractive and efficient, they should be inclusive and promote democracy. Kar (2014) argues that a successful partnership consists of horizontal integration with equal power relations and the ability to discuss and decide collectively. Bitzer and Schouten (2022) state that the form of communication can already be an excluding factor for some stakeholders. In this specific case the preferred communication style during a meeting was technical and smooth which excluded the smaller producers.
Trust building	Trust building is a process which is an important aspect of building a successful MSC. Trust is described by Sloan and Oliver (2013) as "the willingness to rely on another's actions in a situation involving the risk of opportunism, facilitating organizational cooperation and collaboration". Building trust can also reduce the costs of an MSC, as it will simplify managing interactions between actors (Jansen & Kalas, 2020). Building trust is often achieved through time and personal connections.
Leadership	Leadership describes the presence of a body or institution which oversees, guides, influences, or directs a group of stakeholders towards achieving a common goal or objective. Thereby, the term is directly linked to MSC's. In most articles this factor is specifically labeled as "facilitative leadership" and not as leadership (Aswad & Damayanti, 2020; Woldesenbet & Kebede, 2021). This refers to the less influencing role of the leader compared to a true leader. The governing body does not influence decisions but merely facilitates the required processes. A good leader should therefore consist of a solid and relevant body of knowledge, commitment, networking ability and a clear overview of the interests of individuals responsible to a certain organization (Ellis & Idowu, 2018).
Goal setting	To achieve the various Sustainable Development Goals (SDGs) imposed by the United Nations SDG 17 focuses on partnerships to bundle forces. However, various articles discovered that the establishment of specific goals or objectives also strengthen partnerships in MSCs (Bulmer & Yáñez-Araque, 2023). These goals impose an "urgency for change" and "desire for the project to succeed". Pathak et al. (2022) describe this goal setting as a success indicator: if goals are achieved then it could be stated that the partnership is a success. Furthermore, the urgency to satisfy customer needs provides a reason for the creation of partnerships and thereby an MSC.
Face-to-face communication	Face to face communication is an important process in establishing not only the transfer of knowledge but also to build trust and develop new ideas. Furthermore, this communication method is the first face in the collaborative process model (Aswad & Damayanti, 2020). This model aims to strengthen the sustainability of collaboration. Simply put, face to face communication describes the process of exchanging information or ideas between (a composition of) individuals who are physically in the same location. This communication method is most effective as it enables to communicate not only in dialogue but also by body language, facial expressions etcetera and allows for real-time interaction and feedback improving the efficiency as well.
Clear project management	Clear project management should be formed collectively and democratically to manage the network based on the main tasks and functions (Aswad & Damayanti, 2020). A solid management would identify an effective supply chain organization and distribution channels (Morsink et al., 2011). Furthermore, the management should provide a division of tasks based upon the skills of the available stakeholders (Aswad & Damayanti, 2020).
Early connection with all stakeholders	Barrane et al. (2021) identified eleven factors which influence the collaboration of stakeholders in MSCs. Most participants of the research from Barrane and his colleagues highlighted the importance of involving stakeholders in the early stages of the process. This increases trust in collaboration from an early stage which stimulates an effective integration

	into the project team as a whole and will take it to heart. Furthermore, an early connection with stakeholders enables an early identification of potential inefficiencies allowing for a more efficient process.
Encourage stakeholders	Encouraging stakeholders refers to "pushing partners to engage in activities that they would otherwise avoid, thereby inciting them to do what may seem impossible to them and not penalizing them for genuine mistakes" (Barrane et al., 2021). The MSC should thereby provide confidence as a means of a safety net. In this way innovation can achieve its true potential.
Workshops	Workshops are interactive and hands-on sessions to learn or solve specific problems. In this case workshops refer to the latter as most referrals are derived from articles where workshops were carried out to discuss and solve water management issues (Basco-Carrera et al., 2018). Furthermore, Pathak et al. (2022) explain that workshops also provide a great tool to improve partnerships and derive the requirements for a durable MSC.
Holistic	The holistic perspective to MSCs entails a factor which stresses the importance of having all the required partners on board (Beisheim et al., 2018). Sanderink and Nasiritousi (2020) argue that MSCs should often be complemented by international and transnational stakeholders to establish technology transfer and policy learning across national borders. Whether an MSC is saturated is hard to identify.
Willingness to invest resources	Beisheim et al. (2018), Corsaro and Engel (2020) and other authors suggest from their research that successful partnerships can only persist if the partners are willing to invest their own resources. Resources are described in a very broad manner as personnel, time, money, and other resources which are required for the partnership to succeed its goals. It is important that the stakeholders are willing to invest their own resources as it shows their good intentions and thrust towards the project while stimulating active participation from other stakeholders as well.
Flexibility	The flexibility within MSCs refers to the behavior of stakeholders. Pathak et al., 2022) describes this capability as being receptive and adaptable to a dynamic atmosphere. Bhattacharya and Fayezi (2021) explain that this implies that, for example, core stakeholders are willing to adapt or sacrifice their individual goals for the sake of the greater (communal) good. However, the flexibility of stakeholders should not be confused with unclear and vague meanings (Beisheim et al., 2018).
Supportive culture	Having a supportive culture is beneficial for the encouragement and empowerment of the relevant stakeholders. Pathak et al. (2022) suggest that a supportive culture is not merely established through compliments but also by making compromises and appeasement orientation. Hereby this term is an overarching way of thinking within a community which stimulates assistance throughout the collective.
Fair distribution of costs and benefits	It has been concluded that a distribution of cost and benefits which is proportional to the inputs of the stakeholders improves the strength and efficiency of the MSC in which these stakeholders are present. If stakeholders are excluded from the decision-making process or perceive an unequal distribution of costs and benefits, they may exit the partnership and create a rival initiative that corresponds better to their own interests (Bitzer & Schouten, 2022). Furthermore, Sanderink and Nasiritousi (2020) discuss that a non-profit could also be an option. However, even then should there be conclusions on who does and receives what. The funding will then rely on governments, international organizations, and other donors.
Transparency	Transparency or openness is "important for preserving trust between partners, for addressing power asymmetries and empowering vulnerable partners, and for maintaining stakeholder engagement in the long run (Jansen & Kalas, 2020). The importance of transparency also flows outside the management structure as it also. includes measures such as public consultations and comment periods (Buckley et al., 2019). Transparency should be infiltrated into the entire MSC so that there are no secrets for each other, and the learning capacity is at a maximum.
Social acceptance	Social acceptance of a project or MSC provides legitimacy for this project or MSC to exist (Bulmer & Yáñez-Araque, 2023). This legitimacy is derived from "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions (Czischke, 2018). Buckley et al. (2019) describe social acceptance as the acceptance of a shared rule or other

	aspect of a business by a community as appropriate and justified. Achieving social acceptance can be hard since many actors will grant legitimacy only when "the on-ground effects are shown to improve environmental and social integrity". It is therefore best to hold interventions to foster political legitimacy and obtain positive media attention early on (Buckley et al., 2019).
Risk reduction	Bulmer and Yáñez-Araque (2023) propose in their article that more information should be collected about the risks and potential of multi-stakeholder partnerships. To establish this in the real-world a project should start with a preliminary risk assessment. Visser-Amundson (2022) suggests that the identified risks as well as unidentified risks can then be shared by the MSC. In this way the challenges can be tackled easier, and the effects are less fierce for the stakeholders.
Optimal partner mix	An optimal partner mix or configuration of actors is beneficial as the positive effects of an MSC are enhanced (Pérez Perdomo et al., 2016). An optimal mix is defined as having a certain level of heterogeneity to establish a high level of available knowledge and other resources while at the same time obtaining homogeneity in the organization's structures to optimize the collaboration between the companies. Karimova and Lee (2022) conclude that this composition of multiple stakeholders is unique to each MSC and should be done in a way that best reflects the MSC's objectives. Stakeholder mapping provides a solution to the making of this composition by mapping the strengths and weaknesses of and relations between the relevant stakeholders (Haywood et al., 2019).
Time availability	The availability of time is an important aspect for the obvious reason that building thrust, and connections takes time (Corsaro & Engel, 2020). Various articles suggest that time is one of the most important factors for MSCs to fail (Corsaro & Engel, 2020; Karimova & Lee, 2022). Especially while focusing on the durability of partnerships, a long time span and time investment in building trust is essential.
Improved legitimacy	There needs to be an improved legitimacy to the project when partners collaborate as an extra push for stakeholders to collaborate instead of doing it on their own. These incentives can be interpreted in a broad way and can even entail conditions for collaboration. Some examples provided by Kuenkel and Aitken (2015) are: credibility, profit, additional knowledge etcetera.
Veto	Veto is a term for having the power to unilaterally stop an action within the framework or MSC (Czischke, 2018). Some authors argue that having a veto can severely hinder the decision-making process (Vayaliparampil et al., 2021). However, others argue that MSCs require a veto to establish an ethical culture where all stakeholders can remain true to their core principles (Czischke, 2018).
Intermediaries	Various difficulties in the decision-making process can be limited by "the intervention of intermediaries, who can act as partnership brokers, bridging agents, commissionaires or relationship builders for the parties working together (Dragomir & Foris, 2022). In this way meetings can become more efficient.
Clear meanings	For the sake of clear communication with as few misunderstandings possible it is important to define certain terms. Meanings should therefore be complete, easy to understand and consistent (Gao et al., 2019).
Prevent competitive self-interest	Stakeholders should not be tempted by incentives to compete with stakeholders from the same MSC. These incentives should either be prevented or incentives to remain true to the MSC should weigh more (Eweje et al., 2021).
Induce accountability	Inducing accountability on the stakeholders means that stakeholders can be held responsible for a certain task and sanctioned if this task is not carried out (successfully). Desportes et al. (2016) explain that monitoring the activities of the stakeholders is therefore essential.
Commitment	Many stakeholders which operate in long-term MSCs lack the commitment to finish a certain project (Karimova & Lee, 2022). While this factor can be influenced by losing interest or disappointing results, it can also be a product of a lacking commitment which is embedded in the personality of a stakeholder. Commitment can be stimulated by MSCs through rewarding mechanisms or other stimulation methods.
Incentives	This factor entails an overarching term which describes the things that motivate or encourage

	stakeholders to collaborate in MSCs. Galan and Zuñiga-Vicente, (2023) state that institutional and/or fiscal incentives are one of the key factors which influence partnerships. These incentives improve a company's competitive position and can be very broad. Various specific examples of incentives have already been identified and are labeled as individual factors. Examples of these factors are efficiency, availability of resources and
Experience	Experience describes the knowledge that partners can have on MSCs from previous arrangements. The experience can be beneficial in dealing with certain issues related to communication or the management of the MSC, providing tools for standardization or obtaining financial support (Josserand et al., 2018; MacDonald et al., 2022).
Understand landscape	To understand the landscape within which a partnership is established requires an identification of all the relevant partners, the linkages between them and the external factors from the business such as other companies, institutions, and values (Haywood et al., 2019). This is essential to predict, prevent and process barriers which hamper the business as usual.
Monitor and evaluate	Effective monitoring and evaluation promotes a culture of continuous improvement in MSCs and is essential for problem-solving in complex environments (MacDonald et al., 2022). Monitoring describes the process of observing the do's and don'ts of stakeholders. Evaluation is the proceeding phase of analyzing what the stakeholders could have done better. The responsibility of monitoring and evaluating can be either centralized or decentralized meaning that the stakeholders could evaluate each other, or an independent actor could perform these tasks (Woldesenbet & Kebede, 2021)
Having meetings	Having meetings is important to articulate interests, have discussions and share knowledge and current findings (Jansen & Kalas, 2020). The interval of meetings should depend on the necessity to have the above-mentioned actions. However, scientists advise that it is better to have more meetings as it is always a good tool to promote engagement (Sanginga et al., 2007).
Set priorities	Jansen and Kalas (2020) conclude in their article that "partners in a multi-stakeholder partnership should focus their energies, optimize the way they work and operate to ensure that they deliver the greatest value, including agreeing not to work together in areas where extra value is not being created. In short, what is being said is that MSCs should set priorities. This can be achieved through a clear division of tasks (see factor "clear project management") but stresses the importance of stakeholders not unnecessarily intervening with others' work. While a new point of view could result in interesting ideas it could also hamper the pace and thereby the efficiency of the process.
Number of stakeholders	Karimova and Lee (2022) state that it is "reasonable to avoid involving too many and too diverse stakeholders in the beginning of an MSC in order to avoid management complications and effectively move from planning to implementation stages". Beisheim and Simon (2016) contribute to this statement by pointing out that "quality not quantity matters". However, it could also be concluded that successful MSCs have more stakeholders since big MSCs happen only because they work (Kuenkel & Aitken, 2015; Szulecki et al., 2011). Therefore, MSCs should not have too many nor too few stakeholders, depending on the phase in which they are operating. Too few stakeholders hamper the development and distribution of knowledge while too many stakeholders complicate the communication and management processes.
Preliminary stakeholder analysis	A preliminary stakeholder analysis and ranking is instrumental for the identification and recruitment of partners to provide context-specific technical knowledge, influence, and marketing-related needs (Kaumbata et al., 2020). Kaumbata et al. (2020) argues that bringing partners together with a shared common goal is beneficial for overall alignment and will underpin and drive the partnering endeavor forward, create synergy and engagement, and foster the emergence of collective efforts. A stakeholder analysis differs from a risk assessment since a risk assessment analyzes the entire environment of the MSC while a stakeholder analysis merely focuses on the stakeholders. Furthermore, a stakeholder analysis does not only identify the risks but aims to establish an overall idea about a stakeholder and the additional value it might have for the MSC.
Solidarity	Kuenkel (2019) argues that it is important for stakeholders to feel that they are part of something larger, but also know where they belong. The feeling of solidarity is created by having the same objectives and interests. This feeling can be enhanced through workshops, face-to-face meetings, trust building activities and other factors (Paddeu et al., 2018).

	Solidarity further improves trust and sympathy within the MSC making it more durable and efficient.
Collaborative goal first	The collaborative goal should stand above the interests of the component parts, and of an organization serving the interests of only one group (Levi, 1998). If all partners prioritize the collaborative goal over their own goals this shows solidarity and unity (Novkovic, 2019). However, this could result in profit being lost for certain stakeholders. A solution could be to reorganize the distribution of the benefits gained by the MSC.
Rewarding mechanism	A rewarding mechanism refers to the compensation a stakeholder receives for its performed tasks. This compensation is more often than not in the form of monetary value. However, services or other rewards could also be agreed upon. A rewarding mechanism effectuates the long-term effective engagement of stakeholders as an incentive is provided to perform the required tasks within the MSC (López-de-Ipiña et al., 2022). The opposing factor of a rewarding mechanisms is sanctions or institutions which can be used to prevent free riders from enjoying the benefits of an MSC (Pérez Perdomo et al., 2016)
Heterogeneity	While most organizations consist of a single category of members, MSCs allow a heterogeneous membership base (Michaud & Audebrand, 2019). Heterogeneity can be an important criterion for identifying key stakeholders to involve in the redesign process since different perspectives and skills are added to the MSC to obtain a more holistic view (Xie et al., 2015). However, the partnerships should then be complementary and avoid duplication (Beisheim & Simon, 2016).
Creation of internal/domestic capabilities	MSCs can build the required skills, resources, and competencies to tackle certain challenges. Stakeholders can include (inter)national or local companies to create a reliable network. When these local networks can capitalize on certain specific capabilities, the MSC is said to create a competitive advantage (Morsink et al., 2011). Hereby more knowledge can be developed and the MSC grows in terms of additional value.
Short-term and long-term strategy	It should be determined beforehand whether the project will be long-term or short-term to set expectations and prepare the required resources and partners (Pathak et al., 2022). For MSC to be durable and thereby long-term other decisions and resources should be established than short-term projects (Caron et al., 2015).
Ambidexterity	Ambidexterity is a capability of innovation networks to balance exploration and exploitation dynamics (Pérez Perdomo et al., 2016). MSCs should hold a dynamic perspective so that new opportunities are identified while the business as usual is optimized at the same time.
Risk / benefit ratio	For an MSC to work the projected benefits should outweigh the identified risks for all stakeholders (Permatasari et al., 2021).
Institutionalization	Institutionalization refers to the development of policy or the presence of rules and regulations (Sanderink & Nasiritousi, 2020). Vayaliparampil et al. (2021) state that MSCs without institutionalization suffer from unclear structure and very low performance. The rules can be either agreed upon verbally or contractual.
Accessibility	The accessibility of an MSC plays a critical role in determining which stakeholders can participate in the MSC and which are precluded (Sanderink & Nasiritousi, 2020). This concept is closely linked to the ability to "Control the involvement of hindering partners". However, it is important to note that accessibility also pertains to the internal dynamics of an MSC. This refers to the availability and accessibility of data and other findings to partners within the MSC, ensuring that all stakeholders have the necessary information to contribute effectively to the collaboration.
Effectiveness	The effectiveness or success of an MSC is a very broad term and influenced by many of the factors which have already been mentioned. An example of the factors influencing the effectiveness is provided by Vayaliparampil et al. (2021): “The evaluation revealed that the partnerships’ effectiveness could be improved by “clearer linkage to existing institutions and multilateral agreements, measurable targets and timetables, more effective leadership, improved accountability mechanisms, more systematic review, reporting and monitoring””. However, the effectiveness of MSCs can be hard to measure as some stakeholders could lie or go for “bluewashing” (Beisheim & Simon, 2016). The more effective an MSC is, the more successful and durable the partnerships are.

Provide feedback	Providing constructive feedback to other stakeholders within the MSC creates an atmosphere of learning. Positive feedback on contributions stimulates trust and the feeling of unity while negative feedback (brought in a nice manner) improves the capabilities of the MSC (Sanginga et al., 2007).
Goal should be public good	Having a goal which has as a trait, the public good improves the support towards the project (Berti, 2020). Often subsidies can be granted, or donations are gathered. Not only monetary support can be expected, also support from the public or government in terms of cooperation can be established. For example, these groups are often more willing to exchange information (Caron et al., 2015).
Consistency of framework	Preserving consistency within the framework of an MSC is imperative for achieving predictability, trust, efficiency, adaptability, measurability, and effective communication—all of which are fundamental to the success and sustainability of the collaboration (Tepelus, 2006). Nonetheless, upholding consistency does not preclude the possibility of flexibility. The framework can be modified when superior tools or alternatives are identified. It is important to note that consistency pertains to uniformity across the MSC. For instance, if one stakeholder employs a particular tool, it is advisable for other stakeholders to also utilize that tool to eliminate potential miscommunications. Standardization is a radical example of consistency.
Group identity	Vayaliparampil et al. (2021) argue that a group identity should be delineated for every MSC to determine the vision, mission, and strategy of the whole partnership and create unity. A group identity encapsulates the fundamental principles of the MSC, playing a pivotal role in fostering a sense of belonging, aligning goals, promoting collaboration, establishing trust, facilitating conflict resolution, and enhancing stakeholder engagement. Furthermore, the formation of informal relationships can significantly contribute to the development of this group identity, as these relationships tend to be more voluntary and honest, thereby reinforcing trust (Xie et al., 2014).
Early training and practice of CBPR principles	Vayaliparampil et al. (2021) suggest advancing the development, functioning, and effectiveness of MSCs. In their article, the above-mentioned authors recommended the implementation of community-based participatory research principles (CBPR). Some of these principles include open communication, trust, and mutual respect for the knowledge, expertise, and resources of all partners at the time of partnership formation. It is essential to provide early training and practice of CBPR principles so that a community can be formed with effective collaboration.
Map and prioritize issues	By mapping and then prioritizing issues from stakeholders, a chronological order of fixing these issues can be identified (Woldesenbet, 2020). In this way the most urgent problems can be remedied first, and collaboration is maintained in a most efficient manner.
Clear goals	Having clear goals can be seen as a combination of the factors “Goal setting” and “Clear meanings”. However, goal setting refers to the essence of having something to strive for (urgency for change) and knowing when the project has succeeded (success indicator). Having clear meanings refers not only to goals but all terms and tools mentioned in an MSC. The clarity of goals defines what goals have been set, what the expected inputs and outputs are and what the intermediary steps are (Wood & de Morais, 2022). This factor stimulates clarity and thereby improves the efficiency of MSCs.
Facilitate and coordinate decision-making process	The facilitation and coordination of decision-making processes represent a crucial phase that occurs before, during, and after the activities of "Having meetings" and "Workshops". This phase encompasses the determination of the most appropriate decision-making methodology, as well as the subsequent implementation and organization of this chosen methodology (Beisheim & Simon, 2016). Through the facilitation and coordination of the decision-making process, MSCs are endowed with structure and directionality, ensuring their effectiveness and productivity in achieving their objectives.
Stimulate learning	Learning serves as the foundation for innovation and constitutes an integral component of companies. Several scholars contend that learning should be embedded within the fundamental principles of every MSC (Beisheim & Simon, 2016). The facilitation of learning within MSCs can be enhanced through the dissemination of knowledge in meetings and workshops, the expansion of data accessibility, and the allocation of essential resources, including time and financial support. The additional value of an MSC is the mutual learning which speeds up innovation and provides a competitive advantage over companies who are

	operating outside of an MSC.
Control the involvement of hindering partners	In their article, Overton, and Storey (2004) delineate the concept of hindering partners, defined as stakeholders who erect obstacles to the efficiency or potential of MSCs. Such impediments may arise from various factors, including financial constraints, divergent visions, or the failure to fulfill assigned tasks. The control of the involvement of hindering partners is intricately linked to other factors such as "Not too many or too few stakeholders", "Optimal partner mix", and "Heterogeneity", which collectively address the composition of stakeholders. However, it is distinct from these factors in that it affords the opportunity to selectively exclude specific stakeholders from the collaboration.
Geographical location of MSC	The geographical location of a company can be a significant determinant of its success. A substantial body of literature on innovation emphasizes the advantageous impacts of regional clusters and knowledge spillovers. In the context of MSCs, these terms pertain to the knowledge generated by companies situated in close geographical proximity to each other (Szulecki et al., 2011). Face-to-face interactions are particularly efficacious in facilitating the transfer of tacit knowledge, which is often difficult to communicate through written or verbal means alone. Additionally, regional clusters serve as valuable platforms for identifying potential partners further down the production chain, such as suppliers of resources. Furthermore, empirical evidence suggests that industrialized countries tend to outperform their non-industrialized counterparts. Consequently, establishing an MSC in a country that is already industrialized is likely to enhance the potential for success of the collaboration.
Involvement of powerful actor	One of the main ways to keep the government agencies or other partners of an MSC engaged (and to enhance the cross-sectoral cooperation) is to gather support from a higher ranking supervising body (Karimova & Lee, 2022). Involvement of influential actors can significantly enhance the efficacy and scope of an initiative (Szulecki et al., 2011). The authority wielded by these actors serves as a magnet, drawing in other stakeholders. It also bolsters the legitimacy and trust associated with the MSC and facilitates the acquisition of funding. A powerful actor could also be a governmental body.
Brand reputation	A robust brand reputation enhances trust and legitimacy both within and towards the MSC (Eweje et al., 2021). This reputation can be augmented through strategic measures that bolster the reliability, visibility, and popularity of the brand (Szulecki et al., 2011). An MSC can both be strengthened by participating stakeholders who have a positive brand reputation or can strengthen the brand reputation of participating stakeholders.
Sound internal organization of stakeholders	The effective internal organization of stakeholders, at first glance, may appear to align with the previously mentioned factor of "Clear project management". However, while the latter focuses on the overall organization of the Multi-Stakeholder Collaboration (MSC), the former pertains specifically to the organization of the individual components of the MSC: the stakeholders themselves. When the organization of each individual stakeholder is optimal, there is a greater likelihood of effective cooperation and successful task completion (Szulecki et al., 2011).

F: Inductive Clustering Approach

The inductive methodology is characterized as a thematic clustering method. Initially, a comprehensive list comprising 69 factors was compiled. These factors were subsequently subjected to a thematic analysis wherein each individual factor was allocated to a higher-order thematic category. In instances where a factor could not be incorporated into an existing thematic cluster, this cluster could either be incrementally modified or a new thematic category could be inaugurated. This process was continued until all 69 factors were allocated to their higher-order thematic category. It is imperative to underscore that this procedural course is iterative in nature, facilitating an opportunity to refine thematic categories to better accommodate the associated factors. The definitions of all factors are cataloged in Appendix E, whereas the interpretations ascribed to the resultant clusters are elucidated within this section.

The inductive clustering procedure has yielded the identification of eight distinct thematic clusters. An overview of these clusters along with an enumeration of their constituent factors is provided in Figure F1. The clusters are not ordered according to hierarchy. The name of the clusters is written in bold. Below the figure, all clusters are independently discussed.

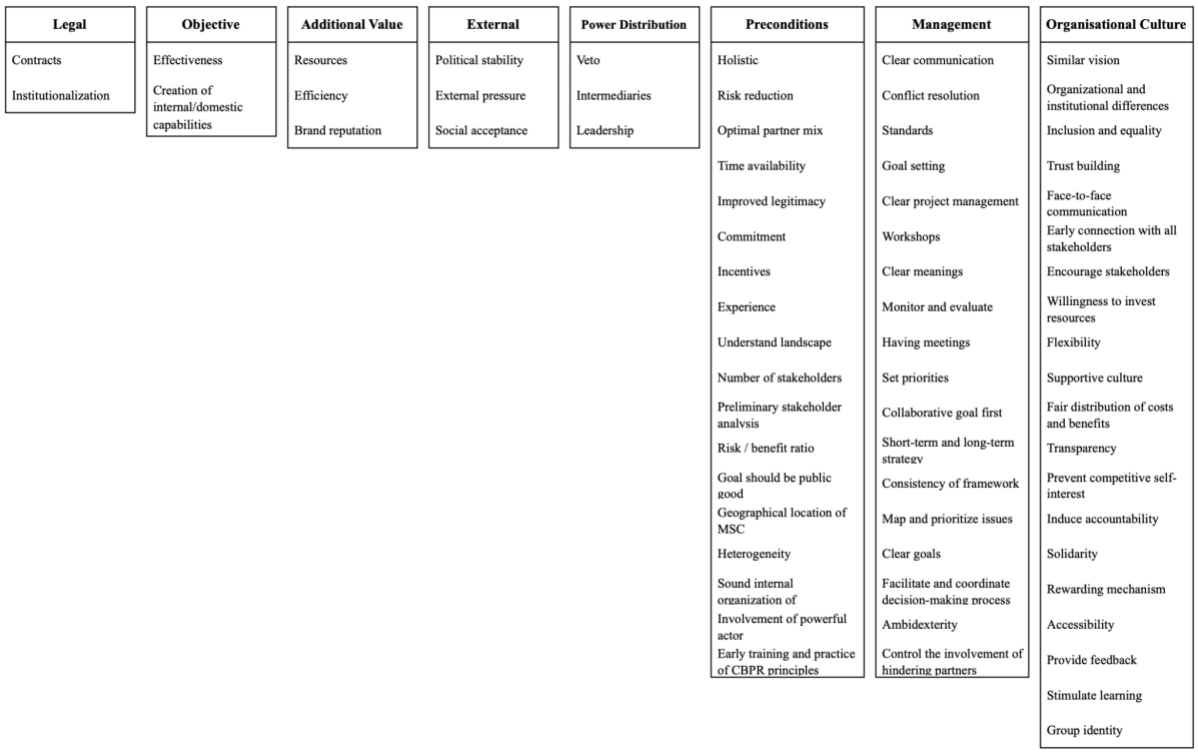


Figure A0.3: Inductive clusters

Legal:
The first cluster pertains to the legal aspect of MSCs and is constituted by the factors “Contracts” and “Institutionalization”. This cluster encapsulates the formulation of agreements, the establishment of policy frameworks, and the delineation of regulatory mechanisms. The imperative nature of adopting a legal perspective while evaluating the sustainability of MSCs is accentuated by its central role in fostering organizational clarity and enhancing performance through the establishment of clear structures and the enhancement of the MSC’s performance through formal agreements (Vayaliparampil et al., 2021). To establish a better understanding of the cluster it is essential to discuss the constituent factors. The factor "Contracts" delineates the formal agreements and legal accords that govern the interactions and obligations of stakeholders within the MSC. The factor "Institutionalization" encapsulates the relevant processes of the establishment and formalization of institutional frameworks, policies, and regulations governing the collaborative efforts.

Competitive advantage:
The second thematic cluster delineates the concept of "Competitive advantage" within the context of MSCs. This cluster is constituted by three factors: Resources, Efficiency, and Brand reputation. Resources are defined as the inputs required for an MSC to operate consisting of, among others, physical resources, human capital, financing, and knowledge (Airike et al., 2016). The contribution of resources is a fundamental aspect of the competitive advantage conferred by MSCs. The exchange of heterogeneous and complementary resources fosters the greatest (mutual) benefit. An example is the exchange or combination of knowledge. (Bendell et al., 2010). The second factor, “Efficiency” pertains to the optimization of resources and combination of skills to save both time and money (Morsink et al., 2011). By streamlining processes and bundling forces, stakeholders can collaboratively address more complex tasks and enhance their efficiency. At last, “Brand reputation” describes the public perception of the reliability, visibility, and popularity of a brand (Szulecki et al., 2011). Having a stakeholder who has a robust brand reputation within the MSC enhances trust and legitimacy both within and towards the MSC (Eweje et al., 2021). An MSC can both be strengthened by participating stakeholders who have a positive brand reputation or can strengthen the brand reputation of participating stakeholders.
In essence, these three factors collectively contribute to the overarching cluster of "Competitive advantage" within an MSC. The competitive advantage is developed by the MSC since combining resources improves efficiency and effectiveness. This competitive advantage might function as an incentive for stakeholders to join the MSC.

Management:
The third cluster pertains to the "Management" dimension within the MSC paradigm. This cluster encompasses a myriad of factors which relate to the orchestration and coordination inherent to managing an MSC. A judicious selection of these factors is elucidated below to provide an understanding of the overall influence which the factors have on the "Management" cluster. To commence, effective communication is foundational to managerial endeavors within an MSC. The factors "Clear communication" and "Clear meanings" can improve the dissemination of information. The establishment of clear meanings and communication between stakeholders within the MSC by the managerial body is imperative to mitigate potential misinterpretations and enhance the efficiency of communicative processes. Another aspect of the management cluster is the formulation and orchestration of objectives. Related to this aspect is the juxtaposition of the factors "Goal setting" and "Collaborative goal first" which underscores the strategic significance of goal formulation. The former establishes clear objectives along their relative importance to provide a roadmap, while the

latter emphasizes the collaborative nature of goal prioritization. Aligning collective aspirations with individual stakeholder objectives should be managed. However, the collaborative goal should be preferred when possible. A third element of effective MSC management involves the factors “Conflict resolution” and "Controlling the involvement of hindering partners". The resolution of conflicts is fundamental in mitigating disruptions that may impede the harmonious progression and efficiency of the collaborative efforts, while stakeholder control is imperative for ensuring strategic alignment and coordinated participation. A fourth facet of managing an MSC is the determination of the scope of the project. This factor is called “Short-term and long-term strategy”. This determination of strategic vision is a foundational aspect of MSC management which contributes to a successful strategic alignment, estimation of required resources, risk management, and effective communication. The last factor which will be discussed to determine the essence of the management cluster is the importance for the management to “Facilitate and coordinate the decision-making process”. This factor entails the establishment of an inclusive environment that fosters open communication. Management is tasked with the alignment of decisions with overarching strategic goals, the resolution of potential conflicts, and the empowerment of stakeholders (Kuenkel, 2019). Additionally, the management provides an environment suitable for the decision-making process and ensures a timely and adaptable decision-making process.

Organizational culture:

The next cluster encompasses factors which state how stakeholders can interact with each other to enhance the durability of their relationships. The core values, approach to work, and the overall atmosphere within the organization are discussed. This cluster called “Organizational culture” emphasizes the importance of fostering a culture that encourages openness, trust, and a shared sense of purpose, all of which are essential for successful and durable MSCs. The organizational culture plays a crucial role in shaping how employees perceive their work environment and how they interact with each other and external stakeholders. A selection of these factors will be discussed. First, the factor “Inclusion and equality” which represents a commitment to creating an organizational culture that values diversity and opinions from everyone. This factor emphasizes the importance of ensuring that all stakeholders, regardless of their organizational affiliations or reputation, have an equal opportunity to participate and influence the collaborative process (Gonzalez, 2017). By valuing heterogeneous perspectives and backgrounds, the MSC can harness a varied range of skills, experiences, and knowledge. This fosters creativity among stakeholders, ultimately enhancing the quality of collaborative decisions (Ayala-Orozco et al., 2018; Woldesenbet & Kebede, 2021). Conversely, while skills and perspectives may be disparate, the factor "Similar vision" posits the necessity for stakeholders to align on the MSC's objectives. The factor "Prevent competitive self-interests" extends this principle by emphasizing the significance of fostering a “Group identity” and encouraging a feeling of “Solidarity” within the collaborative (Loban et al., 2021). Other factors describe the importance of openly sharing information within the MSC. Factors such as “Transparency” and “Accessibility” reduce uncertainties while minimizing the risk of misunderstandings and fostering a culture of “Accountability”. “Transparency” is a cornerstone of effective collaboration and helps to build trust among the stakeholders (Kuenkel, 2019). “Trust building” is another factor which constitutes a dynamic process aimed at establishing reliability and mutual respect among stakeholders within an MSC. Building trust allows for a more efficient decision-making process and improved sharing of information (Jansen & Kalas, 2020). Trust-building activities, such as open “Face-to-face communication”, “Fair distribution of costs and benefits”, and increasing “Accessibility” contribute to the creation of a resilient and cohesive collaborative culture.

External influences:
The fifth cluster termed "External influences" encompasses factors which are beyond the immediate control of the MSC. During the literature review, three factors were combined to constitute this category. “Political stability” refers to the presence of a reliable political environment for the MSC. A stable and transparent political climate with clear regulations and policies provides a conducive context for collaboration (Corsaro & Engel, 2020). Furthermore, the external environment could provide a certain pressure to solve an actual problem: an “External pressure”. This pressure could originate from regulatory bodies, public expectations, or global issues that necessitate a collaborative response. For example, the imposition of new industry regulation (e.g., environmental standards) could necessitate stakeholders to collaborate in MSCs. The common challenge of complying to the new regulations motivates organizations within the affected sector to cooperate. By sharing resources and knowledge, these consortiums collectively address the regulatory changes ensuring mutual benefits. The third factor entails the “Social acceptance” of a project or MSC. The acceptance from the public provides legitimacy for a project or MSC to exist (Bulmer & Yáñez-Araque, 2023). The legitimacy of such a project, stems from a generalized perception or assumption that its actions are desirable, proper, or appropriate within a socially constructed system of norms, values, beliefs, and definitions (Czischke, 2018). Since achieving social acceptance is very complex if not impossible to actively influence, the factor is categorized as an external factor.

Preconditions:
The following cluster delineates the “Preconditions” imperative for the successful establishment and operation of an MSC. These fundamental requirements collectively form the basis for creating an environment conducive to effective collaboration. The factors impose foundational conditions which should be examined before the establishment of the MSC. These preconditions describe, among other elements, the composition of stakeholders, identification of risks, and presence of incentives to collaborate. The composition of stakeholders comprises four factors: “Holistic”, “Optimal partner mix”, “Number of stakeholders”, and “Heterogeneity”. The holistic factor underscores the importance of having all the required stakeholders collaborating within the MSC. This means that the involved stakeholders should cover all skills and resources required for the MSC (Beisheim et al., 2018). Having an optimal partner mix contributes to the composition of stakeholders by stressing the importance of selecting partners with diverse strengths, resources, and expertise, creating a complementary and synergistic mix. According to Karimova and Lee (2022), controlling the number of stakeholders is essential since an insufficient number of stakeholders hampers the development and distribution of knowledge while an excess of stakeholders complicates the communication and management processes. The last factor influencing the composition of stakeholders is “Heterogeneity”. This factor stimulates diversity among stakeholders’ perspectives, skills, and backgrounds, enhancing the collaboration's adaptability and creativity.

Another element which is addressed prior to the establishment of an MSC to prevent unforeseen complications is risk management. The first factor “Risk reduction” advocates proactive measures to identify, assess, and mitigate potential impediments to successful collaboration. Additionally, an exhaustive evaluation of the associated risks and benefits should establish a risk/benefit ratio serving as a quantitative indicator to assess if the potential gains outweigh conceivable drawbacks. Hereby, the evaluative assessment functions as an indication of the project's viability amidst the identified risks. Two factors influencing risk assessment are the execution of a “Preliminary stakeholder analysis” and efforts to “Understand the landscape”. A preliminary stakeholder analysis is instrumental for the identification and recruitment of partners to establish a holistic and optimal

partner mix (Kaumbata et al., 2020). The assessment identifies what the stakeholders can deliver and with whom a successful partnership is feasible, minimizing risks and optimizing the benefits. To understand the landscape within which a partnership is established requires an identification of all the relevant partners, the linkages between them and the external factors from the business such as other companies, institutions, and values (Haywood et al., 2019). This process is essential to predict, prevent and process potential risks.

Other factors discuss the importance of having a benefit for stakeholders to cooperate in MSCs. In other words, the presence of an “Improved legitimacy” and “Incentives” is important to stimulate stakeholders to collaborate. By understanding and addressing these preconditions, an MSC can lay a solid foundation for success and durability, fostering effective collaboration among diverse stakeholders.

Power distribution:
Another important consideration for fostering the durability of MSCs is the distribution of power. This thematic cluster conveys the interplay and dynamics associated with the power and influence exerted by stakeholders during the decision-making process. The cluster acknowledges diverse mechanisms through which stakeholders exercise control. The identified factors include the utilization of veto power, the guidance from intermediaries in decision-making processes, and the role of leadership in steering the collaborative process. Having a veto power allows stakeholders to unilaterally halt a decision or action (Czischke, 2018). Some authors argue that having a veto can severely hinder the decision-making process since unanimous decisions are rare in big collaboratives (Vayaliparampil et al., 2021). However, others argue that MSCs require a veto to establish an ethical culture where all stakeholders can remain true to their core principles (Czischke, 2018). Another factor impacting the power dynamics within an MSC is the influence of intermediaries interacting with the decision-making process. The influence of intermediaries not only structures the proceedings but also distributes power among stakeholders, as an impartial party adeptly organizes the process. The factor "Leadership" encapsulates the final factor influencing the power dynamics within MSCs and supplements the statement of having an intermediary. Leadership describes the presence of a body or institution which oversees, guides, influences, and directs a group of stakeholders towards achieving a common goal or objective (Aswad & Damayanti, 2020). However, various articles advocate for renaming this factor to “facilitative leadership” as this suggests a less influencing role of the leader and moves more towards the role of an intermediary (Aswad & Damayanti, 2020; Woldesenbet & Kebede, 2021). These articles propose that a governing body refrain from influencing decisions and focus solely on facilitating the required processes. Additionally, an effective leader demonstrates a solid and relevant body of knowledge, commitment, networking ability, and a comprehensive understanding of the interests of individuals responsible to a particular organization (Ellis & Idowu, 2018).

Objective:
This cluster embodies the strategic aims and tangible outcomes that stakeholders aspire to achieve within an MSC. The two factors which correlate to the meaning of objective are the “Effectiveness” and the “Creation of internal/domestic capabilities”. The effectiveness of an MSC reflects its ability to achieve intended goals. An effective MSC demonstrates a harmonious alignment between its strategic aspirations and the results attained, signifying a judicious utilization of collective resources. The factor "Creation of internal/domestic capabilities" pertains to the development and enhancement of internal and or domestic competencies within the collaborative framework. Hereby, the collaborative endeavor aims to develop competitive advantages through the cultivation of distinctive capabilities.

G: Abductive Clustering Approach

Cooperative capacity The first cluster titled "Cooperative capacity" is organized by seven level-two clusters: communication, meetings, homogeneity, democracy, relations, encouragement, and dedication. Cooperative capacity is delineated as the ability of partners within a collaborative partnership to engage in concerted efforts, working collectively towards the realization of mutually defined partnership objectives (Vayaliparampil et al., 2021). The above-mentioned seven clusters reflect three overarching level-three clusters: collaboration, unity, and engagement. Collaboration refers to a synergistic and inclusive approach with dynamic and cooperative interactions among various stakeholders. The findings suggest a focus on clear communication, effective and face-to-face interactions, and regular meetings to discuss findings and progress. In this way cooperative work methods are stimulated to achieve shared goals and objectives. Unity refers to the desired harmonious and cohesive work relationships among stakeholders in MSCs. Homogeneity in stakeholders' visions, organizational structures and institutional frameworks fosters a shared perception and objective. Unity also entails the higher-level factor democracy which encapsulates inclusivity, transparency, equality, and fairness during the decision-making process. The relations between stakeholders, which are the backbone of unity, should consist of trust, solidarity, and a shared group identity. Adhering to community-based participatory research principles (CBPR) principles further strengthens relations, promoting engagement and cooperation in achieving collective objectives. Overall, unity within an MSC thrives on shared values, democratic principles, and robust interpersonal connections. At last, collaborative capacity can be stimulated by the level-two cluster of engagement. This cluster pertains to the collective commitment and dedication of stakeholders towards shared objectives. Encouragement between stakeholders plays a crucial role signifying active support and motivation in pursuit of individual and collective goals. Another influential factor is dedication which reflects stakeholders' genuine commitment to the project. This dedication can be assessed by a stakeholder's willingness to invest time and other resources. Hereby, the engagement cluster underscores a collaborative ethos where stakeholders mutually encourage each other and demonstrate dedication to the collaborative endeavor.

Incentives The second cluster "Incentives" is constructed through three level-two clusters which are represented by two level-three clusters: Incentives and Objectives. The incentives cluster encompasses a set of factors which motivate or stimulate stakeholders to participate in MSCs. Incentives refer to tangible and intangible rewards or benefits that stakeholders can gain from collaborating with other stakeholders within a similar project. Stakeholders are enticed to collaborate by the prospect of competitive advantage, which manifests through increased available resources, improved efficiency, enhanced brand reputation, accumulated experience, and the involvement of influential actors. The incentives to engage in MSCs are further amplified by external pressure, social acceptance, improved legitimacy, tangible incentives, and a rewarding mechanism. This synthesis of benefits and inducements creates a compelling environment that fosters stakeholder engagement and commitment within the collaborative framework. The objectives refer to the established goals that the MSC aspires to achieve. The cluster involves the establishment of these goals and the alignment with societal interests for more public acceptance. Another goal is to optimize the risk-benefit ratio so that risks are mitigated, and benefits are enhanced. Furthermore, the cultivation of internal and/or domestic capabilities is a goal by itself, providing stakeholders with a competitive advantage and contributing to the success of the MSC. The overarching goal is the creation of an effective MSC reflecting both efficiency and productivity. Assessing the effectiveness or success of an MSC is challenging due to misinformation and bluewashing as an attempt from stakeholders to enhance brand reputation

(Beisheim & Simon, 2016). Vayaliparampil et al. (2021) offer a pertinent illustration of several influential factors, asserting the effectiveness of MSCs may be improved through various measures, including "clearer linkage to existing institutions and multilateral agreements, measurable targets and timetables, more effective leadership, improved accountability mechanisms, more systematic review, reporting, and monitoring" (p. 3).

Management The third cluster relates to the “Management” of MSCs. The management consists of a total of six level-two clusters which are reflected through two level-three clusters: “Organizational” and “Performance”. Management plays a crucial role in ensuring the durability of MSCs.

On the organizational front, effective management involves mediating between diverse stakeholders, coordinating MSC activities, and managing associated risks to maintain a stable collaborative framework. To mediate between stakeholders entails resolving or preventing conflicts. Conflicts are inevitable. However, they should not hamper the efficiency or result in an unwanted atmosphere. This role can be fulfilled by the intervention from intermediaries, who can act as partnership brokers, bridging agents, commissionaires or relationship builders for the parties working together (Dragomir & Foris, 2022). Furthermore, the accessibility should be managed. The accessibility of an MSC is an important factor in determining the eligibility of stakeholders to engage in the collaboration, as outlined by Sanderink and Nasiritousi (2020). This concept is intricately connected to the capability to "Control the involvement of hindering partners," signifying the influence over the participation of obstructive stakeholders. However, accessibility extends beyond the external considerations of an MSC. The internal dimension pertains to the availability and accessibility of pertinent data and findings to all partners within the MSC, ensuring equitable access to information and fostering effective contribution by all stakeholders to the collaborative endeavor.

The performance-related aspect of management is fundamental to enhance the success of MSCs. The performance of management encompasses research initiatives, rigorous evaluation processes, and perpetual skill development within the MSC. These elements aim to monitor and enhance the performance of MSCs. The research aspect encompasses a thorough analysis of the landscape within which the stakeholders are present. Comprehensive understanding of the stakeholder landscape in an MSC is imperative for research efficacy and sustained collaboration. The knowledge facilitates a nuanced navigation of power structures, potential relationships, and diverse interests. Besides understanding the landscape, a preliminary stakeholder analysis is also an important aspect to doing research. Conducting a stakeholder analysis before establishing the MSC serves as a foundational step to acquire a comprehensive understanding of the diverse entities involved. Such a preliminary examination establishes an identification of key stakeholders along with their respective interests and potential conflicts. This identification facilitates the formulation of an inclusive and efficacious collaboration framework. Insights in the complex relationships between stakeholders creates tailored approaches to align visions and improve collaboration. The second cluster of elements influencing the performance of MSCs is through monitoring. Monitoring shapes the performance of MSCs through the dual mechanisms of continuous evaluation and the systematic delineation and prioritization of issues. The ongoing process of monitoring and evaluating activities within the MSC enables the identification of operational strengths and weaknesses. Simultaneously, the strategic mapping and prioritization of issues within an MSC contribute to the adaptive capacity and identification of improvements. By periodically reassessing and reprioritizing issues, the MSC can respond efficiently to evolving circumstances and dynamic stakeholder needs, fostering resilience and sustainability. The last cluster of factors influencing the performance-related aspect of management is skill development, encompassing three factors. Firstly, instituting a feedback mechanism among stakeholders cultivates continuous improvement, fostering individual proficiency and augmenting collective efficacy. Secondly, the deliberate stimulation of learning within MSCs, manifested through

training or alternative educational modalities, enhances overall stakeholder competence. Thirdly, the adoption of an ambidextrous approach, wherein stakeholders hold a dynamic perspective exploring new skills and opportunities while at the same time exploiting existing proficiencies, also contributes to the development of skills within the MSC.

Institutional The description of the "Institutional" cluster is organized through six factors which aggregate into four level-two clusters which then merge into two level-three clusters: institutional and power.

The institutional sub-cluster comprises agreements, clarity, and institutional frameworks. Institutionalization provides a structured foundation. Hereby, a shared understanding is established while ambiguity in roles and responsibilities is minimized. The institutional cluster significantly impacts the durability of MSCs by establishing shared understandings and decreasing ambiguity in roles and responsibilities. Three clusters are identified which are categorized as an institutional aspect. The first cluster, agreements, emphasizes the potency of contractual arrangements. Contracts, within this context, serve as mechanisms to formalize decisions which underpin the collaborative endeavors. The second cluster, clarity, revolves around the collective determination and documentation of clear meanings and goals. Clear meanings and goals mitigate ambiguity and fortifies the collaborative foundation through a shared understanding. The third cluster, institutional, focuses on institutionalization. This factor refers to policy development and the establishment of rules and regulations. This formal structuring contributes to the establishment of a governance framework, promoting stability and sustainability within MSCs. Institutionalization enables stakeholders to collaboratively enjoy a clear structure and high performance. The rules and regulations can either be agreed upon verbally or contractual.

Additionally, the power sub-cluster focuses exclusively on power dynamics. The power cluster influences the durability of MSCs through two factors. Firstly, leadership discusses the presence of a leader. While it could be argued that leadership should be categorized under management, leadership has its core at the power distribution within an MSC. Effective leadership is characterized by visionary acumen, strategic orientation, and competent management. Clear leadership significantly contributes to the coherency and sustained engagement of stakeholders within the MSC. MSCs often refer to facilitative leadership to stress the less prominent role of the leader. The governing body does not influence decisions but merely facilitates the required processes. A good leader should therefore consist of a solid and relevant body of knowledge, commitment, networking ability and a clear overview of the interests of individuals responsible to a certain organization (Ellis & Idowu, 2018). Secondly, the right to veto relates power as well by distributing the power equally over the stakeholders. The provision of a veto right for stakeholders introduces a mechanism to unilaterally stop an action within the MSC (Czischke, 2018). Various authors argue that implementing a veto right can severely hinder the decision-making process (Vayaliparampil et al., 2021). However, others argue that MSCs require a veto to establish an ethical culture where all stakeholders can remain true to their core principles (Czischke, 2018). Hereby the equality of stakeholders should be guaranteed.

Conditions The last cluster of the abductive approach describes the "Conditions" of an MSC to become successful and durable. The cluster consists of one level-three cluster which is also labeled conditions. There are two level-two clusters which make up the conditions. First of all, external conditions incorporate critical factors such as political stability and the availability of time. External conditions, within the context of MSCs, pertain to potential influential factors outside the immediate control of the collaboration that can significantly impact the durability of the collaboration. The realm of external conditions goes beyond the influence of merely politics and the availability of time.

Identified factors such as the availability of resources, institutionalization, and social acceptance could also be considered as external factors. The presence of adequate resources (e.g., funding), clear regulatory framework and acceptance and support from society creates stability to the MSC.

The second level-two cluster delves into the composition of the MSC and consists of four factors. The four factors encompass the formation of MSCs through a rational combination of stakeholders, considering their respective characteristics. The first factor argues that the composition of stakeholders should be holistic. To obtain a holistic composition of stakeholders within an MSC all the required partners should be on board (Beisheim et al., 2018). This process entails an identification of the required skills and finding a combination of stakeholders which fulfills this prerequisite. A holistic approach ensures a comprehensive and more efficient collaboration. The second factor is labeled optimal partner mix and focuses on the quality and synergy among partners within the MSC. This factor scrutinizes whether stakeholders possess complementary skills, expertise, and resources. An optimal partner mix enhances the overall collaborative's effectiveness by aligning diverse strengths and weaknesses. Optimally, all weaknesses from one stakeholder should be compensated by other stakeholders' strengths. Another factor relates to the number of stakeholders. An excess of stakeholders can lead to inefficiencies and difficulties in reaching a consensus. Managing communication, coordination, and decision-making becomes more complex as the number of stakeholders increases. Furthermore, the feeling of accountability may diminish resulting in an unclear division of tasks. At last, the presence of more diverse opinions and interests could potentially increase the likelihood of conflicts. A deficiency of participants limits the diversity of perspectives and reduces the creativity within the MSC. Crucial resources might not be available for a small consortium. The fourth and final factor which influences the composition of stakeholders overlaps with the optimal partner mix factor. Heterogeneity between stakeholders assesses the diversity between skills and other characteristics. This factor acknowledges value in having variations in skills, distinctive qualities, and perspectives. These valuable assets contribute to innovative solutions and a collaborative dynamic.

H: Deductive Clustering Approach

The deductive approach to clustering describes the last method and commences with a pre-existing theory or framework (Azungah, 2018). As explained during the methodology, in this case the theory has been obtained through existing frameworks of clusters from literature. During the literature review, 17 articles were identified which defined formations of clusters*. These clusters are assigned an asterisk to differentiate from the obtained final clusters for the collaborative form. The resultant clusters are marked with ^ to signify their origin from the frameworks of clusters* and differentiate from the other clusters. Among the 17 articles, six articles provided well-defined frameworks as explained during Section 6.2.2. In total these articles yielded 39 clusters*. During the initial clustering phase these 39 clusters* were listed. Consequently, clusters* with similar meanings were amalgamated. Hereby, 20 distinct clusters* were identified since the other 19 clusters* could be scaled under one of the overarching clusters. Popular clusters* focused on the leadership and institutional design of MSCs. Additionally, clusters* emphasizing the management of MSCs, required resources, and the necessity of monitoring, reporting, and evaluation were recurrent themes that garnered more frequent mentions than other clusters. The second and final clustering phase resulted in a scoping down from 20 to ten final clusters. Due to the ambiguity of some derived clusters*, several of these clusters* are mentioned multiple times under different headings. However, this redundancy does not alter the inherent meaning of the final clusters. The Excel tab called “Deductive clustering approach” exhibits an overview of the deductive clustering approach.

Figure G1 provides an overview of the results of the deductive clustering approach when compared to the conceptual factors. The clusters in bold are the clusters which were established by the deductive approach with the constituting conceptual factors underneath. The clusters in italics are the four additional clusters identified during the comparison with the 69 conceptual factors which were not identified through the deductive approach. Below the figure, all clusters are independently discussed.

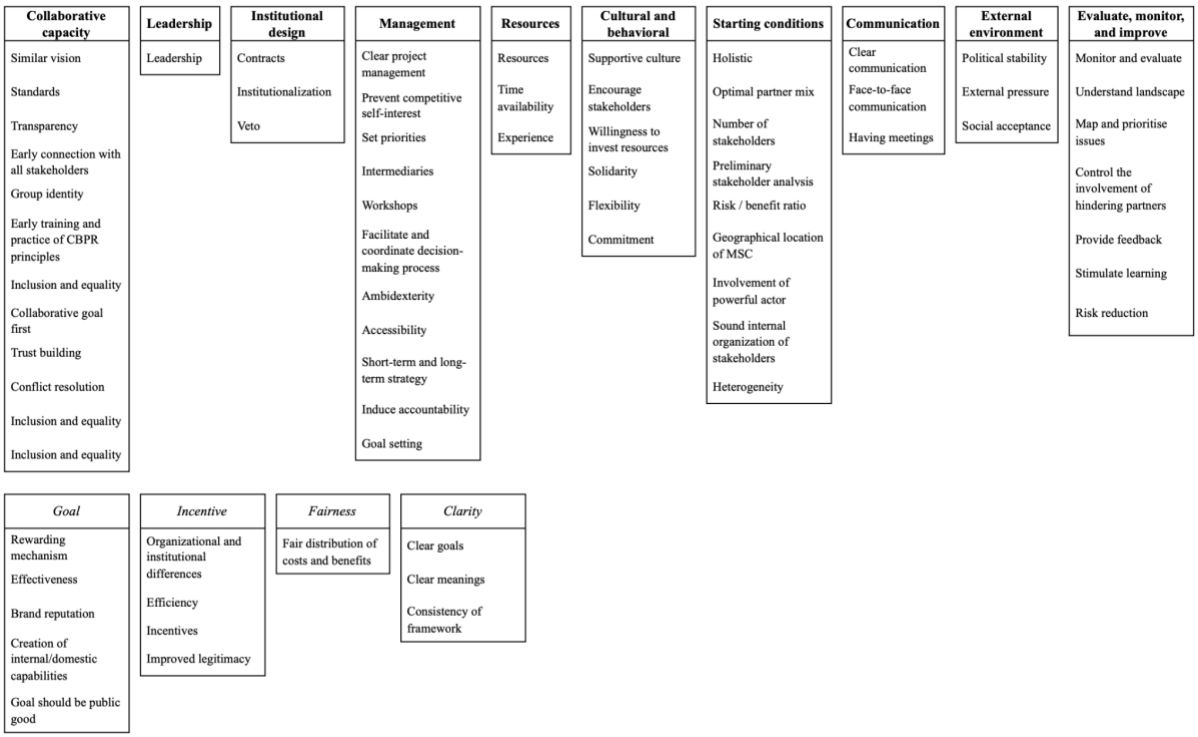


Figure A.0.4: Deductive clusters

Collaborative capacity
The first cluster^, termed “Collaborative capacity”, revolves around the idea that stakeholders require the ability to effectively cooperate with diverse stakeholders to contribute to shared objectives. This cluster encompasses the characteristics of stakeholders and the partnerships between them. A high collaborative capacity means that stakeholders have harmonious characteristics.

Leadership
The second cluster^ emphasizes the importance of effective “Leadership” within MSCs. Effective leadership is crucial for MSCs as it provides direction and establishes a cohesive structure (Bulmer & Yáñez-Araque, 2023). Without clear leadership, decision-making processes become challenging, hindering the collaboration's efficiency. Furthermore, leadership helps in mediating conflicts, fostering communication, and promoting a positive collaborative culture. An effective and facilitative leader contributes significantly to building trust, enhancing the collaborative process, and ensuring the adaptability and longevity of the MSCs over time (Aswad & Damayanti, 2020).

Institutional design
The next cluster^ also induces structure through rules and agreements by means of an “Institutional design”. This third cluster states that MSCs with a strong institutional and regulatory design, which is capable of limiting the occurrence of unwanted events and steer stakeholders in the right direction by stimulating or prohibiting certain actions, are more structured and efficient (Desportes et al., 2016). “Contracts” impose a methodology of enforceable commitments, delineating the terms and obligations binding the participating stakeholders (Beisheim & Simon, 2016). These contracts serve as a methodological framework to enhance clarity, accountability, and adherence to predetermined guidelines.

Management
The concept of “Management” encompasses internal themes such as the establishment of specific objectives and managing the required funding and resources for these projects. Furthermore, the management is reliable for deciding and communicating the vision of the MSC and allocating the roles, targets, and responsibilities to stakeholders (Beisheim & Simon, 2016). The management ought to identify potential obstacles and provide the necessary resources.

Resources
The “Resources” cluster^ describes the tools, assets and inputs required to achieve certain objectives. Specifically to an MSC, these resources entail human resources such as employees, financial resources required for funding, physical resources such as infrastructure and many more (Sanginga et al., 2007). The factors influencing this cluster are “Resources”, “Time availability” and “Experience”. Time availability refers to the available time which stakeholders can allocate to the project. The experience describes the accumulated knowledge and insights of stakeholders based on their past engagements in MSCs and their line of work. Experience encompasses lessons and knowledge learned over the years contributing to effective decision-making and improved collaboration within MSCs.

Cultural and behavioral
The "Cultural and behavioral" cluster^ refers to the collaborative environment. This cluster is shaped by various sub-clusters which stipulate the importance of an enabling environment. Within this context stakeholders are held accountable for their actions while concurrently respecting the characteristics and values inherent to each stakeholder. The cluster* defines how stakeholders

conceptualize and define issues, how their perceptions of others are formed, and how values are attached to knowledge and objectives. These cultural and behavioral nuances influence how stakeholders engage and contribute to the collaborative process (Desportes et al., 2016). By fostering a collaborative culture that adapts to challenges, values diverse perspectives, and integrates accountability measures, this cluster contributes to the sustained success and longevity of MSCs.

Starting conditions

The following cluster^ describes the importance of establishing favorable "Starting conditions" for MSCs. According to the clusters* identified during the literature review these starting conditions determine the foundation of an MSC and influence the potential for long-term success by addressing both internal and external factors which significantly impact collaboration (Beisheim & Simon, 2016). Several internal factors describe the characteristics of stakeholders, the relationships between them, and the exclusion of certain partners (Desportes et al., 2016). The external factors, influencing the starting conditions, refer to the political and social context (Bulmer & Yáñez-Araque, 2023). The management aspect of MSCs, overseeing the funding and resources, could arguably be both an internal and external factor.

Communication

The "Communication" cluster^ recognizes that transparent and effective communication, coupled with well-defined partnership characteristics, is an important aspect for durable MSCs (Desportes et al., 2016). Addressing challenges related to communication and fostering positive partnership attributes contributes to the enhancement of trust, clarity of goals and expectations, and an overall idea of the requisite tasks. Communication encompasses all forms of exchanging information between stakeholders. A deficiency within this process can therefore cause a lack or misinterpretation of information. Clear, transparent, and well-managed communication channels are essential to mitigate these risks and foster a collaborative environment where stakeholders are well-informed and engaged.

External environment

The "External environment" is characterized by a set of circumstances and conditions beyond the direct control of the MSC. The constituent clusters* encapsulate influences from politics, the public, and the availability of staff, infrastructure, and other resources (Beisheim & Simon, 2016; Bulmer & Yáñez-Araque, 2023). Understanding the external environment is an essential aspect to enable strategic planning, risk management, and overall success of the MSC. Although the MSC cannot actively control these factors, acknowledging and responding strategically is crucial in mitigating potential negative outcomes.

Evaluate, monitor, and improve

The final cluster^ is called "Evaluate, monitor, and improve". This cluster ensures a periodic evaluation of the current situation and identification of potential improvements. By integrating systematic reviews and ensuring periodic reporting, the cluster empowers MSCs to evolve, learn from experiences, and make informed adjustments (Vayaliparampil et al., 2021). Consequently, this cluster contributes to the sustained success and resilience over time of MSCs.

Comprehensiveness In order to assess the comprehensiveness of the clusters^ derived through the deductive approach, the resultant ten clusters^ have been compared with the 69 factors from the conceptual analysis. During this examination, the conceptual factors were categorized under the ten deductive clusters^. As can be concluded from Figure F3, 14 of the 69 factors could not be classified under the deductive clusters^. Subsequently, these 14 remaining factors were categorized in four additional clusters denoted as “Goal”, “Incentive”, “Fairness”, and “Clarity”. The fact that four clusters were not established through the deductive approach is most likely to be caused by the different input of data. This means that the input data for the deductive clustering method, originating from the frameworks, is less complete than the 69 factors from the conceptual analysis. Consequently, the inclusion of the comparison with conceptual factors has established 14 clusters.

Additional Clusters Due to the four additional clusters obtained through the process described above, the deductive approach resulted in a total of 14 clusters. It is expected that some of these clusters can be combined to create more inclusive but less-detailed clusters. This anticipation derives from the fact that the abductive clustering method yielded only five clusters despite drawing upon a greater volume of sources from the same database. The subsequent section will conduct an internal cross-validation between the three clustering methodologies to assess the potential merging of clusters or identify if the abductive approach failed to recognize distinct clusters.

The subsequent section of Appendix H provides an additional explanation of several deductive clusters along the composition of the conceptual factors. This elucidation is only provided for clusters which have not yet been thoroughly analyzed or differ significantly from previous clusters.

Cultural and behavioral

The sixth cluster describes the Cultural and behavioral aspects of stakeholders within an MSC. This cluster is similar to the “Organizational culture” cluster mentioned during the inductive approach. However, while the inductive approach identified twenty factors for the organizational culture cluster, the deductive approach only identified six factors. According to the first factor, stakeholders should adopt a “Supportive culture”. Research has shown that a culture of mutual assistance within collaborating entities contributes to increased trust, effective communication, and improved innovation (Kaumbata et al., 2020). The establishment of such a supportive environment enables stakeholders to navigate challenges collaboratively, combining resources, and enhancing the resilience of the collaboration over time. “Encouragement” represents another facet within the cultural and behavioral milieu. Ongoing encouragement stimulates active participation and enriches the collaborative process while strengthening the sense of ownership and commitment (Barrane et al., 2021). The “Willingness to invest resources” includes resources such as financial investments, knowledge, and the allocation of human capital and physical capital. These investments reinforce the collaborative framework, enabling it to withstand challenges and capitalize on opportunities for long-term impact. Stakeholders' willingness to invest not only demonstrates trust but also serves as a stimulus for others, encapsulated in the collective sentiment termed "Solidarity". Another beneficial characteristic of stakeholders is “Flexibility”. Embracing transformative innovation and adaptability enhances the collaborative process by enabling stakeholders to respond effectively to evolving challenges and opportunities. Flexibility contributes to the resilience of MSCs by providing a mechanism to navigate through dynamic environments and sustain relevance over time. The last factor, belonging to the Cultural and behavioral cluster, refers to the “Commitment” exhibited by stakeholders towards shared goals and values. The commitment fosters a resilient collaborative environment where stakeholders are dedicated and convinced about their project. This commitment extends across all levels of stakeholders, creating a sense of purpose.

Communication
Communication entails a cluster which was previously not identified as a competent cluster. Communication stresses the importance of having clear, frequent, and preferably face-to-face communication. To stimulate communication between stakeholders, meetings or less formal gatherings can be organized to build trust and strengthen relationships. These interactions provide a platform for open dialogue, fostering collaboration, and facilitating a better understanding of stakeholder's perspectives and objectives. Additionally, less formal gatherings create an opportunity for individuals to share insights, address concerns, and collectively work towards common goals. Ultimately, communication should stimulate a sense of unity and cooperation within the MSC.

External environment
The ninth cluster describes the influence of the external environment on MSCs. This cluster, similar to the cluster above, was previously not identified as a cluster on its own. The external environment is defined by a set of circumstances and conditions outside the direct control of the collaboration itself. The MSC must continually assess and adapt to these external factors since its ability to influence "Political stability", "External pressure", and "Social acceptance" is limited. However, by understanding and strategically responding to these elements, the MSC can enhance its resilience and effectiveness in navigating the complexities of its external surroundings.

Evaluate, monitor, and improve
The final cluster is called "Evaluate, monitor and improve". This cluster encompasses a set of factors designed to enhance the efficacy and sustainability of MSCs. The cluster integrates elements crucial for the systematic assessment of collaborative endeavors and the refinement of processes. The factors "Monitor and evaluate", "Understand landscape", and "Map and prioritize issues" discuss practices which are fundamental to reviewing the performance of MSCs. Other factors which examine and influence the functioning of the collaboratives are "Controlling the involvement of hindering partners" and "Risk reduction". The latter factor involves the identification, assessment, and implementation of strategies to mitigate potential risks, safeguarding the MSC against adverse outcomes. Controlling the involvement of hindering partners describes a solution to dealing with potential risks. In instances where a stakeholder imposes risks or impediments to efficient collaboration, it becomes imperative to address and rectify such challenges promptly and effectively.

Goal, Incentive, Fairness, Clarity
This section describes the four additional clusters obtained through the comparison of the deductive clusters with the conceptual factors.

The cluster denoted as "Goal" encompasses five factors which collectively represent the key elements that contribute to the overall success and effectiveness of the MSC. This cluster articulates the objectives of collaboration within an MSC. According to López-de-Ipiña et al. (2022), the main objective of an MSC is to provide stakeholders with rewards for their contributions, thereby motivating continued collaboration. Examples of such rewarding mechanisms may include financial benefits or mutual learning within an MSC. Another goal of participating in an MSC is the increased level of effectiveness which is typical to MSCs (Bäckstrand, 2006).
Obtaining a positive, reliable, and robust brand reputation can also be considered as a goal of an MSC. In this way trust and legitimacy is enhanced both within and towards the MSC as stakeholders and external organizations expect a higher level of professionalism, ethical conduct, and reliability from MSCs with a positive brand reputation. (Szulecki et al., 2011). The fourth goal pertains to the "Creation of internal and domestic capabilities" to gain a competitive advantage. This cluster

stimulates innovation within a certain aggregation of stakeholders to create a competitive advantage (Morsink et al., 2011). This cluster stimulates the creation of knowledge enabling the MSC to outperform other organizations in the sector. At last, Berti (2020) suggests that having a goal aligned with the public good improves support, fostering cooperation and financial backing, resulting in greater project success.

The second additional concept represents four factors which collectively describe the presence of “Incentives”. These factors function as stimulants for stakeholders to participate in MSCs. One component describes the importance of minimizing “Organizational and institutional differences” (Vikstedt & Rajala, 2023). Also described as institutional homogeneity, this factor describes the alignment between different stakeholders. Institutional homogeneity in an MSC contributes to a more synergetic and efficient collaboration by aligning stakeholders in terms of values, communication, and overall operational frameworks. Another incentive to collaborate in MSC is to save time and other resources. In other words, stakeholders are incentivized to collaborate in order to improve the overall “Efficiency”. The last two factors describe “Improved legitimacy” and “Incentives". Improved legitimacy refers to an enhanced perception of credibility, authenticity, and validity associated with the collaboration (Kuenkel & Aitken, 2015). In essence, there needs to be a reason for the MSC to exist. For example, because one stakeholder cannot perform the required tasks on its own. Incentives refer to factors stimulating stakeholders to collaborate, which may not necessarily imply improved legitimacy, as incentives such as enhanced profit do not mandate stakeholder participation to achieve the collaboration's objective.

The concept of fairness solely derives from the factor emphasizing the importance of a “Fair distribution of costs and benefits”. According to Bitzer and Schouten (2022) stakeholders should be included during the decision-making process and perceive a proportional distribution of costs and benefits based on their inputs. Failure to achieve fairness may lead to the exit of stakeholders from the partnership, forming a rival initiative that corresponds better to their own interests. Therefore, fairness is essential for the establishment of a successful MSC by fostering trust and equity.

Lastly, the concept of clarity encompasses the importance of setting clear goals and meanings. The consistency of methods, objectives and definitions mitigates misalignments in expectations and communication.

I: Article Categories and corresponding Clusters

The most impactful categories are "divergent visions" and "tensions within and between sectors”. The category "divergent visions" is linked to the homogeneity aspect of MSCs. The collaborative form categorizes homogeneity as an intricate element of the cluster Cooperative capacity. Similarly, "tensions within and between sectors" pertains to the relations established within MSCs and is also categorized under Cooperative capacity. “Differing timeframes and lack of project continuity” is characterized by temporal misalignments between sectors participating in projects. Therefore, this category corresponds to the Management cluster. The only category influencing the Incentives cluster is “insufficient funding and personnel”. This challenge addresses resource limitations which are associated with “competitive advantage”. The category “limited participation and inadequate organization among stakeholders” delineates a reliance on community leaders and is consequently categorized under the Management cluster. “Inadequate institutional organization” offers insights into power dynamics and the significance of agreements. This category relates to the Institutional cluster. The “problems of communication and lack of information” category falls within the description of the communication sub-cluster. The final category mentioned by Ayala-Orozco et al. (2018) is labeled as “structural conditions”. This category encapsulates territorial, economic, and socio-political aspects that set conditions in which collaborations transpire, aligning with the Conditions cluster.

J1: Interview Summary Christian (Hanze university)

Background:

Christian is an employee of Hanze University in Groningen. Here Christian specializes in modeling energy systems, with experience using the ESSIM platform, also employed by the MMvIB group. He has also done some experimenting with linking different models, semi-successfully.

Discussion:

- Modeling energy systems:
  - Purpose and influence: Modeling energy systems aims to explore possibilities and examine different futures. It serves as a cost-effective tool for identifying bottlenecks before implementation.
  - Essentiality: Modeling is crucial for the energy transition, despite its simplifications, offering a cost-effective means to identify potential issues. Implementing potential solutions in the energy system is often impossible and more expensive.
  - Bottlenecks: Current problems in modeling energy systems are often related to the existing infrastructure. Particularly cable capacity has been neglected or taken for granted for an extended period. This oversight has led to complications, and although recognizing the importance of considering the current infrastructure, incorporating it into modeling processes is currently challenging.
- ESSIM Energy model and collaboration:
  - ESSIM functionality: ESSIM involves a user interface with GIS layers, designing energy systems for regions. It's linked to MMvIB, enhancing optimization.
  - Coupling models: Coupling models, including ESSIM, is challenging but improves effectiveness.
- Collaboration in Multi-Stakeholder projects:
  - Agreements: Agreements on milestones and a long-term vision are common, with a lead stakeholder managing tasks.
  - Hierarchy: Projects often have a lead stakeholder, but tasks are frequently managed independently.
  - Measures of effectiveness: Key Performance Indicators (KPIs) depend on stakeholder goals.
  - Transfer of knowledge: Knowledge sharing varies, and CoP effectiveness relies on commitment and engagement.
- Challenges and solutions:
  - Resource constraints: Money and time constraints are common, with knowledge transfer being a potential issue.
  - Active participation: Some stakeholders struggle due to internal issues, emphasizing risk assessment and realistic time estimates.
  - Performance evaluation: KPIs, milestones, and the achievement of project goals determine performance.
- MMvIB project assessment:
  - Project Ambition: Acknowledges the ambitious nature of MMvIB, suggesting a focus on gaining knowledge initially.
  - Revolutionary aspects: Recognizes the project's revolutionary features, highlighting the need for continuous development, potentially involving a full-time PhD student.

- Objective and holistic identification of barriers:
    - Biases and bottlenecks: Acknowledges biases in stakeholder perspectives and suggests considering the cascading effects of one party's issues on others.
    - Tackling biases: Recommends having an expert review results and using questionnaires before meetings to gather unbiased data.
- Overall impression of MMvIB project:
    - Acknowledges the project's ambition, noting its revolutionary aspects and suggesting a phased approach, starting with knowledge acquisition, and expanding later.
    - In summary, Christian’s insights shed light on the complexities of modeling energy systems, collaboration in multi-stakeholder projects, and the challenges and potential solutions within the ambitious MMvIB project.

J2: Interview Summary Rosa (Hanze university)

Background:

Engaged in researching energy transition, specifically in modeling complex energy systems. Utilizes analytical skills to model and analyze data related to challenges in system integration during the transition.

Discussion:

- About research:
  - Focuses on project-based research, particularly on industrial sites facing network congestion.
  - Current issues include insufficient network capacity, addressing solutions like user flexibility and storage methods (hydrogen vs. batteries).
  - Scenario development involves collaboration with users and municipalities, extending beyond industrial settings to residential areas.
- Role of models:
  - Models help in understanding and predicting energy transition by ensuring a balanced energy supply and demand.
  - Challenges include accounting for uncertainties, variability in renewable energy production, and volatile energy prices.
- Multi-modeling:
  - Acknowledges the use of Power Nodes and ESDL models, emphasizing transparency and potential future integration with Python.
  - Highlights the need for transparent models over black-box commercial solutions for effective collaboration.
- Challenges and improvements:
  - Identifies limitations in current energy models, especially in addressing heat-related aspects and lacking standards for various heat pump types.
  - Indicates ongoing efforts to transition from Excel-based Powernodes to Python and increasing model interconnectivity.
  - The collection of necessary data for energy-related purposes can be achieved in various ways but remains difficult due to privacy reasons. There is a project called "energy sense" where households grant permission for the use of data from smart meters. An intermediary reads and anonymizes the data, retaining information about house types but not personal names. Similar approaches could be applied in the industrial context, using aggregated data to maintain anonymity. Challenges include mapping flexibility due to uncertainty about whom to approach. Additionally, non-disclosure agreements with energy companies may be employed to regulate data access, ensuring anonymity in publications. The use of questionnaires is considered less effective, prompting direct visits to companies for data collection.
- MMvIB project:
  - Discusses potential challenges in the MMvIB project, emphasizing the need for continuous improvement and innovation to maintain stakeholder interest.
  - Suggests that having a clear leader for project coordination is beneficial.
  - To keep stakeholders connected to a project means that they should be incentivized. If innovation is present this already imposes an incentive for stakeholders as knowledge

is generated. Organizations such as TNO entail a project-based operation. This means that this organization needs to be granted time for specific projects.

- Communication and coordination:
  - Advocates for a project leader to maintain coordination.
  - Emphasizes the importance of a clear agenda and regular communication mechanisms for project engagement.
- MMvIB Project Pitfalls:
  - Highlights potential challenges in the MMvIB project, including the presence of black-box models and an overemphasis on cost optimization. Black boxes are processes within the project where there is a lack of transparency. In this case this black box occurs when commercial entities are present which hamper the transparent transmission of data to the stakeholders.
  - Advises exploring similar projects at European levels and considering other sectors beyond energy.
  - Proposes looking into comparable projects to gain insights and avoid biases in identifying barriers.
  - Stresses the importance of a clear user interface which enhances the user-friendliness. Users of the multi-model should not have to understand the model to operate it.
  - A good solution to account for innovations in the future should be incorporated. Currently, a growing efficiency factor is often established but there might be a better solution.

J3: Interview summary Ewoud (Hanze university)

Background:

Ewoud is not involved in the Multi-model project. He has a background in energy modeling and serious gaming. Ewoud combines technical physics, technical public administration, and system control. He worked at DMV, Gasunie IT, and is currently a lecturer/researcher at Hanze university, focusing on operational control and teaching strategic energy management using Quintel's model.

Discussion:

- Energy scenario planning:
  - The frequency of updating an energy system model depends on new developments, both in technology and politics.
  - Ewoud's teaching approach involves a scenario matrix, considering key factors influenced by factors like European regulations, political ambitions, and the need for drastic changes for goal attainment.
  - Scenario planning examines key factors with high impact and uncertainty, exploring extreme scenarios. Models need to adapt to technological advancements.
- Multi-modelling challenges:
  - Suggests using multiple models based on the specific goals, acknowledging that a comprehensive multi-model approach might be challenging.
  - Acknowledges the challenges at both technical (IT integration) and conceptual (defining model composition) levels. He emphasizes considering PESTEL factors (Political, Economic, Social, Technological, Environmental, Legal) for a holistic view.
  - Challenges include technical integration difficulties and determining the model composition based on conceptual goals. Achieving accessibility, considering licenses and servers, is crucial.
  - Balancing interconnectivity between models and commercial interests is a potential challenge.
- Multi-stakeholder collaboration:
  - Identifying Problems in Stakeholder Collaboration: To uncover potential problems hindering long-term collaboration, Ewoud suggests interviewing stakeholders and looking beyond their perspectives to ensure a comprehensive understanding.
- Sustaining the MMvIB project:
  - Recommends assessing Key Performance Indicators (KPIs) with stakeholders to gauge their contributions and identify missing elements for project continuation.
  - Highlights the effectiveness of serious games for policy understanding, allowing politicians to experience the consequences of decisions like installing additional solar panels.
  - Determining responsibility for the project's continuity involves evaluating stakeholder contributions through KPIs, emphasizing the need for long-term collaboration as outlined in project agreements.

J4: Interview Summary Linda (TNO)

Background:

Linda works as consultant data science at TNO. The interview was about the BOMOS model which TNO has helped to establish. BOMOS supports standardization communities and their clients in structurally shaping the management and further development of standards. It provides simple and clear models and advice based on practical insights. The interview especially aimed to identify similarities and differences between the BOMOS model and the collaborative form identified during this thesis. The “review of specific factors” section of this interview summarizes some of the factors which were discussed.

Discussion:

- Nature of BOMOS:
  - BOMOS originated from TNO's experience in establishing and managing semantic standards, primarily in data standardization. While it's tailored for open standards, it can be applied to other types. It serves as a framework for discussing and planning standards management.
  - Linda implements BOMOS as a framework to start a conversation and express the complexity of projects.
  - BOMOS 1 (2009) involved discussions with a small group of semantic standardization experts. BOMOS 2, a year later, incorporated experiences and insights. It's a high-level model, and its application depends on the specific context, providing guidance for comprehensive standards management plans.
  - BOMOS evolved from situations where there was a need to establish standards management organizations. It captures commonalities across various branches rather than a specific case study.
- BOMOS’s completeness:
  - BOMOS is experience-driven, lacking strong scientific underpinning. However, personal experiences and colleague feedback suggest it is fairly comprehensive, addressing high-level themes applicable across diverse projects.
  - BOMOS’s practical utility is considered high. While there may be unique characteristics in each domain, the overarching categories cover a broad spectrum. The lack of a scientific study was compensated by Erwin Folmer's PhD research, providing a scientific check for BOMOS.
- Durability:
  - Underscores the significance of sustainability in innovation projects where several stakeholders need to collaborate. Establishing a permanent organization and a long-term plan is crucial, moving away from project-based or one-time subsidized models. The focus is on cultivating a lasting vision, exploring suitable financing and organizational structures for sustainable solutions.
- Comparison with Own Model:
  - BOMOS is experience-based, serving as a guide for discussions on structural standards management. Differences may arise due to the specificity of each domain, but BOMOS offers a comprehensive foundation. It is possible to come up with additional sub-categories, but that wouldn't be the foundation you need to fall back on.
- Review of specific BOMOS factors:

    - Communication: “Communication is not about communication among the parties within the management organization. It is intertwined with other aspects, such as under the heading of operational. The heading of communication pertains to external adoption; one could question whether the heading is accurate—it essentially revolves more around adoption.”
    - Community: ”Community involves a lot of complexity. The model is for "open standards," so that means our objective is that it does not hide behind a goal or that you need various rights. However, you do want to build a community where people participate, attend events, and encourage their own group to join. It can also involve an online community (community portal).”
    - Rights: “Addresses the balance between keeping standards open and the necessity for direct payment, as seen in organizations like NEN.”
- Review of conceptual factors:
    - Trust building: “Trust would be best suited for governance agreements. For instance, you want to prevent that someone who pays more has more influence. This could, for example, enhance trust. Also, in tactics, we try to build a relationship of trust, so it fits here as well.”
    - Transparency: “Transparency applies to many areas. However, concerning open standards, you could, in principle, categorize this under all areas. Perhaps the least under complaint handling.”

J5: Meeting Nihit (TU Delft)

Background:

Nihit works as an Assistant Professor of Policy Innovation at TU Delft, specializing in comprehending, elucidating, and advocating policy innovation within intricate sociotechnical systems. His objective is to stimulate transitions towards a more sustainable future. The convened meeting aimed to ascertain new clustering methods and verify the existing methodologies.

Discussion:

- Additional Methodologies:
  - It is not imperative to employ different clustering methods than was intended.
  - Exploring alternative clustering methods, such as the graphical representation method, introduces additional complexities due to the abundance of factors.
  - An abductive approach could be explored to provide a synthesis of elements from both the inductive and abductive approaches.
  - Considering a chronological arrangement of factors or clusters could be deemed advantageous.
- Challenges:
  - The persistence of personal bias remains a challenge.
  - The mitigation of personal bias through computer programs is feasible. However, clearly defined factor definitions must be provided as input, introducing a level of ambiguity.
  - The circumscription of personal bias is achievable through a meticulous step-by-step documentation of each undertaken action.

J6: Interview Layout Stakeholders

Background:

The next four interviews are all similar in layout to minimize the influence of biases. The interviews are held with four of the stakeholders who operate in the MMvIB project. The intention of the interviews is to discuss the role of the organization, analyze the collaboration within the MSC, discover important factors which stimulate durable collaboration, establish a hierarchy in clusters, and discover future possibilities for the management of the MMvIB project. This section provides an overview of the layout. The interviews themselves will be summarized to remain concise.

Layout:

- Welcome: Extend greetings and provide an overview of the interview's purpose and structure.
- Introduction: Present an overview of my identity and the scope of my research.
- Request for approval: Seek the interviewee's consent for recording the discussion and the use of their name.
- Introduction and role: Invite the interviewee to introduce themselves and elaborate on their role within the MMvIB project.
- Organization's involvement: Explore the organization's role in the MMvIB project.
- Motivation for participation: Investigate the motivating factors behind the organization's participation in the MMvIB project.
- Introduction to my research: Provide insights into the methodology and execution of my research.
- Examination of MMvIB collaboration: Inquire about the strengths and areas for improvement in the collaboration within the MMvIB project.
- Hierarchy within established clusters: Present each cluster and prompt the interviewee to establish a hierarchical order within these clusters. Additionally, gauge their perception of the comprehensiveness of these clusters.
- Recommendations for sustained engagement: Elicit recommendations for specific tools or strategies that can facilitate the organization's continued involvement in the MMvIB project.
- Management of the MMvIB project: Identify factors influencing project management decisions and allow participants to select from four predefined options for the managing organization. These options are: TNO (or an organization under TNO), a commercial company or certified organization consisting of various stakeholders, TU Delft, and EZK (governmental organization).
- Conclude interview: Ask if there are any questions and thank the interviewee for the participation.

J7: Interview Summary Gregor (Quo Mare)

Background:

Gregor has a background in mathematics and has worked at TNO. He spent seven years at ORTEC and has been a supply chain optimization consultant throughout his career, focusing on optimization. At Quo Mare, Gregor has been involved in a project related to the MMvIB project, utilizing his knowledge, and also taking on a project management and COO role for office operations. Quo Mare contributed an optimization model to the MMvIB project. The interviewee is engaged in the MMvIB project from both a substantive and project management perspective. Quo Mare's involvement aims to explore connections with other models in the field of energy transition. Even if direct connections cannot be established, the goal is to gain a better understanding of other models and explore potential future collaborations. The primary focus is not on achieving operational results that would otherwise be unattainable but rather on theoretical exploration to connect models and understand the dynamics. Maintaining contact with other participating parties is considered crucial. The interviewee, along with a second person (usually a graduate student), represents Quo Mare in the project.

Discussion:

- Motivation for participation:
  - Quo Mare participated to gain insights into others' work, avoid missing collaborations, and assess their ability to run models or operate the orchestrator. Their role was substantial, and they aimed to acquire knowledge, maintain relationships, and avoid becoming an outsider.
- Current state of collaboration in the MMvIB project:
  - At this stage, as the project nears completion, there is less active collaboration, primarily focusing on the reporting phase. Two key situations were highlighted: plenary sessions involving all parties and case studies which were divided along three case studies; micro, meso, and macro. The collaboration in the case studies (Quo Mare participated in the micro and meso) was described as positive, with small groups fostering a good atmosphere. However, the effectiveness of collaboration depends on the involved parties. The interviewee noted that one company exited the project, possibly due to time constraints and divergent interests. Given that MMvIB is not profit-driven, the departure might be attributed to the pursuit of more commercially viable projects.
- Post-deadline activities:
  - There is an upcoming closing gathering, but active engagement with project content is not expected to continue. The future involvement depends on the stakeholders' decisions.
- Top three factors for smooth collaboration:
  - The interviewee emphasized the importance of a positive attitude among participants during plenary sessions. The engagement level of some participants, like Hanze University, was unclear, and the lack of progress in the initial phase was attributed to vague leadership and discussions. The interviewee suggested that defining roles and initiating case group activities earlier could have improved the project's momentum. Additionally, the initial project proposal lacked clarity. The collaborative approach

during plenary sessions, involving 25 individuals using post-its, was deemed chaotic and ineffective.

- Cluster ranking:
    1. Cooperative capacity (as it involves the attitude of stakeholders)
    2. Incentives (describes why stakeholders want to collaborate)
    3. Conditions
    4. Management
    5. Institutional (if institutions are the incentive to keep the collaboration going you can better stop)
    - The interviewee ranked the importance of factors in the context of the MMvIB project. Cooperative capacity, reflecting participant attitudes, was deemed most important, followed by incentives, conditions, management, and institutional.
- Cluster completeness:
    - The interviewee expressed confidence that the current model, derived from extensive literature review (134 articles), is likely to be comprehensive, leaving no significant clusters missing.
- Future of MMvIB project:
    - Potential usage: The interviewee sees potential for a follow-up project, envisioning a case where various models could be integrated and applied for real-world calculations. However, the orchestration approach may be more applicable in a commercial setting, where a party could use the MMvIB project's approach to link models and charge fees.
    - Maintaining involvement: To keep Quo Mare engaged, financial aspects need improvement, making it financially more attractive without incurring costs. The focus should be on practical, client-oriented situations, not solely academic benefits.
- Factors influencing project management:
    - Commercial interest: Commercial considerations are crucial in deciding who should manage the MMvIB project, aligning with the notion of potential commercial usage.
- Future management of MMvIB project:
    - The interviewee expressed a preference for practical application over pure research, suggesting TNO for practical use and EZK for research. The interviewee highlighted the importance of clarifying the project's end goal, expressing concerns about government involvement turning it into a never-ending research project. Additionally, the interviewee emphasized the need for a practical approach, connecting models to achieve meaningful outcomes based on customer goals, as opposed to a narrow focus on specific solutions for individual locations, as initially perceived by someone from TNO.

J8: Interview Summary Evert Jan (Hanze university)

Background:

Evert Jan is a lecturer from Hanze university and is also part of LEVE. LEVE is the abbreviation for the Dutch group of lecturers called “Lectorenplatform Energievoorziening in Evenwicht”. Evert Jan has access to all project information but possesses a supervisory role. Their role is focused on the application side, assessing the practical usability of the model once it is ready. LEVE's involvement in the project was driven by the interest in exploring the potential applications of the model, even though, at present, it is considered too challenging and unclear for instructional use.

Discussion:

- Stakeholder collaboration:
  - The interviewee acknowledges good collaboration in the MMvIB project, highlighting the enthusiasm of team members and well-defined case studies. However, vulnerability arises due to specific employees holding crucial knowledge, and external factors like illness or leave could disrupt the project.
- Factors for successful collaboration:
  - The interviewee emphasizes the importance of connecting various aspects beyond individual components, such as considering social and legal factors. The project's long-term goal remains somewhat unclear, posing a challenge for holistic integration.
  - Resource constraints, including the availability of key personnel and potential budget limitations, are identified as challenges. Shifts in timelines and allocations occur to accommodate varying needs of different groups involved.
- Cluster ranking
  1. Incentives (If stakeholders have no benefit from a collaboration, they will not participate)
  2. Cooperative capacity
  3. Management
  4. Conditions
  5. Institutional (Stakeholders should not be forced to collaborate)
- Future of MMvIB project:
  - The interviewee predicts the project's continued focus on research, with ongoing studies to explore uncertainties in the model. The potential for educational use remains uncertain, but as a research object, the MMvIB project holds significant potential.
- Sustaining stakeholder engagement:
  - The interviewee suggests defining a follow-up project with funding, enabling continued collaboration. The potential for stakeholders' ongoing involvement depends on establishing clear benefits and maintaining cooperative capacity.
- Factors influencing project management:
  - The interviewee highlights that the chosen entity to manage the MMvIB project should possess experience, knowledge, and the ability to secure the model. Security and expertise are crucial considerations for the entity taking over the project's management.
- Options for MMvIB project management:

- The interviewee discusses the four established options for managing the MMvIB project: a small entity under TNO, a commercial company or certified foundation, TU Delft, and EZK. The choice depends on how mature the MMvIB model is; if ready for commercial application, TNO or similar entities are suitable, while TU Delft may be more suitable for ongoing research and development. The time frame for each potential managing entity is considered.

J9: Interview Summary Charlotte (Quintel)

Background:

The interviewee, Charlotte, joined Quintel a year into the MMvIB project, where they worked with a team of three on developing an app, possibly in collaboration with ESDL. Charlotte serves as a bridge between team members and actively participates in meetings. The team's work is dependent on open-source models, and they cannot generate revenue directly from the model. The project is seen as a passion project driven by ambition and ideology rather than financial gains. The community's collaborative effort is crucial for the success of the project, as individual contributions may not be sufficient. The interviewee emphasizes the time and community involvement required for developing the ESDL module. Quintel's motivation for participating in the MMvIB project is attributed to building connections with stakeholders, gaining knowledge about the model, and receiving subsidies for their efforts. The primary focus is on networking and utilizing models to contribute to the project's success. The company's role involves active participation, collaboration, and contributing to the development of the ESDL module.

Discussion:

- Project collaboration:
  - Challenges and successes in the collaboration are discussed over the two-year MMvIB project duration. A positive factor was the atmosphere between stakeholders. However, initial uncertainties regarding expertise, deliverables, and the end product caused a slow beginning. Face-to-face interactions, especially in the early stages, were deemed essential for more effective communication and understanding.
- Improving collaboration:
  - Strategies to enhance collaboration are explored, emphasizing the importance of early identification of key steps within the macro and meso cases. Face-to-face meetings, especially during the early stages, and better-defined process agreements are suggested to improve efficiency.
- Factors for durable collaboration:
  - The interviewee highlights the lack of a long-term planning and underscores the importance of continued involvement for sustaining the MMvIB project. Financial support is crucial to maintaining and expanding the project. Demonstrating the practical usability of MMvIB is identified as a challenge and an essential factor for long-term engagement.
- Clustered factors for collaboration:
  1. Conditions
  2. Incentives
  3. Cooperative capacity
  4. Institutional
  5. Management
  - Conditions and incentives, particularly the availability of time and resources, are considered most crucial for successful collaboration. Cooperative capacity and institutional follow. Management is deemed least important since there was no clear end goal. Furthermore, management was not of great influence during the MMvIB project since the cooperative capacity was great. It was assumed that management is less importance when the cooperative capacity within an MSC is efficient.

- Future of the MMvIB project:
    - The interviewee expresses optimism about the future of the MMvIB project, emphasizing the need for practical use without compromising decision-making efficiency. Balancing complexity to avoid hindering decision-making is highlighted as a challenge.
- Sustaining Quintel's involvement:
    - The interviewee suggests that Quintel would be eager to participate in projects based on specific requests from the government, clients, or stakeholders. Maintaining involvement may be challenging when working with new parties, but continuous projects could foster sustained engagement.
- Factors for project management:
    - Factors influencing the choice of a managing entity for the MMvIB project are discussed. The interviewee recommends considering the interconnected nature of the multi-model, suggesting that TNO, with its knowledge and expertise, could be a suitable choice, especially if the focus is on the entire structure rather than specific components.
- Options for MMvIB project management:
    - Four potential managing entities are presented, with TNO and EZK considered the most logical options. Government involvement is seen as lacking expertise, while a stakeholder-driven foundation with certification is deemed less practical due to conflicting interests. The preference is leaning toward TNO due to its involvement in the project's development and ongoing research and development efforts. The choice depends on the ultimate use of the MMvIB project, whether as a working model or for continued development and knowledge acquisition. The interviewee expresses a preference for TNO's continued involvement, given its research and development focus and existing rapport.

J10: Interview Summary Vincent (TNO)

Background:

Vincent has been a project leader and researcher at TNO for the past ten years. He specializes in energy transition and modeling, particularly focusing on business parks. In the MMvIB project, he led the micro-workcase from the summer of 2022, contributing to defining objectives and results. His role extended to overseeing the IT aspects, configuring multi-model infrastructures for effective communication, and bridging the gap between technical details and practical understanding. TNO's involvement in the MMvIB project encompasses a multidisciplinary team, including project leaders and developers, with a fluctuating size of four to eight members. The team's composition allows for active participation in various project phases. TNO's motivation for joining the project aligns with their mission, "Innovation for life". The project offered an opportunity to contribute IT expertise and gain valuable knowledge. TNO emphasized the importance of collective knowledge-sharing, envisioning the acquired insights not just for their benefit but for the broader advantage of the Netherlands.

Discussion:

- Collaboration reflection:
  - The participant reflects on the collaboration, emphasizing positive aspects such as good energy and willingness to contribute. Challenges included varying perspectives, notably the balance between scientific and practical viewpoints.
- Enhancing collaboration:
  - Suggestions to enhance collaboration include expressing expectations more frequently and ensuring project transferability in case of team member change.
- Factors for durable collaboration:
  - Identified factors for sustained collaboration include a shared vision, a clear common goal, and a compelling reason for collaboration, emphasizing mutual benefits such as knowledge development.
- Cluster ranking:
  1. Incentives
  3. Cooperative capacity
  3. Management
  3. Conditions (experience of stakeholders is important)
  5. Institutional (not relevant due to the structure of the project)
  - The participant highlights the significance of having an interest in the collaboration. This best fits the description of having an incentive. From here stakeholders will be guided to having a shared vision and goals, minimizing the impact of institutional factors.
  - Vincent reached the conclusion that the organization of clusters posed a challenge due to the presence of conditional requirements in each cluster, resulting in three clusters occupying the second position. These clusters were ranked at level three.
- Missing clusters:
  - The participant suggests a potential addition to the model, emphasizing the importance of market demand and financial viability, distinct from the existing clusters.

- Future of MMvIB project:
  - The MMvIB project, at the technical proof-of-concept stage, requires further research for a validated prototype. The participant highlights the need to activate market demand for the project's progression.
- Sustaining TNO's involvement:
  - TNO recognizes the project's value and sees potential in market demand. Sustained involvement requires a follow-up project. Required subsidies will come from innovation subsidies but TNO is also willing to invest.
  - For the follow-up project more inclusion is required. For example, the opinion and vision of the grid operators should be incorporated.
- Managing MMvIB project:
  - Factors for selecting a project manager include independence, competence across diverse areas, expertise in ICT, administration, and the capacity needs to be sufficient.
  - TNO sees itself more in the innovation phase than in long-term project management.
- Options for MMvIB project management:
  - TNO is uncertain but open to exploring the possibility.
  - Commercial company is a viable option. In this case TNO is willing to support.
  - TU Delft is seen as a potential manager, but details need further exploration.
  - EZK might be a logical choice if technical support is available, with considerations for potential project management.

K: Elaboration of Table 3

This appendix functions as a description of the utilized factors. The factors are derived from several interviews, brainstorm sessions and from existing knowledge.

- Commercial interests: The pursuit of financial gain through the application of the multi-model.
- Conflicting interests: Divergent desires stemming from the organizational structure.
- Innovation: The organization's capacity to advance the multi-model.
- Expertise: The presence of knowledge, skills, and experience in relevant fields.
- Access to data: Availability of comprehensive datasets (e.g., national energy system).
- Transparency: The clarity and accessibility of the model to third parties.
- Independence: The degree to which external factors, such as commercial interests or privacy concerns, impact the model's objectivity.
- Flexibility: The ability to modify aspects of the multi-model as needed.
- Regulation: Influence on policy development and regulatory frameworks concerning the multi-model.
- Resources: Availability of financial and material assets, excluding knowledge.
- Organizational structure: Alignment of the organization's structure with the objectives of the multi-model.
- Security: The capability to safeguard the multi-model and associated data.