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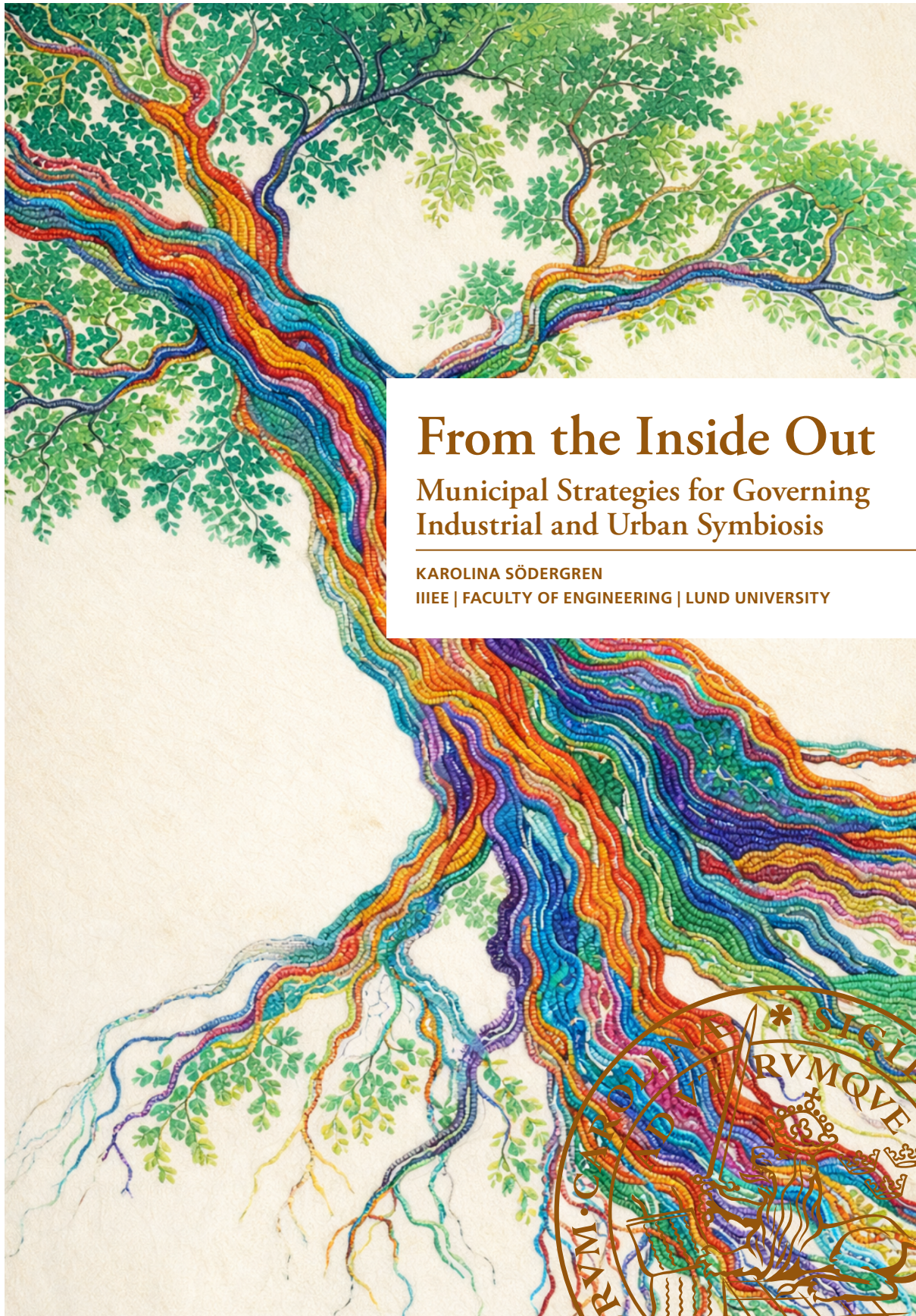
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From the Inside Out

Municipal Strategies for Governing Industrial and Urban Symbiosis

KAROLINA SÖDERGREN

IIIEE | FACULTY OF ENGINEERING | LUND UNIVERSITY



INDUSTRIAL AND URBAN SYMBIOSIS (IUS) is increasingly promoted as a way to reduce resource use and environmental impacts while supporting local sustainability transitions. Municipalities are often seen as key facilitators of such initiatives, yet little attention has been paid to how municipal organizations themselves shape the conditions for symbiosis. This dissertation examines how municipalities govern IUS from the inside out. Drawing on five empirical studies of Swedish municipalities, it explores municipal roles and strategies, the organizational arrangements through which symbiosis work is carried out, and the value orientations shaping IUS governance in practice. The findings show that symbiosis development depends not only on technical solutions or external collaboration, but also on the internal capacity of municipal organizations to coordinate responsibilities, align strategies, and sustain collaboration over time.



From the Inside Out:
Municipal Strategies for Governing Industrial and Urban Symbiosis

From the Inside Out

Municipal Strategies for Governing Industrial and Urban Symbiosis

Karolina Södergren



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DOCTORAL DISSERTATION

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Abstract:

Industrial and urban symbiosis (IUS) is increasingly promoted as a means to reduce resource use, lower environmental impacts, and support local sustainability transitions. Municipalities are often assigned a key role in facilitating such arrangements, yet research has primarily focused on inter-firm collaboration and external coordination, paying limited attention to how municipal organizations themselves shape the conditions for symbiosis. This dissertation addresses this gap by examining how municipalities govern IUS from the inside out.

Drawing on five empirical studies (Papers I–V), the dissertation explores municipal roles and strategies in IUS governance, the organizational arrangements that shape how such work is carried out, and the value orientations of municipal actors, as expressed in governance practice through internal collaboration and coordination. The research combines two in-depth municipal case studies with comparative interviews and a national questionnaire, enabling both contextual insights and cross-municipal comparison. The material consists of a systematic literature review, qualitative interviews, document analysis, participatory observations, and a national questionnaire. The analysis is guided by a framework that combines perspectives on governing modes, public sector organization, and value orientations.

The findings show that municipalities engage in IUS through multiple forms of action, including facilitation, regulation, infrastructure provision, partnership, and experimentation within their own operations. However, sustained engagement is not primarily determined by the choice of governing role, but by whether symbiosis becomes anchored in established municipal practice. This anchoring takes place through the allocation of responsibilities, coordination across departments and municipally owned companies, and the integration of IUS into strategies and administrative routines. The results further demonstrate that organizational form and value orientations shape how IUS is interpreted, prioritized, and operationalized within municipal administrations.

By foregrounding these internal dimensions, the dissertation contributes to research on IUS and to broader debates on public-sector sustainability governance. It shows that municipal contributions to symbiosis depend not only on technical solutions or policy instruments, but on the organizational work required to sustain direction, coordination, and responsibility over time. The dissertation also outlines implications for sustainability policy, suggesting that long-term IUS development requires support for organizational continuity and internal coordination alongside external collaboration.

Key words: industrial and urban symbiosis, municipal governance, internal governance, public sector organizations, municipal organization, circular economy

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From the Inside Out

Municipal Strategies for Governing Industrial and Urban Symbiosis

Karolina Södergren



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*With hopes for a sustainable future
built on kind communities*

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Abstract

Industrial and urban symbiosis (IUS) is increasingly promoted as a means to reduce resource use, lower environmental impacts, and support local sustainability transitions. Municipalities are often assigned a key role in facilitating such arrangements, yet research has primarily focused on inter-firm collaboration and external coordination, paying limited attention to how municipal organizations themselves shape the conditions for symbiosis. This dissertation addresses this gap by examining how municipalities govern IUS from the inside out.

Drawing on five empirical studies (Papers I–V), the dissertation explores municipal roles and strategies in IUS governance, the organizational arrangements that shape how such work is carried out, and the value orientations of municipal actors, as expressed in governance practice through internal collaboration and coordination. The research combines two in-depth municipal case studies with comparative interviews and a national questionnaire, enabling both contextual insights and cross-municipal comparison. The material consists of a systematic literature review, qualitative interviews, document analysis, participatory observations, and a national questionnaire. The analysis is guided by a framework that combines perspectives on governing modes, public sector organization, and value orientations.

The findings show that municipalities engage in IUS through multiple forms of action, including facilitation, regulation, infrastructure provision, partnership, and experimentation within their own operations. However, sustained engagement is not primarily determined by the choice of governing role, but by whether symbiosis becomes anchored in established municipal practice. This anchoring takes place through the allocation of responsibilities, coordination across departments and municipally owned companies, and the integration of IUS into strategies and administrative routines. The results further demonstrate that organizational form and value orientations shape how IUS is interpreted, prioritized, and operationalized within municipal administrations.

By foregrounding these internal dimensions, the dissertation contributes to research on IUS and to broader debates on public-sector sustainability governance. It shows that municipal contributions to symbiosis depend not only on technical solutions or policy instruments, but on the organizational work required to sustain direction, coordination, and responsibility over time. The dissertation also outlines implications for sustainability policy, suggesting that long-term IUS development requires support for organizational continuity and internal coordination alongside external collaboration.

Popular science summary

Many municipalities want to reduce climate emissions and use resources more wisely. Yet turning these ambitions into everyday practice is often harder than expected. The challenge is not only what should be done, but how it can be done in organizations that are already stretched by core responsibilities and tight budgets. This matters because municipalities are responsible for much of the infrastructure that shapes daily life, such as energy, water, waste, land use, buildings, and public procurement. If smarter use of resources is to become the new normal, it has to take root in the organizations that plan, run, and maintain these systems over time. Industrial and urban symbiosis (IUS) is one approach with that potential.

At its core, IUS is a simple idea: resources that are usually treated as waste, such as excess heat, wastewater, sludge, or leftover materials, can instead be used again. For example, a factory's excess heat can warm nearby buildings, treated wastewater can be reused in agriculture, and organic waste can become biogas for public transport. A "symbiosis" is created when different actors exchange resources in ways that benefit all involved. When this works well, it can reduce environmental impact, lower costs, and make local systems more robust in the face of climate change, resource shortages, and economic uncertainty.

Despite its promise, symbiosis rarely happens on its own. It requires coordination, long-term commitment, and the ability to deal with legal, practical, and organizational challenges. This is where municipalities often play a key role. While previous research has focused primarily on collaboration between companies, this PhD shifts attention to what happens inside municipalities themselves. It asks a simple but often overlooked question: how do municipalities need to organize their own work to make symbiosis possible and sustainable over time?

This dissertation draws on studies of Swedish municipalities to examine how this work unfolds in practice. One important finding is that municipalities are involved in symbiosis in more ways than is often assumed. They act as facilitators, for example by bringing companies together and creating spaces for collaboration. But they also work with symbiosis inside their own organizations. They can do this by testing symbiosis-inspired solutions in municipal operations, for example through land-use planning, procurement, and the management of energy, water, and waste systems. In this way, municipalities are not only coordinators but can also become participants in symbiosis.

At the same time, the research shows an important tension: municipalities are often closely connected to symbiosis systems through infrastructure and responsibilities, but they are less often active participants in the sense of actively mobilizing their own resource flows as part of IUS exchanges. Many internal efforts focus on "resource-smart" routines and circular initiatives within the organization, while deeper forms of symbiosis, where resources are exchanged between several actors,

are harder to achieve in practice. This reflects limited time, uncertainty about municipal mandates, and the difficulty of coordinating across many units and actors.

These internal conditions also explain why many of the main obstacles to IUS are found inside municipal organizations rather than outside them. In many municipalities, the work is carried by one or two committed officials, alongside other tasks, making progress fragile and dependent on individuals. Coordination across departments is another challenge, as symbiosis often involves planning, environment, water, waste, energy, and business development, which are typically organized in separate municipal units. Even when political ambitions are high, responsibility for implementation can remain unclear.

This is why internal collaboration becomes a cornerstone. Where municipalities manage to build stable structures for coordination, such as formal working groups, cross-departmental forums, or routines that bring departments together repeatedly over time, symbiosis is more likely to survive beyond projects and individual champions. These working arrangements help create shared priorities and a clearer sense of responsibility across organizational boundaries. Without them, symbiosis easily becomes tied to one unit, one project, or one person.

The research also shows that symbiosis is not only about infrastructure and costs, but about values and the ability to collaborate across differences. Different actors value symbiosis for different reasons: some focus on practical benefits such as secure access to resources or lower costs, while others emphasize innovation, environmental responsibility, or long-term sustainability. If these differences are ignored, collaboration can become fragile. Municipalities often play an important role in holding these perspectives together and building shared understanding over time.

Taken together, the findings point to a clear conclusion. Successful symbiosis depends less on new solutions and more on strong organizational foundations. When municipalities align strategies, organizational forms, responsibilities, and everyday routines across departments, they are better able to work both internally and with external partners. This is why this research matters: it shows that the transition toward smarter, more sustainable use of resources is not only a question of innovation, but of municipal capacity – the ability to coordinate, learn, and maintain continuity over time. If municipalities are expected to contribute to climate and sustainability goals, they need more than inspiring projects. They need ways of organizing responsibility, collaboration, and learning so that industrial and urban symbiosis can become part of everyday municipal development, rather than remaining a series of isolated initiatives.

List of papers

Paper I

Södergren, K. & Palm, J. (2021). The role of local governments in overcoming barriers to industrial symbiosis. *Cleaner Environmental Systems*, 2, Article 100014. <https://doi.org/10.1016/j.cesys.2021.100014>

Paper II

Södergren, K. & Palm, J. (2021). How organization models impact the governing of industrial symbiosis in public wastewater management. An explorative study in Sweden. *Water*, 13, Article 824. <https://doi.org/10.3390/w13060824>

Paper III

Wadström, C., Södergren, K., & Palm, J. (2023). Exploring total economic values in an emerging urban circular wastewater system. *Water Research*, 233, Article 119806. <https://doi.org/10.1016/j.watres.2023.119806>

Paper IV

Södergren, K. & Palm, J. (2025). Governing industrial and urban symbiosis: Internal and external strategies for municipal development. *Journal of Environmental Management*, 384, 125469. <https://doi.org/10.1016/j.jenvman.2025.125469>

Paper V

Södergren, K. (2026). Governing industrial and urban symbiosis from within: Internal municipal strategies in Sweden. *Circular Economy and Sustainability*, 6, 157. <https://doi.org/10.1007/s43615-026-00922-2>

Paper contributions

Paper I

KS: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization.
JP: Validation, Writing – original draft, Writing – review & editing.

KS initiated the paper, developed the research design and methodology, conducted data collection and analysis, wrote the majority of the original draft, and carried out the review and editing in collaboration with JP. JP wrote parts of the original draft and carried out the review and editing in collaboration with KS.

Paper II

KS: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review and editing, Visualization.
JP: Conceptualization, Methodology, Validation, Formal Analysis, Writing – original draft, Writing – review and editing, Visualization.

KS initiated the paper, developed the research design and methodology, conducted all the data collection, wrote the majority of the original draft, and carried out the review and editing in collaboration with JP. JP assisted with the research design and methodology, wrote parts of the original draft, and carried out the review and editing in collaboration with KS.

Paper III

KS: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review and editing.
CW: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Literature review, Writing – original draft, Writing – review and editing, Visualization. JP: Validation, Writing – original draft, Writing – review and editing.

KS and CW initiated the paper, developed the research design and methodology. KS conducted the data collection from the case study, and CW conducted the literature review. KS and CW wrote the majority of the original draft; JP wrote parts of it. CW led the review and editing and handled the visualization (graphics), with contributions from KS and JP.

Paper IV

KS: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review and editing, Visualization.
JP: Validation, Writing – original draft, Writing – review and editing.

KS initiated the paper, developed the research design and methodology, conducted all the data collection, wrote the majority of the original draft, and handled the visualization as well as most of the review and editing. JP assisted with the original draft and contributed to the review and editing.

Paper V

KS: Conceptualization, Methodology, Investigation, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review and editing, Visualization.

KS initiated the paper, developed the research design and methodology, conducted all the data collection, wrote the original draft, handled the visualization as well as the review and editing.

Other publications

Journal publications

Palm, J., Södergren, K., & Bocken, N. (2019). The role of cities in the sharing economy: Exploring modes of governance in urban sharing practices. *Energies*, 12 (24), Artikel 4737. <https://doi.org/10.3390/en12244737>

Bocken, N., Jonca, A., Södergren, K., & Palm, J. (2020). Emergence of carsharing business models and sustainability impacts in Swedish cities. *Sustainability*, 12 (4), Artikel 1594. <https://doi.org/10.3390/su12041594>

Palm, J., Lazoroska, D., Valencia, M., Bocken, N., & Södergren, K. (2024). A gender perspective on the circular economy – a literature review and research agenda. *Journal of Industrial Ecology*. <https://doi.org/10.1111/jiec.13554>

Conference papers & extended abstracts

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Abbreviations

BQV	Bequest Value
CE	Circular Economy
DUV	Direct Use Value
EU	European Union
EXTV	Existence Value
IDUV	Indirect Use Value
IIIEE	International Institute for Industrial Environmental Economics
IS	Industrial Symbiosis
IUS	Industrial and Urban Symbiosis
IWRM	Integrated Water Resource Management
NGO	Non-Governmental Organization
N-DUV	Negative Direct Use Value
N-EXTV	Negative Existence Value
N-IDUV	Negative Indirect Use Value
OV	Option Value
PSO	Public Sector Organization
QCA	Qualitative Content Analysis
QOV	Quasi Option Value
TEV	Total Economic Value
UN	United Nations

Preface

The research presented in this dissertation was carried out at the International Institute for Industrial Environmental Economics (IIIEE) at Lund University. The IIIEE is a center for interdisciplinary research and education, known for its close collaboration with societal actors to advance sustainable solutions.

This PhD is part of the research project *Smart Symbiosis: Collaboration for Common Resource Flows*, funded by the Swedish Energy Agency (grant number 46016-1) within the Graduate School in Energy Systems. The project studies smart symbiosis solutions, that is, solutions that create resource efficiency, innovation, and integration in value chains by connecting energy and material flows among public and private actors. It seeks to increase knowledge about what opportunities, consequences, and values can be obtained when actors adopt a circular perspective, coordinate organizational or business models, and explore new ways of working together in urban planning.

The project is interdisciplinary, bringing together three doctoral students with different academic backgrounds, theoretical perspectives, and methodological approaches. This dissertation contributes to that effort by focusing on how municipalities govern industrial and urban symbiosis internally, and what this implies for their evolving role in sustainable development.

Before beginning my doctoral studies, I worked in Geneva with sustainability and industrial and urban symbiosis related issues in a different setting. This experience has made it especially rewarding to return to the topic in an academic context, and to tie together practice-based insights with research.

This doctoral journey began in October 2018 and concludes in April 2026. During this time, I had the privilege of welcoming two children and taking two periods of parental leave, which have shaped both the timeline of the work and my experience of the PhD.

We also live in unusual times: a moment of both environmental urgency and shifting human values. Writing this dissertation has, in many ways, provided something steady and meaningful to hold onto amid that uncertainty.

With this, I invite the reader to explore the work that follows.

Karolina

Klagshamn, April, 2026

1. Introduction

Climate change, biodiversity loss, and resource scarcity are increasingly visible across the globe, putting pressure on the very systems that sustain planetary and human well-being (Rockström et al., 2009; Steffen et al., 2015). Rising consumption, urban expansion, and industrial production amplify these pressures, making it clear that incremental solutions are no longer enough. To meet these challenges, societies need systemic approaches that can reduce resource use while maintaining economic and social development.

The circular economy (CE) has gained traction as one such approach. Envisioned as an alternative to the linear “take–make–dispose” model, it emphasizes strategies for reducing, reusing, and recycling resources, or closing, narrowing, and slowing material loops (Bocken et al., 2016; Kirchherr et al., 2017a; Murray et al., 2017). CE has become a cornerstone of international and national sustainability agendas, embedded in policy frameworks such as the EU’s Circular Economy Action Plan (European Commission, 2020b). While CE offers a broad vision, its implementation ultimately depends on tangible solutions that connect high-level goals to the infrastructures, organizations, and practices that shape everyday life.

Industrial symbiosis (IS) is a concrete and operational expression of the CE. Whereas the circular economy encompasses a broad range of resource efficiency and reuse practices, IS refers specifically to inter-organizational exchanges of material and energy flows across organizational boundaries. By creating collaborations in which one organization’s residual flows become another’s inputs, IS simultaneously improves resource efficiency, reduces waste, and offers economic gains (Ashton, 2009; Baas & Boons, 2004; Chertow, 2000, 2004; Neves et al., 2020). The well-known Kalundborg Symbiosis in Denmark has demonstrated for decades how industrial collaboration can generate environmental, economic, and social benefits greater than the sum of what any individual actor could achieve alone (Ehrenfeld & Gertler, 1997; Jacobsen, 2006; Kalundborg Symbiosis, 2026).

Building on these principles, industrial and urban symbiosis (IUS) extends the concept into urban contexts, integrating municipalities, utilities, and other public actors into symbiosis networks (Dong et al., 2017; Van Berkel et al., 2009). Practical applications include channeling industrial excess heat into district heating, reusing treated wastewater for agriculture, or recovering organic waste for biogas production. By linking infrastructures of production and consumption, IUS makes

circularity tangible at the city scale – precisely where resource challenges and opportunities intersect most directly (Chertow & Park, 2016).

IUS is increasingly recognized as a promising strategy for advancing sustainable urban development. Its benefits extend beyond efficiency and emissions reductions to include innovation, resilience, and new forms of collaboration across sectors (Fraccascia, 2019; Martin & Harris, 2018; Wadström et al., 2021). For municipalities, IUS aligns directly with core responsibilities in planning, infrastructure, and service provision, while also providing a vehicle for translating national and international climate and resource goals into local practice (European Environment Agency, 2019). Reflecting this potential, IS and IUS feature prominently in policy frameworks such as the EU’s Circular Economy Action Plan and Horizon 2020 research programs, and are further supported by broader EU industry and climate initiatives like the Clean Industrial Deal (European Commission, 2019, 2020b).

Yet despite its promise, IUS often falls short in practice. While promoted as a systemic solution, many initiatives remain confined to pilot projects or isolated collaborations. Numerous studies note a mismatch between expectations and implementation, sometimes described as the “symbiosis gap”, where technical possibilities exist but institutional constraints and coordination challenges limit long-term development (Neves et al., 2019; Palm et al., 2019; Rodin & Moser, 2021; Taqi et al., 2022). Because IUS relies on collaboration between multiple public and private actors, such challenges directly influence whether exchanges can be initiated, scaled, or sustained. This suggests that progress depends not only on technical and economic feasibility, but also on the ways in which public and private actors interact, coordinate, make decisions, and support joint initiatives over time. Understanding how IUS can move from vision to practice therefore requires attention to governance, here understood as the processes and structures through which actors steer and shape interaction and collaboration over time, including the conditions that enable or hinder it (Bevir, 2012; Pierre & Peters, 2000).

1.1 Problematization and research gap

Research on IS and IUS has expanded alongside the growing interest in and experimentation with symbiosis practices. Much of this research has focused on industrial actors and exchanges, examining technical feasibility, environmental performance, and economic outcomes through engineering and techno-economic assessments (Chertow, 2000; Chiew et al., 2025; Neves et al., 2020). Over time, however, scholars have come to recognize that symbiosis is not only a technical arrangement but also a governance challenge involving diverse actors, interests, and institutions (Boons & Spekkink, 2012; Paquin & Howard-Grenville, 2012;

Velenturf, 2016). This recognition has brought municipalities into the spotlight. As planners of infrastructure, regulators of land use, and providers of essential services such as waste, water, and energy, municipalities are indispensable actors in IUS (Baas & Boons, 2004; Mirata, 2004; Palm et al., 2019).

Yet the literature on municipal roles in IUS remains limited. Much of it has examined the external dimension of governance, e.g. how municipalities facilitate industrial collaboration, create partnerships, or provide enabling conditions for businesses (Lenhart et al., 2015; Van Berkel et al., 2009). These studies highlight the important ways in which municipalities can help address barriers such as regulatory misalignment, limited information sharing between firms, or uncertainty around investment risks (Boons et al., 2017; Golev et al., 2015). What remains far less explored is the internal side of municipal governance: the administrative structures, responsibility allocation, coordination practices, and strategic processes through which municipalities shape the conditions for IUS (Bulkeley & Kern, 2006; Palm, 2006). Without coherent internal arrangements, however, municipalities risk fragmented external engagement and limited continuity in collaborations (Boons et al., 2017; Wamsler & Pauleit, 2016).

Within this broader internal context, one important factor is organizational arrangements. Whether services are delivered within municipal administrations or through municipally owned companies shapes priorities, accountability, and the balance between citizen welfare and business-oriented logics (Grossi & Thomasson, 2015). These differences, in turn, influence how IUS initiatives are initiated, resourced, and aligned with broader development goals within the municipal organization. At the same time, formal structures rarely tell the whole story (Christensen et al., 2011). Day-to-day practices such as how departments interact, how information flows, and how shared narratives are built also shape whether symbiosis work gains traction. Informal practices can therefore prove just as important as formal strategies and policies in sustaining momentum (Bevir & Rhodes, 2010; Feldman & Pentland, 2003; Weick, 1995).

Another internal aspect that remains underexplored concerns the values and motivations that guide municipal actors. While technical and regulatory barriers to IS are well documented, far less is known about how municipal organizations perceive and prioritize the benefits of IUS (Ashton, 2008; Mirata, 2004; Ramsheva et al., 2019), or how differing value systems may enable or constrain joint work (Gregg et al., 2020; Haase et al., 2024). Research on inter-organizational collaboration shows that value misalignments can undermine trust, limit legitimacy, and weaken long-term commitment (Walls & Paquin, 2015). Understanding which values are expressed, included, or excluded in IUS is therefore essential for explaining why some initiatives succeed while others falter, and for designing internal governance approaches that can accommodate heterogeneous interests (Mirata, 2004; Walls & Paquin, 2015).

In sum, while IUS is widely promoted as a promising circular economy strategy, research has yet to adequately explain how municipalities govern IUS from within, how internal and external strategies interact, how organizational arrangements shape governing capacity, and how municipal actor values shape governance in practice through internal collaboration and coordination. Addressing these gaps is vital not only for advancing theoretical debates on industrial symbiosis and urban governance, but also for understanding how municipalities can contribute more effectively to the development of IUS systems (Boons et al., 2017; Corvellec et al., 2022).

1.2 Research aim and questions

Building on the gaps identified above, this dissertation aims to advance understanding of how municipalities govern industrial and urban symbiosis internally.

This is explored through three research questions (RQs):

RQ1: What roles and strategies do municipalities adopt in governing IUS?

RQ2: How do internal organizational arrangements and practices shape municipal governance of IUS?

RQ3: How do municipal actor values shape the governance of IUS, as expressed in internal collaboration and coordination?

These questions are addressed through five appended papers, each contributing to different aspects of the overarching aim. Taken together, they provide a comprehensive approach that links municipal roles and strategies with organizational arrangements and municipal actor values, thereby offering an integrated understanding of how municipalities govern IUS internally.

1.3 Overview of papers

Each of the five appended papers contributes differently to the three overarching research questions that frame the analysis of how municipalities govern industrial and urban symbiosis.

Paper I contributes to RQ1. It is titled “*The role of local governments in overcoming barriers to industrial symbiosis*” and aims to develop a theoretical framework for how municipalities can reduce barriers to industrial symbiosis by applying different modes of governing. Published in *Cleaner Environmental Systems* in 2021, the paper applies a local governance framework that distinguishes

five governing modes (self-governing, provision, authority, enabling, and partnership), linking these to the economic, technical, regulatory, social, and informational barriers identified in the literature. A review of previous studies shows that municipalities most often rely on enabling, provision, and authority, but the analysis demonstrates that all modes can be used, individually or in combination, to overcome barriers. The article concludes by suggesting policy recommendations, such as establishing clear municipal strategies for IS and integrating IS into physical planning.

Paper II primarily addresses RQ2, with partial contributions to RQ1 and RQ3. Titled “*How organization models impact the governing of industrial symbiosis in public wastewater management: An explorative study in Sweden*,” it aims to examine how different organizational forms, specifically municipal administrations and municipally owned companies, shape the governance of IS in the wastewater sector. Published in *Water* in 2021, the paper draws on a case study of Simrishamn, which reorganized its water and sewage operations from being managed within the municipal administration to being operated through a municipally owned company during the research period. Using qualitative content analysis of interviews, observations, and documents, the study shows that the administrative form reflects a public-administration model that fosters inclusiveness, transparency, and alignment with citizen welfare goals, but risks deprioritizing IS compared with other pressing issues. By contrast, the corporate form reflects a business-oriented model that promotes technical expertise, innovation, and efficiency, but with reduced transparency and weaker integration of political and citizen-oriented objectives. The article concludes that organizational forms matter because they embody different governance models, which condition municipalities’ capacity to govern IS and shape the balance between efficiency, innovation, and democratic accountability.

Paper III contributes to RQ3. It is titled “*Exploring total economic values in an emerging circular wastewater system*” and aims to investigate which value orientations different organizations express in an emerging wastewater-based symbiosis, and how these converge or diverge. Published in *Water Research* in 2023, the paper develops an interdisciplinary framework combining the total economic value concept with organizational archetypes. Drawing on interviews and document analysis from the Simrishamn case, the study shows that direct and indirect use values dominate, referring to benefits linked to immediate resource use and broader societal or environmental effects, while option and existence values, associated with future opportunities or the intrinsic value of resources, are seldom considered. It also finds that organizational affiliation shapes how values are prioritized: corporate-oriented actors emphasize direct use values, while municipalities and non-governmental organizations (NGOs) recognize a broader range. The article concludes that conflicting value orientations may complicate collaboration in wastewater-based IUS and argues that fostering a minimum level

of value coherence is important for legitimacy and the effective development of such initiatives.

Paper IV broadens the scope by mapping strategies across a larger set of municipalities, contributing to RQ1, and partially to RQ2 and RQ3. Titled “*Governing industrial and urban symbiosis: Internal and external strategies for municipal development*”, it aims to analyze how municipalities balance internal governance with external engagement strategies in IUS. Published in *Journal of Environmental Management* in 2025, the paper is based on a survey of 22 Swedish municipalities, which shows that IUS is widely prioritized, but levels of engagement vary. Internally, self-governing strategies, particularly political anchoring, are identified as key enablers. Externally, municipalities predominantly adopt enabling, provision, and partnership strategies, emphasizing coordination and facilitation over enforcement. The article concludes by clarifying how municipalities combine internal and external strategies, offering a framework that informs both academic debates on governance and practical efforts to institutionalize IUS.

Paper V turns the lens inward to municipal administrations, contributing to all three research questions. Titled “*Governing industrial and urban symbiosis from within: Internal municipal strategies in Sweden*”, it examines how municipalities organize IUS internally and what this means for embedding symbiosis in ordinary administrative work. The paper, published in *Circular Economy and Sustainability*, draws on qualitative interviews and municipal documents, and applies a framework that combines governance modes with public sector organization (PSO) elements. The analysis shows that municipalities govern IUS through evolving combinations of self-governing and authority-based approaches across different parts of the organization. Self-governing initiatives often build legitimacy and shared understanding and, in several cases, serve as stepping stones toward more structured forms of anchoring. Authority-based measures, in turn, are used to stabilize initiatives by integrating them into adopted plans, mandates, and established routines. What proved decisive was not the existence of written commitments alone, but whether ambitions were translated into everyday administrative practice through their integration into organizational processes and coordination structures. The paper further identifies tensions between municipalities acting as facilitators and participants in IUS systems, as well as between circular economy practices and the development of more systemic forms of industrial and urban symbiosis.

Together, the five papers provide complementary insights into municipal governance of IUS, addressing roles and strategies (RQ1), organizational forms and conditions (RQ2), and municipal actor values as expressed in internal collaboration and coordination (RQ3). Table 1 illustrates the relationship between the research questions and the appended papers.

Table 1. Contribution of papers to research questions. Colors: green, fully; pink, partly.

Paper	Title	RQ1	RQ2	RQ3
1	The role of local governments in overcoming barriers to industrial symbiosis	X		
2	How organization models impact the governing of industrial symbiosis in public wastewater management. An explorative study in Sweden	X	X	X
3	Exploring total economic values in an emerging urban circular wastewater system			X
4	Governing industrial and urban symbiosis: Internal and external strategies for municipal development	X	X	X
5	Governing industrial and urban symbiosis from within: Internal municipal strategies in Sweden	X	X	X

1.4 Audience

Given the applied nature of this dissertation and its position at the interface between research and practice, the work speaks to several audiences whose perspectives and actions are critical to advancing IUS.

Academia. The dissertation contributes to research on industrial and urban symbiosis, municipal governance, and public sector organizations. It advances IUS theory by combining governance modes with public sector organization (PSO) system elements, and by highlighting relational, cultural, and temporal aspects of internal governance. The findings may be of interest to scholars in sustainability transitions, public administration, and urban studies who seek to better understand how municipalities shape circular economy initiatives, including IUS.

Policy makers. For municipal, regional and national policy makers, the dissertation highlights the importance of municipal capacity and organizational context in advancing IUS. It underscores the role of supportive frameworks and funding mechanisms, as well as the need to recognize the diversity of municipal strategies. The research can inform policy design that better enables municipalities to integrate symbiosis principles into urban development.

Municipal practitioners. For municipal practitioners, the dissertation provides insights into the roles they can adopt in governing IUS, and how internal organizational forms and practices condition their ability to act. The findings offer practical lessons on how to balance self-governing and authority-based approaches, anchor initiatives politically and administratively, and sustain collaboration across departments.

External practitioners and stakeholders. For external stakeholders engaged in IUS, including companies, utility providers, consultants, and NGOs, the dissertation sheds light on how municipalities operate internally and externally, what values shape collaboration, and what tensions may arise. Understanding these dynamics can help practitioners engage more effectively with municipalities, align expectations, and identify opportunities for co-creation of circular solutions such as IUS.

By addressing these different audiences, the dissertation seeks not only to contribute to academic debates, but also to support municipalities, policy makers, and practitioners in their efforts to design, implement, and sustain IUS initiatives.

1.5 Disposition

Chapter 1 introduced the purpose, background, and research questions of the dissertation. ***Chapter 2*** provides the contextual foundations for the study, outlining how municipalities are conceptualized analytically, describing the key institutional features of Swedish local government, and situating the Swedish case in an international landscape. ***Chapter 3*** outlines the theoretical and conceptual foundations, combining literature on industrial and urban symbiosis with perspectives on governance, public sector organization (PSO), and organizational values. Together, these strands form the analytical framework that guides the empirical and interpretive work of the dissertation. ***Chapter 4*** describes the research design and methodology, including case selection, methods for data collection and analysis, and considerations of scope, ethics, and research quality. ***Chapter 5*** presents the empirical findings, integrating results from the five appended papers into a coherent account of how municipalities govern IUS from within. ***Chapter 6*** develops the discussion, connecting the findings to previous research and theoretical perspectives. It offers a broader interpretation of municipal governance of IUS, identifies key tensions and blind spots, and outlines the dissertation's theoretical contributions, practical implications, and directions for future research. Finally, ***Chapter 7*** concludes the dissertation by synthesizing the overall insights and highlighting how governing IUS from the inside out depends on internal organizational conditions that enable municipalities to coordinate, anchor, and sustain symbiosis as part of their everyday governance.

2. Background

This chapter provides the contextual foundations for the dissertation by situating industrial and urban symbiosis within the broader landscape of Swedish municipal governance. Because the dissertation examines how municipalities govern IUS internally, it is essential to understand both the organizational features of Swedish local government and the infrastructures through which symbiotic collaboration unfolds.

2.1 Defining municipalities and their internal-external boundaries

Municipalities can be understood in several ways: as geographical territories, as democratic institutions, and as public organizations responsible for a wide range of services (Pierre, 2011; Sellers & Lidström, 2007). In this dissertation, the municipality is approached primarily as a political and administrative organization. This encompasses the elected political leadership, which sets priorities and provides democratic legitimacy, and the professional administration, which prepares decisions, coordinates services, and carries out day-to-day governance (Lidström, 2016b; Montin, 2016). Because IUS is closely tied to infrastructures, technical expertise, and everyday operational routines, the administrative organization is particularly central to this study.

At the same time, many municipal responsibilities are exercised not only through the central administration but also through municipally owned companies that manage key infrastructures such as water, waste, and energy (Christensen et al., 2011; Grossi & Thomasson, 2015). Although these companies are legally separate entities, they operate under municipal ownership and political steering. For the purposes of this dissertation, they are therefore considered part of the municipality's internal organizational sphere of action when they contribute to the governance of IUS.

Building on this organizational understanding, the dissertation distinguishes analytically between internal and external dimensions of municipal governing (Bulkeley & Kern, 2006; Gustafsson & Krantz, 2025). This conceptual distinction is elaborated further in Chapter 3:

- *Internal governing* refers to activities and arrangements within the municipal organization itself. This includes administrative structures, the allocation of responsibilities across departments, internal coordination practices, strategic and planning routines, procurement processes, and the infrastructures and material flows that municipalities (and their municipally owned companies) operate directly.
- *External governing* refers to municipal action directed outward, involving interaction with actors such as private companies, utilities, regional authorities, and civil society. Examples include partnership-building, enabling activities, regulatory enforcement, and the facilitation of industrial collaboration.

The analytical focus lies primarily on the internal dimension. While political decisions form an important backdrop, the empirical work concentrates on administrative professionals and the organizational conditions under which they operate. This focus aligns with the aim of the dissertation: to understand how municipalities govern IUS from within, through the structures, routines, and value orientations that shape their capacity to initiate, coordinate, and sustain symbiotic collaboration.

2.2 Municipal governance in Sweden

Sweden has 290 municipalities, each playing a central role in delivering public services and shaping local development (Montin, 2016; SKR, 2025a). Municipal responsibilities include essential services such as preschool, education, social care, and elderly care, as well as broader tasks related to spatial planning, environmental protection, infrastructure, and local development (SKR, 2025b). A defining feature of the Swedish system is its strong tradition of local self-governance, enshrined in the Constitution through the principle of municipal autonomy (Lidström, 2016a; Montin, 2016; SKR, 2025a). This autonomy has deep historical roots: during the major municipal reforms of the 1950s-1970s, the number of municipalities was reduced while their responsibilities expanded, creating local authorities with both the scale and the mandate to manage complex societal tasks (Lidström, 2016b; Montin, 2016).

Within the limits set by national law, municipalities have the right to make independent decisions about how services are organized and delivered, and to levy taxes to finance their activities. The municipal income tax (*kommunalskatt*) is their primary revenue source and provides a stable financial base, reinforcing their autonomy vis-à-vis the national government (Montin, 2016; SKR, 2025a).

Municipalities are governed by an elected Municipal Council (*kommunfullmäktige*), with the Municipal Executive Board (*kommunstyrelsen*) responsible for coordinating municipal operations. Beneath these political bodies, sector-specific committees (*nämnder*) and administrative departments (*förvaltningar*) manage day-to-day responsibilities such as spatial planning, environmental protection, waste management, and water and sewage services (Montin, 2016; SKR, 2025c). Decision-making is generally consensus-oriented and anchored across parties, reflecting a tradition of pragmatism and continuity across electoral cycles (Lidström, 2016b). It is these administrative departments and their everyday practices that constitute the primary analytical focus in this dissertation.

Swedish municipalities are often described as capable and trusted public authorities. Citizen trust in local government is comparatively high (Rothstein & Teorell, 2008; Roos & Lidström, 2014), and municipalities frequently act not only as regulators and service providers but also as facilitators of collaborative sustainability initiatives (Lidström, 2016b). In addition to their own administrations, many municipalities own public utilities and municipally owned companies operating in sectors central to IUS, including energy, district heating, waste management, and water and sewage (Grossi & Thomasson, 2015; Montin, 2016). These companies typically operate as legally separate entities but remain under municipal ownership and political steering, giving municipalities significant leverage over key infrastructures relevant to circular economy initiatives (Montin, 2016; Palm et al., 2025; SKR, 2025b).

At the same time, there is considerable variation between municipalities in size, resources, and expertise. Larger municipalities may have specialized staff and strong financial capacity, whereas smaller ones often face resource constraints and rely on external networks to sustain innovation (Lidström, 2016b; Montin, 2016). These differences matter for IUS because municipalities' ability to initiate and sustain symbiotic collaboration depends heavily on sufficient technical expertise, administrative capacity, and time for coordination.

Together, these characteristics give Swedish municipalities a central role in shaping the prospects for IUS. Their legal autonomy, financial capacity, and responsibility for key infrastructures position them both as facilitators who coordinate cross-sectoral collaboration and as participants who directly manage the material flows that underpin symbiotic exchanges.

In this context, wastewater is used as an especially illustrative case for examining municipal governance of IUS. Wastewater management combines technical complexity, regulatory demands, and close links to public health and environmental quality (OECD, 2020). It also occupies a strategic position at the intersection of core municipal responsibilities and circular economy ambitions, requiring coordination across departments, operational units, and external actors. At the same time, wastewater shares several structural characteristics with other municipal

infrastructures central to IUS, such as district heating, waste management, and biogas systems, which are typically highly regulated, capital-intensive, and closely tied to both technical expertise and political accountability (Lidström, 2016b; Magnusson & Palm, 2019). Moreover, wastewater featured prominently in the empirical studies underpinning this dissertation, offering a concrete arena in which internal governance processes, organizational arrangements, and value orientations become visible.

2.3 Sweden in an international context

Industrial and urban symbiosis has gained increasing attention worldwide, though governance approaches differ across contexts. Denmark has long been recognized for pioneering examples such as the Kalundborg Symbiosis, where stable collaboration among industries has demonstrated the benefits of long-term commitment and trust-building (Chertow, 2000; Ehrenfeld & Gertler, 1997). In China, the development of eco-industrial parks has been promoted as part of national policy, supported by strong central planning and regulatory incentives (Geng et al., 2009; Shi et al., 2010). In Western Europe, countries such as the Netherlands and Germany have advanced circular economy initiatives through decentralized governance, municipal innovation, and integration with spatial and environmental planning (Domenech & Davies, 2009; Fratini et al., 2019; Lenhart et al., 2015; Predeville et al., 2018; Williams, 2023).

Against this international backdrop, Sweden represents an interesting case because IUS unfolds within one of the most decentralized governance systems globally (Sellers & Lidström, 2007). As outlined in Section 2.2, Swedish municipalities enjoy unusually strong constitutional autonomy, independent taxation rights, and direct responsibility for infrastructures such as waste, water, district heating, and environmental protection (Lidström, 2016b; Montin, 2016). Few countries combine this degree of local self-government with such extensive operational responsibilities, meaning that Swedish municipalities are not merely partners or regulators in IUS; they often control the infrastructures through which symbiotic exchanges are realized.

This institutional configuration differs from countries where IUS is primarily industry-driven (e.g. Denmark), where development is centrally coordinated (e.g. China), or where regional authorities play a dominant role (e.g. Germany and the Netherlands) (Geng et al., 2009; Lenhart et al., 2015). In these multi-level systems, local governments have more limited discretion over infrastructure and long-term investment decisions (Hooghe & Marks, 2001; Sellers & Lidström, 2007). By contrast, Swedish municipalities constitute a key arena where political ambitions, administrative capacity, and infrastructure management intersect. This creates

opportunities for local experimentation and cross-sectoral collaboration, but also means that variation in municipal resources and competencies can produce uneven conditions for IUS development.

Positioning Sweden within this broader landscape clarifies how the findings of this dissertation hold relevance beyond the Swedish context. As international policy increasingly shifts toward local implementation of circular economy and sustainability objectives (European Commission, 2020a; OECD, 2020), understanding how municipalities organize themselves internally becomes essential. By examining the administrative structures, organizational routines, and value orientations that shape municipal capacity for IUS, the Swedish case offers insights into the conditions under which local authorities can initiate, coordinate, and sustain symbiotic collaboration. These insights are therefore pertinent not only for Sweden, but also for other governance settings where municipalities or equivalent local bodies are expected to drive circular economy and industrial symbiosis initiatives.

3. Theoretical and conceptual foundations

This chapter develops the conceptual framework for the dissertation by combining three perspectives that together provide the lens for analyzing how municipalities govern IUS: governing strategies, organizational arrangements and value orientations (Figure 1). Since IUS is both a practical strategy and a field of scholarly inquiry, it builds on ideas that span across environmental sciences, governance studies, and public administration. To situate the analysis, the chapter first outlines how IUS has evolved conceptually and identifies the barriers, roles, and governing modes that shape municipal engagement with symbiosis initiatives (3.1).

Building on this, the chapter introduces a public sector organization (PSO) perspective as a way of analyzing internal governance in municipalities, focusing on how organizational elements shape governing capacity (3.2). Two dimensions are explored in greater depth. The first concerns organizational forms, comparing administrative and corporate models and their implications for municipal governance of IUS (3.3). The second concerns the values and motivations that underpin collaboration, highlighting how converging and diverging value orientations influence symbiosis development (3.4).



Figure 1. Conceptual framework combining three perspectives.

3.1 Governing IUS: barriers, roles and strategies

IUS builds on earlier work in industrial symbiosis and reflects a gradual broadening of focus from technical exchanges between firms to the social and institutional conditions that make such exchanges possible. This shift in emphasis highlights the importance of public actors, particularly municipalities, whose infrastructures, planning responsibilities, and regulatory mandates shape the context in which symbiosis initiatives can develop (Boons et al., 2017; Boons & Spekkink, 2012; Paquin & Howard-Grenville, 2012; Walls & Paquin, 2015). As researchers increasingly turn their attention toward municipal systems and urban infrastructures, concepts such as urban symbiosis, urban–industrial symbiosis, and ultimately IUS have gained prominence. Together, this literature underscores that symbiotic exchanges depend not only on industrial processes but also on how municipal services and urban resource flows are organized and governed (Dong et al., 2017; Ness & Xing, 2017; Van Berkel et al., 2009). Figure 2 illustrates the material and energy flows within such an IUS system.

This conceptual broadening is also reflected in the terminology used in this dissertation. While the early papers draw on the established language of industrial symbiosis, the later work adopts the IUS framing to better capture the municipal dimensions that lie at the core of the study.

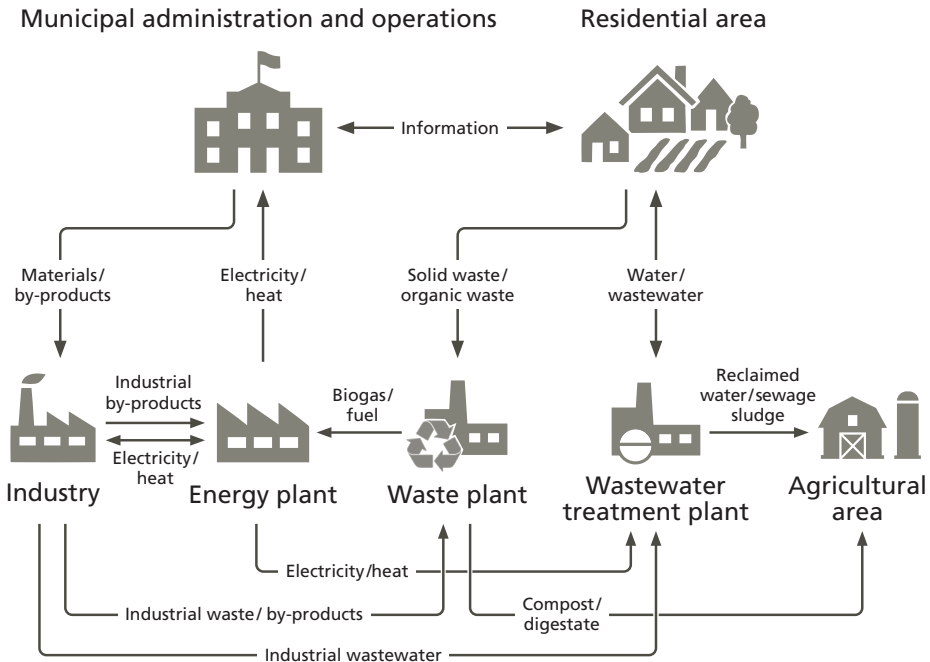


Figure 2. Illustration of material and energy flows in an IUS system.

Despite this evolution, IUS is often presented as a largely technical solution for improving resource efficiency (Ashton, 2009; Chertow, 2000; Chiew et al., 2025; Niu et al., 2026). In practice, however, its development is shaped by a wide set of barriers and governance challenges (Fraccascia et al., 2019). While early research documented the environmental and economic gains from industrial exchanges (Neves et al., 2020), subsequent work has shown that technical potential does not automatically translate into implementation. Symbiosis initiatives routinely encounter economic, regulatory, organizational, social, and informational constraints (Golev et al., 2015; Kosmol & Otto, 2020; Walls & Paquin, 2015; Yu et al., 2014).

Economic barriers are among the most visible: IUS infrastructures often require high up-front investments, while organizations may operate on different investment cycles and hold divergent views on how to allocate costs and benefits. Uncertainty over long-term returns and fluctuating resource prices further undermine willingness to commit (Fichtner et al., 2005; Pajunen et al., 2013; Madsen et al., 2015). Technical barriers stem from the difficulty of integrating by-product flows into production processes, fluctuations in material quality, and the need for additional treatment or storage facilities. Logistical mismatches and insufficient infrastructure can exacerbate these issues, making exchanges less reliable (Fraccascia, 2019; Herczeg et al., 2018; Tudor et al., 2007).

Regulatory barriers frequently arise when existing legislation provides little guidance on how by-products should be classified or reused. Ambiguous or restrictive rules, difficulties in obtaining permits, and conflicting waste regulations have been recurring challenges (Boons et al., 2011a; Corder et al., 2014; Li et al., 2015). On the social side, collaboration is often hindered by organizational silos, lack of trust, and unequal power relations. Since there are few formal mechanisms to mandate or coordinate joint action, trust becomes a critical enabler, yet it is also fragile and difficult to establish (Bacudio et al., 2016; Chertow & Ehrenfeld, 2012; Herczeg et al., 2018). Finally, informational barriers remain a recurrent theme in the literature: firms may lack awareness of symbiosis concepts, have little data on available by-product streams, or face weak channels for sharing information across organizational boundaries (Domenech Aparisi, 2010; Levänen & Hukkinen, 2013). Together, these factors contribute to the “symbiosis gap,” where anticipated benefits remain under-realized in practice (Martin & Harris, 2018; Rodin & Moser, 2021; Taqi et al., 2022). Table 2 summarizes typical barriers identified in the IUS literature. It draws on a structured review conducted in Paper I, which examined 30 studies on common obstacles. The table serves as conceptual background for the dissertation, situating the study within the broader literature on IUS barriers.

Table 2. Typical barriers in industrial and urban symbiosis. Adapted from Paper I.

Category	Examples	Selected references
Economic	High investment costs; different investment cycles; difficulties dividing costs/benefits; fluctuating resource prices	Bacudio et al., 2016; Islam et al., 2016; Madsen et al., 2015; Mortensen & Kørnøv, 2019; Pajunen et al., 2013
Technical / Operational	Material fluctuations; logistical mismatches; need for additional treatment/storage; limited infrastructure	Corder et al., 2014; Fraccascia, 2019; Herczeg et al., 2018; Prosmann & Wæhrens, 2019; Tudor et al., 2007
Regulatory	Unclear waste legislation; difficulties obtaining permits; conflicting regulations	Boons et al., 2011b; Golev et al., 2015; Li et al., 2015; Madsen et al., 2015; Walls & Paquin, 2015; Watkins et al., 2013
Social / Organizational	Lack of trust; siloed practices; low willingness to collaborate; power imbalances	Ashton, 2011; Bossilkov et al., 2005; Chertow & Ehrenfeld, 2012; Chiu & Yong, 2004; Domenech Aparisi, 2010; Gibbs & Deutz, 2007; Mortensen & Kørnøv, 2019; Park et al., 2008; Walls & Paquin, 2015
Informational	Lack of awareness of IS; insufficient data on by-product streams; poor information sharing	Bacudio et al., 2016; Corder et al., 2014; Fichtner et al., 2005; Gibbs & Deutz, 2007; Golev et al., 2015; Levänen & Hukkinen, 2013

Because of these persistent barriers, attention has increasingly turned to the role of governance in enabling or constraining IUS. Recent research emphasizes that effective, multi-actor governance arrangements are essential for coordinating the diverse actors involved in symbiosis systems (Ansell & Gash, 2008a; De Santana Filho et al., 2025; Emerson et al., 2012). Within such frameworks, municipalities and other public authorities play central roles in seeding, facilitating, and institutionalizing symbiosis initiatives (Harris et al., 2018; Lenhart et al., 2015; Mirata, 2018; Mortensen & Kørnøv, 2019a; Van Berkel et al., 2009). They may act as regulators by shaping planning and permitting frameworks, as facilitators by creating meeting arenas and sharing information, and as service providers through their own infrastructures and utilities (Abreu & Ceglia, 2018; Patricio et al., 2018). In some contexts, public actors have also been described as “anchor tenants”. This can relate both to their physical resource flows and to their ability to provide institutional stability, knowledge, and legitimacy to local networks (Burström & Korhonen, 2001; Costa & Ferrão, 2010; Martin & Eklund, 2011; Sun et al., 2017).

Given this range of municipal functions, scholars working on IUS have drawn on established governing typologies to clarify how municipalities can engage in symbiosis initiatives. Velenturf (2016), for example, identified strategic and operational roles for public organizations in the Humber region of the UK, distinguishing between regulator and facilitator functions. Building on earlier work in climate governance, the governing modes introduced by Bulkeley & Kern (2006) have become a common way of describing how municipalities steer sustainability initiatives (Gustafsson & Krantz, 2025; Palm et al., 2019; Smedby & Quitzau, 2016; Voytenko Palgan et al., 2021). Paper I adapts this typology to the IUS context,

outlining five modes of municipal governing: self-governing, governing by authority, governing through provision, governing through enabling, and governing through partnership. These categories illustrate that municipalities may simultaneously govern their own operations and act as service providers, regulators, collaborators, and partners in advancing IUS (Table 3), suggesting that municipal engagement in symbiosis spans both internal organizational domains and external collaborative arenas.

Table 3. Governing modes applied to IUS. Adapted from Bulkeley et al. 2009 and Paper I.

Governing mode	Description	Examples in IUS context
Self-governing	Municipality governs its own operations and practices.	Applying IUS principles within municipal waste, water, energy, or procurement operations, for example by using municipal waste streams as inputs in local exchange systems.
Governing by authority	Use of formal regulatory powers and planning instruments (internal or external).	Adopting binding strategies, spatial plans, environmental permits, or regulatory requirements that influence material and energy flows relevant to IUS.
Governing through enabling	Facilitating, coordinating, and encouraging collaboration.	Acting as coordinator, knowledge broker, or network facilitator to connect firms, share information on resource flows, and reduce barriers to collaboration.
Governing through provision	Municipality provides goods, services, and infrastructure.	Providing district heating networks, waste management systems, industrial land, or shared infrastructure that enables resource exchanges between actors.
Governing through partnership	Municipality collaborates on equal terms with external actors.	Participating directly in symbiosis networks or joint projects where the municipality shares risks, investments, and responsibilities with firms or utilities.

Although this framework has advanced the understanding of municipal roles, most IUS studies have focused on external engagement: how municipalities interact with firms, agencies, and civil society actors to facilitate resource exchanges (Domenech et al., 2019; Lander Svendsen et al., 2021). Much less attention has been given to the internal dimension of governance: how municipalities organize themselves, align departmental responsibilities, and embed IUS in their own strategies, operations and infrastructures. Evidence nevertheless suggests that internal factors

such as political support, strategic planning, and cross-departmental coordination can be just as decisive for IUS implementation as external partnerships (Emerson et al., 2012; Mortensen et al., 2024; Perriton et al., 2025).

This distinction between internal and external governance strategies has been proposed as a refinement of the Bulkeley & Kern (2006) typology and is developed further in Paper IV. In this dissertation, internal governance refers to the processes and strategies through which municipalities steer and organize IUS within their own administrative structures, including self-governing practices (e.g. applying IUS in municipal operations) and the inward use of authority (e.g. politically adopted strategies, binding plans, or regulations applied across departments). External governance encompasses enabling, provision, and partnership roles, as well as authority directed outward (e.g. permits, regulations, or planning instruments), through which municipalities engage with other actors in the local or regional system. Authority thus spans both domains, as planning and regulation may target either internal organizations or external stakeholders. Figure 3 summarizes this distinction.

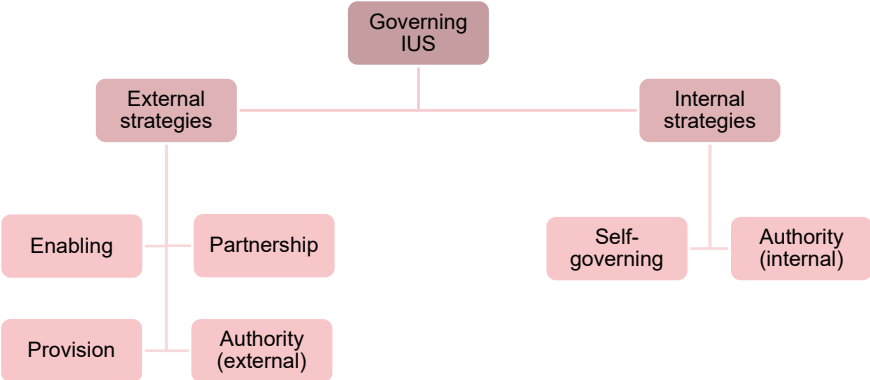


Figure 3. Internal and external strategies for governing IUS. Adapted from Paper IV.

Taken together, the literature shows that governing IUS is not only about overcoming technical barriers or facilitating external collaboration. It is also about municipalities’ internal capacities and strategies, which determine whether symbiosis initiatives become temporary experiments or embedded elements of long-term sustainability governance (Ansell & Torfing, 2021).

3.2 A public sector organization perspective

While governance typologies such as Bulkeley & Kern's (2006) provide important insights into the strategies municipalities adopt, they do not fully capture the organizational foundations that shape whether such strategies can be implemented in practice. In other words, knowing what mode of governing is used (self-governing, authority, enabling, etc.) tells us little about how municipalities are internally equipped to carry those strategies through. For this, perspectives from public sector organization (PSO) research are useful (Christensen et al., 2011).

PSO research draws on several interrelated traditions, including institutional theory, public management research, and general organizational theory. Together, these perspectives provide tools for analyzing how public organizations structure their work, coordinate across functions, and build capacity for complex tasks (Domingues et al., 2017; Klein et al., 2020; Lozano, 2018; Meuleman, 2018). This makes PSO particularly relevant for IUS governance: many of the obstacles identified in the IUS literature, such as siloed departmental structures, weak internal coordination, unclear mandates, or lack of strategic anchoring, are fundamentally organisational rather than technical (Domenech et al., 2019; Golev et al., 2015; Paquin & Howard-Grenville, 2012; Walls & Paquin, 2015; Wolf et al., 2005, 2007). A PSO lens therefore helps illuminate the internal conditions that enable municipalities not only to choose a governing strategy, but also to sustain and operationalize it across their own systems.

Building on this body of work, Klein et al. (2020) identify six interrelated system elements needed to embed sustainability in public organizations: (1) institutional frameworks such as policies and governance structures; (2) public management and strategy; (3) public processes and services; (4) public procurement; (5) organizational systems such as leadership, culture, and innovation capacity; and (6) collaboration. Taken together, these elements draw attention to both formal and informal aspects of how municipalities operate, and to the ways in which sustainability ambitions must be anchored across multiple organizational domains (Lozano, 2018). Figure 4 summarizes these six PSO system elements and shows how they can be used to understand the internal organizational conditions that shape municipal capacity to govern IUS. The figure is adapted from the conceptual framework developed in Paper V, where it is applied empirically.

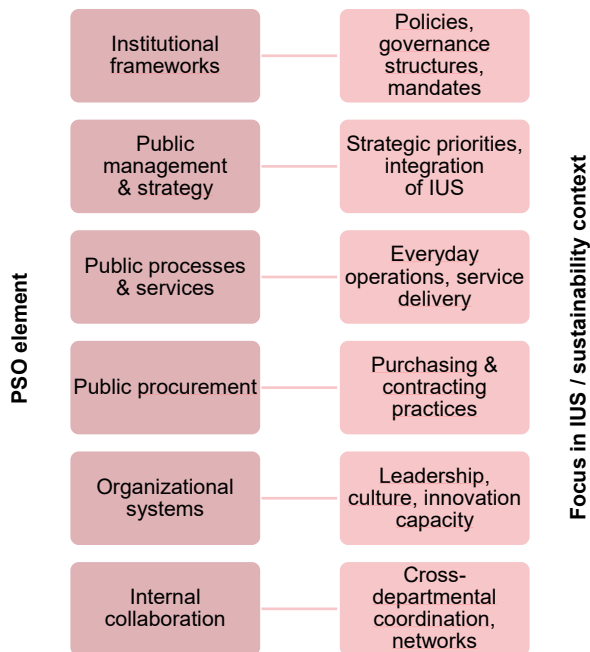


Figure 4. PSO system elements relevant to governing IUS. Adapted from Klein et al. (2020) and Paper V.

Considering the PSO elements alongside governing modes highlights the interaction between municipal ambitions and organizational realities. While the governing modes outline how municipalities choose to steer IUS, the PSO elements clarify what is required for those strategies to unfold in practice, including the routines, capacities, and coordination mechanisms that underpin municipal action. A municipality may, for example, commit to self-governing by applying IUS principles within its own waste, water, or energy operations. However, such efforts are unlikely to succeed unless supported by organizational cultures, leadership, and cross-departmental collaboration, and anchored in frameworks and procurement routines that integrate them into everyday work (Klein et al., 2020). Similarly, authority-based approaches require not only formal anchors in strategies, budgets, and regulations, but also organizational systems that ensure they are understood, prioritized, and enacted across departments (Christensen et al., 2011). In this dissertation, the PSO framework is therefore not used as a strict analytical template in isolation, but as a conceptual complement to governing perspectives. It shifts attention from the choice of governing strategy to the organizational conditions that make such strategies viable, offering a structured way to examine how internal arrangements enable – or constrain – the governing of IUS.

3.3 Organizing municipal services

While the PSO framework highlights the different organizational functions through which municipalities approach sustainability, it does not fully capture the structural arrangements that shape how these functions are carried out in practice. Municipal services can be organized in several ways, and these organizational forms influence more than day-to-day routines. They also shape the priorities, capacities, and operating conditions that public organizations bring to their work (Pahl-Wostl, 2015a; Thomasson, 2013). Understanding how organizational form shapes municipal capacities for IUS requires attention both to the concrete structures through which services are organized and the broader coordination logics that these structures reflect.

In this dissertation, the terms organizational forms and organizational models are used with a slight but important distinction. Forms refer to the concrete arrangements through which municipalities deliver services, for example whether water and wastewater operations are placed within the municipal administration or managed through a municipally owned company. Models, by contrast, refer to the broader coordination logics or archetypes that these forms draw upon, such as hierarchy, market, hybrid, civic/NGO, or network. This distinction builds on public administration and governance literature and informs how organizational arrangements are examined in Papers II and III (Alexius & Furusten, 2019; Grossi & Thomasson, 2015; Thomasson, 2013).

To make these coordination logics more concrete, the dissertation draws on a set of organizational archetypes that capture how municipal services are organized in different institutional settings. These archetypes describe distinct principles for decision-making, accountability, and value orientation (Niehaves & Plattfaut, 2011; Pahl-Wostl, 2015b; Thomasson, 2013; Thompson, 2003; Van Der Brugge et al., 2005), and provide a conceptual grounding for understanding how municipalities structure core services relevant to IUS.

- *Hierarchy* corresponds to municipal administration, where services are delivered within the municipal organization itself. Bureaucratic structures, rule-based control, and political oversight are central. This form ensures transparency and accountability, but can be resource-constrained, particularly in smaller municipalities.
- *Market* relates to private management of water services, where ownership and operations are handed to private firms. This archetype is largely absent in Sweden because water and wastewater services are a statutory municipal responsibility under the Water Services Act (LAV 2006:412; see also Grossi & Thomasson, 2015). Nonetheless, market-based provision remains relevant in international debates about the circular economy and IUS, where efficiency and profit motives dominate.

- *Hybrid* reflects municipally owned companies, situated at the intersection of public and private logics. Such corporations often allow for quicker decision-making, more specialized competence, and financial autonomy. At the same time, they raise concerns about democratic control, transparency, and value conflicts.
- *Civic/NGO* captures grassroots and advocacy-based organizations that mobilize around resource flows. While not central to Swedish water management, civic initiatives and NGOs can play significant roles in broader IUS contexts, where they drive experimentation, awareness, and community engagement.
- *Network* archetypes emerge when actors self-organize around resource exchanges without central coordination. In IS/IUS, networks often arise among firms developing symbiotic relations, though municipalities frequently remain involved as facilitators.

Although the prominence of these archetypes varies internationally, they appear across many service systems. Private, market-based provision is common in England and Wales; hybrid utilities dominate in several European water sectors; and civic or NGO-led initiatives have shaped sustainability projects globally (EurEau, 2018; Tang & Zhan, 2008; Van Der Brugge et al., 2005). Table 4 summarizes these archetypes and the coordination principles that underpin them.

Table 4. Organizational archetypes, their logics, and implications for IUS governance. Adapted from Paper II and Paper III.

Archetype	Typical organizational form	Core values & logics	Implications for IUS
Hierarchy	Municipal administration	Bureaucracy, rule-based control, accountability	Transparency, integration across departments, but risk of resource constraints
Market	Private operators	Efficiency, competition, profit	Innovation potential, but limited public accountability; rare in Sweden
Hybrid	Municipally owned companies	Blend of public and private logics	Faster decisions, financial autonomy, competence; but weaker transparency, risk of value conflicts
Civic/NGO	Grassroots initiatives, NGOs	Advocacy, trust, community engagement	Mobilize awareness, complement municipal action; less central in core water services
Network	Self-organizing exchanges among firms	Reciprocity, coordination through relationships	Supports innovation and flexibility; municipalities often act as facilitators

In this dissertation, the water and wastewater sector serves as an illustrative case for examining these organizational logics. As discussed in Chapter 2, this sector combines regulatory demands, essential public responsibilities, and long-term infrastructure commitments, making organizational arrangements especially visible (Hoyer, 2019; Naturvårdsverket, 2022). It also forms the empirical setting for Papers II and III, where administrative and corporate organizational forms are analyzed in relation to municipal governing capacity. Using this sector as an example clarifies how different organizational arrangements shape the conditions under which municipalities engage with IUS.

In Sweden, the hierarchy and hybrid archetypes take concrete form in two long-standing ways of organizing water and wastewater services: either within the municipal administration or through a municipally owned company (Mattisson & Thomasson, 2019; Svenskt Näringsliv, 2025; Thomasson, 2013). These are the two dominant empirical expressions of the organizational models introduced above. Each comes with characteristic advantages and limitations that influence how municipalities manage infrastructure, coordinate internally, and engage in sustainability work.

When water services are organized within the municipal administration, they remain closely connected to other municipal functions, which can facilitate day-to-day coordination and maintain clear democratic accountability. At the same time, administrative units often operate with limited financial or technical capacity, particularly in smaller municipalities, which can constrain long-term development work (Mattisson & Thomasson, 2019; Montin, 2016).

Municipally owned companies, by contrast, operate with greater financial flexibility and specialist competence, which can support investment, innovation, and technical problem-solving. However, their arm's-length position may reduce transparency and make it harder to align corporate priorities with broader municipal goals (Alexius & Furusten, 2019; Grossi & Thomasson, 2015). As a result, both forms involve familiar trade-offs: administrative units may struggle with resources, whereas corporations face the risk of drifting toward commercial rather than public priorities.

Taken together, organizational forms are not simply structural arrangements but also shape municipal capacity to govern IUS. They influence how resources are mobilized, how accountability is maintained, and how different priorities are balanced in the pursuit of circular and symbiosis solutions. They also mediate how PSO elements unfold in practice, for example by affecting whether collaboration is supported or constrained, or whether organizational systems enable innovation or reinforce established routines. In this way, organizational form shapes how governance ambitions turn into the everyday routines and decisions that make up municipal work with IUS. The following section (3.4) develops this point further by turning to the role of values within organizational and governance arrangements.

3.4 Value orientations in IUS

While organizational forms structure how municipalities operate, they do not alone determine how IUS unfolds in practice. Equally important are the values that shape organizational choices, influence what is regarded as legitimate or worthwhile, and condition how collaboration is pursued (Alexius & Furusten, 2019; Pahl-Wostl, 2015a). Research on industrial symbiosis and related fields consistently shows that technically and financially viable projects may still falter when actors prioritize different goals, hold divergent risk perceptions, or attach value to different aspects of a resource or partnership (Costa & Ferrão, 2010; Mirata, 2018; Paquin & Howard-Grenville, 2012). Such differences often test the foundations of trust and legitimacy, which have been identified as critical yet fragile conditions for symbiotic collaboration (Chertow & Ehrenfeld, 2012; Ramsheva et al., 2019). Studies of recycled and reclaimed water further illustrate how conflicting priorities and value framings can undermine projects even when material synergies appear robust (Verhoest et al., 2022). Related work on sustainability practice highlights how organizational orientations, whether centred on efficiency, citizen welfare, or long-term ecological goals, can enable or constrain collaboration across sectors (Gregg et al., 2020; Ramsheva et al., 2019). Together, this literature shows that values are not peripheral: they are constitutive of how IUS initiatives are initiated, maintained, or abandoned.

Values are understood here not only as abstract principles but as organizational rationales that shape priorities, decisions, and perceptions of legitimacy (Alexius & Furusten, 2019; Pahl-Wostl, 2015b). Although they could theoretically be subsumed under the organizational systems element of the PSO framework, this dissertation treats them as a distinct analytical dimension (Klein et al., 2020). This choice reflects existing scholarship showing that value orientations operate across multiple organizational functions and influence how actors interpret problems, assess acceptable solutions, and prioritize among competing aims in sustainability transitions (Boons & Lüdeke-Freund, 2013; Paquin & Howard-Grenville, 2012; Smith et al., 2005). Distinguishing values analytically therefore makes it possible to examine how they cut across organizational structures and shape municipal approaches to IUS, an insight that also aligns with the empirical material in this study, particularly Paper III, where differences in value orientations played a central role.

To examine these value orientations more systematically, the analysis draws on the total economic value (TEV) framework, which can be used beyond economics as a conceptual tool for distinguishing between diverse value types (Pearce & Turner, 1990). TEV distinguishes between use values (such as direct and indirect use of resources, or option values linked to future opportunities) and non-use values (including existence and bequest values). Although sometimes contested, particularly with regard to how non-use values are measured (Crowards, 1997; Cummings & Harrison, 1995), the TEV framework remains influential for

structuring debates about the benefits and trade-offs of sustainability initiatives. Subsequent work has also introduced quasi-option value, capturing the welfare gains of delaying irreversible decisions under uncertainty (Fisher & Hanemann, 1985). Table 5 summarizes these categories and provides illustrative examples derived from the empirical material on wastewater-related IUS in this dissertation.

Table 5. Classes of value in the Total Economic Value (TEV) framework. Adapted from Paper III.

Value category	Definition	Illustrative meaning in IUS contexts
Direct use values (DUV)	Benefits derived from the immediate, practical use of a resource.	Reclaimed water used for irrigation, industrial processes, or reducing groundwater dependence.
Negative direct use values (N-DUV)	Costs or drawbacks directly associated with using a resource.	Perceived risks to brand identity for firms using externally recycled water; sunk costs if infrastructure investments are underutilized.
Indirect use values (IDUV)	Benefits from secondary effects and ecosystem services.	Innovation, job creation, ecological co-benefits (e.g. wetland creation), improved public health.
Negative indirect use values (N-IDUV)	Negative externalities or secondary effects from resource use.	Environmental harm from certain treatment processes; unintended side-effects of infrastructure.
Option values (OV)	Value of retaining the possibility of future use under conditions of uncertainty.	Safeguarding water security and flexibility in the face of climate change or shifting demand.
Quasi-option values (QOV)	Value of delaying irreversible decisions to preserve learning and flexibility.	Using advanced wastewater treatment facilities as testbeds for research before committing to large-scale reuse.
Bequest values (BQV)	Value of preserving resources for future generations.	Ensuring productive soils and healthy ecosystems remain available for coming generations.
Existence values (EXTV)	Value placed on the inherent worth of a resource, regardless of direct use.	Farmers' attachment to soil quality; appreciation of healthy ecosystems.
Negative existence values (N-EXTV)	Disutility from knowing about resource use, even if impacts are not physical.	Discomfort with reused water previously connected to meat-processing, despite no residues.

From an organizational perspective, values are not expressed in the abstract but become visible through institutional logics and governance arrangements. Different organizational archetypes, such as hierarchies, markets, hybrids, civic/NGOs, and networks, tend to privilege distinct value orientations (Niehaves & Plattfaut, 2011; Pahl-Wostl, 2015a; Thompson, 2003). Municipal administrations, grounded in hierarchical logics, often emphasize accountability, transparency, and collective welfare (Thomasson, 2013). Municipally owned companies operating under hybrid logics may foreground efficiency, innovation, and financial stability, while grappling with tensions between public mandates and market rationales (Alexius & Furusten, 2019; Grossi & Thomasson, 2015). Civic and NGO actors may instead prioritize trust, community engagement, or long-term ecological stewardship (Tang & Zhan, 2008).

IUS brings these divergent orientations together within shared projects and resource flows (Baas & Boons, 2004; Chertow, 2008). Because IUS initiatives typically span municipal administrations, corporate utilities, private firms, and sometimes civic actors, they involve actors who interpret problems and potential solutions through different value lenses. As research shows, such value pluralism is not static: value priorities shift over time, align or clash across organizational boundaries, and shape whether collaborative initiatives gather momentum or lose support (Boons & Lüdeke-Freund, 2013; Mirata, 2004; Pahl-Wostl, 2015a; Paquin & Howard-Grenville, 2012). These dynamics make values a central aspect of how IUS collaborations are formed and sustained, shaping the capacities and strategies through which municipalities engage in governing IUS. In this sense, value orientations are expressed in how actors collaborate, coordinate responsibilities, and negotiate shared priorities within municipal systems.

To deepen the analysis of these dynamics, this dissertation brings together institutional logics and the TEV framework as complementary conceptual tools. TEV helps distinguish between different types of values (direct, indirect, future-oriented, and non-use), while institutional logics clarify why different organizational actors tend to privilege particular value types. Together, these perspectives provide the conceptual foundation for examining how municipal actors interpret and work with IUS in the empirical chapters. The analytical application of this combined lens is developed in Paper III, where differences in value orientations among municipal actors are explored in greater depth.

In sum, this chapter has outlined three conceptual strands that together frame the analytical approach of the dissertation. First, governance strategies draw on established distinctions between different governing modes and between internal and external governance, offering a lens for understanding how municipalities steer IUS-related activities. This strand speaks most directly to RQ1 and is examined in Papers I, IV, and V. Second, organizational arrangements emphasize how municipal capacities are shaped by the structuring of services and the coordination logics underpinning different organizational forms and archetypes. This strand builds on the PSO framework and relates to RQ2, forming a central component of Papers II and V. Third, value orientations are approached as a distinct analytical dimension, informed by the TEV framework and by scholarship on institutional logics that explains why actors privilege different types of values. This strand speaks most directly to RQ3 and examines how such orientations shape municipal governance of IUS, particularly as expressed in internal collaboration and coordination, and is examined in Papers III and V. These three strands offer complementary entry points for understanding how municipalities govern IUS, and guide the empirical analyses in the following chapters (see Table 7).

Table 7. Conceptual strands and their connections to research questions and papers.

Conceptual strand	RQ	Paper
Governance strategies (governing modes, internal vs. external governance)	RQ1	I, IV, V
PSO framework, organizational forms and models	RQ2	II, V
Total Economic Value (TEV), organizational logics and value orientations	RQ3	III, V

4. Research design and methodology

This chapter outlines the methodological choices that underpin the dissertation and links them to the research aim and questions. The study builds on a qualitative approach guided by an interest in how municipalities govern industrial and urban symbiosis in practice. The research design combines multiple methods, including in-depth case studies and complementary comparative material, to capture both detailed organizational processes and broader variation across Swedish municipalities. The chapter proceeds by clarifying the scientific positioning of the research (Section 4.1), outlining the overall research design (Section 4.2), and describing case study logic, selection, and rationale (Section 4.3). It then presents methods for data collection (Section 4.4) and data analysis (Section 4.5). Finally, Sections 4.6–4.9 discuss methodological reflections, ethical considerations, scope and delimitations, and research quality.

4.1 Scientific positioning

The dissertation is positioned within industrial and urban symbiosis research and uses governance, organizational, and value-based perspectives as analytical lenses for understanding how municipalities govern IUS internally. Given the complexity of IUS as both a technical and organizational practice, the study adopts a pragmatic and pluralist philosophical stance that draws on multiple qualitative traditions. This reflects the need to account for both the material and institutional structures that shape municipal action and the interpretive processes through which actors construct meaning, legitimacy, and direction in their symbiosis work (Hajer, 1997; Sayer, 2000).

The primary orientation is towards critical realism. Critical realist perspectives emphasize that social phenomena are shaped by real underlying structures, such as legal frameworks, organizational forms, and infrastructural systems, that exist independently of individual perceptions (Archer, 1995; Sayer, 2000). This aligns with the dissertation's focus on how municipal capacities and organizational arrangements impact IUS governance. Municipal plans, budgetary systems, or the physical realities of wastewater infrastructures, for instance, are not reducible to discourse alone but constitute material and institutional contexts that shape what forms of IUS governance are possible.

At the same time, the analysis is informed by social constructivist insights. Constructivist approaches highlight that the meaning and legitimacy of governance practices are socially produced and reproduced through discourse, value orientations, and interaction (Fischer, 2003; Hajer, 1997; Weick, 1995). This resonates with the dissertation's attention to how municipal actors frame symbiosis, articulate values, and interpret their roles and responsibilities. Municipal staff may work within the same organizational structures, but the ways they perceive IUS as technical innovation, political opportunity, sustainability initiative, or regulatory burden shape the direction and outcome of governance.

These perspectives are not contradictory but complementary. Critical realism highlights the enduring institutional and material structures within which municipalities operate, while constructivism illuminates how these structures are navigated, enacted, and sometimes contested in practice. Following Flyvbjerg (2001) and Delbridge & Edwards (2013), the dissertation treats complex sustainability challenges as phenomena that require attention to both the structural conditions that shape municipal action and the interpretive processes through which meaning is constructed. This combined orientation also frames IUS governance as shaped by institutional and material contexts while being carried out through practices of framing, negotiation, and coordination.

4.2 Research design

The research design provides the overall logic that connects the dissertation's research questions with the empirical material and analytical approach (Blaikie & Priest, 2018; Bryman & Bell, 2015). Because the aim is to understand how municipalities govern IUS and why particular arrangements and practices emerge, the study adopts a qualitative, problem-driven design that allows for in-depth examination of organizational dynamics and meaning-making in context (Flyvbjerg, 2001, 2006; Maxwell, 2012).

The dissertation draws on several qualitative methods distributed across the five appended papers. This multi-method design enables both descriptive analysis, mapping how municipalities organize and act around IUS, and explanatory analysis, examining the mechanisms and rationales behind these practices (Blaikie & Priest, 2018; Yin, 2018). The five papers use partially different forms of material, including literature, interviews, observations, documents, workshops, and a questionnaire, but are analytically connected through a shared focus on internal municipal governance in IUS. Table 8 summarizes how methods were used across the appended papers.

Table 8. Synthesis of methods used across Papers I-V.

Paper	Main data source	Methods for data collection	Methods for data analysis
1	Literature	Literature review	Systematic text analysis
2	Simrishamn case	Interviews, participatory observation, workshop, literature and document review	Thematic analysis
3	Simrishamn case	Interviews, literature and document review	Qualitative content analysis
4	22 municipalities	Questionnaire, webinar, literature and document review	Questionnaire analysis, thematic analysis
5	Malmö case; multiple municipalities	Interviews, participatory observation, literature and document review	Thematic analysis

Although the papers differ in empirical focus, Papers II, III, and V draw on case study logic, which is elaborated further in Section 4.3. The questionnaire in Paper IV and the literature review in Paper I complement these case studies by situating municipality-level insights within a wider conceptual and empirical landscape. This combination supports an integrated analysis of how organizational arrangements, value orientations, and governing strategies manifest across different municipal contexts (Creswell & Creswell, 2018; Maxwell, 2012).

4.3 Case study research, selection and rationale

Case studies form a central component of this dissertation and provide the depth and contextual sensitivity needed to examine how municipalities govern IUS. Case study approaches are well suited for investigating organizational phenomena that unfold in real-life settings where the boundaries between a process and its context are intertwined (Flyvbjerg, 2006; Yin, 2014). This aligns with IUS research, where case studies have long been used to analyze the situated, relational, and place-specific dynamics of symbiosis initiatives (Neves et al., 2020). Here, case study design is used in a delimited way: two municipalities are examined in depth and are treated as full case studies, while additional municipalities contribute comparative insights without being defined as cases in the formal sense. This allows the analysis to capture both the particularities of local governance processes and the broader patterns that emerge across municipal contexts.

The case-based elements of the dissertation are presented most explicitly in Papers II, III, and V. Paper II uses a single-case study of Simrishamn municipality to analyze how a change in organizational form from municipal administration to a municipally owned company shaped the governance of wastewater-based IUS. Paper III also focuses on Simrishamn but extends the analysis to collaborations involving municipal, corporate, private, and civic actors, with particular attention to

how value orientations were articulated and negotiated. Paper V uses Malmö municipality as a primary case and incorporates interviews from six additional municipalities. While these municipalities are not investigated as cases, this broadened empirical base makes it possible to identify both recurring patterns and meaningful contrasts in how municipalities organize IUS internally.

Across the case-based papers, municipalities were selected purposively in line with the dissertation's qualitative, problem-driven approach. Purposive sampling is used in qualitative research to select cases that can shed light on key processes, not to represent a population statistically (Flyvbjerg, 2006; Seawright & Gerring, 2008). The municipalities selected here were either actively engaged in, or experimenting with, IUS-related initiatives, which made them strategically relevant settings for studying internal governance dynamics.

Two municipalities were examined in depth: Simrishamn and Malmö. Simrishamn is a small coastal municipality and was originally selected because of its active work on wastewater-based symbiosis, including investments in advanced treatment technologies and circular reuse (IVL, 2024; Marint Centrum, 2023). During data collection, the municipality underwent a major organizational reform in which water and sewage services were transferred from the municipal administration to a municipally owned company. Although unplanned, this development substantially enriched the material and strengthened the analytical value of the case by offering rare insight into how changing organizational form shapes governing capacity in the wastewater sector. Simrishamn also appears among the comparative municipalities in Paper V. These interviews, conducted several years after the original case study, were used solely for comparative purposes and are analytically distinct from the in-depth case-study material.

Malmö was selected as a large urban municipality with long-standing circular economy ambitions and a well-established history of IUS (Malmö Industrial Park, 2025; Malmö Stad, 2025). Since the 1990s, the Malmö region has hosted collaborations between industries, energy and waste companies, and the district heating utility. In the 2010s, these efforts were further expanded through municipal strategies that aimed to facilitate new symbiosis networks (SNIUS, 2025a). Malmö's scale and its established sustainability profile made it a relevant context for examining how IUS becomes integrated into municipal strategies and internal governance structures, and how tensions between different governing modes are handled.

In addition, comparative interviews were conducted with representatives from six other municipalities: Bengtsfors, Lysekil, Sotenäs, Umeå, Vänersborg, and Simrishamn. These municipalities were not examined with the depth required of full case studies (Yin, 2018), but they contributed additional perspectives that broadened the empirical base of Paper V. Their inclusion made it possible to explore whether the internal governance dynamics observed in Malmö also appeared in other

organizational settings and to identify variations that would not have been visible through the in-depth cases alone.

Before conducting the comparative interviews, a questionnaire was distributed to 22 Swedish municipalities (Paper IV) to map ongoing or emerging IUS-related work. The responses helped identify Malmö as a relevant primary case and guided the selection of municipalities for follow-up interviews. In this way, the questionnaire functioned as a scoping tool that situated the case studies within a broader national landscape, while the methodological details of the questionnaire are presented in Section 4.4.

Table 9 summarizes the rationale and characteristics of the empirical material, including the case studies and the complementary interviews and questionnaire.

Table 9. Selection criteria and empirical case characteristics.

Case / Interviews	Rationale for selection	Key contribution
Simrishamn (Paper II–III)	Active wastewater IUS initiatives; advanced treatment investments; organizational reform occurred during data collection	Insight into how organizational form (administration → corporation) shapes IUS governance
Malmö (Paper V)	Large urban municipality; long-standing IUS initiatives since 1990s; explicit CE strategy	Insight into strategic, long-term municipal engagement with IUS and internal governance processes
Comparative municipalities: Bengtsfors, Lysekil, Sotenäs, Umeå, Vänersborg, Simrishamn (Paper V)	Selected for variation and known IUS efforts	Provided contrasts; tested whether Malmö’s challenges and enablers appeared elsewhere
Questionnaire respondents (Paper IV)	National sample of 22 municipalities involved in IUS work; exploratory mapping of internal IUS governance	Broader context; informed case selection and design of comparative interviews

4.4 Methods for data collection

The dissertation draws on multiple qualitative methods of data collection, applied across the appended papers and adapted to their specific aims. These include literature and document review, semi-structured interviews, participatory observation, workshops, and a questionnaire. Together, these methods generated complementary insights into how municipalities govern IUS and helped clarify the governance processes involved.

Literature and document/archival review (Papers I-V)

Across the dissertation, literature reviews were conducted in parallel with empirical data collection, primarily in the form of narrative reviews of relevant subfields such as industrial symbiosis barriers, municipal governance, organizational forms, and values. Only Paper I was explicitly designed as a structured review, whereas the other papers integrated literature iteratively, allowing the theoretical framing to evolve alongside empirical insights (Booth et al., 2016; Jesson et al., 2011). In Paper I, searches in Scopus and Web of Science were used to identify earlier studies of IS barriers and municipal roles. In the case studies of Simrishamn and Malmö (Papers II, III, and V), local documents were collected, including municipal strategies, policy documents, planning materials, and reports from water and sewage departments. Newspaper articles and press releases were also reviewed to trace political and organizational decision-making processes (Bowen, 2009a). These sources complemented the primary data and helped trace how IUS initiatives and organizational reforms developed over time.

Interviews (Paper II, III, V)

Semi-structured interviews formed the core of the empirical material in Papers II, III, and V. This format was selected because it allows exploration of predefined themes while also following participants' interpretations and experiences in greater depth (Galletta, 2013). This flexibility was important given the variation in municipal roles, organizational settings, and ways of working with IUS across the participating municipalities.

In Simrishamn, around twenty interviews were conducted between September and December 2019. Interviewees included municipal officials with operational and strategic responsibilities in sustainability and water-related issues, staff from the municipally owned water and sewage corporation, and local actors involved in or affected by wastewater-based symbiosis. A subset of these interviews informed the analysis of organizational form in Paper II, while Paper III drew on a broader selection and incorporated additional interviews with corporate and civic actors to examine how values were articulated and negotiated. Although the papers overlap in their empirical base, they use the interviews for analytically distinct purposes.

In Malmö, nine municipal employees with roles spanning urban planning, environmental management, water services, business development, and strategic development were interviewed in spring 2023, identified through purposive and snowball sampling (Noy, 2008; Patton, 2015). Two additional interviews were conducted in 2025 with staff newly involved in circular economy and IUS-related coordination, thereby extending the empirical basis for Paper V.

To complement the Malmö case, seven comparative interviews were conducted between December 2024 and March 2025 with staff from six other municipalities: Bengtsfors, Lysekil, Simrishamn, Sotenäs, Umeå, and Vänersborg. The interviewees

were municipal employees directly involved in their IUS-related work, selected to provide informed perspectives on internal governance practices. These interviews were designed to explore whether the challenges and enabling conditions identified in Malmö also appeared in other organizational settings. The questionnaire that preceded these interviews, and its role in informing this selection, is described in Section 4.4.

All interviews were audio recorded with participant consent, transcribed verbatim, and stored securely in accordance with GDPR and Lund University ethical guidelines (Lund University, 2025). Transcripts were anonymized during transcription by removing identifying details, and only the researcher had access to the raw material. Participants were informed that they could clarify or withdraw statements after the interview, although transcripts were not returned for formal revision. These procedures ensured confidentiality and appropriate handling of the material throughout the project (Swedish Research Council, 2024).

Participatory observation (Paper II, V)

In Simrishamn, participatory observations were conducted on five occasions between September 2019 and January 2021, with additional observations originally planned but later limited by the Covid-19 pandemic. These included attendance in internal meetings, site visits to wastewater facilities, and a public information event where municipal staff engaged with residents. The observations involved municipal officials working with wastewater services, environmental management, and strategic development. Access was facilitated through ongoing collaboration with the municipality, which invited the researcher to relevant meetings. The purpose was to gain contextual insight into how roles, routines, and interactions shaped the municipality's work with wastewater-based symbiosis. While the material was not analyzed as standalone data, it sensitized the researcher to emerging themes, including the significance of the organizational restructuring that later became central in Paper II, and informed subsequent interview and document analysis (Kawulich, 2005; Spradley, 1980).

In Malmö, the researcher attended five events on circular economy and IUS between March and September 2023. These included municipal workshops on procurement and symbiosis, and webinars connected to ongoing circular initiatives in Malmö. The researcher was invited to these events, which involved municipal officials working with environmental management, strategic development, urban planning, and business development, as well as external actors engaged in related issues. The purpose was to gain a deeper understanding of ongoing initiatives, actor constellations, and how IUS-related work was embedded in broader municipal processes. As in Simrishamn, the observations were not treated as formal data for analysis, but they provided valuable contextual insights that informed the interpretation of the interview and document material in Paper V.

Questionnaire (Paper IV)

In Paper IV, a self-administered questionnaire was distributed between March and May 2023 to 28 Swedish municipalities identified as actively engaged in IUS development. The sample was based on earlier national mapping of ongoing IUS initiatives and included municipalities with established or emerging work in the field (Neves et al., 2020; RISE, 2024; SNIUS, 2025b). A contact person was identified in each municipality, typically someone with substantive knowledge of the municipality's IUS-related activities. In some cases this person was already known through prior research contacts, in others the municipality directed the researcher to an appropriate respondent. Each contact person received an individual link to the online questionnaire and was encouraged to consult colleagues where needed. Twenty-two municipalities submitted completed responses.

The questionnaire was developed in Google Forms and included both closed- and open-ended questions, which enabled the generation of descriptive figures and qualitative coding of responses (Boynton & Greenhalgh, 2004; Bryman & Bell, 2015). While the data were not subjected to statistical analysis, they provided a national overview of internal governance practices relevant to IUS and informed the identification of Malmö as a primary case for Paper V. A full list of participating municipalities is provided in Appendix 1.

Questions were designed to be clear, specific, and aligned with the research aims (Lietz, 2010). The structure followed established recommendations on questionnaire design and question ordering (Krosnick & Presser, 2010). The questionnaire asked respondents about: their role in the IUS initiative; duration of the initiative; whether IUS was considered a municipal priority; the perceived municipal role; activities considered inappropriate for municipalities; internal responsibility structures; involved administrations and municipally owned companies; tools and processes used; citizen engagement; and who held ultimate responsibility should an IUS initiative fail.

The questionnaire was piloted with two Swedish sustainability experts to ensure clarity and relevance. Although multiple respondents per municipality would have been preferable, in practice IUS work was often concentrated in the hands of a single individual or a very small team. This meant that one response per municipality was typically the most realistic option. To improve accuracy, respondents were explicitly encouraged to consult colleagues when needed, particularly on questions involving organizational structures or cross-departmental processes.

Workshops & webinars (Paper II, IV)

Workshops and webinars complemented the primary data by providing insight into how municipal officials discussed and interpreted IUS in collective settings. While these settings generated valuable contextual understanding, the material was not analyzed as formal data.

In May 2023, the researcher organized a joint workshop with municipal staff from Malmö and Simrishamn involved in water management and IUS. The purpose was to facilitate mutual learning on circular water management and to discuss ongoing and planned IUS-related initiatives. Although the discussions were not systematically analyzed, they offered a deeper understanding of how practitioners framed challenges and opportunities related to wastewater-based symbiosis.

In November 2024, the researcher hosted an interactive webinar that gathered municipal employees from across Sweden, primarily those responsible for IUS coordination, sustainability, and business development, to discuss preliminary findings from the questionnaire (Paper IV). Participants were largely the same officials who had completed the questionnaire, often joined by colleagues with related responsibilities. While the discussions were not treated as data, they helped identify municipalities with relevant ongoing work and informed the selection of participants for follow-up interviews in Paper V.

Together, the workshop and webinar provided contextual insight into how municipal officials communicated, exchanged experiences, articulated priorities, and made sense of IUS-related work in collective forums (Bergold & Thomas, 2012; Eidenskog et al., 2024; Ørngreen & Levinsen, 2017; Salmons, 2021). These interactions supported the interpretation of the interview, document, and questionnaire material by situating the research within ongoing professional and national dialogues about municipal governance of IUS.

4.5 Methods for data analysis

The analyses across the dissertation relied on qualitative approaches tailored to the types of material generated. Although the appended papers differ in empirical focus and analytical depth, they share a systematic approach to interpreting textual data in order to identify patterns, meanings, and governance dynamics in IUS. The main analytical strategies included systematic text analysis, qualitative content analysis, thematic analysis, and descriptive analysis of questionnaire data. NVivo software supported the organization and coding of qualitative material, and Excel was used for processing questionnaire responses.

Systematic text analysis (Paper I)

Paper I applies systematic text analysis to twenty-three articles identified through structured database searches (Bowen, 2009b; Esaiasson et al., 2024). The aim was to classify and interpret the core content of each text by grouping findings into analytically meaningful categories. The analysis focused on two dimensions central to the paper: how municipalities are positioned within industrial symbiosis research and which barriers to IS development are identified in the literature. A typology of

municipal governing modes developed by Bulkeley & Kern (2006) and Bulkeley et al. (2009) guided the interpretation of municipal roles, while the barrier analysis enabled a synthesis of recurring obstacles described in earlier studies. Together, these analytical steps provided a conceptual foundation that informed the framing of the subsequent papers.

Qualitative content analysis (Paper III)

Paper III analyzed the Simrishamn case study using qualitative content analysis (Schreier, 2012). A coding frame was developed that combined deductive, theory-driven categories, such as organizational form or value categories drawn from the Total Economic Value framework, with inductive, data-driven categories that emerged when engaging with the material. Following Schreier's (2012) recommended approach, the process involved developing and testing the coding frame, segmenting the material into meaningful units, applying and refining codes, and interpreting the resulting patterns.

To strengthen reliability, coding was conducted iteratively and cross-coded by two researchers. Intercoder agreement was assessed using Cohen's kappa coefficient, with all categories reaching a threshold of $\kappa \geq 0.7$, which indicates high reliability (Cohen, 1960). NVivo 12 Pro supported data organization and comparison across interviews, documents, and archival sources (Mortelmans, 2025).

Thematic analysis (Papers II, IV, V)

Thematic analysis (Braun & Clarke, 2006, 2019) was applied to interview material in Papers II and V, and to the open-ended questionnaire responses in Paper IV. The approach facilitated the identification of recurring themes across respondents, including organizational opportunities and constraints, internal governing strategies, and different interpretations of IUS.

In Paper V, the analysis combined deductive codes informed by local governance and public sector organization literature with inductive codes developed from the empirical material. This combined strategy made it possible to trace both theoretically anticipated patterns and novel dynamics emerging from the data. NVivo supported the consistent application of codes across the Malmö case and the comparative municipalities.

Questionnaire analysis (Paper IV)

The questionnaire generated both qualitative and quantitative material. Responses to closed questions were analyzed using descriptive statistics, with Excel used to produce figures and tables summarizing response frequencies and distributions (Boynton & Greenhalgh, 2004; Bryman & Bell, 2015). Open-ended responses were coded thematically, allowing respondents' qualitative reflections on municipal roles and internal governance practices to complement and deepen the descriptive results

(Krosnick & Presser, 2010). Although the analysis did not include inferential statistics, the questionnaire provided a national comparative overview of internal IUS governance that helped identify patterns later examined in the Malmö case study.

Integration across methods

The analyses were designed to build cumulatively across the dissertation. Paper I establishes the conceptual point of departure by identifying how municipal governing modes and IS-related barriers have been treated in earlier research. Papers II and III then deepen the analysis through qualitative content analysis and thematic analysis of the Simrishamn material, offering detailed insight into organizational form, value expressions, and internal governance processes. Paper IV adds a national descriptive overview that highlight broader patterns in how Swedish municipalities organize and understand IUS internally. Finally, Paper V combines thematic analysis of interviews in Malmö with insights from additional municipalities, which makes it possible to explore whether the governance dynamics observed in the primary case also resonate in other municipal contexts.

Together, these analytical steps created an iterative process in which conceptual ideas and empirical findings informed one another. Insights from earlier analyses shaped the focus of later ones, while results from the case studies and the questionnaire prompted refinement of the conceptual framing. This approach strengthened the overall study by linking detailed, context-sensitive analysis with broader municipal patterns.

4.6 Methodological reflection

A first reflection concerns the disciplinary positioning of the dissertation within the IUS field, at the intersection of municipal governance and organizational studies. While IUS research emerged primarily from engineering and natural science traditions (Chertow, 2000; Jacobsen, 2006), the field has since diversified. Nevertheless, technical and techno-economic analyses continue to occupy a prominent place in the literature (Neves et al., 2020; Yazan & Fraccascia, 2020; Yu et al., 2014). The present research instead foregrounds governance and organizational dimensions, positioning itself somewhat apart from dominant framings in both published work and conference settings. The analyses emphasize institutional arrangements, managerial strategies, and value negotiations shaping interaction and collaboration, contributing to a more governance-oriented understanding of symbiosis.

A second reflection concerns interdisciplinarity. The dissertation does not combine radically divergent epistemologies but instead integrates approaches within the social sciences and adjacent fields. Case study and governance literature provide tools for

analyzing institutional frameworks and public strategies, organizational research highlights internal dynamics and managerial processes, and environmental economics contributes valuation perspectives using the TEV framework in Paper III. Paper III is therefore the most explicitly cross-disciplinary contribution, emerging partly through collaboration within the broader IUS research environment, while the remaining papers rely primarily on qualitative social science traditions. In this sense, the dissertation reflects an integrative approach to interdisciplinarity, where insights from different but compatible traditions are combined to address complex governance challenges (Barry et al., 2008; Lang et al., 2012).

A third reflection concerns the researcher's position, particularly in relation to the case studies. The combination of interviews, observations, and workshop participation meant that access developed gradually through collaboration with municipal staff rather than through brief encounters. This proximity created opportunities to understand governance practices as they unfolded, while also requiring awareness of how my presence might shape interactions and interpretations (Berger, 2015). In practice, this meant being clear about my role as a researcher, avoiding attempts to steer discussions during meetings, and remaining attentive to how my involvement formed part of the social context of the fieldwork. Rather than detailing specific instances of participation, which are addressed in Section 4.7, this section highlights that close engagement required ongoing reflection on how access and interaction influenced the research process (Alvesson & Sköldbberg, 2018). Maintaining analytical distance while working closely with municipal actors was therefore a continual methodological consideration throughout the dissertation.

The plurality of methods applied across the papers also merits reflection. Case studies, interviews, document review, participatory observation, workshops, and a questionnaire were combined to generate complementary insights. This multi-method design enabled triangulation, strengthening validity by allowing findings from one source to be considered in light of others (Denzin, 2012; Flick, 2022). At the same time, working with materials that differed in depth, scope, and purpose was not always straightforward, and required continuous reflection on how each method could contribute to the developing analysis. The case studies gradually became the primary sites for more in-depth, interpretive work, while the questionnaire and comparative interviews provided broader indications of how internal IUS governance was approached in other municipalities. This iterative process made it possible to retain the contextual richness of the focal cases while also situating them within a wider national landscape.

A further reflection concerns the types of actors represented in the empirical material. The dissertation focuses primarily on administrative professionals, with limited direct involvement from elected politicians. This was partly a pragmatic decision: day-to-day work with IUS is largely carried out within the administrative organization, and access to political representatives proved more challenging. On occasions when politicians were approached, interviews were redirected to

municipal officials on the grounds that they possessed more detailed knowledge of the IUS initiatives. While this focus aligns with the dissertation's interest in internal governance processes, it also means that political perspectives are less visible in the empirical base. Including elected representatives could have added an additional layer of insight into priority-setting, strategic direction, and the political framing of IUS, and this constitutes a limitation discussed further in Section 4.8 (Pierre, 2011).

Finally, the extended timeline of data collection, stretching from 2019 to 2025, influenced the research process. It allowed the study to follow organizational reforms, shifting political priorities, and evolving circular economy agendas over time. At the same time, it introduced challenges in maintaining analytical coherence across changing contexts. For instance, the reorganization of water services in Simrishamn and the growing emphasis on circular procurement in Malmö emerged only after data collection had begun, leading to adjustments in analytical focus. These temporal dynamics illustrate both the value and complexity of studying governance processes as they unfold over time (Langley, 1999). Together, these reflections clarify the choices and trade-offs that shaped the dissertation's empirical base and analytical scope, while connecting to the ethical and quality considerations elaborated in the sections that follow.

4.7 Ethical considerations

Ethical considerations have been central to the design and execution of this dissertation (Brinkmann & Kvale, 2018; Israel & Hay, 2006). Because the research is qualitative and case-based, ethical issues primarily concern how participants were approached, how their contributions were handled, and how silences or exclusions shaped the knowledge produced.

Informed consent and confidentiality

All interviews were conducted on the basis of informed consent, with participants briefed about the purpose of the research, their right to withdraw at any time, and the intended use of data. Permission was sought before recording, and all interviews were transcribed and stored securely (Lund University, 2025). In accordance with good research practice, confidentiality has been safeguarded by anonymizing quotes and removing identifying details when presenting results (Swedish Research Council, 2024). Although municipalities are named in some parts of the dissertation to support transparency, individual respondents are not. Where sensitive issues arose, material was handled with care, and potentially compromising details have either been rephrased or excluded from publications.

Role of the researcher

Building on the methodological reflections in Section 4.6, this subsection addresses the ethical implications of the researcher's role in the field. In several cases, the researcher's role was not only that of an observer but also of a participant. For example, during workshops in Malmö, the joint Malmö–Simrishamn exchange, and the national webinar, the researcher contributed knowledge and facilitated discussions. Such involvement helped establish trust and provided contextual insights but also introduced positionality into the research process. This dual role is acknowledged here to highlight how access, interpretation, and the framing of findings were shaped by the researcher's presence (Berger, 2015). Ethical reflexivity was maintained by continuously considering how interactions with municipal actors might influence both the material produced and its subsequent analysis (Alvesson & Sköldberg, 2018).

Invisible and neglected perspectives

A further ethical consideration relates to the perspectives that are not fully represented in this study. While municipal staff formed the core of the empirical material, Paper III included five interviews with local businesses and one farmers' organization, adding complementary insights into value negotiations in wastewater symbiosis. Yet these perspectives did not extend across the other case studies. Larger firms were partly included in Malmö fieldwork, but those interviews were ultimately excluded from the dissertation dataset to maintain a focus on internal municipal governance. As a result, certain dimensions of IUS remain less visible in the findings, particularly business dynamics, citizen engagement, and broader societal debates. Acknowledging these silences is important for situating the scope of the research and recognizing the partiality inherent in qualitative inquiry (Mauthner & Doucet, 2003; Seawright & Gerring, 2008).

Data storage and protection

All data have been handled in accordance with Lund University's data management protocols and GDPR legislation (Lund University, 2025; Swedish Research Council, 2024). Interviews, transcripts, and field notes were stored securely on university servers and accessible only to the research team. Data may be retained by the university for up to ten years after the conclusion of the project and made available publicly only if sufficiently anonymized to protect participants' identities.

Use of digital tools and AI support

Digital tools, including AI-based language models, were used in a limited and supportive capacity during the writing process, primarily for language refinement and clarification of structure. No empirical material was generated, analyzed, or interpreted using AI tools, and all analytical decisions, interpretations, and conclusions remain the sole responsibility of the author. The use of such tools was

guided by principles of transparency, academic integrity, and current discussions on responsible AI use in research (Bender et al., 2021; Swedish Research Council, 2024; Van Dis et al., 2023).

4.8 Scope and delimitations

This dissertation is delimited in several important respects, which shape both the contribution and the limits of the findings. Conceptually, the work adopts a social science perspective on IUS, with a focus on governance and organizational aspects. While closely related concepts such as circular economy or urban metabolism provide relevant points of reference, they are not analyzed in depth. The emphasis is instead on how municipalities organize, strategize, and negotiate their role in IUS (Chertow, 2000; Harris et al., 2018; Kennedy et al., 2007; Kirchherr et al., 2017b).

Geographically, the scope is limited to Sweden. This provides a relevant and analytically rich context, given the strong role of municipalities in service provision and sustainability governance (Montin, 2016; Pierre, 2011), but it also reflects the institutional characteristics of the Nordic welfare state (Pierre & Peters, 2000; Sellers & Lidström, 2007). The findings are therefore context-dependent, yet many of the governance dynamics identified, such as internal coordination challenges, organizational fragmentation, and the role of administrative capacity, are likely to be analytically relevant beyond the Swedish case. Transferability should thus be understood in analytical rather than statistical terms (Yin, 2018). Within Sweden, the dissertation combines in-depth studies of two municipalities, Simrishamn and Malmö, with broader comparative material from 22 municipalities responding to a national questionnaire. This creates asymmetries in empirical coverage, where some municipalities are richly detailed while others provide more limited comparative perspectives (Seawright & Gerring, 2008).

Methodologically, the dissertation is grounded in qualitative and exploratory approaches (Creswell & Creswell, 2018; Maxwell, 2012). While Paper IV employed a questionnaire, the analysis remained descriptive and interpretive rather than statistical, meaning that the findings are not intended to support probabilistic generalization. Instead, the contribution lies in developing conceptual insights into how municipalities organize and govern IUS internally. Paper III also introduces a degree of interdisciplinarity through the use of a valuation framework from environmental economics (TEV), but the overarching analytical orientation remains anchored in governance and organizational studies.

In terms of actors, the empirical material is primarily drawn from administrative professionals within municipalities and municipally owned companies. This reflects the dissertation's focus on internal governance processes and day-to-day organizational practice. While elected politicians form an important backdrop to municipal decision-making, they are not systematically included as respondents. As

discussed in Section 4.6, this was partly a pragmatic decision related to access and partly an analytical choice, given that much IUS-related work is carried out within the administrative organization. The limited inclusion of political perspectives means that the findings emphasize administrative capacity and organizational dynamics in IUS rather than political contestation or agenda-setting.

Finally, the temporal scope of data collection (2019–2025) allowed the study to follow organizational reforms and evolving policy priorities over time. At the same time, it introduces challenges of comparability, as municipal contexts changed during the research process (Langley, 1999).

Together, these delimitations define the contribution of the dissertation: to offer in-depth, empirically grounded insights into how municipalities govern IUS from within, while generating analytical perspectives that may inform studies of municipal sustainability governance in other institutional contexts.

4.9 Research quality

The quality of qualitative research can be assessed through several complementary criteria (Maxwell, 2012; Yin, 2018). In this dissertation, the discussion follows Yin’s (2018) four-part framework of construct validity, internal validity, external validity, and reliability, supplemented with reflections on triangulation and analytical generalization. These four dimensions are summarized in Figure 5, which provides an overview of how research quality is addressed across the dissertation.

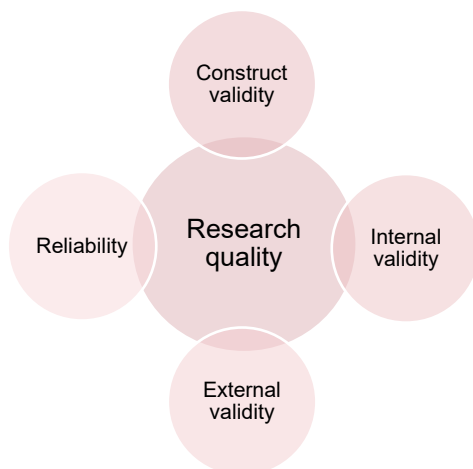


Figure 5. Dimensions of research quality applied in this dissertation. Adapted from Yin (2018) and Maxwell (2012).

Construct validity

Construct validity refers to the extent to which the study uses appropriate measures for the concepts being investigated. In this dissertation, construct validity was enhanced by using multiple sources of evidence to allow for cross-checking and complementarity: interviews, documents, observations, workshops, and questionnaires (Bowen, 2009a; Flick, 2022). Draft protocols and analytical choices were reviewed with supervisors and peers, providing critical scrutiny throughout the research process. Construct validity was also supported by ensuring that the analytical categories were clearly connected to the research aims and theoretical framing. For example, governance modes were operationalized through established typologies (Bulkeley & Kern, 2006), while organizational dimensions were drawn from public sector organization literature (Christensen et al., 2011; Domingues et al., 2017). Establishing “chains of evidence” meant documenting how insights developed step by step across data collection, coding, and interpretation, so that links between raw material and analytical claims could be traced transparently (Yin, 2018).

Internal validity

Internal validity concerns the credibility of explanatory claims, particularly in research that seeks to account for relationships and processes (Maxwell, 2012). Although the dissertation does not claim to establish universal causal relationships, it does seek to explain how certain organizational forms and governance strategies shape IUS development. Internal validity is strengthened through triangulation (Denzin, 2012):

- *Data triangulation*, by drawing on interviews, documents, and observations collected at different times and from different actors.
- *Methodological triangulation*, by combining qualitative content analysis, thematic analysis, and descriptive questionnaire analysis.
- *Theory triangulation*, by interpreting findings through multiple theoretical perspectives, including governance modes, organizational systems, and valuation frameworks.
- *Observer triangulation*, partly achieved in Paper III through double coding and assessment of inter-coder reliability using Cohen’s kappa (Cohen, 1960).

These strategies help guard against single-source bias and allow emerging interpretations to be tested from several angles.

External validity

External validity refers to the generalization of findings. Because the dissertation is grounded in qualitative case study logic, the aim was not statistical but analytical

generalization (Seawright & Gerring, 2008; Yin, 2018). Insights from the Simrishamn and Malmö cases were interpreted through broader theoretical frameworks of governance modes and public sector organization, making it possible to extend lessons beyond the immediate cases. Comparative interviews with six additional municipalities, together with the national questionnaire, enabled the plausibility of observed patterns to be checked against a wider empirical base. This does not mean that findings apply universally across all contexts, but rather that they contribute to theory-building by showing how internal municipal governance of IUS can be understood in relation to established analytical frameworks.

Reliability

Reliability concerns the extent to which the research process is documented and carried out in a consistent and transparent manner (Yin, 2018). To enhance reliability, clear protocols for data collection were followed, interviews were recorded and transcribed, and coding procedures were systematically documented. In Paper III, intercoder reliability was explicitly tested through Cohen's kappa (Cohen, 1960), ensuring agreement across categories. Data management followed GDPR standards and university protocols, creating an auditable trail of the research process (Lund University, 2025; Swedish Research Council, 2024). Together, these measures support the transparency and dependability of the findings.

5. Findings

This chapter presents the findings of the dissertation. Its purpose is to synthesize insights from the five appended papers in relation to the overarching aim and research questions, while drawing on their combined contributions. The guiding aim of the dissertation has been to advance understanding of how municipalities govern IUS from within, with attention to their roles and strategies, internal organizational arrangements, and municipal actor values as expressed in internal collaboration and coordination.

As introduced in Chapter 1, this aim is addressed through three interrelated research questions:

- **RQ1:** What roles and strategies do municipalities adopt in governing IUS?
- **RQ2:** How do internal organizational arrangements and practices shape municipal governance of IUS?
- **RQ3:** How do municipal actor values shape the governance of IUS, as expressed in internal collaboration and coordination?

The chapter is structured around these three questions. Organizing the findings in this way serves two purposes. First, it avoids duplication of the overview of papers provided in Section 1.3. Second, it enables an integrated account of the dissertation's overall findings, drawing on evidence from across the five studies. Each section therefore combines insights from multiple papers, with particular studies taking the lead depending on the research question addressed, highlighting complementarities, contrasts, and cross-case patterns.

Section 5.1 addresses findings related to RQ1, focusing on the roles and strategies municipalities adopt. Section 5.2 then considers RQ2, examining internal organizational arrangements and practices, while Section 5.3 explores RQ3, focusing on how municipal actor values shape governance through internal collaboration and coordination.

5.1 Municipal roles and governing strategies in IUS

The first research question asks how municipalities govern IUS through different roles and strategies. This section shows that municipalities draw on a broad repertoire of governing approaches that combine internal and external forms of action. As discussed in Chapter 2, internal governing concerns activities and arrangements within the municipal organization itself (including municipally owned companies), whereas external governing concerns municipal action directed outward toward other actors and arenas.

It brings together insights primarily from a systematic review of the literature, a national questionnaire, and an in-depth study of internal strategies, with complementary perspectives on how governing strategies are shaped by administrative and corporatized service arrangements.

Governing modes in theory (Paper I)

Industrial symbiosis research has historically been dominated by a business-to-business focus, where firms are treated as the primary actors. Municipalities and local governments have appeared mainly as peripheral facilitators, rather than as central agents of governance. Paper I addresses this gap using a systematic review of the literature, examining how local governments are described in relation to IS, and how they make use of different modes of governing. Drawing on the Bulkeley & Kern (2006) typology, later expanded by Bulkeley et al. (2009), five governing modes are analyzed: self-governing, provision, authority, enabling, and partnership.

The review finds that municipalities are most frequently associated with governing through enabling, where they take on a role as coordinators, facilitators, or act as “anchor tenants” in symbiosis networks (Sun et al., 2017). In practice, this involves the creation of meeting arenas, brokering knowledge, simplifying administrative processes, and fostering trust among actors. For example, actions by local governments have been described to initiate and promote resource exchanges, provide transparent information, and help attract new members into networks (Lenhart et al., 2015; von Malmborg, 2004). By creating platforms for data sharing and acting as knowledge brokers, municipalities address informational barriers, while their role in building trust and creating common goals also contributes to reducing social barriers that often stall IS collaboration (Chertow & Ehrenfeld, 2012b; Domenech Aparisi, 2010).

Provision is another prominent governing strategy observed in cases where municipalities take an active role as service providers or infrastructure owners rather than merely facilitators. Through this mode, they govern by supplying or maintaining the material and institutional preconditions for symbiotic exchanges. Municipalities often provide essential infrastructure, technology, or services such as waste management facilities, energy networks, or district heating systems that

enable industries and other actors to connect their resource flows. In some instances, this provision is channelled through municipally owned companies acting as operational providers of goods or services, which helped reduce technical barriers (e.g. lack of infrastructure or technology) and economic barriers (e.g. high start-up costs). At the same time, the literature noted potential risks: when municipalities assume too strong a provisioning role, they may unintentionally distort local markets or outcompete private actors (Palm et al., 2019).

Although governing by authority is observed to be less applied at the local level than at the national level, the literature still contains examples where municipalities developed supportive policies, strategies, or planning frameworks to enable symbiosis initiatives (Domenech et al., 2019). Regulatory barriers such as conflicting waste codes, unclear legislation, or difficulties in obtaining permits are often beyond local control, but targeted local policies and incentives can play a role in overcoming them (Xiang & Yuan, 2019). Local strategies, for example, have been used to integrate IUS into urban plans, environmental programs, or energy strategies, addressing regulatory barriers that would otherwise block development.

Partnership-based governance emerges in cases where municipalities enter IS networks as equal partners, co-investing time and resources in collaborative projects. This was described, for instance, when local authorities consumed by-products from industrial partners or engaged in joint planning with neighboring municipalities (Music, 2019). Such arrangements directly address economic barriers (by sharing costs and risks) and informational barriers (by circulating knowledge and experience), while also helping to overcome social barriers by embedding municipalities as trusted and accountable participants.

Finally, while less common, the review finds examples of self-governing approaches, where municipalities implement their own symbiosis solutions or leverage municipal material flows to initiate exchanges. This included cases where municipal waste or energy systems were used to trigger resource circulation, or where city authorities integrated IS thinking into planning routines (Ban et al., 2016). Such cases shift the IS perspective from a business-to-business (B2B) model towards an authority-to-business (A2B) model, in which municipalities act as resource owners and direct participants (Horváth & Harazin, 2016). Self-governing most often addressed technical barriers, for example by ensuring that key municipal facilities or infrastructures could be harnessed for symbiosis exchanges.

Taken together, Paper I shows that all five governing modes have potential functions in overcoming economic, technical, regulatory, social, and informational barriers to IS. Table 10 illustrates this relationship by mapping how different governing modes correspond to the barrier categories identified in the literature. It highlights that municipalities are not limited to facilitation but can, in principle, act across a broader spectrum of governing activities.

Table 10. Governing modes and barriers in industrial symbiosis. Adapted from Paper I.

	Economic	Technical	Regulatory	Social	Informational
Enabling	X		X	X	X
Provision	X	X		X	X
Authority		X	X		
Partnership		X	X	X	X
Self-governing		X			

Yet the analysis also reveals an important gap: while enabling, provision, and partnership roles are well represented in the literature, the internal and self-governing dimension of municipalities remains largely unexplored. Municipalities are generally conceptualized as external facilitators rather than as organizations with their own resource flows, processes, and authority structures that can shape IS development from within. This absence provides the basis for the empirical investigations that follow in Papers IV and V.

Governing modes in practice (Paper IV)

Building on the international review in Paper I, Paper IV explores how municipalities in Sweden themselves perceive and describe their role in industrial and urban symbiosis. Through a national questionnaire answered by 22 municipalities, the study provides a broad picture of governing practices, priorities, and limits, revealing the diversity, constraints, and underlying logics shaping municipal engagement.

A first finding concerns the uneven distribution of resources and roles. Most municipalities reported that only one to three officials were actively working on IUS, often alongside other responsibilities, while a handful had larger teams and a few had none. Engagement was primarily concentrated at the level of officials rather than senior managers or politicians, with only one municipality reporting direct political involvement. Respondents described themselves in multiple ways, ranging from business developers and environmental strategists to “spiders in the web”. Many also emphasized that IUS was not yet anyone’s sole responsibility. This indicates a limited and sometimes ad hoc organizational capacity for IUS, where political will might exist without translating into resources or routines. As a result, IUS work often depends on a few committed individuals, leaving progress vulnerable to staff turnover and shifting priorities.

Despite these limits, municipalities largely framed IUS as a prioritized issue: 91% answered “yes” or “yes, but through another topic” such as circular economy or energy. This prioritization often took the form of activities categorized in the questionnaire as self-governing. Political anchoring was the single most common activity reported, alongside incorporating IUS into municipal processes such as procurement, establishment procedures, and strategic leadership via planning or management of municipally owned companies. These findings suggest that political recognition often preceded organizational capacity: municipalities first sought to secure legitimacy and mandate, and only then to formalize operational routines and responsibilities.

Enabling roles were also widely reported. Municipalities described themselves as facilitators and coordinators, helping to build networks, host meetings, support corporate gatherings, and communicate symbiosis to a broader audience. Many emphasized the importance of trust-building, joint goal setting, and providing knowledge or testbeds to encourage experimentation. These enabling practices mirror the “anchor tenant” role identified in Paper I, but here municipalities themselves underlined how relationship-building and symbolic leadership are central to their governing repertoire. In other words, enabling was not just about coordination, but about shaping how symbiosis was framed and communicated locally.

Provision and partnership strategies appeared, but to a lesser extent. Municipalities reported providing infrastructure, meeting venues, or assistance with project funding and data sharing. Partnership was most visible where municipalities themselves became consumers of residual flows or engaged in joint arrangements with businesses or neighboring municipalities. Authority-based roles ranked lowest among the five governing modes reported in the questionnaire. While some municipalities saw themselves as working to influence legislation nationally, very few reported creating local legal frameworks or taking responsibility for resolving conflicts within IUS initiatives.

Respondents stressed legal and political limits: municipalities should not prioritize individual firms, provide direct subsidies, or compete with industry. Nor should they lobby or assume the role of the state or region. Several added that limited influence over permits, lack of technical competence, and reluctance to take financial risks, since municipal budgets are tax-funded, further constrained authority-based roles. Land ownership was another critical factor. Where municipalities owned land, they had leverage to steer development; where land was privately owned, their influence was much weaker. These constraints were often described in terms of where municipalities could legitimately act, particularly through instruments such as planning, land ownership, and coordination, while avoiding areas beyond their mandate.

In addition, the questionnaire mapped which municipal administrations and corporations were involved. Business administrations dominated, but technical, planning, environmental, and city board administrations were also commonly

engaged. In a few cases, social, cultural, or school administrations participated, pointing to the potential for broader organizational anchoring. Among municipally owned companies, energy, water, and waste companies were most frequently involved, illustrating how existing service providers can become infrastructural enablers of symbiosis. Yet the fact that engagement is concentrated in technically oriented units also points to a continued tendency to frame IUS primarily as a resource-efficiency issue, with weaker links to welfare or social development agendas.

The findings also highlight the role of municipal tools and processes. Strategic goals and visions, such as climate neutrality, were the most common instruments, followed by establishment and planning. Land development processes and procurement were also used in some cases to integrate IUS into contracts, development agreements, or purchasing criteria. Inspection and permit processes were rarely applied, but some municipalities experimented with material flow mapping through environmental reporting. These examples highlight that municipalities can embed IUS into their ordinary governance machinery, though in practice such tools were only sporadically mobilized.

Citizen involvement was found to be generally low: two-thirds of respondents reported no involvement, and only a minority mentioned activities such as food waste collection, local champions, or participation in public events and consultation processes. This indicates that public participation remains marginal in most IUS initiatives, with engagement focused on industrial and administrative actors.

Finally, the study probes perceptions of responsibility in the event of major change or closure of IUS initiatives. Four positions emerged. Some argued that industry should take the lead, especially larger companies with strong interdependencies, while others pointed to contracts as the main safeguard, ensuring “backup” arrangements for resource streams. A third emphasized IUS as a permanent way of working, suggesting that municipalities were institutionalizing symbiosis into normal routines to avoid dependence on individual projects, and a fourth held that municipalities themselves might bear final responsibility, although this was rarely specified in detail. Across these perspectives, municipalities appeared aware of their dual position: as facilitators seeking to empower others, yet as accountable public actors responsible for stability and continuity.

In sum, Paper IV confirms that municipalities adopt a wide repertoire of governing strategies, though these are unevenly distributed and constrained by legal frameworks, organizational capacity, and institutional mandates. Self-governing and enabling strategies dominate, while provision and partnership are more limited, and authority is least commonly applied (see Figure 6). Taken together, these responses reinforce the gap identified in Paper I: while the literature has conceptualized municipalities mainly as external facilitators, municipalities’ own accounts highlight that the internal dimension – anchoring, resources, processes, and organizational roles – is central to their governing practice yet remains little explored in research.

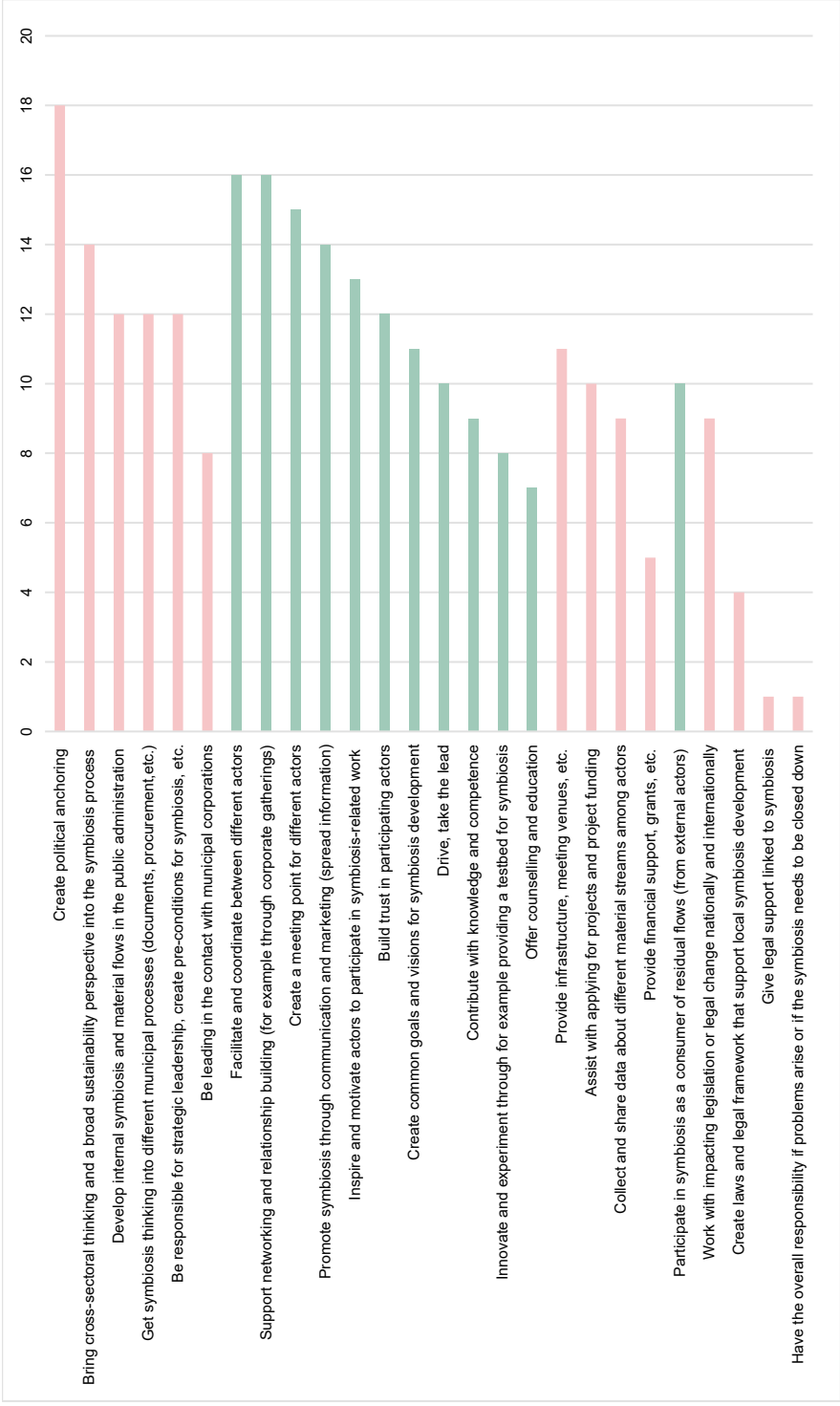


Figure 6. Reported municipal roles in IUS, categorized by governing mode. From top to bottom: self governing, enabling, provision, partnership, authority. Adapted from Paper IV.

Governing from within: internal strategies (Paper V and II)

While Papers I and IV highlight municipalities' external and self-reported roles in IUS, Paper V turns inward to examine how symbiosis is governed within municipal organizations. Using a framework that combines governing modes with public sector organization (PSO) elements, the study shows that municipalities do not rely on a single way of governing. Instead, they combine different governing strategies in ways that reflect organizational context, available resources, and institutional responsibilities. This aligns with perspectives that describe governance as a repertoire of approaches (cf. Bulkeley & Kern, 2006), although Paper V adds new insight by tracing how different governing strategies take shape within the everyday settings of municipal administration.

In practice, municipalities developed self-governing strategies by embedding IUS ambitions into their own operations and routines, often in subtle and experimental ways. Officials described integrating symbiosis thinking into planning processes, procurement, or internal resource flows as a way to “clean up our own house first” before promoting IUS externally. Such efforts carried symbolic weight, signalling commitment, but also practical effects: internal experimentation created credibility and learning-by-doing.

At the same time, authority-based strategies were mobilized to give IUS continuity and legitimacy. By anchoring symbiosis in binding strategies, statutory plans, or cross-departmental mandates, municipalities sought to safeguard initiatives against political shifts or project-based volatility. Often this went hand in hand with earlier self-governing efforts: initial initiatives and pilot projects helped create legitimacy and internal support, which in turn made it possible to move toward formal adoption. In this way, municipalities combined softer measures with binding instruments to build buy-in and secure accountability, visibility, and resilience over time.

Paper II complements this analysis by showing how the organizational form itself shapes the strategic space available to municipalities. When wastewater services were managed within the municipal administration, governance tended to reflect inclusive, welfare-oriented logics that supported transparency and alignment with political goals, but often deprioritized IUS compared to other pressing issues. By contrast, when services were shifted into a municipally owned company, governance strategies became more business-oriented, privileging efficiency, technical innovation, and market alignment, but with weaker integration into the broader administrative coordination and cross-sectoral work of the municipality.

Taken together, Papers V and II suggest that municipalities govern IUS through combinations of governing modes shaped by both organizational culture and structure. The internal role of municipalities therefore involves navigating between different modes depending on organizational form, available resources, political mandates, and relational dynamics. Municipalities' ability to govern appears to rest

on how they combine facilitation with authority, external engagement with internal anchoring, and organizational flexibility with more formal structural arrangements.

In this way, the findings complement earlier research by showing that municipal governance of IUS is characterized by patterned sequencing of governing modes that span both internal and external domains of action. Authority, in particular, emerges less as a tool for enforcement and more as a stabilizing mechanism, used to anchor initiatives in plans, mandates, and organizational routines once legitimacy and support have been built through softer, self-governing and enabling strategies.

5.2 Internal organizational arrangements and practices

The second research question asks how internal organizational arrangements and practices shape the governance of IUS. The findings draw primarily on Papers II and V, with Paper IV providing a comparative backdrop. Together, Papers II and V show that municipalities' capacity to govern IUS is shaped both by formal organizational arrangements and by how governance is carried out in everyday work (Christensen et al., 2011; Klein et al., 2020; Lozano, 2018). One central insight concerns how organizational logics differ when services are managed within municipal administrations compared to municipally owned companies, with implications for priorities, transparency, and how IUS is integrated into broader municipal work. In this dissertation, municipally owned companies are treated as part of the internal organizational landscape of municipalities, given their public ownership and their role in delivering core municipal services (Alexius & Furusten, 2019; Grossi & Thomasson, 2015; Thomasson, 2013).

This perspective is developed further through the application of a public sector organization framework (Klein et al., 2020; Lozano, 2018), including strategy, processes, procurement, organizational systems, and collaboration, to examine how self-governing and authority-based approaches take shape within municipal administrations. A broader comparative backdrop is provided by the national questionnaire study, which shows how internal arrangements and practices vary across Swedish municipalities. Taken together, the findings indicate that municipalities' capacity to govern IUS depends not only on formal internal structures, but also on less tangible organizational conditions, including culture, leadership, and how initiatives are introduced, coordinated, and built up over time across different parts of the municipal organization (Christensen et al., 2011; Domingues et al., 2017; Meuleman, 2018).

Organizational form and governing logics (Paper II)

Paper II examines how the organization of municipal services shapes the governance of IUS, focusing on water and sewage management. The analysis compares two organizational forms, services located within the municipal administration and services organized in municipally owned companies, using four analytical dimensions: actors and organizations, goals and ambitions, resources, and policy. The findings show that these organizational forms are not merely technical arrangements but embody distinct governing logics, understood here as different ways of setting priorities, making decisions, and organizing responsibilities within municipal organizations (Pahl-Wostl, 2015a; SKL, 2011; Thomasson, 2013; Thompson, 2003), which influence how IUS is understood, positioned, and managed in practice (Domenech et al., 2019; Velenturf, 2016; Walls & Paquin, 2015). These differences are summarized in Table 11.

When water and sewage services were organized within the municipal administration, proximity to other departments supported more integrated internal coordination. Respondents described how this facilitated collaboration across policy areas, particularly in smaller municipalities where coordination often relied on personal relations (Mattisson & Thomasson, 2019). Being part of the administration also made it easier to link IUS to wider municipal responsibilities, such as citizen welfare and democratic principles like transparency and participation (Montin, 2016; Thomasson, 2013; Wihlborg & Palm, 2008). When services were located within the administration, decisions were more directly embedded in municipal committees, councils, and budget processes, making it easier to anchor IUS-related issues politically, even if this did not guarantee prioritization in practice. Interviewees also noted that IUS often had to compete with other municipal concerns, such as healthcare or education, which could limit available resources and attention for innovation.

When services were corporatized into municipally owned companies, governing practices became more narrowly focused and business-oriented. Respondents emphasized gains in efficiency, clearer responsibility structures, and improved capacity for technical development, as expertise was more clearly gathered within a single organization (Erlingsson et al., 2014; Thomasson, 2019). Decision-making processes were often faster, enabling more focused development of symbiosis-related solutions. However, this organizational form also reduced everyday interaction with other municipal departments. As a result, IUS was more weakly connected to broader municipal agendas and less embedded in cross-sectoral coordination, even though the corporation remained publicly owned and politically governed through owner directives.

Table 11. Organizational form and governing logics of IUS: comparison between municipal administration and municipally owned companies. Adapted from Paper II.

Governing logic	Municipal administration	Municipally owned companies
Actors & organizations	Broad inclusion of municipal departments, enabling holistic perspective and easier collaboration across sectors; political anchoring and democratic accountability stronger.	Concentrates expertise and resources in one place, enabling more efficient operations and quicker decision-making; clearer boundaries of responsibility.
Goals & ambitions	Tied to citizen welfare, equity, and long-term development goals; easier to align with political priorities and ensure transparency.	Focus on efficiency, cost reduction, and developing viable business models; stronger innovation capacity and technical focus.
Resources	Access to diverse municipal resources across sectors (water, energy, transport, etc.); can rely on tax revenues for riskier or long-term investments.	Dedicated resources and expertise gathered in one place, strengthening technical competence and financial discipline.
Policy & development	Easier to integrate IUS into municipal policies, planning, and political steering; decisions can be anchored and prioritized politically.	Guided mainly by owner directives and national regulations, offering autonomy from municipal politics and room for experimentation.

As Table 11 indicates, the two organizational forms also differed in how resources were mobilized. Municipal administrations could draw on a wider range of sectors, such as water, energy, transport, and spatial planning, and situate IUS within a broader local development perspective. Municipally owned companies, by contrast, tended to rely on more specialized technical and financial resources linked to their specific service mandate. Financial conditions differed accordingly: administrations could rely on municipal tax revenues to support longer-term or riskier initiatives, whereas companies had to balance their budgets through customer fees, which created financial discipline but reduced room for experimentation (EurEau, 2018; SKL, 2011).

Finally, organizational form also affected how municipalities related to policy and regulation. Administrative arrangements facilitated integration of IUS into local strategies, planning documents, and political steering, while municipally owned companies were primarily guided by owner directives and national regulation, granting greater autonomy in daily operations. Interviewees in corporatized settings described experimenting with regulatory interpretations in practice, for example, exploring alternative approaches to water or waste regulation, as a way to advance IUS despite formal constraints. These practices reflected a perception that the corporate form offered greater room for operational innovation in relation to regulatory barriers, even when such initiatives were not fully anchored in political processes (Alexius & Furusten, 2019).

Taken together, Paper II shows that organizational form is a key factor in how municipalities govern IUS, influencing how responsibilities, resources, and policy engagement are organized and translated into practice.

Internal arrangements and PSO elements (Paper V and IV)

While Paper II highlights how organizational form sets the conditions for municipal governance, Paper V turns to the internal practices through which municipalities enact industrial and urban symbiosis. Using a framework of public sector organization (PSO) elements, the study explores how municipalities embed IUS across strategies, processes, procurement, organizational systems, and internal collaboration (Klein et al., 2020), and how these efforts draw on both self-governing and authority-based governing approaches (Bulkeley et al., 2009). Paper IV provides an empirical context, showing through questionnaire data that resources, roles, and responsibilities are unevenly distributed across municipalities, illustrating the broader landscape within which the practices of Paper V are situated.

A first set of findings concerns how municipalities anchor IUS in strategies and frameworks. Paper V shows that this often begins with self-governing approaches, where IUS is integrated into climate, sustainability, or circular economy strategies to gain visibility and legitimacy. Officials described this as both symbolic and practical, signalling commitment internally while creating a platform for later action. In one municipality, respondents stressed that IUS had been woven into “so many strategic documents” that this layering itself became a strength, though implementation remained elusive. Another example showed how IUS was strategically re-framed depending on the audience, presented as a business idea in economic discussions and as resource efficiency in environmental ones. Authority-based efforts added another layer, with some municipalities embedding IUS in binding strategies or detailed development plans to safeguard continuity across political cycles. Yet across both modes, respondents noted that written commitments rarely guaranteed implementation without persistent advocacy and leadership. The questionnaire responses in Paper IV indicate a similar pattern of formal prioritization, often through integration into other agendas rather than stand-alone symbiosis policies.

In terms of public management and strategy, Paper V highlights the tension between ambition and capacity (Ansell & Torfing, 2021). Self-governing approaches relied on flexible coordination and project-based resources, often with staff “borrowed” across departments to address skill gaps or ease workloads. This informality created space for experimentation but left IUS vulnerable to shifting priorities. In one case, project-based contracts forced officials to prioritize IUS because “you have to deliver on the contract,” showing how temporary funding could trigger organizational attention while also creating risks of short-termism. Authority-based approaches were used to move beyond this volatility by aligning IUS with budgetary planning, measurable objectives, and long-term transition goals. For example, one

municipality emphasized how securing IUS in adopted strategies made it harder for opponents to resist, even if implementation remained incremental. Yet in both studies, progress was often held back at the middle layer of municipal hierarchies, where departmental priorities and established routines made it difficult to move cross-cutting initiatives forward. This bottleneck was noted clearly in Paper V and is consistent with questionnaire responses in Paper IV, where political prioritization often failed to translate into resources or operational alignment.

Municipalities also experimented with embedding IUS into processes and services. Paper V documents a range of internal initiatives: using urban metabolism tools to map the municipality's own inflows and outflows, reusing materials within municipal buildings, and designing "vertical symbiosis" through architectural planning of shared flows across departments (Ness & Xing, 2017; Van Berkel et al., 2009). In some cases, this work was framed as credibility-building, e.g. the idea of "cleaning up our own house first" before promoting symbiosis externally.

Authority-based measures sometimes reinforced these efforts, for example when internal coordination was formalized through municipal mandates or when municipally owned companies incorporated circularity into their core operations. Yet engagement remained uneven across departments, with technical and environmental units more active than social or cultural ones. Paper IV complements this observation, showing that involvement in IUS was similarly concentrated in certain departments across municipalities, while others were rarely engaged. Moreover, municipalities still tended to frame IUS as outward-facing, although some had begun to adapt internal procedures such as establishment and land development processes to reflect symbiosis thinking.

Procurement emerged as one of the more contested arenas. Paper V shows how self-governing approaches involve both symbolic and practical experiments, such as prioritizing the reuse of furniture or the repurposing of building materials. These efforts were driven by motivated individuals or units and carried cultural weight by modelling circularity, but they rarely scaled beyond projects. Authority-based approaches cautiously adapted formal procedures: in one municipality, tenders began asking suppliers to describe their circular measures, signalling direction without making it a binding criterion. Respondents across municipalities emphasized the tension here: procurement rules emphasize transactions and compliance, while symbiosis depends on sustained collaboration and long-term relationships. As one official put it, "Symbiosis shouldn't have a transaction in that way... it should be about collaboration." Paper IV confirms that procurement is one of the processes most frequently reported as a tool for IUS, while Paper V suggests that in practice this use remains largely limited and experimental. Together these findings highlight procurement's dual role: it can reinforce municipal sustainability ambitions, but if applied too rigidly it risks reducing symbiosis to a procedural checklist rather than supporting a relational and long-term practice of coordinating resource flows (Alhola et al., 2019).

Findings on organizational systems underscored the interplay of culture, leadership, and structure. Paper V emphasizes that organizational culture often shaped IUS work more than formal strategy (Christensen et al., 2011). Open, trust-based environments enabled experimentation, while risk-averse or siloed settings constrained it. Leadership proved decisive both formally and informally: cross-party political support created legitimacy, while informal leaders built credibility and persistence within administrations. One respondent stressed that persistence and repetition – “just keeping at it, over and over” – was as important as formal authority, illustrating how everyday practices could sustain initiatives. Structural placement also mattered: being housed in a central department or close to leadership provided visibility and faster access to decision-making, while more peripheral placements weakened influence. Paper IV echoes these findings, showing that while political prioritization was common, it often lacked translation into sustained routines or resourcing, leaving implementation dependent on committed individuals.

Internal collaboration was central to both studies. Paper V shows how municipalities experimented with cross-departmental groups, ranging from informal knowledge exchanges to institutionalized coordination mechanisms. These arenas created space for staff to interpret IUS in relation to their own roles and to learn across silos, though voluntary participation sometimes limited sustained engagement. Authority-based strategies helped stabilize these efforts: in some cases, political mandates gave staff explicit authority to work across departments, or knowledge groups were institutionalized to coordinate responses to external actors. Collaboration was often described as both a technical and cultural challenge, requiring alignment across professional languages, departmental silos, and even differing generational perspectives. Paper IV similarly mapped how business, technical, and environmental departments were most involved, while others like social services were rarely engaged, highlighting both the reach and unevenness of cross-organizational anchoring (Paquin & Howard-Grenville, 2012). Figure 7 summarizes how municipalities worked with different PSO elements, drawing together insights from Papers V and IV.

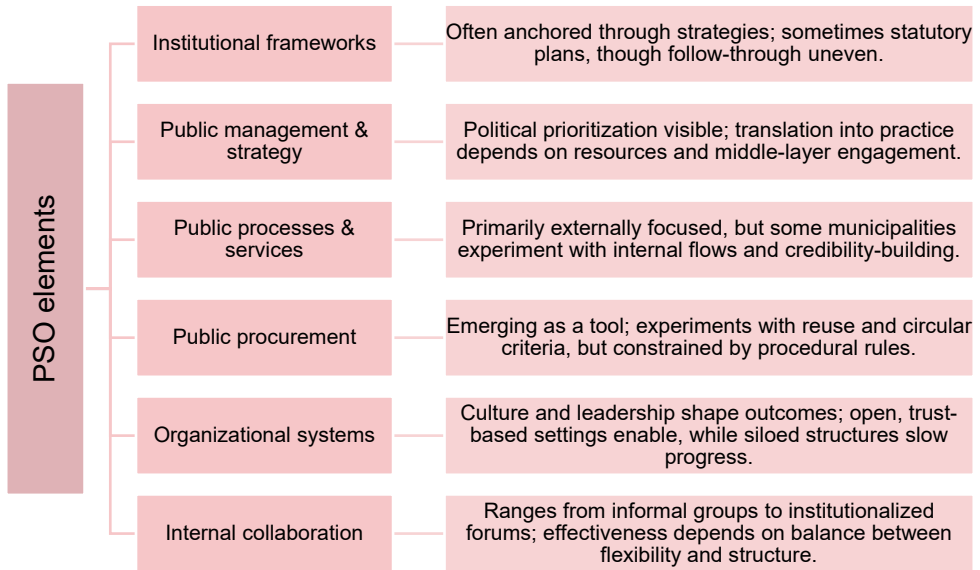


Figure 7. Empirical insights on PSO elements in the governance of IUS, based on Papers IV and V.

Taken together, findings across Papers II, IV, and V show that municipalities' internal arrangements for governing IUS are neither uniform nor static. Instead, they reflect shifting combinations of self-governing practices and authority-based structures, applied differently across PSO elements and organizational forms. Voluntary initiatives often created momentum, while formal instruments provided continuity, particularly when embedded across multiple organizational elements. These combinations varied across municipalities and over time, shaping how IUS became embedded in everyday administrative work.

In doing so, the findings suggest that the municipal organization is not merely the context in which governance takes place, but an integral part of governance itself: how responsibilities are structured, services organized, and routines coordinated actively conditions which forms of IUS governance become possible in practice.

5.3 Value orientations and internal collaboration

The third research question asks how municipal actor values shape the governance of IUS, and how these values are expressed through internal collaboration and coordination. This section builds primarily on Paper III, which explored the broader societal values at stake in an emerging circular wastewater system, and Paper V, which examined the intra-organizational and interdepartmental collaboration that underpins municipal IUS efforts. Together, these papers highlight that the

governance of symbiosis is not only a matter of organizational form or strategy, but also of how actors interpret their roles, build trust, and negotiate responsibilities in practice.

In this dissertation, internal collaboration and coordination are treated as arenas in which value orientations become visible. These arenas include both formal arrangements, such as structured coordination between departments or organizations, and informal practices, such as trust-building, persuasion, and repeated interaction (Ansell & Gash, 2008b; Bryson et al., 2015; Perriton et al., 2025). Through these interactions, actors frame, justify, and anchor IUS in ways that reflect their value orientations and broader societal expectations of legitimacy.

The two papers approach the relationship between value orientations and internal collaboration from different but complementary angles. Paper III focuses on how multiple economic, environmental, and social values shape perceptions of legitimacy and acceptable collaboration in IUS. Paper V, in turn, examines how collaborative work is enacted and stabilized within municipal organizations, through everyday interaction across departmental and organizational boundaries.

Value pluralism and legitimacy (Paper III)

Paper III examines how actor values shape the governance of an emerging circular wastewater system, with a particular focus on how plural understandings of value influence collaboration and perceived acceptance. Drawing on the total economic value (TEV) framework as an analytical lens (Pearce & Turner, 1990; Wadström et al., 2021), the study identifies how multiple categories of value (including use, option, existence, and bequest values, as well as negative values) were expressed by the municipal administration, the municipally owned companies, industries, the County Administrative Board, and civic stakeholders such as a farmers' association. Rather than applying TEV in a narrow economic sense, the analysis uses it as an interpretive tool to capture the breadth of values articulated by different actors. In this way, values were not abstract principles but situated in organizational roles, everyday responsibilities, and the narratives through which actors justified their engagement (Alexius & Furusten, 2019; Ramsheva et al., 2019; Suchman, 1995).

In the Simrishamn wastewater-reuse initiative, industry actors and the municipally owned water corporation tended to emphasize direct use values, highlighting opportunities such as irrigation for agriculture, process water for industry, and reducing dependence on groundwater during dry periods. One industry actor also articulated a negative direct use value, expressing concern that relying on externally recycled water might conflict with its carefully cultivated image of self-sufficiency.

The municipal administration also acknowledged direct use values, such as reducing dependence on groundwater, but its emphasis was stronger on indirect use values, linking the initiative to local innovation, business development, job creation, and ecological co-benefits such as wetland creation. In addition, officials in both the

municipal administration and the municipally owned company articulated option values, pointing to uncertainty around future water access and the need to safeguard resilience. The decision to invest in an advanced treatment facility further reflected a quasi-option value, with the wastewater treatment plant being framed as a testbed for research and knowledge development prior to making long-term reuse commitments.

The municipally owned company expressed a distinct combination of values. In terms of direct use values, it emphasized the practical benefits of reclaimed water for agricultural and industrial use. At the same time, it highlighted indirect use values, linking the initiative to technical innovation, operational efficiency, and the municipality's profile as a forward-looking actor in resource management. The municipal company also articulated option values, stressing the importance of flexibility under future climate and demand uncertainty. Alongside these positive framings, respondents raised a negative indirect use value related to sunk investments in advanced treatment infrastructure: not making full use of the facility was seen as a lost opportunity for public resources and knowledge development. Together, these concerns reflected the dual role of the municipally owned company as both technical service provider and publicly owned organization responsible for long-term infrastructure investments.

Civic actors, notably the farmers' association, articulated values that extended beyond immediate use. They emphasized existence values, describing soil as having an inherent worth that shaped their stance on wastewater reuse, and bequest values, stressing the importance of preserving productive land and environmental assets for future generations. The material also contained some instances of negative existence values: for some individuals, the mere knowledge that reused water had previously passed through meat-processing facilities was disturbing, even when no residues remained.

The County Administrative Board contributed a policy perspective that combined option values, stressing the importance of long-term water security and regional resilience, with bequest values that echoed statutory commitments to ensure a healthy environment for future generations. In the written material, indirect use values such as innovation and secondary environmental benefits were emphasized more strongly than existence or bequest values.

Rather than tracing direct episodes of collaboration, the findings point to how plural values shape the conditions under which collaboration could emerge (Chertow & Ehrenfeld, 2012a; Paquin & Howard-Grenville, 2012). Diversity of perspectives sometimes created opportunities for negotiation and mutual learning, but it could also fragment discussion when no effort was made to translate across different understandings. In this sense, the governance of IUS was shaped not only by formal strategies or organizational arrangements, but also by how different actors understood the purpose of the initiative, its benefits, and its risks.

Within this plural landscape, municipalities emerged as particularly central actors. Both municipal administrations and municipally owned companies articulated their own value orientations while also carrying responsibility for holding together divergent perspectives (Grossi & Thomasson, 2015; Thompson, 2003; Wihlborg & Palm, 2008). By embedding environmental and welfare-oriented rationales into political and administrative processes, municipalities sought to connect efficiency-oriented objectives with longer-term collective concerns. Paper III thus reinforced a central theme of the dissertation: municipal value orientations and internal strategies shape whether symbiosis initiatives gain acceptance and become institutionalized, or remain fragile and contested.

Table 12 summarizes how municipal administrations and corporations emphasized distinct categories of value. It shows that while their framings overlapped in some respects, they also reflected divergent organizational logics when justifying engagement in the wastewater-reuse initiative.

Table 12. Value orientations expressed by municipal actors in the Simrishamn wastewater-reuse initiative. Adapted from Paper III.

Municipal actor	Value categories emphasized	Illustrative focus
Municipal administration	Direct use values; indirect use values; option values; quasi-option values	Reducing dependence on groundwater; local innovation, business development, job creation; ecological co-benefits (wetlands); uncertainty of future water access and regional resilience; wastewater treatment plant as research and development testbed.
Municipally owned company	Direct use values; indirect use values; option values; negative indirect use values	Irrigation for agriculture; process water for industry; reducing dependence on groundwater; efficiency and innovation framings; concern over sunk costs in treatment infrastructure (lost opportunity if unused).

By foregrounding these dynamics, Paper III shows that the viability of IUS depends not only on regulatory compliance or infrastructure provision, but also on whether actors perceive their priorities and perspectives as acknowledged and respected. Different actors emphasized different kinds of benefits, risks, and responsibilities, and these differences shaped how the initiative was discussed, justified, and supported. In this sense, the study illustrates that symbiosis is governed not only through formal arrangements, but also through how its purposes and consequences are interpreted by those involved.

Internal collaboration and coordination (Paper V, II and IV)

Paper V examines how Swedish municipalities organize collaboration around IUS within their own organizations, showing that these processes were rarely linear or straightforward. Instead, they unfolded through a mixture of informal exchanges, trust-building, and gradually formalized arenas. Collaboration was not a ready-made

instrument applied from above but an ongoing process of coordination and relationship-building, shaped by organizational cultures, departmental practices, and the values actors attached to their roles (Ansell & Gash, 2008b).

In several municipalities, collaborative practices first took shape through informal exchanges. Staff described how conversations across departments, personal initiative, or small ad hoc groups laid the groundwork for later collaboration. These beginnings often relied on trust, shared motivation, and a sense of contributing to something meaningful for the municipality's future. At the same time, self-governing also appeared in more structured forms, such as assigning explicit responsibility to a coordinating unit, including IUS in departmental plans, or allocating staff time to sustain activities. Respondents stressed that while informality allowed flexibility, it also carried risks: when responsibilities were diffuse and no department was clearly in charge, collaboration and coordination efforts could easily stall or lose continuity (Bryson et al., 2006).

Over time, several of these arrangements were consolidated into semi-structured or even formally mandated structures. Examples included knowledge groups and cross-departmental forums that met regularly and developed shared language for IUS. Once connected to municipal strategies or supported by political endorsement, these structures helped stabilize collaboration and cross-departmental coordination, thereby reducing reliance on individual champions. At this stage, the work was no longer only about trust and enthusiasm but also about establishing credibility, providing coherent responses to external stakeholders, and embedding IUS in organizational routines.

These dynamics were also shaped by departmental cultures and working styles (Christensen et al., 2011; Paquin & Howard-Grenville, 2012). Respondents pointed out that some units were open, experimental, and easy to work with, while others were perceived as rigid or risk-averse. This unevenness influenced who was invited into collaborative arenas and whose perspectives were sidelined. In several municipalities, departments like social services remained largely absent, suggesting that the values promoted through IUS were often tilted toward environmental and resource-efficiency concerns, with fewer links to broader social priorities. These findings are also reflected in Paper IV, which shows that while business, technical, and planning departments were commonly involved in IUS, social and welfare administrations were rarely present, and citizen engagement remained limited. There were exceptions, however: at least one municipality in Paper V explicitly sought to connect IUS with social objectives, framing collaboration as a way of building community value.

Paper II adds a structural perspective, showing that these value-laden differences were also conditioned by organizational form (Mattisson & Thomasson, 2019; Pahl-Wostl, 2015b). Collaboration was often easier to sustain within administrative setups, where proximity to other departments supported holistic perspectives and

cross-unit work could evolve more organically. At the same time, administrative organizational forms sometimes struggled to balance competing priorities, which could dilute focus on IUS. Corporate structures, by contrast, promoted efficiency and professional specialization and could strengthen innovation capacity, but they also risked narrowing collaboration to a smaller circle of actors and making it more dependent on formal mandates or owner directives.

Building on these structural and cultural contrasts, Paper V shows that collaboration was not simply a matter of bridging governance modes but an everyday practice that required persistence, patience, and relational work (Ansell & Gash, 2008b). Respondents described repeating the same messages “over and over” to build awareness, using stories to make symbiosis tangible, and relying on credibility and trust to draw colleagues into shared efforts. Collaboration was thus not only technical, nor merely a matter of aligning flows and responsibilities. It was also cultural, sustained by the values people attached to their roles and to the municipality as a collective actor.

Seen through this wider lens, collaboration was not only a matter of how municipal departments and units worked together day-to-day, but also of why they invested in doing so. Respondents described such internal efforts as a way to maintain continuity across political cycles, to present a coherent voice to external actors, and to sustain engagement despite scarce resources. These accounts point to values of credibility, trust, and long-term responsibility as central to sustaining joint work (Ramsheva et al., 2019). Paper V therefore underscores that collaboration was shaped as much by departmental cultures and value orientations as by organizational structures, influencing how far municipalities could mobilize IUS as a collective endeavor.

Taken together, these findings show that collaboration around IUS operates at several levels: as external convening and facilitation roles, as internal coordination shaped by organizational form, and as everyday relational work within municipal administrations. Across the studies, collaboration was sustained not only through formal arrangements but also through repeated interaction, trust-building, and efforts to develop shared language. These patterns link collaboration to municipalities’ strategies, value orientations, and internal organizational arrangements in the development of IUS initiatives. In this way, the dissertation contributes to IUS research by showing how value orientations shape the governance of symbiosis through everyday practices of collaboration and coordination, where organizational boundaries are bridged, responsibilities negotiated, and differences managed in practice.

6. Discussion

This dissertation set out to examine how municipalities govern industrial and urban symbiosis. While the point of departure was broad, addressing municipal roles, organizational arrangements, and value orientations that shape governance through internal collaboration and coordination, the empirical studies show that the internal dimensions of governance play a more significant role than previous research has typically acknowledged. Across the five papers, a consistent pattern emerges: governing IUS is not primarily a matter of external facilitation, but of building internal municipal capacity through organizational anchoring, cross-departmental coordination, and legitimacy work. The ways municipalities structure their organizations, anchor strategies, and negotiate values internally often prove decisive for whether IUS remains confined to isolated projects or becomes embedded in everyday governance.

The discussion is organized in six sections. Section 6.1 engages directly with the three research questions, highlighting that municipalities govern IUS through a combination of modes and activities (RQ1), that organizational forms and internal capacities condition how these roles are enacted (RQ2), and that municipal actor values shape how symbiosis is sustained, negotiated, and embedded through internal collaboration and coordination (RQ3). Section 6.2 then lifts the discussion to a broader level, considering how IUS relates to municipal development and organizational continuity. Section 6.3 critically reflects on tensions and blind spots in IUS practice and scholarship, including the limits of circular economy framings, questions of power and asymmetry, and the relative neglect of social dimensions. The subsequent sections outline the dissertation's theoretical contributions (6.4), practical implications (6.5), and limitations and avenues for future research (6.6).

6.1 Discussion of findings

This section interprets the findings in relation to the three research questions, focusing in turn on municipal governing roles and strategies (RQ1), organizational arrangements and capacities (RQ2), and value orientations and internal collaboration (RQ3).

Governing roles and strategies (RQ1)

The first research question asked what roles and strategies municipalities adopt in governing IUS. The findings show that municipalities rarely act through a single governing mode in isolation. Instead, they draw on self-governing, authority-based, enabling, provision, and partnership roles in different combinations and sequences, depending on context and phase of development. This aligns with Bulkeley & Kern's (2006) argument that local sustainability governance relies on multiple governing modes operating together. However, this dissertation complements this perspective by showing that these combinations are shaped not only through municipalities' external interactions, but also through internal organizational practices and administrative decision-making (Paper IV; Abreu & Ceglia, 2018; Boons & Spekkink, 2012; Mortensen et al., 2024; Walls & Paquin, 2015). This challenges the dominant depiction in parts of the IUS literature, where municipalities are primarily portrayed as external facilitators or enablers (Mortensen & Kørnøv, 2019b; Paquin & Howard-Grenville, 2012). Instead, the findings suggest that governing modes operate across both outward-facing and inward-facing domains of municipal action (Paper IV; Paper V).

A central contribution of the dissertation is to highlight how self-governing is internalized as an organizational practice. Paper V demonstrates that municipalities frequently mobilize self-governing through the integration of IUS into strategies and statutory plans, and through experimentation in their own operations. Such initiatives, including pilot projects, internal reuse practices, and symbolic “clean-up-our-own-house” efforts, helped establish credibility, shared understanding, and administrative legitimacy. These internal processes were often a precondition for sustained external engagement, as they enabled municipalities to convene other actors and to justify more binding forms of coordination. Self-governing thus appears not only as “leading by example”, but as a mechanism for building organizational capacity for broader governance action (Ansell & Torfing, 2021; Bulkeley et al., 2009). This finding supports the analytical distinction developed in the dissertation between internal and external governance strategies and suggests that governing modes should be understood as spanning both domains (Paper IV; Paper V).

The findings also point to a more nuanced role for authority than is typically assumed in the IUS literature. While municipalities were rarely in a position to impose hard regulation on firms, they exercised authority through planning instruments, land-use decisions, and internal mandates within their own organizations (Bulkeley et al., 2009). Rather than functioning primarily as a coercive tool, authority operated as a means of institutionalizing and stabilizing symbiosis initiatives by anchoring them in formal strategies, statutory plans, and organizational routines. In this way, authority contributed to continuity across political cycles and reduced dependence on temporary project funding.

At the same time, the empirical material also shows that authority was rarely mobilized in isolation or from the outset. Instead, municipalities often began with self-governing and enabling approaches, such as pilot projects, internal experimentation, and symbolic leadership, to build legitimacy, shared understanding, and administrative support before turning to more formal instruments. This sequencing of governing modes adds to the literature on local sustainability governance, suggesting that authority is most effective when deployed after softer modes have established organizational capacity and political acceptance (Meadowcroft, 2007). Authority thus emerges not as a primary mechanism of control, but as a stabilizing phase in longer governance processes through which municipalities translate emerging initiatives into durable institutional arrangements.

Finally, the findings underline that governing strategies are not entirely freely chosen but structured by organizational capacity and formal constraints. The questionnaire study shows that in most municipalities, IUS work was carried by only one to three officials at operational level, with limited involvement from senior management or politicians (Paper IV). Legal boundaries regarding subsidies, competition, and mandate further restricted the scope of municipal action, as did the distribution of land ownership, which conditioned whether planning and development processes could be used strategically. These constraints highlight that the use of governing modes is shaped by administrative capacity, formal responsibilities, and available resources. Read together with a PSO perspective (Christensen et al., 2011; Klein et al., 2020; Lozano, 2018), this suggests that municipalities' roles in IUS governance are produced not only through strategic intent, but through the organizational conditions that enable or limit what forms of governing can be sustained in practice.

Organizational forms and capacities (RQ2)

The second research question asked how internal organizational arrangements and practices shape municipal governance of IUS. Across Papers II, IV, and V, the findings indicate that governing capacity is shaped not only by formal goals or stated priorities, but by how municipalities are organized and coordinated in practice. Organizational structures, routines, and resource configurations condition what kinds of IUS strategies can be sustained, by whom, and with what degree of continuity. This supports previous research findings that organizational form is not neutral, but actively channels governing action and policy outcomes (Christensen et al., 2011; Thomasson, 2013).

A first implication concerns the role of organizational form itself. Paper II shows that administrative and corporatized service arrangements embody different governing logics (Pahl-Wostl, 2015a; Thomasson, 2013) that shape how IUS is interpreted and prioritized. When services are located within municipal administrations, governance tends to emphasize transparency, political accountability, and cross-departmental coordination, which facilitates linking IUS

to long-term development and welfare objectives but also exposes it to competition with other municipal priorities. Corporatized services, by contrast, concentrate expertise and financial responsibility, enabling technical development and operational efficiency but often weakening connections to broader municipal agendas (Alexius & Furusten, 2019; Grossi & Thomasson, 2015). Rather than one model outperforming the other, the findings suggest that organizational form structures the strategic space available to municipalities, privileging certain problem definitions, decision-making routines, and performance criteria. In this sense, organization becomes part of governance, not merely its setting.

Paper V extends this insight by showing that strategies mattered less as formal documents than as practices enacted in everyday organizational work, including management routines, service delivery, procurement, leadership, and internal coordination (Christensen et al., 2011; Lozano, 2018). Municipalities that progressed beyond symbolic commitments were those able to combine written strategies with persistent advocacy, experimentation in their own operations, and workable forms of cross-departmental coordination. Procurement illustrates both the possibilities and limits of this translation: while often presented as a key policy instrument, in practice it remained difficult to align procedures oriented toward compliance and standardized transactions with the relational and long-term collaboration that symbiosis requires. More broadly, leadership, the structural placement of responsibility, and organizational culture frequently determined whether initiatives gained momentum or stalled (Klein et al., 2020).

The comparative material in Paper IV further underscores how unevenly such organizational capacities are distributed. In most municipalities, IUS work was carried by a small number of officials at operational level, often without sustained managerial or political involvement. Departmental engagement was concentrated in technical, environmental, and business units, while social and welfare administrations were largely absent. Municipally owned companies, particularly in energy, water, and waste, functioned as important infrastructural enablers, whereas housing and real-estate companies were less involved. Together, these patterns reveal how organizational arrangements reinforce a framing of IUS as a technical-economic issue rather than a broader development concern, with implications for which perspectives are included and which are marginalized (Paper IV; Pahl-Wostl, 2015a; Perrucci et al., 2022; Van Der Brugge et al., 2005).

Taken together, the findings suggest that internal organizational conditions do not merely support or obstruct municipal strategies, but actively shape what governance of IUS becomes in practice. Strategies, service arrangements, leadership structures, and resource allocations interact, sometimes reinforcing one another and sometimes pulling in different directions. Municipalities that were able to align these elements were better positioned to embed IUS in ordinary administrative work, while others became more dependent on temporary projects or individual commitment. From this perspective, organizational form and internal arrangements are best understood as

integral components of municipal IUS governance, rather than as background conditions.

Value orientations and internal collaboration (RQ3)

The third research question asked how value orientations of municipal actors shape governance of IUS as expressed through internal collaboration and coordination. Across the five papers, values emerge not as abstract ideals but as organizationally situated orientations that influence how municipalities define legitimate objectives, appropriate forms of action, and acceptable distributions of responsibility (Alexius & Furusten, 2019; Pahl-Wostl, 2015a). In this sense, values are closely tied to legitimacy: they condition whether IUS initiatives are perceived as credible, reasonable, and worth supporting by different actors. Together, these findings point to value pluralism as a defining feature of IUS governance, where multiple, partly conflicting rationalities must be navigated if sustained collaboration, internally and externally, is to endure (M. Chertow & Ehrenfeld, 2012a; Haase et al., 2024; Pahl-Wostl, 2015a; Paquin & Howard-Grenville, 2012; Thompson, 2003).

This pluralism was illustrated clearly in Paper III. Using the TEV framework as an interpretive lens (Fisher & Hanemann, 1985; Pearce & Turner, 1990), the study showed that municipal administrations, municipally owned companies, and civic actors emphasized different categories of value when justifying their engagement in wastewater reuse. Administrative units tended to frame symbiosis in terms of public benefit, long-term resilience, and ecological co-benefits, while municipal corporations emphasized efficiency, innovation, and careful use of infrastructure investments. Civic actors articulated existence and bequest values related to soil, land, and future generations. These differences were not simply matters of individual preference but reflected actors' organizational positions, responsibilities, and accountability structures. For municipalities, this meant operating within, and across, several value logics at once. Governing IUS therefore involved not only coordinating material flows but also maintaining acceptance among actors who evaluated the same initiative through different normative lenses. The viability of IUS arrangements depended, in part, on whether such differences could be acknowledged and managed without undermining trust (Ramsheva et al., 2019; Verhoest et al., 2022).

Paper V complements this perspective by showing how internal collaboration and coordination become the practical sites where value orientations are enacted and negotiated in everyday organizational work. Collaboration was not initially foregrounded as a core analytical category in the dissertation design but emerged across the empirical material as a central arena through which value orientations and governance practices were expressed. This reflects the cross-sectoral and interdependent character of IUS (Chertow, 2000; Dong et al., 2017; Ness & Xing, 2017), which links technical systems, administrative responsibilities, and diverse stakeholder interests across organizational boundaries. Collaboration within

municipalities rarely followed linear or pre-designed pathways. Instead, it evolved through informal exchanges, personal initiative, and small ad hoc groups that sometimes later developed into semi-formal or mandated coordination structures. These processes relied on trust, shared motivation, and the gradual development of a common language around IUS (Ansell & Gash, 2008b; Chertow & Ehrenfeld, 2012; Ramsheva et al., 2019). Where collaboration was institutionalized, for example through knowledge groups or cross-departmental forums, initiatives became less dependent on individual champions and more anchored in routines.

Taken together, the findings suggest that collaboration around IUS is shaped by value diversity as much as by organizational design. Municipal IUS initiatives do not rest on a single shared understanding of what symbiosis is for; rather, they depend on continued work to translate between different ideas of benefit, responsibility, and risk (Pedersen et al., 2023). Which values become stabilized through collaboration and which remain marginal is closely connected to how municipalities organize internal coordination and whose perspectives are given space in those processes (Alexius & Furusten, 2019; Pahl-Wostl, 2015a). In this way, value orientations shape how IUS is implemented and sustained. Through internal collaboration and coordination, these orientations are translated into concrete practices that influence what kind of sustainability project IUS becomes.

6.2 Broader implications

Whereas Section 6.1 interpreted the findings in relation to the research questions and existing theory, this section steps back to consider what the results imply for municipalities' longer-term capacity to develop and sustain IUS beyond project-based forms of organization. The analysis in Section 6.1 showed that the governance of IUS is shaped from within municipalities, through organizational forms, internal arrangements, and value negotiations. This section builds on that insight by examining how IUS becomes connected to broader processes of municipal development and how it can be integrated into ordinary administrative structures and routines over time. This move also resonates with research that treats municipalities as central actors in sustainability governance, translating broad environmental ambitions into planning, infrastructure, and service provision (Bulkeley & Betsill, 2005; Bulkeley & Kern, 2006; Evans et al., 2004; Meadowcroft, 2009).

IUS and municipal development

IUS is relevant to municipal development because it connects environmental management with infrastructure planning, service provision, and local economic strategy. When approached as something that municipalities work with over time, rather than as a stand-alone project, IUS offers municipalities a way to integrate

sustainability goals into existing development agendas and to link technical functions with broader societal objectives (Bulkeley & Betsill, 2005; Meadowcroft, 2007).

The empirical material illustrates this in several ways. Initiatives such as internal reuse of construction materials, shared energy systems, or coordination between water, waste, and heat infrastructures linked environmental targets with spatial planning, investment decisions, and local business development (Papers IV and V). In these cases, IUS functioned less as a separate environmental program and more as a practical way of aligning infrastructure management with longer-term development priorities.

Seen in this light, IUS also creates real connections between organizational areas that are often handled separately. By centering attention on material flows and shared infrastructures, it brought environmental administration, technical services, planning, and business development into closer interaction around specific projects and investments. Rather than remaining a general ambition, collaboration became tied to concrete tasks and shared responsibilities within everyday municipal work (Klein et al., 2020).

The findings further suggest that municipalities that managed to sustain IUS over time tended to frame it as part of their broader development priorities rather than as a narrow environmental task. In these cases, symbiosis was linked to long-term infrastructure planning, municipal operations, and business development objectives, alongside environmental performance, which made it easier to justify cross-departmental involvement and to anchor initiatives in ordinary planning and budgeting processes (Paper V; Christensen et al., 2011; Meadowcroft, 2007).

From this perspective, IUS contributes to municipal development less through immediate economic outcomes than by gradually aligning environmental objectives with infrastructure planning and organizational routines. It reinforces municipalities' dual role as facilitators of external collaboration and as organizational actors responsible for shaping the material systems on which local development depends (Bulkeley & Kern, 2006; Evans et al., 2004).

Building organizational continuity

One central implication of the findings is that sustaining IUS depends less on isolated initiatives than on whether symbiosis practices become embedded in municipal organizations. Across the cases, IUS was often introduced through time-limited projects, external funding, or the efforts of particularly committed individuals. While such entry points were important for initiating activity, they also made governing fragile. When projects ended, staff changed, or priorities shifted, momentum was frequently lost (Paper IV; Paper V).

This highlights the importance of organizational continuity: the capacity of municipalities to carry IUS beyond temporary arrangements and integrate it into ordinary administrative routines (Christensen et al., 2011; Lozano, 2018). Research on industrial symbiosis has similarly pointed to embedding practices in everyday institutional settings as a condition for long-term viability (Chertow & Ehrenfeld, 2012; Mirata, 2004; Paquin & Howard-Grenville, 2012). From a PSO perspective, this involves anchoring symbiosis in strategies, procedures, coordination structures, and organizational systems such as leadership and responsibility allocation (Domingues et al., 2017; Klein et al., 2020), so that governing does not rely solely on temporary projects or individual commitment.

The questionnaire study in Paper IV illustrates this pattern clearly. Rather than being broadly distributed across municipal organizations, responsibility for IUS was typically concentrated in a small part of the administration, often with limited involvement from senior management or political leadership. This concentration of responsibility weakened continuity and made coordination across departments difficult. Paper V further shows how collaboration frequently relied on personal networks and informal commitment rather than on clearly assigned roles or formal mandates (cf. Domenech et al., 2019; Mortensen et al., 2024).

By contrast, in municipalities where IUS was anchored in politically adopted strategies, departmental mandates, or formal coordination arrangements, initiatives were less dependent on particular individuals and more resilient over time (Paper V). Authority-based instruments such as binding plans and formal objectives supported this process by helping stabilize priorities across organizational layers and political cycles (Meadowcroft, 2007).

Project-based funding constituted a further challenge. While external projects enabled experimentation and visibility, they also reinforced short time horizons and fragmented responsibility (Fred, 2020). Paper V shows how new initiatives were sometimes launched before earlier ones had been integrated into ordinary operations, leading to parallel structures and unclear ownership. Embedding symbiosis in procurement routines, infrastructure planning processes, and budgetary frameworks was therefore described as one way to move from experimentation toward more durable arrangements (Lozano, 2018).

Finally, the findings point to the middle layers of municipal organizations as particularly decisive. Departmental managers were often expected to translate strategic ambitions into operational practice, yet had limited room to prioritize IUS within existing routines and sectoral responsibilities (Paper V). Where this translation failed, strategies tended to remain weakly integrated into everyday work; where it succeeded, symbiosis became part of everyday decision-making (Christensen et al., 2011; Meuleman, 2018).

Taken together, these patterns suggest that governing IUS is not primarily a question of accumulating new knowledge, but of building organizational memory: routines,

responsibilities, and coordination mechanisms that persist beyond individual projects and actors (Christensen et al., 2011; Walsh & Ungson, 1991). From this perspective, municipal capacity for symbiosis is closely tied to the ability to make sustainability practices durable within the structures of public administration (Domingues et al., 2017; Klein et al., 2020; Lozano, 2018).

The role of research and policy support

Based on the findings in this dissertation, research and policy can play an important role in supporting municipalities' capacity to govern IUS, not primarily by providing technical solutions, but by strengthening internal organizational conditions for sustained action. Across the empirical material, municipalities struggled less with identifying potential symbiotic exchanges than with coordinating internally, anchoring initiatives in strategies and routines, and maintaining continuity beyond individual projects or staff members (Paper IV; Paper V; Christensen et al., 2011; Klein et al., 2020).

Rather than offering prescriptive blueprints for IUS design, research can therefore contribute by making visible how organizational forms, coordination mechanisms, and value orientations shape what municipalities are able to do in practice. In this sense, research functions as a resource for reflection on internal governance arrangements, helping municipalities to identify bottlenecks related to responsibility distribution, middle management translation, procurement routines, or strategy implementation (Domingues et al., 2017; Meuleman, 2018), all of which were recurrent issues in the cases examined in Papers IV and V.

Policy support plays a complementary role. The cases in this dissertation indicate that municipalities often lack time and analytical capacity to evaluate ongoing initiatives or redesign internal procedures while simultaneously managing core service provision. Targeted policy instruments, such as long-term funding frameworks, guidance on cross-departmental coordination, or requirements that IUS-related goals be integrated into ordinary municipal strategies and planning documents, can therefore support continuity more effectively than short-term project calls focused primarily on innovation outputs. Research examining policy instruments in the context of industrial symbiosis similarly suggests that different tools are more or less effective at different phases of symbiosis formation, and that stable, long-horizon policy mixes and knowledge-sharing mechanisms (e.g., advisory services, cluster and collaboration policies, innovation networks) are particularly important for sustaining processes beyond their initial emergence (Laatsit & Johansson, 2025). Seen in this light, policy design becomes central not only for initiating new exchanges, but for shaping whether municipalities are able to consolidate symbiosis practices within their own administrative structures (Fred, 2020; Klein et al., 2020; Meadowcroft, 2007).

Universities and regional agencies may also contribute as long-term partners in this process, supporting evaluation, documentation, and comparison across municipalities, and helping translate isolated project experiences into more durable organizational practices (Domingues et al., 2017; Lozano, 2018). Seen from this perspective, research and policy support are most valuable when they reinforce municipalities' ability to organize, coordinate, and stabilize their own governance of IUS, rather than when they introduce additional short-term initiatives that risk reproducing project dependency.

6.3 Tensions, blind spots and critique

While the previous sections have shown how municipalities govern IUS through combinations of different governing modes and through evolving internal organizational arrangements, the findings also point to important tensions and blind spots that warrant closer examination. These do not undermine the potential of IUS as a sustainability practice, but they indicate limits and trade-offs that shape what municipalities can realistically achieve. In this section, these issues are discussed at a more general and critical level, in dialogue with existing research. Taken together with debates in the wider literature, three interrelated strands of critique emerge: the ambiguous role of municipalities as both facilitators and participants; the narrowing of symbiosis under the circular economy agenda; and deeper questions of power, equity, and long-term sustainability that frame the limits of current IUS practice and research.

Municipalities between facilitation and participation

A first tension concerns the dual position of municipalities as both facilitators and participants in symbiosis systems. The empirical findings indicate that municipalities often present their role as enabling collaboration between external actors, yet in practice they also participate directly in symbiotic exchanges through their infrastructures, land ownership, and organizational systems. This duality creates an institutional ambiguity: municipalities are expected to coordinate collective processes without overtly favoring particular actors, while simultaneously managing their own flows of energy, water, and waste and pursuing their own organizational objectives. They are thus not only facilitators of exchanges between others, but participants whose own operations and assets constitute core parts of the IUS system.

This ambiguity complicates the common portrayal of municipalities in IUS research as primarily facilitators of exchange (Paquin & Howard-Grenville, 2012; Schlüter et al., 2022; Spekkink, 2015). While the facilitative role is often described as collaborative and non-hierarchical, it can obscure the influence municipalities exercise through planning, ownership, and regulation. Conversely, adopting a more

explicit participant role may raise questions about market neutrality or favoritism. The result is a delicate balancing act between impartiality and engagement, coordination and competition.

Recognizing this dual role more explicitly matters for two reasons. First, it clarifies how municipalities can exercise influence legitimately without overstepping their mandate, for example, by aligning their own infrastructures, procurement, and planning with broader symbiosis goals while ensuring openness and equal treatment of external actors. Second, it highlights why internal organization is so critical: municipalities' credibility as facilitators is shaped in important ways by how coherently they coordinate participation across their own departments and companies, since fragmented internal positions make it difficult to act consistently and credibly toward external actors (Ansell & Gash, 2008b). In short, governing IUS effectively requires clear internal coordination and workable institutional boundaries between when municipalities act as facilitators of collective processes and when they act as participants in them, even though in practice these roles often overlap.

Circular economy practices versus systemic symbiosis

A second set of tensions arises from how IUS has increasingly been subsumed under the broader circular economy agenda. Many of the self-governing activities identified through the research for this dissertation, such as internal material reuse, circular procurement, and climate-neutral strategies, reflect the language and tools of the circular economy rather than the relational exchanges characteristic of symbiosis (e.g. Corvellec et al., 2022; Gregson et al., 2015). These activities are valuable in themselves, but they tend to focus on incremental efficiency improvements within existing organizational boundaries rather than the systemic resource integration that IUS implies.

This slippage from symbiosis to circular practice raises conceptual and practical questions. Circular economy frameworks emphasize closing loops and reducing waste (e.g. Geissdoerfer et al., 2017; Kirchherr et al., 2017b), yet they often do so through firm-level or municipal initiatives that remain organizationally isolated (Corvellec et al., 2022). IUS, by contrast, demands cross-boundary coordination and shared infrastructures that link sectors, organizations, and governance levels (Chertow, 2000; Dong et al., 2017; Ness & Xing, 2017). When symbiosis becomes conflated with CE practices, the systemic ambition risks being narrowed to incremental or symbolic forms of circular practice (Hobson & Lynch, 2016). In the material studied here, self-governing efforts to “clean up our own house first” often functioned as stepping stones, providing legitimacy and learning opportunities. However, they rarely translated into sustained coordination around shared infrastructures, long-term exchange agreements, or jointly managed resource flows involving multiple organizations.

This critique resonates with earlier warnings that CE framings can reinforce technocratic and managerial approaches to sustainability (Corvellec et al., 2022; Gregson et al., 2015). By emphasizing efficiency, measurability, and implementation within existing institutional arrangements, such approaches privilege an efficiency-oriented value framing that risks underplaying social, political, and institutional dimensions of transformation (Domenech & Davies, 2011; Meadowcroft, 2007). In this sense, municipalities' CE-driven IUS work risks leaving underlying resource systems largely unchanged, for example by securing efficiency gains within existing systems without fundamentally reconfiguring how resources, infrastructures, and responsibilities are organized across actors and sectors.

In the municipalities examined in this dissertation, this was reflected in an emphasis on improving internal material and energy use, while more demanding forms of inter-organizational coordination remained limited or episodic (Paper V). The implication is therefore not that CE and IUS are incompatible, but that their conflation can obscure the relational and institutional depth that genuine symbiosis requires, particularly when the aim is to develop durable forms of collaboration beyond the municipal organization itself.

Power, asymmetry, and the neglected social dimension

A third and broader line of critique concerns the relative neglect of social and power-related dimensions in both IUS research and municipal IUS practice. While symbiosis is often portrayed as a win-win arrangement, the findings here – as well as previous literature – suggest that interdependencies among actors are rarely symmetrical (Chertow & Ehrenfeld, 2012; Domenech et al., 2019; Velenturf & Purnell, 2021). Large industrial or infrastructural players often control key resources, while smaller firms or municipalities assume greater risk and dependency (Burström & Korhonen, 2001; Sellitto et al., 2021). Such asymmetries can result in sub-optimization and lock-in effects, where benefits are unevenly distributed and arrangements become difficult to revise once established. At least one municipality in this study explicitly warned of this risk, stressing that symbiosis “must not become an end in itself.”

The limited attention to these power dynamics is further reinforced by a persistent omission of social aspects. As several scholars have noted, IUS studies continue to privilege technical and economic perspectives while paying little attention to social outcomes, inclusion, or everyday practices (Bai et al., 2026; Nugroho et al., 2025). Questions of gender, labor, and distributive justice remain almost entirely absent (Palm et al., 2024). Yet these are central for understanding who benefits from IUS arrangements, who bears risks, and whose knowledge and priorities shape their design and operation. Overlooking these dimensions risks reinforcing existing inequalities rather than transforming them.

The cases examined in this dissertation illustrate this imbalance at the municipal level. IUS work was often concentrated in technical, environmental, and business departments, with minimal involvement from social or welfare administrations. Citizen engagement was rare, and discussions of equity or participation largely absent. That said, re-centering social and distributive concerns within municipal IUS governance would not only broaden the scope of accountability but also reconnect symbiosis with municipalities' established responsibilities for public welfare and social service provision.

At the same time, the convergence of IUS and CE raises a deeper normative and analytical question: to what extent do these frameworks offer a pathway to development that is ecologically sustainable and socially acceptable over the long term? While IUS can reduce resource consumption and support innovation, it operates largely within the logic of continued growth and efficiency-oriented sustainability strategies (Sorrell, 2010). Recent industrial symbiosis research also suggests that outcomes are often framed primarily in terms of market-based benefits for participating organizations, while broader societal and non-market effects receive less attention, and that symbiosis may thus prolong environmentally detrimental industrial activities that might otherwise have been phased out (Wadström et al., 2021). These concerns connect to wider debates about whether such approaches can address underlying issues of overproduction and overconsumption, with critics arguing that sufficiency-oriented perspectives, which emphasize reductions in absolute levels of resource use and demand rather than efficiency improvements alone, may be needed as complements (Bocken et al., 2022; Chenavaz & Dimitrov, 2025; Rudolf & Schmidt, 2025; Sahakian et al., 2021). From this viewpoint, the challenge is not merely to make industrial systems circular but to reflect on the scale and purpose of production and consumption that IUS ultimately supports.

For municipalities, this tension manifests in the difficulty of reconciling economic development objectives with environmental and social goals. IUS was frequently justified in terms of innovation, competitiveness, and business development, reflecting value orientations that align closely with CE discourse but less clearly with ecological limits or social equity (e.g. Corvellec et al., 2022; Gregson et al., 2015). Addressing this imbalance does not require municipalities to abandon symbiosis as a strategy. It does, however, suggest a need to reflect not only on how they govern symbiosis, but also on why: whether IUS initiatives primarily strengthen local welfare and long-term resilience, or mainly extend existing growth-oriented development trajectories.

These critiques, taken together, do not diminish the value of IUS but underline the need for greater reflexivity in how it is governed. Municipalities occupy a pivotal yet institutionally constrained position: they are facilitators and participants, stewards of collective welfare yet bound by legal, fiscal, and organizational limits. Circular practices, including IUS initiatives, can provide visibility and incremental

progress, but without sustained attention to power relations and social dimensions they risk remaining partial in their effects. The wider IUS field likewise stands to gain from expanding its analytical lens from flows and efficiencies to values, power, and purpose (Avelino & Wittmayer, 2016; Meadowcroft, 2007; Stirling, 2014).

In this light, the municipal governance of IUS can be seen as an ongoing effort to navigate tensions between economic development, environmental protection, and social responsibility within existing institutional constraints. Acknowledging these tensions is not a call for a single alternative model, but rather a way of clarifying the conditions under which IUS is likely to contribute to forms of local development that municipalities themselves regard as socially legitimate and environmentally robust.

6.4 Theoretical contributions

This dissertation contributes to IUS research by reframing three core analytical assumptions in the literature: where governance is located, how governing capacity is understood, and how values enter the analysis of symbiosis practices. Rather than proposing a new model of industrial and urban symbiosis, the contribution lies in clarifying how municipal IUS governance can be understood as a process shaped by internal organization, administrative practices, and recurring judgments about priorities and responsibility in municipal systems. In doing so, the dissertation clarifies how the durability of IUS efforts is linked to the alignment of governing approaches across organizational elements and their translation into municipal routines.

Reframing where governance is located

IUS research has often conceptualized governance as something that happens mainly between organizations, for example through facilitation, coordination, or network management among firms and public actors (Paper I; Mortensen & Kørnøv, 2019b; Paquin & Howard-Grenville, 2012). This dissertation shifts that focus by treating the municipal organization itself as a central site of governance. Governing symbiosis is not only a matter of steering external collaboration, but also of organizing responsibilities, mandates, routines, and decision-making internally (Paper IV; Paper V). This reframing extends the analytical scope of IUS governance from being mainly an inter-organizational activity to also being an intra-organizational one. It highlights how strategic ambitions must pass through internal translation layers, including middle management, departmental structures, and administrative procedures, before they shape practice. By foregrounding the municipality as an internally differentiated organization rather than a unified actor, the dissertation helps explain why similar external roles or policy ambitions can produce different outcomes depending on how municipalities are internally

structured and where within the organization IUS is positioned (cf. Bulkeley et al., 2009; Bulkeley & Kern, 2006).

Reframing governing capacity in IUS

Relatedly, the dissertation reconceptualizes governing capacity in IUS as more than the availability of policy instruments, technical expertise, or political support. Capacity is instead understood as emerging from how organizational elements are aligned and activated in practice, including formal mandates, management routines, coordination arrangements, leadership structures, and organizational placement (Klein et al., 2020). This perspective adds an organizational layer to how capacity is typically discussed in IUS research (Boons & Spekkink, 2012; Mortensen et al., 2024; Spekkink, 2013). It suggests that the ability to sustain symbiosis over time depends not only on resources or intentions, but on whether administrative systems are configured in ways that support continuity, cross-departmental work, and long-term responsibility (Alexius & Furusten, 2019; Pahl-Wostl, 2015a; Thomasson, 2013). Capacity, in this sense, is not a static attribute that municipalities simply possess. It is built and maintained through ongoing organizational alignment, where experimentation, formalization, coordination, and follow-up reinforce one another (Paper V; Christensen et al., 2011; Lozano, 2018).

Reframing how values enter IUS analysis

Finally, the dissertation advances a value-oriented perspective on IUS governance. Instead of treating values as abstract ideals or individual preferences, it approaches them as recurring ways in which organizations interpret what counts as reasonable action, acceptable risk, and appropriate use of public resources (Paper III; Paper V). From this perspective, disagreements about priorities, responsibility, and acceptable trade-offs are not exceptions, but a normal part of governing symbiosis in a municipal setting. Different parts of the organization may emphasize efficiency, service reliability, environmental protection, budget discipline, or long-term precaution, and these value orientations influence which initiatives are supported, delayed, reshaped, or rejected (Paper II; Paper III). They are not fixed, however, but emerge and evolve through organizational negotiations, institutional mandates, departmental positioning, and shifting priorities. These orientations also shape how governance modes are enacted in practice: whether authority is applied cautiously or assertively, whether experimentation is encouraged or restrained, and how internal collaboration and coordination are organized, prioritized, and stabilized within existing administrative routines (Paper V). This reframing extends IUS theory beyond the coordination of material flows to include how practical judgments about legitimacy and responsibility shape how symbiosis is governed within municipalities and what kinds of initiatives they are willing and able to pursue (cf. Alexius & Furusten, 2019; Pahl-Wostl, 2015a).

Together, these three reframings provide a more integrated understanding of municipal IUS governance by linking how municipalities act (through governing modes that are combined and adjusted over time), what enables them to act (organizational systems and administrative arrangements across PSO elements), and why they act as they do (recurring value orientations embedded in public organizations). In doing so, the dissertation highlights how the governance of IUS within municipalities is shaped by organizational structures and established ways of reasoning about development, responsibility, and long-term change (Meadowcroft, 2007; Stirling, 2014).

6.5 Practical implications

The findings of this dissertation carry several implications for how industrial and urban symbiosis can be advanced in practice. While the study is analytically focused on municipal governance, its insights are also relevant for a broader range of actors engaged in circular and symbiosis development.

For municipal practitioners

For local politicians, administrative professionals, and staff in municipally owned companies, the findings highlight that effective IUS governance depends as much on internal organization as on external collaboration. In many municipalities, symbiosis work rests on a small number of committed individuals, which makes continuity fragile when staff change or projects end. A central practical lesson is therefore the importance of anchoring IUS in ordinary municipal structures, through political decisions, clear allocation of responsibility, and integration into planning, service provision, and everyday administrative work. Without such anchoring, ambitions for symbiosis tend to remain project-based and vulnerable over time.

More consistently across cases, internal coordination and collaboration across departments proved decisive for maintaining alignment and learning over time. Cross-departmental collaboration and the creation of coordinating functions, whether formal working groups or more informal arenas, can help sustain shared priorities across election cycles and reduce dependence on individual champions.

Externally, municipalities benefit from recognizing themselves not only as facilitators but also as active participants in IUS systems. This entails acknowledging their own material and organizational roles, for example as infrastructure owners or major resource users, while maintaining transparency and equal treatment of external actors. Balancing these internal and external functions is demanding but critical if IUS is to become part of ordinary municipal governance rather than remain a project-based activity.

From a practitioner perspective, the internal organizational dimensions identified across Papers I–V can be summarized as a practical orientation framework for reflecting on how internal organizational conditions shape municipal IUS development (see Figure 8).



Figure 8. Practical orientation framework.

Rather than constituting a checklist of best practices, these dimensions highlight organizational conditions that may require attention when seeking to move IUS from isolated initiatives toward more durable governance arrangements.

For policy makers

For policy makers at local, regional, and national levels, the research underscores that policy frameworks need to reflect the diversity of municipal contexts and organizational conditions. Municipalities differ widely in size, staffing, and internal structure. Smaller municipalities may lack dedicated personnel or municipally owned companies, while larger ones face coordination challenges across complex administrations. When such differences are not taken into account, policy frameworks tend to work well in some municipalities but less well in others.

The findings also suggest that while project-based funding is valuable for experimentation and early-stage development, it often provides weak support for continuity once projects end. From a policy perspective, this points to the importance of complementing short-term project funding with instruments that strengthen long-term capacity, such as support for competence development, peer-learning platforms, and guidance on how symbiosis-related objectives can be integrated into ordinary planning, procurement, and permitting systems.

Finally, although not examined in depth in this dissertation, clearer and more consistent regulation around the reuse of by-products and secondary resources would likely reduce legal uncertainty and administrative workload for both municipalities and firms. Taken together, these observations indicate that policy support can play an important role not only in initiating new projects, but also in strengthening the organizational conditions under which IUS can become part of everyday municipal governance.

For external practitioners and stakeholders

For companies, consultants, and utility providers, the study shows that engaging municipalities in IUS requires an understanding of how municipal organizations function in practice. Responsibilities are often distributed across several departments and municipally owned companies, which can affect decision timelines, priorities, and points of contact. Being aware of these internal arrangements can help reduce misunderstandings, unrealistic expectations, and delays in collaboration.

External practitioners can also play a constructive role by linking technical proposals to objectives that matter within municipal organizations, such as local service provision, long-term infrastructure planning, risk management, or public accountability, in addition to considerations of efficiency and cost savings. This may involve adapting project timelines, communication strategies, and partnership models to municipal planning and budgeting cycles.

For researchers and educators

Finally, the study points to opportunities for stronger dialogue between research, education, and municipal practice. Comparative and longitudinal studies could further explore how organizational form, value orientation, and institutional context shape governing capacity. In professional education, these insights could inform the training of future public managers, planners, and engineers, helping them navigate the organizational and relational dimensions of circular work alongside its technical aspects.

6.6 Limitations and future research

Like all research, this dissertation has limitations that shape both the scope of its conclusions and the directions it opens for further study. These limitations are methodological, empirical, and conceptual, reflecting the choices made to explore the internal governance of IUS within Swedish municipalities.

Methodologically, the study's multi-method and qualitative design privileged depth and contextual understanding over breadth and statistical representativeness. The combination of interviews, documents, and a national questionnaire enabled triangulation and analytical generalization. However, the findings are not intended to be statistically or universally generalizable. The empirical base is geographically confined to Sweden, where municipalities hold unusually strong responsibilities for infrastructure and sustainability. The transferability of the findings to other governance settings, particularly where local autonomy or institutional conditions differ, therefore remains to be examined. Comparative research across different policy and administrative contexts could further illuminate how structural and institutional arrangements shape municipal capacity to govern IUS.

The case selection also created asymmetries in coverage. Simrishamn and Malmö were studied in depth, while the additional municipalities provided comparative breadth rather than detailed ethnographic insight. This design yielded valuable contrasts but limited the extent to which everyday practices, cultural dynamics, and informal decision-making could be followed. Future longitudinal and ethnographic studies could trace these processes over time, showing how initiatives evolve across political cycles and how individual agency interacts with institutional structures.

Conceptually, the analytical framework linking governance modes with public sector organization (PSO) elements proved useful for capturing the diversity of municipal engagement with IUS, yet it also revealed its own boundaries. Governance modes often overlapped and blurred in practice. Self-governing, authority-based, and corporatized approaches, including those enacted through municipally owned companies, were frequently intertwined. Municipalities also navigated between facilitation and direct participation in symbiosis systems. This

suggests that future research may benefit from moving beyond fixed typologies and paying more attention to how governance takes shape through everyday organizational practices and coordination over time. Likewise, relational and cultural dimensions, such as trust, workplace norms, and shared understandings of purpose and responsibility, emerged as important but were only partly captured by formal analytical categories. Future studies could therefore explore these aspects more directly, for example by examining how routines, roles, and accumulated experience within municipal organizations influence which forms of symbiosis are considered feasible or appropriate, and which are difficult to sustain. Such work could draw more explicitly on institutional perspectives in public administration and organizational research, and thereby complement the present framework by providing a more detailed understanding of how IUS is introduced, developed, and maintained within municipal organizations.

The study's focus on municipalities means that other perspectives remain less visible. The voices of firms, citizens, and regional actors appear indirectly but not in depth, and the social consequences of IUS – who benefits, who participates, and whose value orientations prevail – require further investigation. In particular, research could examine how competing value orientations are negotiated within and across organizations, how certain framings gain institutional authority over time, and how alternative perspectives are marginalized, stabilized, or transformed in the course of governing symbiosis. Extending the analysis beyond the municipal organization to include these broader actor constellations would allow a more complete picture of how IUS is shaped and negotiated across governance levels.

Taken together, these limitations point to several directions for future research: cross-national comparison, longitudinal and ethnographic analysis, and broader inclusion of firms, citizens, and regional actors. Developing these lines of inquiry would refine understanding of municipal IUS governance and strengthen the analytical foundations for studying symbiosis as a public-sector sustainability practice.

7. Conclusion

This dissertation has examined how Swedish municipalities govern industrial and urban symbiosis. Rather than starting from individual exchanges or formal policy instruments, it approaches symbiosis as something that takes shape within municipal organizations: in how work is coordinated across departments and municipal companies, how responsibilities are allocated, and how long-term ambitions are translated into planning, projects, and administrative routines.

Across the empirical studies, municipalities engage with IUS through a range of activities. They facilitate collaboration, regulate land use and infrastructure, provide technical systems, enter partnerships, and experiment within their own operations. Yet what differentiates short-lived initiatives from more sustained trajectories is not which roles are emphasized, but whether symbiosis becomes part of established municipal practice. Where IUS is anchored in strategies, planning routines, mandates, and cross-departmental working relations, it becomes something the organization can return to, develop, and defend over time.

The dissertation also demonstrates that this anchoring is shaped by how municipalities are organized. Administrative departments and municipally owned companies operate under different institutional arrangements, accountability structures, and professional priorities, which influence how easily symbiosis can be connected to political goals, long-term infrastructure planning, and service provision. At the same time, municipal actors approach IUS through different value orientations, for example as a matter of efficiency and investment opportunity, environmental precaution, public responsibility, or innovation. These orientations do not merely color decisions; they shape which initiatives are regarded as reasonable, how responsibilities are negotiated between organizational units, and how collaboration and coordination across internal boundaries develop.

Together, these findings show that municipal engagement with IUS is shaped as much by internal organization as by external collaboration. How municipalities coordinate work, distribute authority, mobilize competence, and stabilize priorities influences not only whether symbiosis initiatives begin, but whether they are maintained, expanded, or set aside. Seen this way, municipal governance of IUS is not primarily a matter of selecting individual instruments or applying predefined models, but of actively shaping the organizational conditions under which symbiosis can be interpreted, prioritized, and acted upon. Municipalities do not merely

implement external sustainability agendas; they translate them into institutional arrangements, routines, and divisions of responsibility that fundamentally condition what symbiosis can become in practice.

Efforts to promote IUS will therefore remain limited if they focus on technical solutions or coordination between external actors, without equal attention to how municipalities are organized to carry such work over time. Infrastructure development and inter-organizational exchange remain essential, but they depend on less visible forms of internal organizational arrangements and coordination practices within public organizations. Ultimately, this dissertation shows that whether industrial and urban symbiosis takes hold, endures, or fades away depends on how municipalities organize themselves to govern it – from the inside out.

Appendix 1

List of municipalities that participated in the questionnaire in Paper IV.

1. Bengtsfors
2. Bjuv
3. Gotland
4. Göteborg
5. Helsingborg
6. Höganäs
7. Karlstad
8. Lidköping
9. Lindeberg
10. Lysekil
11. Malmö
12. Norrköping
13. Simrishamn
14. Sotenäs
15. Stenungsund
16. Sävsö
17. Vänersborg
18. Vimmerby
19. Ånge
20. Åre
21. Örnsköldsvik
22. Östersund

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