# DYNAMIC INSTITUTIONAL CAPACITIES FOR INDUSTRIAL WATER USE EFFICIENCY IN VIETNAM

TRAN THU TRANG

**Propositions**

1. Dynamic institutional capacities are essential for centralized states to realise water use efficiency in industrial zones.
   (this thesis)

2. Public rules, norms and standards first need to foster relational capacity before knowledge and mobilisation capacity for industrial ecology to be operationalized.
   (this thesis)

3. Social science is an integral part of ecological science.

4. Qualitative methods are no less convincing than quantitative methods.

5. Individual challenges are best overcome by internal reflection rather than external consultation.

6. The Covid-19 pandemic revealed that the divide between rich and poor can be overcome.

Propositions belonging to the thesis, entitled
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Tran Thu Trang
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# DYNAMIC INSTITUTIONAL CAPACITIES FOR INDUSTRIAL WATER USE EFFICIENCY IN VIETNAM

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# DYNAMIC INSTITUTIONAL CAPACITIES FOR INDUSTRIAL WATER USE EFFICIENCY IN VIETNAM

Tran Thu Trang

**Thesis**

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*to my parents*

## Table of Contents

## List of key terms and abbreviations

| | |
|---|---|
| CEPIZA | Can Tho Export Processing Zone and Industrial Zone Authority |
| DOH | Department of Health |
| DONRE | Department of Natural Resources and Environment of Ho Chi Minh |
| DOST | Department of Science and Technology |
| EIP | Eco-Industrial Park |
| GIZ | German Corporation for International Cooperation |
| HEPZA | Ho Chi Minh City Export Processing and Industrial Zone Authority |
| HCMC | Ho Chi Minh City |
| IC | Institutional Capacity |
| IE | Industrial Ecology |
| IS | Industrial Symbiosis |
| IZ | Industrial Zone |
| IZIC | Industrial Zone Infrastructure Company |
| LAEZA | Long An Economic Zone Authority |
| MOC | Ministry of Construction |
| MOH | Ministry of Health |
| MOIT | Ministry of Industry and Trade |
| MONRE | Ministry of Natural Resources and Environment |
| MOST | Ministry of Science and Technology |
| MPI | Ministry of Planning and Investment |
| NGO | Non-Governmental Organization |
| NWO | Dutch Research Council |
| PC | People Committee |
| SAWACO | Saigon Water Company |
| UNIDO | United Nations Industrial Development Organization |

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# Chapter 1

# Introduction

## 1.1. WATER ISSUES IN VIETNAM

Water shortage, in terms of both quality and quantity, is a global problem. Many countries in Asia and North and sub-Saharan Africa are predicted to face water scarcity by 2025 (Zhongming et al., 2022). Exacerbated by a combination of climate change, ecosystem degradation and rapid urbanization, the challenges faced by these regions mean that around half of the world's population will continue to face severe water scarcity for sustained periods during the year (Zhongming et al., 2022). While arid regions face obvious shortages, high levels of variability in water quantity and quality are most likely to seen in Deltaic environments – largely because of the concentration of human activity in these areas coupled with their vulnerability to water allocation over river basins and impacts to coastal environments due increasing climate variability (Whitehead et al., 2019). The ability of society to adapting to this forecast variation will be a major challenge over the next decades.

Deltaic environments in Asia, which are subject to urbanisation and industrialisation while continuing to deliver food production for growing populations, are particularly vulnerable to effects of growing water scarcity (De Souza et al., 2015). The Mekong River Delta is a case in point. As a result of the increasing impact of climate change and hydropower developments, the Mekong region faces a range of transboundary water challenges with downstream coastal countries, such as Vietnam, especially susceptible to large scale water scarcity (Tran & Tortajada, 2022). The effects of climate change on the quality and quantity of freshwater water resources include more pronounced periods of flood and drought, and reduced water freshwater quality due to salt intrusion as a function of reduced outflow (MONRE, 2021). These issues are in many respects already visible in the Mekong Delta of Vietnam, with drought and saltwater intrusion causing 96,000 households, the equivalent to about 430,000 people, in seven coastal provinces to have a deficit of drinking water (MONRE, 2021).

At the same time, non-climatic factors, such as rapid urbanization and industrialization are also driving a complex mix of higher water demand and poorer water quality in the worlds Deltas (Giri, 2021). Here the Mekong Delta of Vietnam is also a case in point (Dang et al., 2022). The total annual water consumption of Vietnam is 80.6 billion $m^3$, accounting for about 10% of the total water flow throughout the country. Of this total consumption 80% is used for agricultural purposes, while industrial water use equates to 9% or 7.49 billion m3 (MONRE, 2021). This amount of water used for industrial purposes is more extreme in specific river basins. In the Dong Nai river basin, for instance, which flows through Ho Chi Minh city, 68% of the water is used for industrial purposes (MONRE, 2021). Overall, industrial water use in Vietnam is expected to double to about 130-150 billion m3 by 2045 – meaning potentially even higher demands for specific river basins (MONRE, 2012). In addition to surface water sources, demand for groundwater is also likely to expand considerably over the next decades. The consequence of this growth in groundwater extraction will likely exacerbate a range of environmental risks, ranging from water quality issues such as saline intrusion to major geotechnical issues such as land subsidence – especially in highly urbanized areas (Massard et al., 2018; MONRE, 2021).

The challenge of industrial water use is particularly challenging in Vietnam, like many other Southeast Asia countries, because of the importance of processing and manufacturing to the national economy. Following the Resolution No. 39/2021/QH15 of the National Assembly on National Land Use Planning for the period 2021 - 2030, vision to 2050, current projections for Vietnam show that despite environmental concerns, the number of industrial zones is set to expand 1.5 times beyond their existing number of 558 in Vietnam. This means that far greater attention is needed to manage the environ mental risks industrial water use pose into the future. In general terms, three main challenges exist when it comes

to reducing industrial water use in Vietnamese industrial zones – the main sites of industrial development: (1) improving currently poor levels of industrial water efficiency; (2) the continued growth of industrial water consumption; and (3) the increasing levels of untreated wastewater from manufacturing and processing activities that (in Vietnam and other countries) is used for domestic and agricultural purposes (Massard et al., 2018). Each of these challenges require greater attention to both technological and policy innovations that can scale up water use efficiency (Massard et al., 2018; Velenturf & Jopson, 2019), including a range of reuse, recycling and/or water sharing strategies (e.g. Massard et al., 2018; Trinh et al., 2013). Policy has been developed, such as the Cleaner Production Strategy for Industry until 2020 (Decision 1419/QD-TTg), which stipulates that half of all 50% of industrial manufacturing enterprises apply cleaner production strategies and 90% of medium and large enterprises have a specialized department of cleaner production. However, whether and how such strategies lead to meaningful improvements to resource use efficiency, including water reuse in industrial zones, remains poorly understood.

Current attempts to improve water use efficiency in Vietnamese industrial zones, beyond mandatory wastewater treatment (MONRE, 2021), focus largely on three strategies: (1) demand minimization by implementing efficient "end-of-pipe" technologies and cleaner production technologies; (2) wastewater minimization by "cascading" and "recycling" reclaimed water flows for low quality reuse and reducing wastewater discharge to the environment; and (3) "multi-sourcing" away from primary ground or surface water sources to secondary water sources such as rain water (Agudelo-Vera et al., 2012; GhaffarianHoseini et al., 2016). These strategies are linked to the wider principles of industrial ecology and industrial symbiosis, which aim at enhancing circular resource flows in the processing and manufacturing sectors through cooperative strategies that enable by-product exchange and utility sharing for resource efficiency (Ngo et al., 2015; Nguyen & Ye, 2015). The implementation of these strategies has, however, remained highly technical in nature. In spite of the considerable attention given the importance of the capacities of industrial actors to progress industrial ecology and industrial symbiosis that contribute to tackle the industrial water use challenges through enhancing water use efficiency (Willems and Baumert, 2003; Boons and Spekkink 2012; Wang et al., 2017), there has been limited focus on the industrial actors, including industrial zones, have the necessary capacity to innovate. It is precisely this focus on technical innovation without an understanding of social processes of innovation that this thesis addresses.

## 1.2 INDUSTRIAL ECOLOGY AND INDUSTRIAL SYMBIOSIS

Industrial development in Vietnamese is dominated by a linear model of production and consumption. This means consumer goods are produced from raw materials, sold, used and the discarded as waste (Cobo et al., 2018). Improving the efficiency of resource use, including water, requires a new paradigm based on social and ecological innovation for realizing industrial ecology and industrial symbiosis ambitions.

Depending on the strategies and the boundary of the implementation, water use efficiency contributes to the achievement of industrial symbiosis and industrial ecology. For example, "multi-sourcing" strategies by rainwater harvesting contributes to achievement of industrial ecology as the boundary of the industrial system is linked to the natural system; "wastewater minimization" strategies by water cascading contributes to achievement of industrial symbiosis as this approach is applied between sectors of an industrial zone (Jia et al., 2016). Both industrial ecology and industrial symbiosis focus on

the exchange of materials, resources and energy and therefore offer an approach to reduce industrial demand and increase availability of key resources (Li, 2017). Notably, the Vietnamese government's Cleaner Production Strategy (and a range of provincial policies and regulations) expresses ambitions for both industrial ecology and symbiosis. However, as outlined above, the strategy tends to rely on a top-down assumption, based on a logic of top-down decision making, that industrial actors have the capacity to improve technologically-based strategies for industrial ecology and industrial symbiosis innovations.

The following further elaborates the challenges of industrial ecology and industrial symbiosis in general terms, before returning to the specific challenges by Vietnamese industrial zones in implementing these strategies for improving water use efficiency.

### 1.2.1 Industrial ecology

Industrial ecology is an interdisciplinary field of study encompassing a variety of methods, approaches, and frameworks for the design and transformation of industrial system into industrial ecosystems. Industrial ecology considers "principles of biological ecosystems when designing and redesigning industrial systems to create more efficient interactions both within industrial systems and natural systems" (Leigh & Li, 2015) p.632. The normative goal of industrial ecology is exchange and use energy, resources and raw materials effectively in a near to closed-loop as possible. It as such offers a systems approach to resource efficiency that focuses on the interaction between industrial and natural systems (Mantese & Amaral, 2018). The boundary of an industrial ecosystem depends on opportunities for recycling industrial waste and resources. For example, recycling wastewater through collaborations between industrial park or industrial zones and local communities for domestic and/or agricultural use. This should result in a reduction of resource demand and pollution to the external environment and/or increase business opportunities within the boundary of this industrial ecosystem (Li, 2017).

Industrial ecology was first introduced at the end of 1980s when it became increasingly clear that traditional "end-of-pipe" technologies were insufficient for reducing industrial waste (Frosch & Gallopoulos, 1989). In addition to moving the normative goals of policy making beyond such linear thinking, industrial ecology opened up the possibility for linking industrial processes in rapidly industrializing countries to questions of resource efficiency that aligned to sustainable and circular forms of industrial development (dos Santos Dalbelo & Rutkowski, 2021). Industrial ecology provided a broad framework for reshaping material flows and the managerial processes governing them within industrial zones, as well as improving resource efficiency between wider eco-industrial networks – where flows of energy, water and (waste) materials are exchanged through shared services and infrastructures across regions within and even between countries (Li, 2017).

Various critiques of industrial ecology have been long recognized. Attention has been given to the use of pricing poor resource use practices and waste flows as a means of incentivizing consumers, individual firms and industrial zones to engage with industrial ecology practices (Mathews & Tan, 2011; O'Rourke et al., 1996). While social dimensions of industrial ecology have been recognised, these tend to be limited to individual behaviour of consumers through markets, or on the ineffectiveness of government policy, or on specific processes of technology innovation (Vermeulen, 2006; Walker et al., 2021). Only limited attention has been given to the need for capacities to be developed throughout industrial systems to enable more circular flows of resources. And as industrial ecology has shifted to more recent debates around circularity, similar critiques have persisted. For example, some argue that a focus on win-win policies can shift attention to only 'perceived conflict free solutions and strategies

rather than addressing systemic issues of industrial resource use (Corvellec et al., 2022). Furthermore, as argued by Mavropoulos & Nilsen (2020), questions remain over whether circularity under the auspices of industrial ecology can fully address the complexity of waste and water reuse given the inherent complexity both within and beyond industrial parks and processes. In short, improved resource use efficiency through industrial ecology requires not only the indentification and design of circular material, energy and water flows, but also realistic strategies for building capacities and relations for enabling such flows.

### 1.2.2 Industrial symbiosis

Ehrenfeld and Gertler (1997) defined industrial symbiosis as being "closely related" with industrial ecology, and "involves the creation of linkages between firms to raise the efficiency, measured at the scale of the system as a whole, of material and energy flows through the entire cluster of processes" (p. 68). A later definition by Chertow (2000) presents a wider scope for industrial symbiosis, including reciprocal engagement between "traditionally separated industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products" (p. 313). Chertow also emphasised that the "keys to industrial symbiosis are collaboration and synergistic possibilities offered by geographic proximity" (p. 314). As argued by Spekkink (2013), the literature is consistent in emphasising the creation of opportunities for resource exchange between firms through by-product reuse, utility/infrastructure sharing and the joint provision of services. Looking beyond the exchange of resource, materials and energy flow, industrial symbiosis engages traditionally separate industries in a collective approach to create competitive advantage involving not only physical exchange of materials, energy, water and by-products, but also sharing of trust, knowledge and collective goals (Chertow, 2007; Spekkink, 2013).

In response to the shortcomings of industrial ecology, and the need to better specify the creation of opportunities for innovation aimed at industrial symbiosis, Li (2017) presented a case (based on wider shift in academic literature) for more focused attention on collaborative relationships in symbiotic networks that can create synergistic possibilities for material exchange. Central to this relational approach industrial symbiotic innovation were collaborations between industrial and other organizations innovative reuse, recycling or sharing of resources based on relations creating mutual understanding and trust through new forms of working agreements and supporting policy and regulation (Ashton & Bain, 2012; Chertow, 2009). Going even further, Domenech & Davies (2011) emphasise the need for a knowledge network to facilitate the establishment of resources exchange between diverse organizations – industrial, policy and civil society (also reflecting earlier work by Mol, 1995). Core to Li's (2017) case is also the integration of webs of knowledge and networks of diverse organizations that can enable improved business and technical processes, value-added destinations for non-product outputs, and a collective approach to industrial systems as a whole. To develop such webs and networks, they argue, industrial symbiosis needs to focus on social processes enabling the exchange of knowledge, material, energy and resource, including water.

In spite of its theoretical promise, and growing update as a broad normative goal for industrial zone planning in countries such as Vietnam, the specific demands its places on policy and industrial actors alike remains under researched. While claims are made that industrial symbiosis should involve the collective action of firms and other organizations, less attention has been given to the social and institutional processes that can enable such collective action leading to the adoption of industrial symbiotic practices (Velenturf & Jensen, 2016). Even though, following Li (2017), research has identified issues such as trust, knowledge, understanding as important, there is continued limited attention to:

(1) the actual processes of how cooperation and symbiotic relationships come about and (2) the capacity of actors overcome collective resource exchange challenges (Moreau et al., 2017) and (3) the social and institutional factors that enable actors to develop the social means of innovation required for industrial symbiotic practices to emerge (Boons et al., 2017; Wang et al., 2017).

## 1.3 INSTITUTIONS AND INSTITUTIONAL CAPACITY TO IMPLEMENT INDUSTRIAL SYMBIOSIS AND INDUSTRIAL ECOLOGY

Based on the short review above, three premises on the development of industrial ecology and industrial symbiosis are identified. First, the development of industrial ecology and industrial symbiosis is dependent on the ways in which collaborations emerge between industrial actors. Second, the emergence of collaborations needed for industrial ecology and industrial symbiosis are in turn dependent on the wider institutional setting within which industrial ecology and industrial symbiosis emerges. Third, and finally, to respond to these institutions and create opportunities for collaborations to ultimately result in strategies for industrial ecology and industrial symbiosis, networked industrial actors need a requisite level of 'institutional capacity' (Wang et al., 2017; Healey et al. 2003). The following further elaborates the concepts behind these assumptions and their relationship to each other that influence water use efficiency, as a part of industrial ecology and industrial symbiosis.

### 1.3.1 Institutions

Institutions are sets of rules, norms and values that steer action towards predefined (societal) goals, such as enhanced water use efficiency (Keohane, 1988). In the context of industrial ecology and industrial symbiosis (and in many other fields), institutions are key for shaping learning, trust and collaborations between actors whose collaboration can lead to the development of new technological resource use efficiency strategies (Boons et al., 2017; Chertow, 2007).

Building off the field of new institutional economics, the literature on industrial ecology and industrial symbiosis focuses on institutions at three levels. First, macro level institutions make up the broader institutional settings, often involving national or supranational policies, rules, and norms designed to shape actors and organizations to achieve a common goal (Willems & Baumert, 2003). Second, meso level institutions consists of rules, norms and values at an organization level that involves collaboration between a defined group of actors (e.g., industrial firms organized in industrial zones and/or communities and service providers outside industrial zones) aligned by common or linked practices of industrial production and consumption, or ambitions for pursuing common goals such as industrial ecology and industrial symbiosis. Finally, micro level institutions refer to the rules, norms and values that shape and influence the actions and behaviors of individual firms that contributes to industrial ecology and industrial symbiosis outcomes.

The relationship between these levels of institutions can be more or less hierarchical. In some countries the relationship might be more networked or polycentric in nature, meaning that control over setting and implementing institutions is devolved between multiple actors (e.g. Patala et al., 2022). In other countries, such as Vietnam, the relationship between these levels can be more hierarchical, with the centralized state managing and planning the management of industrial water use with little devolution of responsibilities from actors at lower levels on successes or failures (Garschagen, 2016; Phuong et al., 2018). The degree of hierarchy between these levels determines to a large extent how open actors responsible for institutions across these levels are to adapting rules, norms and values in

response to knowledge and experiences from actors at other levels (Bruel et al., 2019). Importantly, the degree of openness to change can also be inscribed into the design of these institutions through governing principles of transparency, openness and learning (Parida et al., 2019). Such principles also shape the use of specific policy instruments that are designed to put wider rules, norms and values to work in steering the behaviour of, in the case of this thesis, industrial actors.

There are various forms of policy instruments available to actors at all three institutional levels. Regulatory and economic policy instruments at the macro level are widely designed and implemented from the macro level to stimulate individual firms and the industrial zones to make changes towards more efficient water use practices (Rosenblum, 2021). Regulation can do this by defining acceptable processes, establish emission standards, or specify quality targets. In addition, regulatory instruments can be complimented with economic instruments that either tax or set a market price on pollutive or inefficient water practices (Du & Li, 2020; Guo et al., 2018). They can also be supplemented by voluntary (market-based) approaches are also applied to stimulate the adoption of sustainable practices and technology. For example, private voluntary standards and certification have been studied on their effect on both target actors and on state rule making and governance (Kalfagianni et al., 2020; Ponte et al., 2021). Notably, economic instruments and voluntary instruments can also be designed and implemented at the meso and micro level - for instance by establishing codes of conduct within industrial zones or by a firm for their own (environmental) quality control.

Overall, regulatory, economic and voluntary instruments assume that enterprises and industrial zones will respond in a rational manner, meaning that they will comply in response to penalties or opportunities for economic benefits (Connelly et al., 2012). However, response to these instruments, and the wider rules, norms and values behind them, are by no means as straight forward as is often intended. Whether an industrial actor or a group of industrial actors at the meso and/or micro level complies these instruments depends on their capabilities or capacities to understand, react and organise a response that is aligned to the wider goals underpinning these instruments and institutions they represent (Connelly et al., 2012; Renzetti, 2005; Wang et al., 2017). This thesis places particular emphasis on these capacities - and what we specifically term institutional capacities (following Healey et al., 2003) - as a starting point for understanding how systemic changes towards industrial ecology and industrial symbiosis can be realised.

### 1.3.2 Institutional capacity

Institutional capacity has acquired many definitions and has been employed within different disciplines. While some emphasize institutional capacity to be about the capacity of actors to respond to and resolve collective problems (Wang et al., 2017, 1571), others define institutional capacity as the ability of private or public actors to work through an existing system of rules, norms and values to achieve a specified goal (Fuentes & Borreguero, 2018). In this thesis, institutional capacity is defined as the abilities of specific actors, private or public actors, to work through a system of rules, norms, values to achieve a specified goal, for example, water use efficiency, as a part of industrial ecology and industrial symbiosis.

As illustrated in Figure 1.1, we follow Willems and Baumert (2003) to identify institutional capacities at three levels: (1) Micro level institutional capacity refers to the skills and performance of individual firms; (2) Meso institutional capacity refers to organization level, including public or private organizations such as an enterprise, a company, a governmental organization; and (3) Macro institutional capacity refers to ways in which networked organizations such as the state organize and affect change on other

actors. As the following outlines, the specific form of institutional capacity exhibited at each level is in turn dependent on the interplay between three specific dimensions.

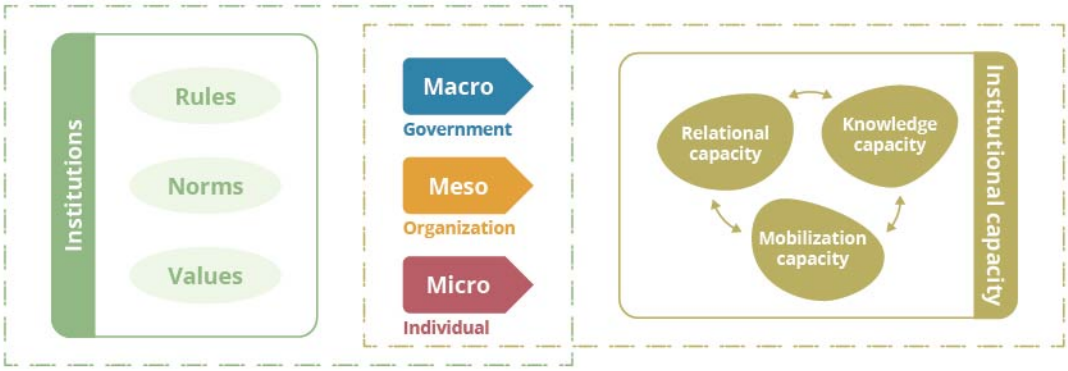


***Figure 1.1*** *Distinct levels of institutions and institutional capacity*

### 1.3.3 Dimensions of institutional capacity

Healey and colleagues (2003) developed a three-dimensional approach in the realm of planning theory to analyse the capacity (noting they initially use the term 'resources') of an institution or organisation. These three dimensions of institutional capacity are: (1) knowledge capacity, (2) relational capacity and (3) mobilization capacity. Others subsequently adapted this approach to analyze the institutional capacity required to implement industrial symbioses (Boons et al., 2011; Gibbs & Deutz, 2007). According to Boons and Spekkink (2012), this translation from planning theory is reasonable because of its comparability to industrial symbioses - both, they argue, focus on the capacity of involved organisations to collectively address a problem and/or reach a common goal.

*Knowledge capacity*

Healey et al., (2003) describe knowledge capacity as the ability to access and employ knowledge resources. They argue that knowledge capacity is affected by the range of knowledge resources - explicit and tacit, systematized and experiential - to which participants have access. They also argue that knowledge capacity is dependent on the frames of reference which shape conceptions of issues, problems, opportunities and interventions, including conceptions of place, as well as the extent to which these frames are shared among stakeholders. Furthermore, they argue that knowledge capacity depends on openness and learning – that is, the ability to absorb new ideas and learn from them. Translating knowledge capacity to industrial symbiosis, Boons and Spekkink (2012) argue that knowledge capacity refers to the acquisition and use of information that enables firms and other actors to shape their exchanges in such a way as to reduce ecological impact. Wang et al (2017) defined knowledge resource as formal or tacit knowledge operating at multiple levels and developed by governance actors to promote an issue.

Developed from these authors, this thesis defines knowledge capacity as such refers to identify and acquire relevant knowledge and information necessary for water use efficiency which are part of industrial ecology and industrial symbiosis. The knowledge capacity is assessed through variety of dimensions. First, the type of knowledge that is identified necessary for implementing water use efficiency and industrial ecology (Barry, 2012; Wang et al., 2017). Second, the frames of references represent the

activities, relations, problems, opportunities and interventions are employed to access the knowledge sources and influence the identification of these knowledge (Healey et al., 2003). Third, understanding the influence of institutions (e.g., regulatory instruments) on the strategy of actor, for example industrial zone, to enhance water use efficiency (Harrison & Corley, 2011). Fourth, openness and learning describe the extent to which knowledge is taken up, made accessible and share between actors within networks in developing water use strategies and industrial ecology (Abreu & Ceglia, 2018; Healey et al., 2003). Fifth, integration refers to the ways in which the knowledge of these actors was integrated in legislation and policy supporting the implementation of water use efficiency strategies and industrial ecology (Healey et al., 2003).

*Relational capacity*

Healey et al., (2003) describes relational capacity as consisting of four key elements. First, the range of stakeholders are involved, in relation to the potential universe of stakeholders in the issue or in what goes on in an area. Second, the morphology of their social networks, in terms of the density (or 'thickness') of network interconnections and their 'route structure'. Third, the extent of integration of these various networks. And finally, the location of the power to act, the relations of power between actors and the interaction with wider authoritative, allocative and ideological structuring forces. Boons and Spekkink (2012) and Wang et al (2017) translate these dimensions into a definition of relational capacity as a network of relationships that serves to reduce transaction costs among firms through increased trust and mutual understanding and is qualities of social relations such as trust and norms in networks - linking governance actors together, respectively.

Building on Boons and Spekkink (2012) and Wang et al (2017), this thesis defines relational capacity as the ways and the actions the actors, for example, industrial zones and government establish, affect and maintain trust and mutual understanding within their wider network, including government, NGOs and private firms, to influence the development and implementation of technological, infrastructural or organizational innovations related to industrial resource use efficiency (e.g., water use efficiency) and industrial ecology development (Boons & Spekkink, 2012; Healey et al., 2003; Wang et al., 2017). Drawing on all of the above authors, relational capacity consists of different dimensions. First, the number, type and range of actors interacted with in a given network and the extent to which these relationships support water use efficiency enhancement and industrial ecology (Wang et al., 2017). Second, the morphology of the network includes intensity of relations and way to develop relations with key actors (Barry, 2012; Healey et al., 2003). And third, how these relations foster and reinforce trust and mutual understanding with actors within the network in developing water use efficiency and industrial ecology (Abreu & Ceglia, 2018; Veselovsky, 2015).

*Mobilization capacity*

Healey et al., (2003) describes mobilization capacity as also consisting of four key elements. First, the opportunity structures that afford opportunities for change. Second, the institutional arenas used and developed by stakeholders to take advantage of opportunities. Third, the repertoire of mobilisation techniques which are used to develop and sustain momentum. And finally, the presence or absence of critical change agents at different stages. Boons and Spekkink (2012) and Wang et al (2017) adapt these dimensions to the context of industrial symbiosis by defining mobilization capacity as the ability of actors within the industrial park to activate relevant firms and other parties to develop symbiotic linkages. In doing so they refer to the capacity of actors to activate knowledge and relational resources

to meet network goals, and to capture external attention and resources, respectively. Building on these authors, this thesis defines mobilization capacity as the ability to identify, involve, enhance and active multiple actors to support and enable collective action and goals like water use efficiency and industrial ecology. Three dimensions of mobilization capacity adapted from Healey et al. (2003) and Boons and Spekkink (2012). First, opportunity structures refer to engaging with and using existing rules, norms and incentives to support the design and adoption of water use efficiency strategies and industrial ecology. Second, the repertoire of mobilization techniques applied to mobilize support for the design and implementation of the policy instrument. And finally, change agents as key persons or organizations that motivate other actors to shape their actions to the achievement of water use efficiency and industrial ecology.

## 1.4 INTERACTIONS BETWEEN INSTITUTIONS AND INSTITUTIONAL CAPACITY FOR INDUSTRIAL ECOLOGY AND INDUSTRIAL SYMBIOSIS

Institutional capacity is a function of not only the individual attributes of knowledge, relational and mobilization capacity, but also the interplay between them (as illustrated by the yellow arrows in Figure 1.2). Boons and Spekkink (2012) also argue that there is an order to this interplay, with relational capacity most often a pre-requisite for the development of knowledge and mobilization capacity. Actors, they argue, develop their overall institutional capacity for identifying and acting towards innovation by first bringing a range of actors together to discuss issues of common concern, and in doing so develop the trust and mutual understanding necessary for sharing knowledge and increase mutual understanding of each other's interests. If this knowledge is internalized by key actors, it helps them in coordinating action and reducing areas of conflict. By developing a will to work together, the participating actors may also begin to influence policy processes outside the process of institutional capacity building in ways they were unable to when acting individually.

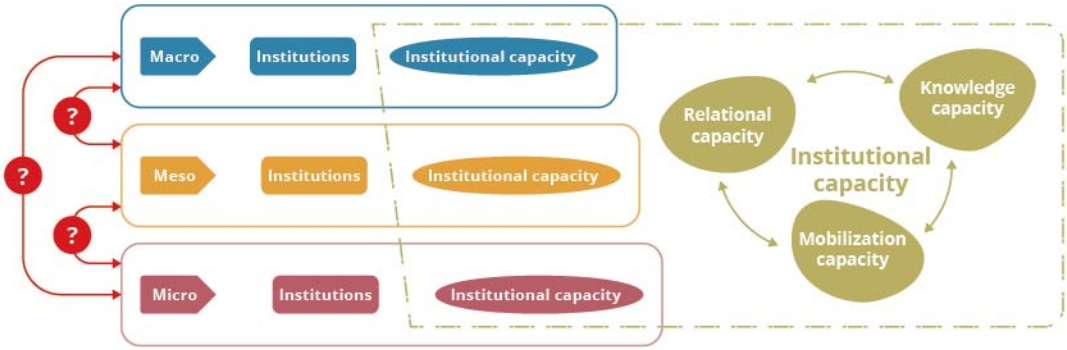


***Figure 1.2*** *Interactions between different capacities and levels of institutions and institutional capacity for industrial ecology and industrial symbiosis development.*

It is also recognized that the three dimensions of institutional capacity also interact with the institutions to which they are subject (see Figure 1.2). The definition of institutional capacity of both Boons and Spekkink (2012) and Wang (2017) alludes to the relevance of institutions when stressing that institutional capacity is about the abilities of specific actors, private or public actors, to work through a system of rules, norms, values to achieve a specified goal - for example, water use efficiency, as a part of industrial ecology and industrial symbiosis. Institutions not only steer action by directly constraining

or incentivizing (groups of) actors and individuals to comply with these goals (Fresneda Fuentes & Hernández Borreguero, 2018; Zhu, 2016), but also by indirectly shaping the capabilities of these actors to resolve underlying constraints to comply with these goals and norms over the long term (Cohen-Rosenthal, 2000; Wang et al., 2017). For example, by fostering co-operation among individuals and institutions (Willems & Baumert, 2003). Actors (at various levels) can also use their institutional capacity to change institutions. For instance, actors can use their knowledge, relational and mobilization capacity to influence institutions and in doing so reshape the opportunities afforded to them in order to either comply with rules and norms or innovate towards achieving industrial ecology and industrial symbiosis.

While theoretically feasible, it remains unclear what kinds of interaction between institutions and institutional capacity affect industrial ecology and industrial symbiosis outcomes (illustrated by the question marks in Figure 1.2). On the one hand, it is clear that institutions can, albeit often imperfectly, shape the institutional capacity of actors (across levels) to comply with rules and norms related to industrial ecology and industrial symbiosis (see for e.g., Cohen-Rosenthal, 2000; Wang et al., 2017; Da Silva et al., 2019; Samerwong et al., 2020; Tröster & Hiete, 2018). On the other hand, however, it remains unclear why some certain institutions reinforce institutional capacity of actors and others or undermine their capacity. Instead, much of the industrial symbiosis literature has focused on the outcomes of collaboration to reduce transaction costs and establish higher levels of material exchanges and energy efficiency, and not capacities that enable these outcomes to be achieved (Li, 2017). And while some studies have focused on the effects of macro-level policy instruments on industrial compliance, far less attention has been given to the effects of institutional capacity of public authorities to develop and/or adapt these instruments. Furthermore, virtually no attention has been given the design and implementation of institutions/instruments at meso and micro levels.

What also remains unclear is how institutions and institutional capacity interact in the context of rapidly industrializing centralized states like Vietnam. The ways in which Vietnamese Industrial Zones are situated within a context of a centralized and hierarchical state system and how the extent to which these institutions enable or constrain industrial capacity to respond key resource challenges such as water scarcity and pollution remains unclear. The centralized government of Vietnam is expected to drive the development of relationships that can enable access to knowledge and assist in the mobilization of other actors needed for industrial ecology and industrial symbiosis that water use efficiency is a part of these approaches. However, whether the actions of the state enable or constrain these capacities, and the extent to which they in turn enable or constrain industrial ecology and industrial symbiosis, remains highly uncertain (Boons & Spekkink, 2012; Healey et al., 2003; Wang et al., 2017). Given the perceived dominance of the state, as well as adoption of industrial ecology and industrial symbiosis within government policy, also enables a wider exploration of how interaction between institutions and institutional capacity beyond inter-firm relations (Clift & Druckman, 2015) – which have dominated the literature to date.

## 1.5 RESEARCH OBJECTIVE

This thesis uses the concept of institutional capacity to understand the conditions under which industrial ecology and industrial symbiosis can emerge, in particular under the context of centralized state like Vietnam, and how the implementation of industrial ecology and industrial symbiosis depend on both institutions and institutional capacity of actors. The overall goal of this thesis is, as such, to contribute

an improved understanding of how the interactions between different levels of institutions and institutional capacity of the Vietnamese State and Industrial Zones reinforce or undermine the development of industrial ecology and industrial symbiosis.

Following from this overall research goal, the primary research question addressed in this thesis is "In what ways do interactions between institutions and institutional capacities affect the potential for systemic innovation towards industrial water use efficiency in Vietnam?".

To answer this question three sub-questions will be addressed in the subsequent chapters of the thesis:
1) How does the interaction between different capacities influence the implementation of industrial water use efficiency in Vietnamese industrial zones?
2) How do institutions affect the institutional capacities of industrial zones to implement industrial water use efficiency in Vietnam?
3) How do institutional capacities of the Vietnamese state and industrial zones influence institutions that support the implementation of industrial water use efficiency?

## 1.6 METHODOLOGY

### 1.6.1 Research design: case study approach

The exploratory analysis of institutional capacities in the following chapters is based on a multiple case study approach which, as argued by Yin (2009), allows in-depth analysis of a phenomenon and is intended for analytical or conceptual generalization. Multiple case studies also allow for a broader base to develop conceptual insights (ibid.). Case studies, though predominantly a qualitative study design, are of great relevance when the focus of a study is on discovery and insight rather than validation and quantification. A case study provides the opportunity to gain an overview and insight into the processes and dynamics within a given object of research unit, but at the same time, cannot claim to make any generalizations to the population other than to the case studies (Kumar, 2014). In addition, a major limitation of this study design is that due to the relatively high number of resources required for the case study, the study could only study a few specific cases.

Chapters two to five of this thesis use a social network analysis and the case study design to understand (1) the importance of network ties in shaping industrial innovation for water use efficiency and types of capabilities needed for both government and industry to utilize a wider range of relationships that go beyond purely material ones and then (2) the dynamic interaction between different levels of institutions and institutional capacity that reinforce or undermine the implementation of water use efficiency that contributes to industrial symbiosis and industrial ecology. The following provides an overview of the case study selection and different collection and analysis methods to explore, understand and compare multiple specific case studies.

### 1.6.2 Case study selection

The industrial zones studied in the following chapters were selected during three workshops in July 2015, March 2016, and July 2017. During these workshops, extended discussions with representatives and site visits to industrial zones in Ho Chi Minh City, Long An and Can Tho, provided information on the local situation and challenges of water availability and use, water reuse, water shortage and storage, water multi-sourcing and treatment, water policy/regulation and management. These meetings and site visits also revealed that the infrastructure companies are not only responsible for the supply of

water and sanitation within the industrial zones, but also for the associated residential areas (Long Hau industrial zone). Each industrial zones clearly expressed a major interest in innovation towards more water use efficiency, including recycling/reuse of industrial effluent for various applications, storage and use of rain water, use of brackish/salt water or recharging groundwater.

The selection of industrial zones as case studies, outlined in Table 1.1, was based on five criteria: (1) industrial zones that face different water supply issues, (2) are interested in pursuing technological water efficiency strategies, (3) host different types of industries and sources of investment, (4) are located in different provinces, and (5) were willing to participate in the project. The four industrial zones out of this selection process are Hiep Phuoc industrial zone and Tan Thuan export processing zone in Ho Chi Minh City, Long Hau industrial zone in Long An province, and Tra Noc industrial zone in Can Tho City (also see Figure 1.3 for the location of these three administrative areas in Southern Vietnam).

**Table 1.1** Case studies for chapters

| Chapter | Hiep Phuoc IZ | Long Hau IZ | Tan Thuan EPZ | Tra Noc IZ |
|---|---|---|---|---|
| 2 | ✓ | ✓ | ✓ | |
| 3 | ✓ | ✓ | ✓ | |
| 4 | ✓ | | ✓ | |
| 5 | ✓ | | ✓ | ✓ |

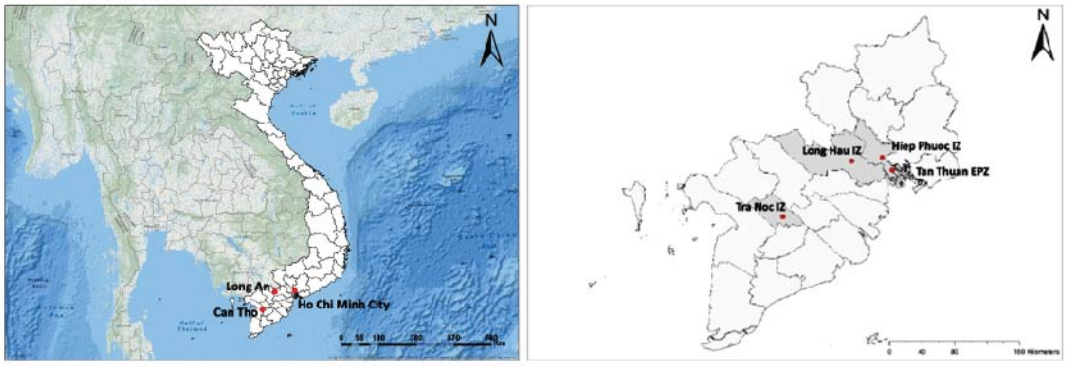


***Figure 1.3*** *Location of case studies.*

*(Source: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors).*

In addition to the Industrial Zones, the analysis in the following chapters is based on a variety of policy instruments which each enable an analysis of the interaction between macro and meso institutions on the institutional capacity of relevant state and industrial actors. These instruments reflect the variation outlined in section 1.3.1 above.

First, we focus on an economic instrument - a wastewater levy introduced in Ho Chi Minh City under Resolution No.02/2018/NQ-HĐND and Decision No.2129/QD-UBND by the provincial government. This levy aimed to set a range of measures to stimulate innovation including water saving, reuse wastewater after treatment, limiting wastewater discharge and restricting environmental pollution through adjusting the environmental protection fee for industrial wastewater in Ho Chi Minh City. In this thesis, we studied on the effect of economic instrument (macro institutions) beyond prescribing goals by understanding the capacities of industrial zones (meso institutional capacity) to develop strategies of water technological innovations to comply with these instruments.

Second, the public certification scheme for Eco Industrial Parks implemented through Decree 82 of the central government was selected to study specific macro institutions. Decree 82 (public certification) set out the five voluntary criteria for certifying eco-industrial parks. The certification process is voluntarily initiated by the industrial zone's management board who applies to the four designated key Ministries; MPI, MONRE, the Ministry of Industry and Trade (MOIT) and the Ministry of Construction (MOC). This thesis focused on understanding the ways in which different stages of developing Decree 82 can affect the Vietnamese state's capacity to coordinate and implement Eco Industrial Parks.

### 1.6.3 Social network analysis

After selecting appropriate industrial zones, the thesis analyzes and compares the networks of three industrial zones in the South of Vietnam: Hiep Phuoc industrial zone and Tan Thuan export processing zone in Ho Chi Minh City, and Long Hau industrial zone in Long An province by using social network analysis. Social network analysis investigates the structure of networked relations among policy, economic, societal and knowledge actors and the potential of these relations to shape action and innovation for industrial symbiosis.

Social network analysis (SNA) is used to analyze (1) the typology of actors involved and their ties (or connections); (2) the structure of the network and (3) the degree of influence different actors in these networks have on the creation of industrial symbiosis within industrial zones. The detailed social network analysis descriptors are presented in Table 1.2.

**Table 1.2** Social network analysis descriptors (Adapted from Borgatti et al., 2018)

| Analysis | Descriptor | Description |
|---|---|---|
| Network typology | Node | An actor in the network |
| | Tie | A connection between a pair of nodes |
| | Type of tie | Type of connection among two actors/nodes (economic, policy, knowledge and social) |
| Network structure | Number of ties | Number of all connection between a pair of actors in the whole network |
| | Geo-distance | Shortest path length or number of ties between two nodes |
| | Density | Proportion of all possible connections that are actually present |
| | Network centralization | The extent a network is dominated by a single node. The degree of variability in the degrees of actors in our observed network as a percentage of that in a star network of the same size |
| Network influence | Degree centrality | The number of ties which nodes in the network received |
| | Betweenness centrality | The measure of how often a given node falls along the shortest path between two other nodes, measure of the extent to which a node is connected to other nodes that are not connected to each other. |
| | Closeness centrality | The measure of how often a given node falls along the shortest path between two other nodes, measure of the extent to which a node is connected to other nodes that are not connected to each other. |

### 1.6.4 Data collection and analysis

Data was collected for social network analysis and dynamic interaction between different levels of institutions and institutional capacity through five qualitative methods to allow data to be triangulated for internal consistency (Olsen, 2004; Yin, 2009), namely observation, document review, semi-structured interviews, workshops and stakeholder meetings. All the primary data was collected between 2015 and 2019. Table 1.3 shows that different chapters are based on different combinations of these five data collection methods.

First, observation was employed to collect primary data on interactions during workshops and during site visits. By observing actors at policy-related meetings and stakeholder, further questions were identified to ask curing interviews. In addition, these observations provided an opportunity to ground truth the status of claims made during interviews on water use efficiency policy and regulation (Kumar, 2014).

For social network analysis, the observations were made to know and understand the roles and interaction between actors and to determine who are able to make final decisions to implement water use efficiency innovation.

Second, document review was used to triangle with unclear and irregular data from interviews related to water use efficiency strategies, the promulgation of wastewater levy, and public voluntary standard. The document was reviewed including legal and policy documents, environmental reports sourced from website of law library, websites from governmental departments, and industrial zones. For social network analysis, a review of documents from the Vietnamese government and environmental reports of industrial zones was then conducted to further identify and elaborate the roles, task and responsibilities of networked actors. Based on the observations and the document review, an initial network mapping was generated.

**Table 1.3** Method of data collection applied in this thesis

| Chapter | Data collection method |
|---|---|
| 2 | Observation, document review, interview, workshop |
| 3 | Interview, observation, document review, workshop |
| 4 | Interview, observation, document review, stakeholder meeting |
| 5 | Interview, document review |

Third, face to face, in-depth, semi-structured interviews were employed throughout this thesis. This method involves repeated contacts and hence extent length of time spent with an interviewee and it is assumed that the corresponding understanding and confidence between researcher and respondent will lead to in-depth and accurate information (Kumar, 2014). Respondents were selected through snow ball sampling; starting from an initial interview with the directors and vice-directors of the industrial zone infrastructure companies. In total, 121 interviews were conducted in this study. Respondents included representatives from industrial zone infrastructure company, industrial enterprise, industrial zone authority, residents, research center, and provincial and central government. However, for different topics in multiple chapters, the interviews were also conducted with the same respondents from the government, industrial zone infrastructure company and industrial enterprises (Table 1.4). The interview questions for each Chapter are presented in the Appendix 1. For social network analysis, the network diagrams that emerged out of the initial mapping were then used during interviews about the relationships, roles and influences of actors in water use and management that contribute to enabling the implementation of water use efficiency innovations in IZs.

Fourth, workshops were organized, in 2015, 2016, 2017 and 2018 to reflect on and validate information and collected from the respondents. The industrial zones were selected to study in this thesis in three workshops held prior to the start of the project (in July 2015, March 2016, and July 2017). For social network analysis, the empirical data collected including observation, document review and interviews was validated during a workshop in 2017.

Finally, information of four stakeholder meetings in 2019 also added to information from interviews. More information about the workshops and stakeholder meetings were summarized in Appendix 2.

**Table 1.4** Number of interviewees in different chapter of this thesis

| Chapter | Number of interviewees |
|---|---|
| 2 | 33 respondents from governmental and industrial zone authorities, water supply company, research institute, residents, and 20 enterprises |
| 3 | 27 respondents from industrial zones, 13 respondents from government and client companies |
| 4 | 9 key respondents from administrator, client forms and technicians in industrial zones, 4 additional interviews were conducted with representatives of ministry, department and industrial zone authorities |
| 5 | 15 key respondents from government, industrial zone authorities, industrial zones, and enterprises |

Interview transcripts and data collected from observation, and document review in Chapter three and five were analyzed by deductively coding based on the objective of the chapter. Chapter 3 analyzed all the data based on a coding scheme aligned with the variables in our combined relational, knowledge, and mobilization capacity framework. Chapter 5 analyzed all the data by deductively coding based on the themes of relational, knowledge, mobilization capacity and the dimensions of each capacity as presented in Section 1.3.3.

For social network analysis in chapter 2, after validating during a workshop, the collected data was transformed into a binary-directed matrix (Borgatti et al., 2018) to describe the relationships between different actors/organizations in networks related to water use and management. The matrix vector represents the existence of a relationship or a tie in this industrial network, with "1" confirming the existence of at least one relationship and "0" denying the existence of relationship. This matrix was fed into UNICET 6 to generate the network typology and calculate quantitative network descriptors for the analysis of network structure and degree of network influence.

## 1.7 THESIS OUTLINE

The rest of the thesis is structured by the four empirical chapters, presented in the format in which they have been published or submitted to scientific journals, and a final chapter that concludes by answering the overall questions outlined above and discussing the wider significance of these findings for advancing a fundamental understanding of how institutions and institutional capacities interact.

Chapter two applies Social Network Analysis to compare the networks of three industrial zones - Hiep Phuoc, Long Hau, and Tan Thuan, by applying social network analysis, the structure, strength and content of relations of actors within the industrial zone network is determined, including the relative influence of actors within the network, and relatedly, possibilities for collective action needed for enabling industrial water symbiosis outcomes. These results provide a basis not only for strengthening the empirical evidence on the importance of network ties in shaping industrial innovation but also for a more fundamental understanding of the types of capabilities needed for both government and industry to utilize a wider range of relationships that go beyond purely material ones.

Chapters three then analyses the interplay between macro level institutions and meso level institutional capacity in Vietnam to understand the conditions under which industrial water symbiosis can emerge. In this chapter the institutional capacity framework is elaborated further and employed to assess the relational, knowledge, mobilization capacities of three industrial zones and the ways in which these institutional capacities are affected by the hierarchical regulatory and political structure of the centralized Vietnamese state. The chapter indicated the value of institutional capacity as a framework for assessing processes of technical innovation for industrial ecology, especially in the context of centralized states.

Chapter four examines the effects of implementing an economic policy aimed at promoting water use efficiency in two Vietnamese industrial zones. Located in Ho Chi Minh City, each of these industrial zones represent different responses to the wastewater levy implemented by the Ho Chi Minh City (HCMC) People's Council and People's Committee in 2018 (Decision No.2129/QD-UBND). The institutional capacity framework is used to understand why this new macro level institutions fails to affect the institutional capacity of the two Industrial Zones. Chapter 4 contributes to ongoing debate on the effectiveness of economic environmental regulation in Vietnam and the ongoing challenges of the Vietnamese government in not only prescribing ambition, but also enabling capacities for innovation and ultimately compliance.

Finally, chapter five examines the development of Decree 82 to understand the ways in which different stages of developing a voluntary public standard affects the Vietnamese state's capacity to coordinate and implement EIPs. This standard codified under Article 42 of Decree 82, was instigated by the United Nations Industrial Development Organization (UNIDO) with the Vietnamese Ministry of Planning and Investment (MPI) (UNIDO, 2018). In the process of developing the standard, multiple governmental Ministries and Departments responsible for investment, financing, environment, social security of EIP formation were involved. The aim of this chapter is to assess how the institutional capacity of these governmental bodies was affected through their involvement in the development of a public standard and the effect of this capacity on supporting systemic and inter-ministerial support for transformation towards industrial symbiosis and industrial ecology.

The concluding chapter answers the research questions for this thesis. It also introduces a dynamic model to understand the interaction between macro, meso and micro institutions and the institutional capacity of actors at different levels. It makes a distinction between pathways of interaction between institutions and institutional capacity that undermine or strengthen progress towards industrial symbiosis and industrial ecology. It shows that while the institutions and institutional capacity interact in complex ways, it is possible to identify different co-existing pathways that ultimately shape the outcome of industrial symbiosis and industrial ecology. The concluding chapter ends with policy recommendations for economic instrument and a public eco-industrial park standard implementation, and provides a new approach by not only focusing on setting macro rules and norms, but also developing a pathway by establishing institutional capacity support programs at meso and micro level in which Industrial Symbiosis and Industrial Ecology is implemented in Vietnamese Industrial Zones.

# Chapter 2

# Enabling industrial symbiosis through extra-firm networks in Vietnam

**Abstract**

Significant attention in the industrial symbiosis literature has focused on the social aspects of material exchange between networked actors. The degree to which networks can generate commitment, relevance and interconnection has a direct influence over the collective capacity of industrial actors to develop shared material and energy flows that meet the goals of industrial symbiosis. We apply social network analysis to explore the degree to which actors operating through different types of policy, societal, economic and knowledge ties contribute to the development of industrial water symbiosis in industrial zones in Vietnam. Our results show that Vietnamese industrial networks are hierarchical in nature and dominated by the state, which limits the exchange of perceptions, agendas and norms and affect the mutual dependencies for aligning economic and resource efficiency goals. Industrial zones need to reshape their relations with the state to take advantage of their central position by establishing alternative network ties. The results provide a basis to not only strengthen the empirical evidence of the importance of network relations in shaping industrial innovation, but also to enable a more fundamental understanding of the kinds of capacities needed for both the government and industrial zones to use a wider set of relations, beyond purely material ones.

**Keywords:** social network analysis, industrial symbiosis, industrial zones, tie, network

This chapter was submitted for publication as:
Trang, T. T., van Leeuwen, J & Bush, S. R., (Under review). Enabling industrial symbiosis through extra-firm networks in Vietnam. This paper is currently under review.

## 2.1 INTRODUCTION

Industrial symbiosis incorporates cooperative networks of industrial actors to enable physical exchange of materials, energy, water, and/or by-products as well as services and infrastructure with the aim of closing energy and resource loops (Baldassarre et al., 2019; Chertow, 2007; Neves et al., 2020). Industrial symbiosis is particularly relevant for achieving water use efficiency in industrial zones through reciprocal exchange loops that reduce material, energy and economic costs, while improving operating efficiency and quality, and enhancing water use efficiency (Neves et al., 2020; Song et al., 2018; Wallner, 1999). Industrial symbiosis, as such, is seen as a means of delivering social, environmental and economic benefits between profit seeking enterprises often working in close proximity (Chertow, 2007).

Considerable attention within the industrial symbiosis literature has focused on the social dimensions of material exchange between networked actors (Ashton, 2008; Domenech & Davies, 2011; Jacobsen, 2005; Neves et al., 2020; Song et al., 2018). A central premise of this research is that material flows between these networked actors, including water re-use, are motivated by common perceptions, agendas, and norms that shape recognition of their mutual dependencies for aligning economic and resource efficiency goals (Domenech & Davies, 2011; Song et al., 2018). They are not only connected through their exchange of waste, by-products and sharing of resources, but also through information to know and process these material flows (Nuhoff-Isakhanyan et al., 2017). Symbiosis, and the interdependencies it implies, are as such affected by the social conditions of networks – including the degree and type of collaboration, communication and trust between actors, as well as their position in wider social hierarchies of state, status and markets beyond firms in industrial zones (Song et al., 2018). It also implies durable engagement that can facilitate long term processes of social technological innovation that include diverse policy, economic, societal and knowledge actors (Velenturf & Jensen, 2016). As argued by Koppen & Mol (2002), the degree to which these networks can generate commitment, relevance and interconnection has a direct influence over the collective capacity of industrial actors to develop shared material and energy flows that meet the goals of industrial symbiosis.

While there is considerable evidence to show that networked social relations are imperative for industrial symbiosis, less is known about the influence of different network typologies. The typology of an industrial symbiosis network refers to the structure of multiple social linkages that link the experience and knowledge of constituent organizations to shape network objectives such as resource efficiency or improved capacity to deal with other complex problems (Vahidzadeh et al., 2021; Wang et al., 2017). Yet research on industrial symbiosis network topologies tend to focus only on the material flows enabled by inter-firm synergies within industrial parks and zones and not the ways in which different types of relations and networks enable symbiosis-oriented innovation (ibid.). A networked understanding of industrial symbiosis has as such emphasized dyadic ties between enterprises and industrial managers rather than wider set of policy, economic, societal and knowledge ties that enable industrial actors to innovate and reshape complex material flows.

Illuminating the typology of industrial symbiosis networks that goes beyond inter-firm relations is especially relevant in emerging economies of East Asia, including Vietnam, where political and economic decision making tends to be more centralized and hierarchical in nature (Garschagen, 2016; Phuong et al., 2018). The extent to which wider policy, economic and knowledge relations are in place and enable industrial zones and their client firms to create symbiotic resource flows has received relatively limited attention. Past research has been largely instrumental in nature – focusing on proximate flows of exchange and sharing of resources and utilities, exchange by-products and knowledge at the enterprise

level and the strength of trust in other stakeholders internally (Ashton, 2008; Domenech & Davies, 2011; Song et al., 2018). However, in centralized and hierarchical states such as Vietnam, the role of and the connections with governmental actors are undeniable important in the implementation and development of resource use efficiency and industrial symbiosis (M. Huang et al., 2019; Song et al., 2018). Excluding the role of the state, and the wider set of policy, economic, societal and knowledge ties that the state enables, undermines a clear understanding of the wider enabling role of industrial symbiosis networks in promoting goals such as water use efficiency.

This article applies social network analysis to explore the degree to which actors operating through different types of policy, societal, economic and knowledge ties contribute to the development of industrial water symbiosis in Vietnamese industrial zones. In doing so we extend Mol's (1995) triad network model (see also Dieu, 2006 and Anh et al., 2011) focused on the embedding of economic, political and social-cultural rationalities for industrial reform in corresponding economic, policy and (civil) societal actor-networks. We do this by applying Social Network Analysis to examine three industrial zones - Hiep Phuoc, Long Hau, and Tan Thuan - which together are representative of the challenges and different types of relations in the network relevant for industrial zones seeking to address key challenges of resource use efficiency. By applying social network analysis, we determine the structure, strength and content of relations of actors within the industrial zone network, including the relative influence of actors within the network, and relatedly, possibilities for collective action needed for enabling industrial water symbiosis outcomes (Bodin et al., 2006). Following Crona et al. (2011), we also explore the potential of more and less central actors in the network to influence the emergence of collective actions for implementing industrial ecology that enhance water use efficiency. Our results contribute to an improved understanding of the relative impact of the actors in the networks with various relations in driving improvements in Vietnamese eco-industrial parks.

The next section introduces network approach to analyze the composition, structure of a network, and the roles of actors based on different type of ties. Sections 3 and 4 then outline the social network analysis method and results. We then discuss the findings of our analysis arguing that their networks are hierarchical in nature, the state dominated network that limit the exchange of perceptions, agendas and norms that affect the mutual dependencies for aligning economic and resource efficiency goals. Industrial zones need to reshape the nature of their relation with the state to take the advantage of their position and establishing alternative network ties. The article concludes that the role of policy ties to governmental actors in the implementation and development of resource use efficiency and industrial symbiosis in Vietnamese industrial zones and identifies areas for further research on better characterize the role networked actors and the variation in the networked ties can play in affecting flows of knowledge and resources for innovation as well as acknowledge the role of the Industrial Zone Infrastructure Companies in mediating or brokering ties with non-governmental actors.

## 2.2 SOCIAL NETWORK ANALYSIS

Social network analysis investigates the structure of networked relations among policy, economic, societal and knowledge actors and the potential of these relations to shape action and innovation for industrial symbiosis. Following Ashton, 2008 and Song et al., 2018, we apply social network analysis in three discrete steps with the aim of analyzing – (1) the typology of actors involved and their ties (or connections); (2) the structure of the network and (3) the degree of influence different actors in these networks have on the creation of industrial symbiosis within industrial zones. By focusing on the ties

that constitute these networks in step 1, following Mol (1995), we provide improved understanding of the roles of actors and the kinds of relationships among them that enable or disenable innovation for water use efficiency and management.

The first step of our analysis maps the typology of the networks in which industrial zones are embedded. We do this by measuring a set of network topological descriptors derived from Borgatti et al. (2018) that are based on the existence and type of ties between pair of nodes (i.e., actors) in the entire network of each industrial zone (see Table 2.1 for a summary of these terms). The first category of these ties is between industrial actors that emerge through (1) material exchange and (2) service and utility sharing (Ashton, 2008) – both of which are relevant to water use efficiency (Song et al., 2018). The second category of these ties are connections between actors based on the implementation of policy or regulation; such as the inspection and/or management of (water) resource use in industrial zones (see for e.g., Song et al., 2018; Velenturf & Jensen, 2016). The third category are connections between industrial zones and civil society groups expressing concern around the re-use of material flows, such as treated water, or perceived risks around pollutive and/or waste flows (see for e.g., Borgatti et al., 2018; Song et al., 2018). The final category are knowledge ties with experts leading to enhanced understanding of environmental goals and or the technologies needed for material resource flows to be enacted (e.g., Domenech & Davies, 2011; Nuhoff-Isakhanyan et al., 2017).

The second step of our analysis characterizes the structure of the industrial zone network through five core parameters (see Table 2.1). First, we identify the number of ties actors have in the network; with a high number indicating a higher chance for collaboration aimed at enhanced resource efficiency (Borgatti et al., 2018; Domenech & Davies, 2011). Second, we calculate the geo-distance of the networked connections for each industrial zone, with higher average geo-distance indicating that an actor is more dependent on other actors to create new connections (Borgatti et al., 2018; Gilsing, 2005; Nuhoff-Isakhanyan et al., 2017). Third, we measure the density of ties, referring to the proportion of all possible connections that are actually present in a network. We assume that a higher density of networked ties increases the likelihood of trusting relations, shorter cognitive distance (and therefore goal alignment) among actors, and higher levels of knowledge exchange related to resource exchange and efficiency (Nuhoff-Isakhanyan et al., 2017). Fourth, we measure the network centralization, referring to the extent a network is dominated by a single node (Borgatti et al. 2018). The more centralized a network is the greater the dependence of networked outcomes are on that actor or node for any kind of inputs that can facilitate industrial symbiotic exchange. A high degree of centralization may indicate that a network will not expand because only a few actors have opportunities to connect with others to, for instance, enhance resource efficiency (Borgatti et al., 2018; Gilsing, 2005; Nuhoff-Isakhanyan et al., 2017). Conversely, low centralization indicates that more opportunities for a greater number of actors to create new linkages exists, but also may imply weak leadership and/or regulation for steering industrial zones to adopt industrial symbiosis practices. Following Kellogg & Samanta (2018), it may also enable greater flexibility in the network by enabling new actors to enter into the network which in turn may result in a higher probability of introducing new (knowledge, economic or policy related) opportunities innovating water use efficiency.

The third level of analysis, aimed at determining the influence of each actor in the network to create the change and innovations for resource efficiency, is based on degree, betweenness and closeness as measures of network centrality (Nuhoff-Isakhanyan et al., 2017; Borgatti et al., 2002). Degree centrality measures the number of ties nodes have in the network– with more ties indicating a more central role in the constitution of and, as such influence over setting goals or 'programming' network

goals (see Castells, 1996) and/or coercing the actions of other actors in the network (Neumeyer & Santos, 2018). Betweenness centrality is a measure of how often a given actor is positioned along the shortest path between two other nodes, the extent to which a node is connected to other nodes that are not connected to each other – potentially indicating an intermediary or brokering position between other actors in the network (Gilsing et al., 2008; Zhang & Chai, 2019). Closeness centrality, in contrast, is a measure of the distance between every actor and with all other actors in the network – the sum of geodesic distances indicates the overall inter-connectivity and potential coherence between the actors involved, and with the potential for aligned goals and collective activities (Borgatti et al., 2018).

These measures of network influence can be combined to assess the possibility for network outcomes related to industrial symbiosis. For instance, an actor or group of actors with a high degree and betweenness centrality indicates greater autonomy for shaping network outcomes than those actors with lower measures for these network attributes (e.g., Zhang & Chai, 2019). Actors with higher scores of degrees and betweenness centrality may also be more able to influence the shared outcomes of a network by, for instance, (dis)enabling knowledge exchange, regulatory compliance, or the design and provisioning of material exchange (Song et al., 2018). In addition, lower scores for closeness centrality may illustrate less dependency on other actors. This can either lead to isolation from shared activities or knowledge flows leading to industrial symbiosis, or, as argued by Neumeyer & Santos (2018), a greater opportunity for building connections with other actors - either through policy or economic forms of entrepreneurialism and innovation.

**Table 2.1** Social network analysis descriptors (Adapted from Borgatti et al., 2018)

| Analysis | Descriptor | Description | Example in this study |
|---|---|---|---|
| Network typology | Node | An actor in the network | Enterprises, industrial zone infrastructure company (IZIC), ministry, etc. |
| | Tie | A connection between a pair of nodes | IZIC provides services for enterprises, so between them have a tie |
| | Type of tie | Type of connection among two actors/nodes (economic, policy, knowledge and social) | The type of tie between enterprises and IZIC is economic tie because IZIC provide services for enterprises |
| Network structure | Number of ties | Number of all connection between a pair of actors in the whole network | The quantity of all connection is presented among all actors in the network |
| | Geo-distance | Shortest path length or number of ties between two nodes | Distance equal 1 for two actors have a direct tie |
| | Density | Proportion of all possible connections that are actually present | The network has all 60 possible ties, number of existing ties is 15. So, the density (number of existing ties divided by possible ties) is 0.25 |
| | Network centralization | The extent a network is dominated by a single node. The degree of variability in the degrees of actors in our observed network as a percentage of that in a star network of the same size | The network has 5 nodes. The most central node has 4 ties. The sum of different for the star network with 5 nodes is 12. The sum of different for the observed network with 5 nodes is 8. So, the network centralization is equal 8/12 = 0.667 (66.7%) |

| Analysis | Descriptor | Description | Example in this study |
|---|---|---|---|
| Network influence | Degree centrality | The number of ties which nodes in the network received | An actor has two connections with other actor, the degree centrality is 2 |
| | Betweenness centrality | The measure of how often a given node falls along the shortest path between two other nodes, measure of the extent to which a node is connected to other nodes that are not connected to each other | If A is between B and G, B and F, C and G in the network, the betweenness centrality is 3 |
| | Closeness centrality | The distance among an actor and other actors in the network, as the sum of geodesic distances from a node to all others | If the sum of the geo distance from each actor to all other actors in the network is A. The closeness centrality is 1/A |

## 2.3 METHODOLOGY

We analyze and compare the networks of three industrial zones in the South of Vietnam: Hiep Phuoc industrial zone and Tan Thuan export processing zone in Ho Chi Minh City, and Long Hau industrial zone in Long An province. These industrial zones were selected in three workshops from the beginning state of the study in July 2015 and March 2016 based on their common interest in introducing industrial symbiosis principles for water efficiency (e.g., through wastewater reuse and rain water harvesting) to overcome salt water intrusion, growing fresh water demand, restrictions on groundwater-use and discharge wastewater that does not meet the national water quality standards (Table 2.2).

The data was collected in 2017 using observation, document review, interviews, and a workshop (summarized in Table 2.3). Observations were made during site visits to know and understand the roles and interactions between actors and to determine who are able to make final decisions to implement water use efficiency innovations in IZs. A review of documents from the Vietnamese government and environmental reports of industrial zones was then conducted to further identify and elaborate the roles, task and responsibilities of networked actors. Based on these observations and the document review, an initial network mapping was generated. The network diagrams that emerged out of this mapping were then used during 53 interviews with 39 respondents from March 2017 to 7 September 2018 from governmental and industrial zone authorities, three industrial zones, water supply company, research institute and residents about the relationships, roles and influences of actors in water use and management that contribute to enabling the implementation of water use efficiency innovations in IZs (see Appendix 1). The empirical data collected was validated during a workshop held in July 2017.

Once validated, the collected data was transformed into a binary-directed matrix (Ashton, 2008; Borgatti et al., 2018; Domenech & Davies, 2011) to describe the relationships between different actors/organizations in networks related to water use and management. The matrix vector represents the existence of a relationship or a tie in this industrial network, with "1" confirming the existence of at least one relationship and "0" denying the existence of relationship. This matrix was fed into UNICET 6 to generate the network typology and calculate quantitative network descriptors for the analysis of network structure and degree of network influence (see Table 2.1). Extending beyond other studies (Ashton, 2008; Borgatti et al., 2018; Domenech & Davies, 2011), these quantitative data

were then cross-referenced with qualitative data (coded by policy, economic, societal and knowledge ties) to contextualize and further explain the role and influence of each actor over water use innovation in line with the principles of industrial symbiosis.

**Table 2.2** Characteristics of selected industrial zones

| Industrial zone | Location | Type | Water challenges | Key social actors | Specific policies/ regulations |
|---|---|---|---|---|---|
| Hiep Phuoc IZ | Nha Be District, HCMC | General industry (mechanics, electricity - electronics, rubber - plastics, food processing) | Salt water intrusion, raising water demand | MONRE, DONRE, HEPZA, Hiep Phuoc IZIC (HIPC), Companies in IZ | Environmental protection regulation for all units in Hiep Phuoc IZ |
| Tan Thuan EPZ | District 7, HCMC | General industry (light, clean and un-polluted industry, high value-added industries, bio-tech industry, logistic, trading and services) | Salt water intrusion, raising water demand | MONRE, DONRE, HEPZA, Tan Thuan EPZIC (TTC), Companies in EPZ | Regulation on standard and limitation of wastewater discharge |
| Long Hau IZ | Can Giuoc District, Long An province | General industry (food processing, construction material (except cement and steel), logistic and ancillary industries) | Salt water intrusion, raising water demand, restriction on groundwater-use | MONRE, DONRE, LAEZA, Long Hau IZIC (LHC), Companies in IZ | Environmental protection regulation in Long Hau IZ |

**Table 2.3** Methods of data collection

| Method | Description | Output information |
|---|---|---|
| Observation | Observe roles and interactions between stakeholders when going directly to the IZIC and enterprises at the sites; | • Roles and interactions between stakeholders<br>• Decision-making ability of actors |
| Document review | Review detail legal policies/ regulations<br>Review several environmental reports of IZ | The roles, tasks and responsibilities of actors |
| Interview | In-depth interviews with the representatives of governmental authorities, infrastructure companies, enterprises in IZ, water supplied company, research institute and District People Commitee (See Table S1) | • Identify the types of connections between different actors<br>• Identify who plays an important role in current water use and management and makes a decision for the enabling of technical innovations for enhancing water use efficiency in IZs |
| Workshop | Workshops were organized in 2015 and 2016 | Identify the IZs that participate in the project |
| | Workshops was organized in 2017 | • Reflect on results of roles and connections between relevant actors to all stakeholders<br>• Get feedbacks and comments from all stakeholders about the results |

## 2.4 ANALYSIS OF INDUSTRIAL ZONE NETWORKS

### 2.4.1 General characteristic of the network

*Network typology*

The water use and management networks of Hiep Phuoc and Tan Thuan industrial zones consist of thirteen related governmental and non-governmental actors (see Table 2.4 for a description of actors). This includes key decision-making actors from all levels of government – from national to the city and district levels – and research institutions, NGOs and adjacent communities (see Figure 2.1).

**Table 2.4** Description of actors

| No. | Abbreviations | Organization | Description |
|---|---|---|---|
| 01 | MONRE | Ministry of Natural Resource and Environment | Agency of the government, state management and submit to the government the draft of law, resolution, strategies, master plans, decisions, circulars in the following field: land, water resource, environment, climate change, etc. |
| 02 | Ministry of Special Products | Ministry of Special Products | Agency of the government, state management and submit to the government the draft of law, resolution, strategies, master plans, decisions, circulars in the field of special product |
| 03 | DONRE | Department of Natural Resource and Management | Agency of City/Province People Committee, submit to the City People Committee the draft of decision, master plans, program and other legal document of City People Committee in the field of natural resource and environment |
| 04 | DOST | Department of Science and Technology | Agency of City/Province People Committee, submit to the City People Committee the draft of decision, master plans, program and other legal document of City People Committee in the field of science and technology |
| 05 | SAWACO | Saigon Water Corporation | Founded by Ho Chi Minh City People's Committee, manage and develop the water supply system, exploit, produce, supply and trade clean water for consumption needs, production and business of other products and services related to the water industry |
| 06 | HEPZA | Ho Chi Minh City Export and Processing Zone Authorities | Agency of Ho Chi Minh City People's Committe, state management of enterprises, industrial zones, export processing zones in the city, providing public and administrative services and other supporting services related to investment, production and business activities for investors |
| 07 | LAEZA | Long An Economic Zone Authorities | Agency of Long An Province People's Committe, state management of enterprises, industrial zones, export processing zones in the city, providing public and administrative services and other supporting services related to investment, production and business activities for investors |

| No. | Abbreviations | Organization | Description |
|---|---|---|---|
| 08 | District PC | People Committee at District level | Executive body of the People's Council of the district, the state administrative agency in the district, under the direct direction and management of the Province People's Committee, manage and direct the commune level, cooperatives, enterprise and non-busisness unit and state agency assigned to the district level for management |
| 09 | HCMC PC | Ho Chi Minh City People Committee | Executive body of the People's Council of the city/province, the state administrative agency in the city/province, manage and direct the district level, cooperatives, enterprise and non-busisness unit and state agency assigned to the province level for management, develop the master plans, schemes to collect fees, charges, and contributors, direct and inspect the implementation |

In contrast, Long Hau industrial zone is connected to ten mainly governmental actors and does not have relationships with NGOs, the city level Department of Science and Technology (DOST) or the Saigon Water Corporation (SAWACO). The representative of Long Hau argued that they have no experience in connecting with the DOST and NGOs to conduct research as well as share experiences in the implementation of effective water use technologies.

**Table 2.5** The distribution of different kinds of ties from actor in the network of three IZs

| | Hiep Phuoc | | | | Long Hau | | | | Tan Thuan | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Actor | P | K | E | S | P | K | E | S | P | K | E | S |
| City PC | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| MONRE | 7 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 6 | 1 | 0 | 0 |
| DONRE | 7 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 7 | 1 | 0 | 0 |
| HEPZA/LAEZA | 7 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 7 | 0 | 0 | 0 |
| IZIC | 4 | 1 | 2 | 2 | 3 | 0 | 2 | 2 | 4 | 1 | 2 | 2 |
| Enterprises | 3 | 1 | 1 | 0 | 4 | 1 | 1 | 0 | 5 | 1 | 1 | 0 |
| District PC | 3 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 5 | 0 | 0 | 1 |
| NGOs | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Universities/Institutes | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 |
| Residents | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 1 |
| Ministry of special product | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| DOST | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| SAWACO | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 |

Note:
P: number of policy ties
K: number of knowledge ties
E: number of economic ties
S: number of societal ties

Despite the differences in the composition of their networks, all three industrial zones have a high number of policy ties demonstrating the hierarchical state-led structure of water use and management in Vietnamese industrial zones (see Figure 2.1 and Table 2.5). The dominance of these policy ties confirms the importance of the central government in passing decisions and setting out long term plans under which lower levels of government and industrial zones are obliged to conform (Phuong et al., 2018). Feedback from industrial zones to higher levels of government through these hierarchical policy ties remains a highly 'administrative' (cf. KimDung et al., 2017) rather than deliberative process, with Industrial Zone Infrastructure Companies and enterprises passing information back to the People's Committee or MONRE for unspecified consideration.

The hierarchical policy ties of all three industrial zones are also evident in their economic ties. This is illustrated by the common link to the Saigon Water Corporation and the Industrial Zone Infrastructure Companies which are both state owned. The Saigon Water Corporation falls under the control of the Ho Chi Minh City Peoples Committee and is responsible for setting prices and other contract conditions, including fixed costs for water consumption and investments in water infrastructure, with the Industrial Zone Infrastructure Companies. These relations, while nominally market-based, reflect the state centered and top-down nature of resource provisioning and decision making over industrial zones.

The results additionally show that Hiep Phuoc and Tan Thuan industrial zones have knowledge, economic and societal ties, albeit to a limited extent. The knowledge ties are with formal knowledge actors such as Universities and research institutes and, as illustrated through interviews with key informants, enable them to access research and development related to water use efficiency technologies. Hiep Phuoc and Tan Thuan's outward links demonstrate no connectivity to NGOs and community actors, so there is not any substantive input to the management and/or innovation of water use. The representative from Tan Thuan argued that only the government at city level has connection with NGOs (Interview #7, 8). On the other hand, Long Hau has both economic and societal ties with residents who live around the industrial zone. For example, the direct sale of water from Long Hau to surrounding resident who are not supplied water directly by the province represents such an economic tie.

Overall, the typology and interview data show the dominance of policy ties in each industrial zone network, from the national Ministry and provincial Department of Natural Resources and Environment, the Provincial and City People's Committees and industrial park authorities. These policy links enable the state the maintain control over the economic, social and knowledge ties of industrial zones that might enable water use efficiency innovation and ultimately industrial symbiosis.

*Network structure*

The network structure, as illustrated in Figure 2.1, shows that the morphologies of the industrial zone networks are not evenly distributed or 'web-like'. Instead, the networks are formed around key state actors.

The low geo-distance observed in these networks demonstrates the direct policy and economic ties between industrial zones and the Ministry and provincial Department of Natural Resources and Environment. These close policy ties are maintained by administrative demands for reporting on inspections and management plans for resource use in industrial zones. Similarly, the dominant economic ties with the Saigon Water Corporation are characterized by fixed and long-term contracts

that, rather than open up economic opportunity, limits economic ties to administrative reporting. The short geo-distance, as argued by key respondents, is largely created and maintained by the direct and highly administrative use of policy and legal documents that maintain oversight by the Ministry of Natural Resources and Environment, the People's Committee with the Industrial Zone Infrastructure Companies.

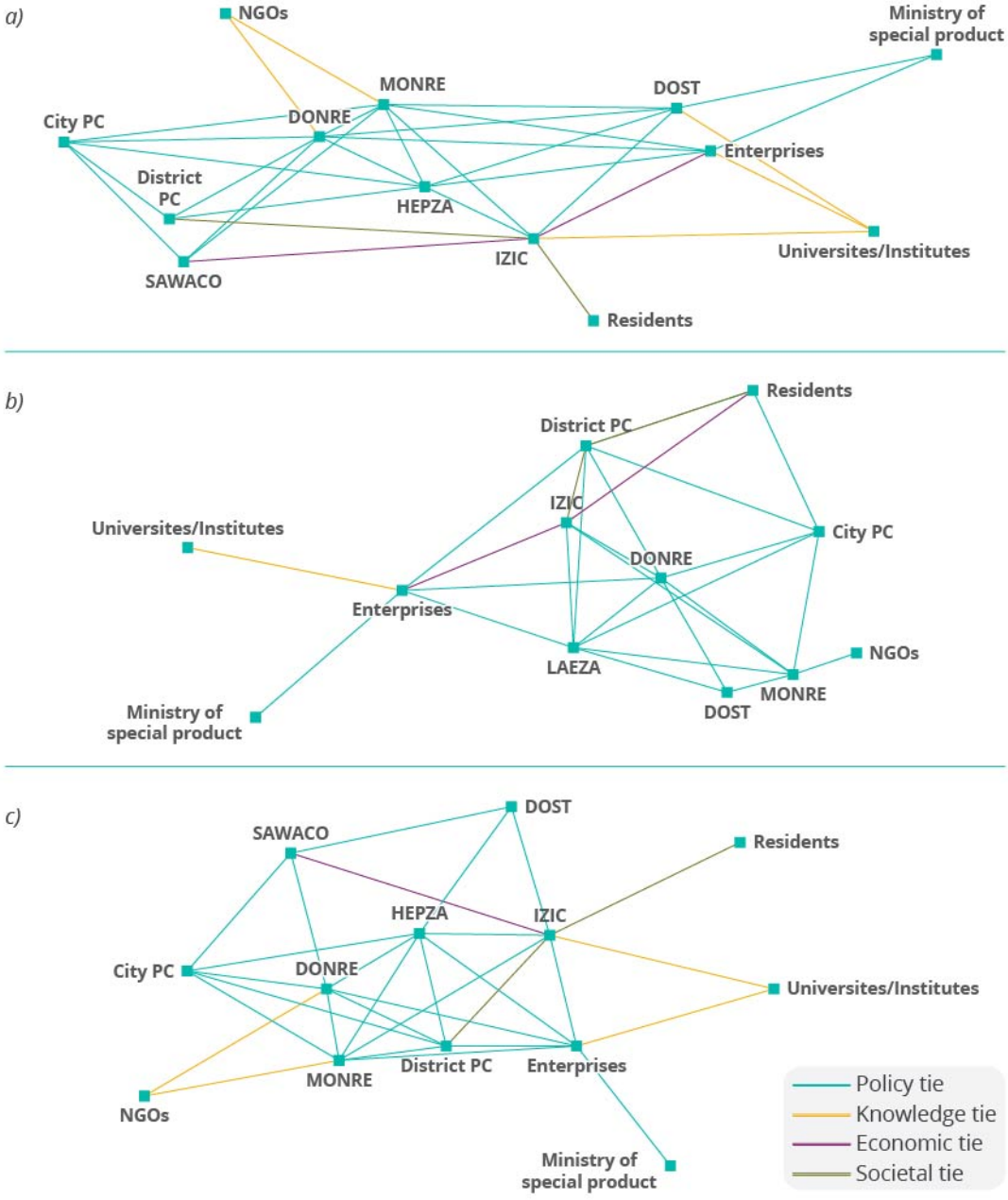


***Figure 2.1*** *Network structure in a) Hiep Phuoc IZ (Trang, 2019); b) Long Hau IZ and c) Tan Thuan EPZ*

The low density of relations measured on average at 0.4 (± 0.09) (around 40 ± 9%) indicates that industrial zones exploit just under half of all possible network connections available to them (see Table 2.6). Following Nunhoff-Isakhanyan et al. (2017), the under exploitation of network ties indicates that industrial zones have little opportunity to exchange knowledge and information to develop the collaboration around resource use efficiency, a finding that is confirmed by the representatives of three industrial zones. This limitation is demonstrated through linkages with the government with very low frequency of direct interaction. The density score also reinforces the observation that there exists a wider dependence on administrative government processes to gain access to knowledge and wider information related to resource exchange and efficiency.

**Table 2.6** Structure characteristic of industrial zone water networks

| | Hiep Phuoc IZ* | Long Hau IZ | Tan Thuan EPZ |
|---|---|---|---|
| Number of ties | 68 | 44 | 60 |
| Density | 0.4 | 0.5 | 0.4 |
| Network centralization | 22% | 37% | 29% |
| Average Geo-distance | 1.7 | 1.6 | 1.7 |

**Data from previous research of Trang (2019).*

The results also show a relatively low network centralization for Long Hau, Hiep Phuoc and Tan Thuan with the degree of difference in the degrees of actors in three industrial zone networks as a percentage of that in a star network at the same number of actors is only 22 to 39% (Table 2.6) - indicating the industrial zone networks are dominated by multiple (albeit governmental) 'central actors' (Borgatti et al., 2018). In principle, low network centralization indicates there are possibilities for creating new ties in the network to access, for instance, knowledge and resources necessary for water use efficiency innovation (Kellogg & Samanta, 2018) - a claim also supported by one government representative who stated that industrial zones "can completely decide whether to implement water use efficiency or other forms of industrial symbiosis" (Interview #3). However, when linked to the low geo-distance and density, it becomes clear that industrial zone networks remain strongly conditioned by the policy ties of government as these always take precedence over other knowledge, economic and societal network ties. As a result, any new ties in the network are most likely with other governmental actors or, as argued above, economic actors that are equally aligned to state administrative control (such as the Saigon Water Corporation). There remains little opportunity for societal and knowledge ties that could support alternative sources of knowledge and resources for resource use innovation.

### 2.4.2 Actor influence

The results of degree, betweenness and closeness centrality further demonstrates the strong influence of government actors in industrial zone networks (Table 2.7). Here the main finding is again that in addition to the national level Ministry and Provincial level Department of Natural Resources and Environment, the Industrial Zone Infrastructure Companies play a particularly influential role given their position in these networks.

The degree and betweenness centrality values of Industrial Zone Infrastructure Companies of both Hiep Phuoc and Tan Thuan ranks the highest with degree centrality scores around 9.0 and betweenness centrality scores of 17.2 and 22.1, respectively. In Long Hau's network, Industrial Zone Infrastructure Company also have the highest value of 'degree' but ranks second of betweenness centrality score.

Enterprises in Long Hau have the highest betweenness centrality score at 12.2. As the betweenness value measures the extent to which a node is connected to other nodes and these other nodes are not connected to any other node. The enterprises in Long Hau having more connections with actors that are, in turn, not connected to each other, for example, the universities/institutes and Ministry of special product (Table 2.7), so that is why they have higher score of betweenness.

The higher value of degree centrality means that Ministry and Department of Natural Resources and Environment and the Industrial Zone Infrastructure Companies have a greater number of policy and economic ties. By having these ties, they are assumed to have greater influence over 'programming' goals towards, for instance, water use efficiency and/or the coercing actions taken to influence networked actors to align and ultimately achieve these goals (following Neumeyer & Santos, 2018). The higher betweenness centrality also indicates the intermediary control of the Ministry and Department of Natural Resources and Environment and the Industrial Zone Infrastructure Companies over information and access to resources for innovation. The role of the Ministry and Department of Natural Resources and Environment is not surprising in showing the importance of the setting and implementing policy and regulation. However, the mediating role of the Industrial Zone Infrastructure Companies is notable because they play a direct role in enabling resource use efficiency implementation. While, in their own words, they need "decisions from the government" (Interview #5,7,10) in order to act, they do play a role in creating economic, knowledge and societal ties - as illustrated through the variation in ties in Figure 2.1.

Industrial Zone Infrastructure Companies demonstrate the ability to develop ties with non-government actors including residents, as illustrated in the case of Long Hau. By selling water to the residents who face water shortage due to salt water intrusion, Long Hau has been able to demonstrate the need for technological innovation for enhancing water use efficiency in industrial zones. It is also apparent that Long Hau has ambitions for developing eco-industrial parks or zones; as stipulated by the Vietnamese government through Decree 82/2018/ND-CP on the Management of Industrial Parks and Economic Zones (see Tran et al., 2023). For industrial zones to comply with this decree, Industrial Zone Infrastructure Companies are recognized by respondents as most able to foster opportunities for investment, development and application of technology and new forms of management. Such a role for Industrial Zone Infrastructure Companies is also supported by their low closeness centrality in all three networks (Table 2.7), which indicates their higher potential for inter-connectivity and, relatedly, aligning the goals of multiple actors in the network.

**Table 2.7** Variation in actor degree centrality, betweenness and closeness of water network in industrial zones

| | Hiep Phuoc* | | | Long Hau | | | Tan Thuan | | |
|---|---|---|---|---|---|---|---|---|---|
| | Degree | Betweenness | Closeness | Degree | Betweenness | Closeness | Degree | Betweenness | Closeness |
| City PC | 5.0 | 0.5 | 22.0 | 5.0 | 2.5 | 19.0 | 5.0 | 1.0 | 22.0 |
| MONRE | 9.0 | 9.1 | 15.0 | 8.0 | 6.4 | 14.0 | 7.0 | 5.6 | 17.0 |
| DONRE | 9.0 | 9.1 | 15.0 | 8.0 | 6.4 | 14.0 | 8.0 | 8.6 | 16.0 |
| HEPZA/LAEZA | 7.0 | 2.6 | 17.0 | 7.0 | 1.9 | 15.0 | 7.0 | 5.1 | 17.0 |
| IZIC | 9.0 | 17.2 | 15.0 | 8.0 | 9.4 | 14.0 | 9.0 | 22.1 | 15.0 |
| Enterprises | 6.0 | 6.6 | 18.0 | 7.0 | 12.2 | 15.0 | 7.0 | 13.9 | 17.0 |
| District PC | 5.0 | 0.5 | 20.0 | 6.0 | 0.9 | 16.0 | 6.0 | 1.1 | 18.0 |
| NGOs | 2.0 | 0.0 | 25.0 | 2.0 | 0.0 | 23.0 | 2.0 | 0.0 | 26.0 |
| Universities/ Institutes | 3.0 | 0.2 | 23.0 | 3.0 | 0.4 | 21.0 | 2.0 | 0.0 | 24.0 |
| Residents | 1.0 | 0.0 | 26.0 | 2.0 | 0.3 | 22.0 | 1.0 | 0.0 | 26.0 |
| Ministry of special product | 2.0 | 0.2 | 27.0 | 1.0 | 0.0 | 25.0 | 1.0 | 0.0 | 28.0 |
| DOST | 5.0 | 0.5 | 18.0 | 1.0 | 0.0 | 18.0 | 2.0 | 0.0 | 24.0 |
| SAWACO | 4.0 | 0.5 | 21.0 | - | - | - | 3.0 | 0.5 | 22.0 |

*Data from previous research of Trang (2019).

## 2.5 DISCUSSION

Our analysis demonstrates that social network analysis can go beyond an analysis of inter-firm ties to better understand the wider set of extra-firm policy, knowledge, societal and economic ties of industrial zones that affect symbiosis-oriented innovation (Vahidzadeh et al., 2021; Wang et al., 2017). Despite the potential for industrial zones to establish a broad set of ties with diverse policy, knowledge, societal and economic actors, our results show that their networks are hierarchical in nature, dominated by government actors who control information and resource flows through administrative policy processes. The state dominated networks in turn appear to limit the exchange of perceptions, agendas and norms that affect the mutual recognition of their mutual dependencies for aligning economic and resource efficiency goals (Domenech & Davies, 2011; Song et al., 2018). The centrality and influence of key state actors, in particular the Ministry and Department of Natural Resources and Environment, also implies a high degree of influence over these networks - with the consequence of limiting the exchange of the kinds of information needed (as assumed by Nuhoff-Isakhanyan et al., 2017) for knowing, processing and exchanging waste, by-products and other share resources.

The observation that the Vietnamese government plays an undeniable role in the implementation and development of resource use efficiency and industrial symbiosis has been emphasized by several other studies (Huang et al., 2019; Song et al., 2018). As emphasized by Song et al. (2018), both the Ministry and Department of Natural Resources and Environment regulate the implementation of water

efficiency strategies in industrial zones and strongly influence in the social hierarchy correlated with industrial symbiosis. Similarly, Phuong et al. (2018) found that industrial zones that create connections with government affect the extent to which industrial symbiosis strategies, like water use efficiency, are initiated. While our results show that the administrative relations established by the Ministry and Department of Natural Resources and Environment appear to limit symbiosis-oriented innovation (cf. KimDung et al., 2017), the centrality of these government actors means they are well positioned to proactively provide and exchange information, as well as steer guidelines, policies and regulation towards enhancing ties to other actors in the network.

Our results also indicate that any shift the Ministry and Department of Natural Resources and Environment might make to facilitate more open processes of networked innovation likely depends on their relationship with Industrial Zone Infrastructure Companies. While currently still dependent on guidance from the state and subject to administrative forms of control (in support of KimDung et al., 2017), the centrality of the infrastructure companies and their demonstrated ability to foster ties with knowledge and societal actors indicates their potential intermediary or brokering position in the networks of industrial zones. However, for Industrial Zone Infrastructure Companies to take advantage of their position to influence the flow of exchange information and knowledge related to water use efficiency and industrial symbiosis (Borgatti et al., 2018) they need to reshape the nature of their relation with the state. This mutual yet paradoxical interplay between the Ministry and Department of Natural Resources and Environment and the Industrial Zone Infrastructure Companies appears as such central to the realization of industrial symbiosis. The question is how this relationship can move from administrative to more deliberative interactions that can (1) establish trust and enable the government to understand and acknowledge feedback from industrial zones to improve policy and regulation (Trang et al., 2023) and (2) open up the number and type of ties industrial zones can make to access necessary knowledge and wider information related to resource exchange and efficiency.

Despite the dominance of the government in the industrial zones networks, and the limitations of overly administrative interactions, our results also indicate that potential remains for establishing more diverse ties. More specifically, the low density of industrial zone networks demonstrates a high number of latent ties. Furthermore, the relatively low level of network centralization means that the administrative ties of the state are not so dominant that new economic, knowledge and societal ties that could support water use efficiency are impossible (see for e.g., Neumeyer & Santos, 2018). However, establishing these alternative networked ties, for instance with non-government actors and (national and international) research institutes, remain unlikely without government support. Some government policies already show the potential for enabling more diverse network ties. For instance, public standards that codify, and in doing so aim to stimulate, the development of eco-industrial parks explicitly promote the creation of partnerships with investors and knowledge actors that can assist in the development and application of water use efficiency technologies (Trang et al., 2023). Other policies, such as the Ho Chi Minh City wastewater levy, aim to incentivize industrial zones to innovate by increasing the cost of poor wastewater practices. Such innovation, while not explicit in the levy, requires industrial zones to improve their economic ties with clients as well as the Saigon Water Corporation (Trang et al. In Review). Nevertheless, it remains unclear whether these new ties would overcome the clear tendency of government control over such relations - or whether and how these relations would lead to necessary levels of innovation.

Whatever opportunities are afforded by the state, it appears that the actual establishment and exploitation of networked ties is most important for the Industrial Zone Infrastructure Companies.

Industrial Zone Infrastructure Companies have long been identified as key actors who hold the potential to support industrial zones and their client firms to engage in industrial symbiosis - including the exchange of resources, by-products and knowledge at the enterprise level (Dieu et al., 2020; Mol, 1995). However, as argued by Wang et al. (2017) and Boons and Spekkink (2013), the realization of such engagement is linked to specific 'institutional capacities' - that is, the ability to negotiate (state) rules, norms, values to establish ties that can facilitate the acquisition of resources and knowledge for improving water management techniques, and relations necessary for establishing collective water management strategies (see also Fresneda Fuentes & Hernández Borreguero, 2018; Willems & Baumert, 2003). While such capacities are generally agreed to be important for industrial ecology goals, there has been relatively little elaboration of their status and/or potential for instigating change in the context of hierarchical state systems like those in Vietnam. Arguably the hierarchical nature of relations within Industrial Zone networks in Vietnam has implications for the institutional capacities of Industrial Zones, but which implications and to what extent this hierarchical setting enables or constrains Industrial Zones in using and developing these capacities is unknown.

## 2.6 CONCLUSION

Our results demonstrate the role of policy ties to governmental actors in the implementation and development of resource use efficiency and industrial symbiosis in Vietnamese industrial zones. While industrial networks are heavily influenced by state actors through policy ties, the typology of the industrial zone networks does indicate there are opportunities to move beyond the top-down administrative role of the state and establish new ties with knowledge and societal actors such as NGOs. In line with the wider assumptions of industrial ecology, we speculate that such a broadening of network ties can enable innovation in technologies and forms of organization within industrial zones for enhanced water use efficiency.

Our results offer the first application of social network analysis on industrial zones in Vietnam. While insightful, further application of social network analysis is needed to better characterize the role networked actors and the variation in the networked ties can play in affecting flows of knowledge and resources for innovation. Further research is also needed on the role of the Industrial Zone Infrastructure Companies in mediating or brokering ties with non-governmental actors - both in the service of ongoing government policies, including those related to eco-industrial parks and wastewater levies. The results of this research would provide a basis to not only strengthen the empirical evidence of the importance of network relations in shaping industrial innovation, but also to enable a more fundamental understanding of the kinds of capacities needed for both the government and industrial zones to use far wider, even international networks, to identify and enable improved resource efficiency in one of fastest growing industrial sectors in the world.

# Chapter 3

# Enhancing institutional capacity in a centralized state: The case of industrial water use efficiency in Vietnam

**Abstract**

This article uses an institutional capacity framework to assess the interplay between the macro level institutional environment in the form of the centralized Vietnamese state, and the meso level institutional capacity of three different industrial zones to develop technological water use efficiency strategies. Our results show that the relational, knowledge and mobilization capacities of these industrial zones are constrained by the centralized nature of the Vietnamese state. These industrial zones also show a limited capacity to instigate reform of macro level regulatory institutions. However, we also find instances where industrial zones do demonstrate capacity for implementing water use efficiency technologies because of their capacity to coordinate relations with client firms, universities and provincial industrial zone authorities. If the institutional capacities of industrial zones are better supported, we argue there remains room for them to influence the macro institutional context to support innovation in water use efficiency. Our results indicate the value of institutional capacity as a framework for assessing processes of technical innovation for industrial ecology, especially in the context of centralized states.

**Keywords:** institutional capacity; water use efficiency; industrial ecology; governance; innovation; Vietnam.

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## 3.1 INTRODUCTION

By 2025, industrial zones in Vietnam are estimated to make up 10% of total annual surface and ground water use (Agudelo-Vera et al., 2012; GhaffarianHoseini et al., 2016). At the same time, Vietnam is facing increased rates of surface water pollution and saline intrusion, as well as restrictions on ground water-use designed to reduce the risk of subsidence (Ha et al., 2018; MONRE, 2010; Ngo et al., 2015). As a result, industrial zones increasingly compete for water with growing urban populations and the agriculture sector (Giuliani et al., 2019; Ray & Shaw, 2019). To ensure such competition does not lead to the further degradation of surface and ground water, technological innovation to enhance water use efficiency has been prioritized by the Vietnamese government to meet future industrial water demand (Vo, 2007).

Three strategies of technological innovation for water use efficiency show promise for Vietnamese industrial zones (Agudelo-Vera et al., 2012; Leusbrock et al., 2015; Levidow et al., 2016): (1) demand minimization through efficient 'end-of-pipe' technologies (Ozturk et al., 2016); (2) 'cascading' reclaimed water flows for low quality reuse (Agudelo-Vera et al., 2012; Luckmann et al., 2016); and (3) multi-sourcing from primary ground or surface water sources and secondary water sources such as rain water (Agudelo-Vera et al., 2012; GhaffarianHoseini et al., 2016). These technologically driven strategies are linked to the wider principles of industrial ecology and symbiosis, aimed at enhancing circular resource flows in the processing and manufacturing sectors through cooperative strategies that enable by-product exchange and utility sharing for resource efficiency (Jiao & Boons, 2017; Mol & Dieu, 2006; Spekkink, 2013). Collaboration within and between industries is important to manage environmental and resource issues, e.g., water, energy, materials, through industrial symbiosis and industrial ecology (Baldassarre et al., 2019).

Following Boons and Spekkink (2012) and Wang et al. (2017), the extent to which technological strategies for water use efficiency are identified and implemented also depends in part on the institutional capacity of key actors such as industrial zones; defined as the ability of private or public actors to work through an existing system of rules, norms, values to achieve a specified goal (Fuentes & Borreguero, 2018; Willems & Baumert, 2003; Johansson et al., 2017). In particular, meso or organizational level institutional capacities (Willems & Baumert, 2003) are considered key for acquiring resources, accessing knowledge for improving water management techniques, and developing the relations necessary for establishing collective water management strategies (Boons & Spekkink, 2012; Healey et al., 2003; Wang et al., 2017; Wickham et al., 2009).

Successful implementation of technological innovation, however, is also dependent on 'macro' national-level institutions (Willems & Baumert, 2003) as these rules, norms and values shape learning, trust and collaboration between government, industrial zones and their client firms (Boons et al., 2017; Chertow, 2007; Gibbs, 2003; Willems & Baumert, 2003). Research on institutional capacity often assumes that industrial ecology policies, such as water use efficiency, fosters and/or positively reinforces relationships between government and industrial zones (Boons & Spekkink, 2012; Wang et al., 2017). While there is evidence that such reinforcement is possible, it is not clear whether this is the case under all political systems – including centralized states, such as Vietnam, with centralized planning and management and hierarchical decision making and regulation (Garschagen, 2016; Phuong et al., 2018). It is also not clear how the macro institutional environment of centralized states affects the meso level institutional capacity of industrial zones to forge relationships, gain access and expand knowledge, and mobilize other actors, including the government, to support the development and implementation of water use efficiency strategies.

In this article, we explore the interplay between macro level institutions and meso level institutional capacity in Vietnam to understand the conditions under which industrial water symbiosis can emerge. We do so by employing an institutional capacity framework (Dang et al., 2017; Wang et al., 2017) to assess the relational, knowledge, mobilization capacities of three industrial zones and to understand the ways in which this institutional capacity is affected by the hierarchical regulatory and political structure of the centralized Vietnamese state (Boons & Spekkink, 2012).

The following section introduces our institutional capacity framework. We then introduce the methodology used for data collection and analysis before outlining the centralized governance system of Vietnam. We then present our main findings based on data collected from three industrial zones in southern Vietnam. Finally, we discuss the significance of our findings for enhancing industrial ecology and symbiosis in the context of centralized state governance.

## 3.2 INSTITUTIONAL CAPACITY

Macro level institutions constitute the policies, rules, and norms that steer action, either by directly constraining or incentivizing actors to comply with these goals in the short term (Fuentes & Borreguero, 2018; Zhu, 2016), or, as illustrated in Figure 3.1, by indirectly shaping the capabilities of actors to resolve underlying constraints to comply with these goals and norms over the long term (Cohen-Rosenthal, 2000; Wang et al., 2017). Distinct from the short-term deontic logic underpinning technical compliance to prescriptive rules and norms (Ostrom & Basurto, 2011), systemic problem solving requires institutional capacities that enable the strategic development of collective resolution of complex issues, including knowledge development, material exchange and utility sharing (Koop et al., 2017; Wang et al., 2017). This includes the ability of a meso level organization to work through an existing system of rules, norms, values to implement industrial ecology solutions such as water use efficiency by: (1) participating in decision-making and implementation (De Abreu & Ceglia, 2018); (2) complying with governmental polices and regulation (Willems & Baumert, 2003) and/or (3) actively engaging individual or collaborative problem solving and innovation (Boons & Spekkink, 2012).

The three most commonly identified meso level institutional capacities are relational, knowledge and mobilization capacity (Boons & Spekkink, 2012; Healey et al., 2003) (see Figure 3.1). These capacities should not be seen as a stock of assets, but instead represent "a force that is emergent, produced in the interactive context of its use" (Healey et al., 2003, p 64). Relational capacity refers to the ways in which industrial zones affect trust and mutual understanding between themselves and other actors, including government, NGOs and private firms (Healey et al., 2003; Wang et al., 2017). We assess relational capacity by determining the number and type of actors that industrial zones interact and engage with and the degree to which this engagement translates into support for water use innovation (Wang et al., 2017). We in particular examine the morphology of these networks, including the way in which industrial zones develop relations with key actors (Barry, 2012; Healey et al., 2003). We also study how these relations affect collaborative learning and innovation between networked actors. Building on the previous two variables, we explore how these relations foster trust and mutual understanding with actors in developing their water use efficiency strategies (De Abreu & Ceglia, 2018).

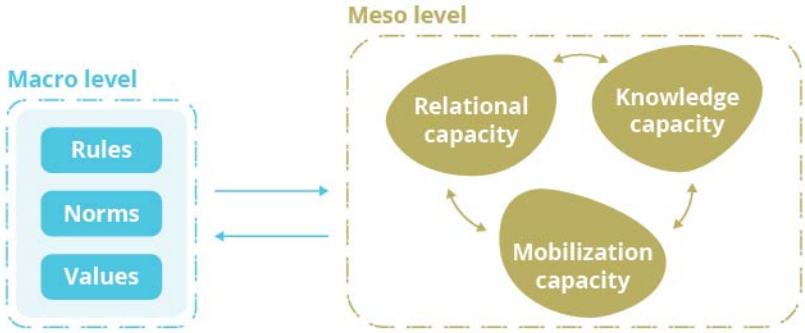


***Figure 3.1*** *The interplay between macro level institutions and meso level institutional capacity*

Knowledge capacity refers to the ability of industrial zones to acquire the knowledge necessary for the adoption of water use efficiency strategies, including the limits and opportunities of how these strategies are able to reduce water use inefficiencies (Boons & Spekkink, 2012; Healey et al., 2003). We assess knowledge capacity by analyzing the ways in which industrial zones identify the type of knowledge necessary for adopting water use efficiency strategies (Barry, 2012; Wang et al., 2017). We then analyze the frames of references, which activities and relations industrial zones employ to access the required knowledge. Lastly, we explore the extent knowledge is taken up and made accessible, how knowledge is being shared between industrial zones, their client companies as well as governmental actors, including the way in which these key actors are open to taking up new ideas on water use efficiency and learn from experimentation (Healey et al., 2003; De Abreu & Ceglia, 2018).

Mobilization capacity assesses the ability of industrial zones to enhance and activate multiple actors to support collective goals like water use efficiency (Boons & Spekkink, 2012; Healey et al., 2003). We first examine the opportunity structures afforded to industrial zones to engage the government or non-government actors (including private universities and NGOs) to use existing rules, norms and incentives to support the design and adoption of water use efficiency strategies (Boons & Spekkink, 2012). Following Wickham et al. (2009), this includes the extent to which the influence that industrial zones have over public policy and regulation translates into governmental regulation that support operational management decisions to improve water use efficiency. We also examine the extent to which industrial zones take advantage of these opportunity structures to either further opportunities for innovation or develop new opportunity structures that can incentivize client companies, donors, financiers and NGOs to work towards the realization of collective resource use efficiency goals (Healey et al., 2003).

## 3.3 METHODOLOGY

This study is part of the ENTIRE research project exploring options for optimizing industrial fresh water use in Vietnamese delta areas through technological-cum-institutional innovations (NWO, 2021). Our exploratory analysis is based on a multiple case study approach focusing on three industrial zones in Southern Vietnam: Hiep Phuoc industrial zone and Tan Thuan export processing zone in Ho Chi Minh City, and Long Hau industrial zone in Long An province. We adopt an exploratory case study methodology because it allows for in-depth analysis of a phenomenon and aims at analytical or conceptual generalization (Yin, 2009). Moreover, drawing on multiple case studies allows for a broader basis to develop conceptual insights. The industrial zones used for this analysis were selected in three workshops

held prior to the start of the project (in July 2015, March 2016, and July 2017). Selection was based on discussions industrial zones that (1) face different water supply issues, (2) are interested in pursuing technological water efficiency strategies, (3) host different types of industries and sources of investment, (4) are located in different provinces and (5) were willing to participate in the project (see Table 3.1).

Primary data was collected between 2015 and 2018 using three methods to allow data to be triangulated for internal consistency (Olsen, 2004; Yin, 2009). First, semi-structured interviews were held with 27 respondents from the three industrial zones and 13 actors representing both government and client companies. Respondents were selected through snow ball sampling; starting from an initial interview with the Saigon Water Company and the directors and vice-directors of the three industrial zone infrastructure companies. All respondents are people who are responsible for or knowedgeable about water use and management in these organizations. Second, observations were made during site visits and attendance at four policy-related meetings to contextualize our interview responses and ground truthing the status of infrastructure and discussions on water use efficiency policy and regulation (Kumar, 2014). Third, we sought out further evidence of water use efficiency strategies through a review of legal and policy documents sourced from the website of law library, websites from governmental departments and industrial zones. All of these data were then analyzed based on a coding scheme aligned with the variables in our combined relational, knowledge and mobilization capacity framework. Finally, a final workshop was organized in December 2018 to reflect on and validate information collected from the selected IZs.

**Table 3.1** Key characteristics of the three sampled industrial zones

| Key characteristic | Output information | Hiep Phuoc IZ | Output information |
|---|---|---|---|
| Area of industrial zone | 348 ha | 246 ha | 300 ha |
| Province | Ho Chi Minh | Long An | Ho Chi Minh |
| Main water issues | Salt water intrusion, raising water demand | Salt water intrusion, raising water demand, restriction on groundwater usedemand | Salt water intrusion, raising water demand |
| Type of companies | Mechanics, electricity-electronics, rubber-plastics, food processing | Light, clean and un-polluted industry, high value-added industries, bio-tech industry, logistic, trading and services | Food processing, construction material (except cement and steel), logistic and ancillary industries |
| Number of enterprises (% of foreign investors) | 117 (8% foreign investors) | 158 (50% foreign investors) | 199 (85% foreign investors) |
| Capacity of wastewater treatment plant | 6000 $m^3$/day | 5000 $m^3$/day | 15000 $m^3$/day |
| Water supply system | SAWACO supplies 45000 $m^3$/day | Supplied by two water sources: (1) Long Hau underground water plan supplies 10000 $m^3$/day and (2) Ho Chi Minh City water supply system supplies 15000 $m^3$/day. Long Hau IZ also supplies water for the surrounding resident. | SAWACO supplies 30000 $m^3$/day |

## 3.4 MACRO LEVEL INSTITUTIONAL SETTING

The regulatory and political macro level institutions in Vietnam are of a highly hierarchical and top-down nature. Decision making in Vietnam is based on a system of centralized planning, regulation and policy supported by judicial enforcement (Benedikter & Nguyen, 2018). Water use efficiency, including reuse and water saving, is governed by both national and provincial level legislation covering issues related to water volume and quality (see Table 3.2).

**Table 3.2** Regulation and policy relevant to water use efficiency in industrial zones of Vietnam

| Regulation | Content related to water use efficiency |
|---|---|
| Law on Water resource 2020 | Article 4 - Invest in and have mechanism to encourage to invest in research and innovative technology to develop water saving and water use efficiency<br>Article 39 - Measures to use water economically and effectively<br>Article 41 - Incentives for economical and efficient use of water<br>Article 42 - Developing science and technology for economical and efficient use of water |
| Law on Environmental Protection 2020 | Article 4 - Increase reuse and recycling of waste<br>Article 5 - Strengthen scientific research, develop technology for recycling and waste treatment; prioritize the transfer and application of advanced, high-tech, and environmentally-friendly technologies<br>Article 72 - Wastewater is encouraged to be reused when it meets the requirements for environmental protection and water use purposes |
| Law on Technology transfer 2017 | Article 9 (section d) - Encourage the transfer of advanced technologies, new technologies that use resources economically and efficiently |
| Decree 80/2014 on drainage and wastewater treatment | Article 16 (section 10) - The criteria for technology selection, Capability of energy saving and recycling wastewater and waste sludge |
| Decree 54/2015 on incentives for economical and efficient use of water | Article 6 - Activities eligible for incentives: reuse, cyclic use of water, collection of rainwater for domestic use, production and import of water-saving products, equipment, technologies<br>Article 7 - Incentives for reuse, cyclic use of water<br>Article 8 - Incentives for production, import of water-saving products, equipment, technologies<br>Article 9 - Incentives for collection of rain water... |
| Decision 2129/2018 on adjustment of environmental protection fees for industrial wastewater in Ho Chi Minh City | Section I.1 - Objective: ...encourage economical use of water, reuse treated water, limit discharge and limit environmental pollution... |
| Bill on National Strategy for Environmental Protection to 2030 | The strategy will focus on implementing the tasks of efficient use of natural resources |
| Decision No. 2502/QD-TTg of the Prime Minister: Approving the Adjustment of Orientation for Development of Urban Water Supply and Industrial Parks in Vietnam to 2025, with a Vision to 2050 | Article 1, Section I.4 - Encourage the rational and economical use of clean water and reuse it for other purposes<br>Article 2, Section 4 - Choose advanced technology and equipment, have high automation, save water, research rainwater reuse technology to support domestic water and other needs |

These documents do not, however, stipulate water use efficiency strategies should be implemented, nor do they offer specific standards for industrial zones to follow as a target to develop these strategies (van Leeuwen et al., 2016). For example, the 2015 Environmental Protection Law sets water reuse and recycling priorities and stipulates the development of reuse and recycle technologies. However, the law provides limited guidance to industrial zones based on their changing water demands - and has not kept pace with the resource efficiency challenges brought about by the rapid expansion of industrial processes within these zones.

Other national policy and regulation (including Laws and Resolutions of National Assembly, Ordinances and Resolutions of National Assembly Standing Committee, Commands and Decisions of President, Decrees of government, Decisions of Prime Minister, and Circulars of a Minister) is 'administratively' decentralized (KimDung et al., 2016a). As illustrated in Figure 3.2, this means that the national government decentralizes responsibility rather than decision making power for the implementation, enforcement and communication of various policy domains to the Provincial People's Council - the political branch of the provincial government.

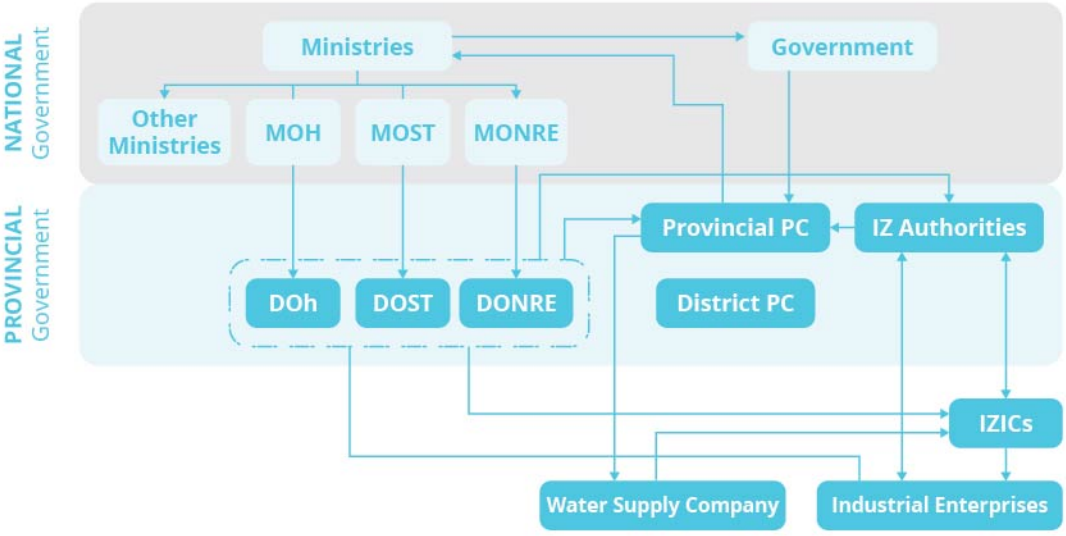


***Figure 3.2*** *Schematic organisation of government bodies involved in industrial water policy*

The Ministry of Natural Resources and Environment (MONRE), for instance, is responsible for water management and counsels the central government on water management policy. Their remit extends to devolving responsibility for environmental management to industrial and economic zones (Decree No.29/2008/ND-CP). The Provincial People's Council then has the power to decide on policies and measures to encourage technical development for environmental improvement, but has to remain within the boundaries set by the Ministry. The Provincial People Committee, the executive body of the Council, is also given the remit to develop a Master Plan for the Economic-Social Development at the provincial level (based on Law No.11/2003/QH11), including regulation, fees and incentives for environmental protection (e.g., Ngoc, 2017). However, all policy and regulation have to ultimately conform to the national level Master Plan for Industrial and Economic Zone Development in Vietnam controlled by the Ministry of Planning and Investment, the Ministry of Construction and the City People's Committee, who answer directly to the Office of the Prime Minister.

Within this context the Export Processing and Industrial Zone Authorities (such as those of Ho Chi Minh City and Long An province - HEPZA and LAEZA) are responsible for managing, disseminating, guiding, inspecting and supervising the implementation of master plans and regulations from the state agencies. They have the right to adjust and approve construction plans without changing the land use function and planning structure. But they remain obliged to follow all water related regulation set by the People's Committee in line with national legal documents, policies and master plans for industrial and economic zone development (Decree No.29/2008/ND-CP).

A consequence of this hierarchical decision making is that there is limited interaction between ministries, central committees, departments, scientific institutes and organizations dealing with the water sector. In addition, there is poor communication between end-users and government officials, and little government transparency and accountability (Grafton et al., 2019). As argued by Van Leeuwen et al. (2016), and demonstrated in the next section, this means that sharing ideas, knowledge and information between different institutions involved in water use and management is limited and there are difficulties in ensuring the transparency of practices due to lack of commitment, concern, awareness and participation of relevant stakeholders.

## 3.5 INSTITUTIONAL CAPACITY OF VIETNAMESE INDUSTRIAL ZONES

While differences between institutional capacities are seen between the three industrial zones analyzed in our study, we also observe that there is a low degree of overall variation in these differences (see Table 3.3). This in part confirms that macro level state institutions in Vietnam have a strong influence over the relational, knowledge and mobilization capacity of industrial zones. It also indicates that Vietnamese Industrial Zones do not display the overall capacity to change the macro level institutional environment in which they operate in order to create opportunities for implementing water use efficiency strategies. The following analysis examines each of the institutional capacities placing emphasis on this low variation and overall influence of macro institutions.

**Table 3.3** Variations of institutional capacities of three Vietnamese industrial zones

| Capacity | Dimensions | Hiep Phuoc IZ | Long Hau IZ | Tan Thuan EPZ |
|---|---|---|---|---|
| Relational capacity | Number and type of actors | • Weak relations with the Provincial People Council<br>• Close relationship with Industrial Zone Authorities | | |
| | | Strong cooperation in research in water use efficiency (DOST/Universities/ Institutes/NGOs) | No collaboration with DOST and NGOs | Strong cooperation in research in water use efficiency (DOST/Universities/ Institutes/NGOs) |
| | Morphology of the network | • Hierarchical morphology between PC, MONRE, DONRE and IZICs, enterprises<br>• Web-like morphology between industrial zones authorities, IZICs and enterprises<br>• Spatial and temporal reach is low | | |
| | Trust and mutual understanding | • High level of trust between industrial zones authorities, IZICs and enterprises<br>• Low level of trust and understanding between IZs and Ministries, People's Council and Committee | | |

| Capacity | Dimensions | Hiep Phuoc IZ | Long Hau IZ | Tan Thuan EPZ |
|---|---|---|---|---|
| Knowledge capacity | Type of knowledge | Recognition of the need for water use efficiency improvement and the economic implications of resource degradation | | |
| | Frames of references | • Lack of expertise on water use efficiency<br>• Lack of expertise for establishing more active forms of dissemination | | |
| | | New knowledge is provided by industrial zone authority | New knowledge is provided by industrial zone authority, entrepreneurs and law library | New knowledge is provided by industrial zone authority |
| | The extent is taken up and made accessible | • Lack of deliberation and sharing of knowledge between IZs, companies and governmental agencies<br>• Limited uptake of knowledge from industrial zone authority workshops by staff members of IZIC<br>• Limited knowledge sharing among client companies of IZ | | |
| Mobilization capacity | Opportunity structure | • Mobilizing support for developing water use efficiency is highly dependent on the system of regulations and laws set by the state<br>• Lack of opportunity to influence provincial or national regulation for water use efficiency development is limited by the openness and timing of publishing new regulations | | |
| | Develop new opportunity structures | Not able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies | Able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies | Able to create internal opportunity structure to mobilize industrial enterprises to adopt water use efficiency technologies |

### 3.5.1 Relational capacity

All three of the industrial zones demonstrate some capacity to engage with state and non-state actors. However, their ability to use these relations to support experimentation and innovation for developing water use efficiency strategies remains constrained by the hierarchical nature of relations within the centralized Vietnamese state. The industrial zones studied are also, as outlined above, limited in their ability to develop relations within the state that might enable them to influence the macro institutions to which they are subject. As a consequence, the levels of trust and mutual understanding between Industrial Zones and key governmental actors is too low to support technological water efficiency experimentation and innovation.

None of the industrial zones have been able to develop direct relations with the Provincial People's Council and their executive Committee. The weak relation with the Council is consequential because of the central role it plays in coordinating with other parts of government that are relevant to water innovation (Table 3.3). For example, the Master Plan for Water Demand in Ho Chi Minh city issued by the Prime Minister at the macro level focuses almost exclusively on upgrading the Saigon Water Company facilities to increase overall capacity of water supply as a means to meet future urban demand (Decision 2631/QD-TTG, 2013). Respondents from both Hiep Phuoc industrial zone and Tan Thuan export processing zone argued, if water supply increases and prices are driven lower there may be no incentive for industrial zones to seek out new partners to develop or implement water use

and recovery strategies. As a representative from the Saigon Water Company claimed, the focus on supply also means that "the state is disincentivized to set policies that will reduce consumption, because of the consequences this holds for state revenues". Combined these dual disincentives at the macro and meso level undermine any aspiration of industrial zones to reach out to utility companies and industry bodies that could support experimentation and innovation.

The industrial zones have been successful in overcoming the hierarchical decision-making structure of state policy and regulation (as illustrated in Figure 3.2) by engaging and working through the Export Processing and Industrial Zone Authorities of Ho Chi Minh City and Long An province (HEPZA and LAEZA). As outlined by two senior industrial zones executives, these provincial authorities have a close working relationship with the People's Committees. The collaboration between HEPZA, LAEZA, industrial zones infrastructure companies (IZICs) and enterprises is described by a web-like pattern in which HEPZA is a clear node. Although positioned within the state, respondents from IZICs and industrial enterprises saw HEPZA and LAEZA as bridging organizations providing industrial zones and their client companies the possibility to access, discuss and exchange innovative technology knowledge and experience. The direct relations between industrial zones and both industrial zone authorities are perceived by IZIC managers interviewed as indications for high levels of trust – which in turn is thought to enable experimentation with water use efficiency technologies such as water reuse and, rain water harvesting. As one of these managers argued when interviewed, "HEPZA has a strong relationship and impact on the enterprises ... enterprises will have more trust when they receive the information and request from HEPZA than from the industrial zones infrastructure company".

The interaction between HEPZA and LAEZA and industrial zones is nevertheless infrequent – limited to annual or biannual workshops. Communication between MONRE, People's Council and Committee and industrial zones happens through official documents. The way the relations are organized and maintained are just administrative and one-directional rather than based on dialogue (Carmona et al., 2002). The relations between industrial zones, Ministry of Natural Resource and Environment (MONRE), People's Council and Committee and Department of Natural Resource and Environment (DONRE) remain embedded in a highly hierarchical structure, through which water use efficiency continues to be planned and controlled by the macro level regulations of the People's Council and Committee, MONRE and DONRE, rather than being led by industrial zones and enterprises at the meso level. A lack of trust and mutual understanding exists between industrial zones, People's Council and Committee, MONRE and DONRE as respondents from both Hiep Phuoc industrial zone and Tan Thuan export processing zone argued that their calls for clearer explanation of regulation specifying when and how wastewater can be reused, as well as their concerns over its effectiveness, have not been effective. In the words of one company operating in Hiep Phuoc industrial zone, they "have no choice, this is policy, enterprise is not able to resist". Industrial zones thus face difficulties in having meaningful engagement with higher level of government preventing them from experimenting with and pursuing reusing treated water for watering the green area or supplying it to industries that require lower quality of water for their operations.

Finally, industrial zones demonstrate capacity to connect with knowledge actors such as universities. For example, Hiep Phuoc industrial zone has a memorandum with Ton Duc Thang University and the University of Technology to cooperate on problems related to odor in wastewater treatment. These knowledge actors provide direct support for industrial zones in calling for macro level regulatory reform. State regulations stipulate that the promulgation or updating of a legal document requires the results and experiences from scientific research and pilot studies. This provides an opportunity for

meso level industrial zones to influence macro level regulations by collaborating with experts from universities and/or research institutes in doing scientific research. However, as we now go on to examine, while industrial zones demonstrate the capacity to develop affective relations with some non-state actors, their ability to use these relations for enabling improved macro level regulatory conditions which guides them how to reuse, exchange and save to increase water use efficiency remains limited.

### 3.5.2 Knowledge capacity

All three industrial zones acknowledge the need for enhanced efficiency in surface and ground water use. They also recognize that the degradation of these resources will lead to economic implications over the long term – especially when coupled with continued rising demand by both industry and surrounding urban areas. However, their knowledge capacity is constrained by the lack of access to and sharing of knowledge between companies and governmental agencies (Table 3.3). Industrial zones rely on the limited knowledge shared by the government within existing macro level institutions and regulatory procedures. As a result, industrial zones are not able to acquire the knowledge needed to justify making investments in technological water use efficiency strategies, or promote investment in such technologies by individual companies operating under their remit.

As presented in Table 3.3, respondents from all three industrial zones recognize the need for developing and implementing water use efficiency strategies. They also identify the need to target expertise that could help improve the quality of treated waste and rain water and assess the costs and benefits of implementing water technologies; such as doing a pilot study on rain water harvesting to assess the requirements for storage and how the quality and quantity of rainwater differs between seasons. As the manager of one company operating in Tan Thuan export processing zone argued when interviewed, "we plan to save water by rain water harvesting,... we have a high amount of rain water but the investment cost is also high... we have to invest in two systems of pipes".

Very few respondents across all three industrial zones could identify current activities designed to foster partnerships with the private sector, government and (national and international) universities to increase the range of knowledge available to them. For example, a manager at the Long Hau industrial zone described how his team had reached out to universities and entrepreneurs to seek out expertise on wastewater reuse and treating water of high salinity. Hiep Phuoc and Tan Thuan could provide no examples of proactive engagement. All three industrial zones do, nevertheless, enroll in workshops led by MONRE, DONRE and HEPZA aimed at transferring knowledge on international best practices related to water use efficiency strategies (e.g. water reuse, water exchange, water saving). However, these workshops, organized once or twice a year, remain largely performative. It is neither clear whether and how the knowledge presented is taken up by industrial zones nor whether feedback provided by industrial zones during these workshops, while included in the official reporting, influences the design of or support provided by macro level institutions in any way. As a result, all three industrial zones perceive the government as not being open to discussing how challenges with implementing water use efficiency strategies can be overcome.

We also observe that the capacity of three industrial zones to share new knowledge amongst their client companies appears limited (Table 3.3). Managers from all three IZICs stated that they have no clear structure to share information and knowledge amongst their client companies. As one industrial zone manager said, "we do not have any section to inform the knowledge or even have not heard about that... the staff is provided the knowledge often share and discuss with the director first". This,

they went on to argue, is attributable to the lack of expertise on water use efficiency within the industrial zones, making it difficult for managers to discuss any newly acquired knowledge within their office, let alone with their clients. It is also this lack of expertise that these managers argue limits their capacity for establishing more active forms of dissemination, such as piloting new water use efficiency technologies. As illustrated by a representative from Long Hau industrial zone, "we know that... technologies exist. For example, rain water harvesting is a very good idea, but we need pilot studies or pre-feasibility research to say that we should do that or not".

### 3.5.3 Mobilization capacity

Finally, we observe that the mobilization capacity of industrial zones remains dependent on the conditions set by macro level state institutions. Within these conditions, however, industrial zones are able to create opportunity structures by setting internal rules and incentives for their clients to adopt water use efficiency technologies.

The extent to which industrial zones are able to mobilize support for developing and implementing water use efficiency strategies is highly dependent on opportunity structures provided by the state (see Table 3.3). But even though these opportunity structures exist, engaging the government to support the design and adoption of water use efficiency technology at the level of the industrial zone remains challenging. The representatives from Hiep Phuoc and Tan Thuan industrial zones reported opportunities to apply for financial support for implementing water use efficiency strategies from the state, but also explained that they failed in obtaining this financial support because of "unclear administrative procedures". The resulting lack of financial support from state agencies, such as the Ho Chi Minh City Environmental Protection Fund, has meant that both Hiep Phuoc and Tan Thuan have not upgraded their central wastewater treatment plants. One respondent from Hiep Phuoc IZIC explained that while they applied for financial support, they only received the answer that they will not receive the fund without any further explanation. In rare cases, an industrial zone can be successful in mobilizing support, but only with the specific consent of the government. Long Hau IZIC, for instance, has been able to arrange an exemption from the state to reuse treated wastewater within Long Hau industrial zone, but only because the treated wastewater is of higher quality than local surface water sources.

In addition, while all industrial zones are interested in water reuse and saving, they do not have the capacity to engage with central and provincial government to translate the current legal system at the macro level into decisions that help to further develop water use efficiency strategies. The 'participative' processes developed by the government to communicate policy and regulation has proven largely performative - meaning industrial zones can participate in, but not influence these relations and therefore decisions at the macro level. As illustrated by one industrial zone manager who participated in the design phase of the new Ho Chi Minh wastewater discharge levy in 2019, workshops are "designed to get ideas but in the end those ideas ... [are] not incorporated". The industrial zones have, as such, limited opportunities to influence the regulation related to water use efficiency in order to create concrete next steps to develop and apply the technologies (e.g., water reuse) for water use efficiency improvement within industrial zones. According to the respondents from HEPZA and IZICs, there is a lack of specific Circulars (i.e., guidelines) that instruct industrial zones how to implement standards and regulations. For example, representatives from Hiep Phuoc and Tan Thuan IZICs pointed out that Decision 2129 (see Table 3.3) promotes the use of water reuse, which is a technical solution to enhance water use efficiency by reducing the amount of supplied water and discharged water, but provides no guidance for the industrial zones on the purpose of reuse, or which national technical regulations should be used to assess treated wastewater.

Opportunities to influence provincial or national regulation on the use of wastewater is also limited by the weak transparency and timing of new regulations. While industrial zones regularly communicate with the Industrial Zone Authorities, they are unable to establish direct lines of communication with either central and local government. This limits their capacity to understand the reasoning for new regulation and/or give feedback on the practicalities of translating regulation into action. As one respondent explains, "in principle, there is a survey for industrial zones and enterprises on related legal documents, but this is only administrative, opinions are not accepted". The unpredictable timing between receiving notice of new regulations to their implementation, ranging from the next day to as long as six months, further undermines any opportunity for open communication. As pointed out by the manager of Long Hau IZIC, these delays mean that they need to sometimes gather information on updated regulations and policies from a law library rather than in dialogue with regulators. This again emphasizes the limited impact of meso level institutional capacity (of industrial zones) on the macro level institutional environment and vice versa. Industrial zones strongly rely on national legal documents to develop and implement strategies or solutions for water use efficiency, such as, water reuse or water cascading, but the slow time for promulgating new or updated central regulations prevent them to implement any water use efficiency innovation to meet their demand and interest in time.

Despite the lack of external mobilization, the industrial zones do demonstrate some capacity for creating internal opportunity structures that mobilize client firms to set rules and incentives for the adoption of water use efficiency technologies. Long Hau and Tan Thuan both demonstrate a capacity to create internal incentives for their client companies to develop or adopt water use efficiency strategies (see Table 3.3). For example, Long Hau IZIC uses the wastewater treatment fee to incentivize firms to engage in the implementation of water use efficiency and treatment. If an enterprise discharges a higher quality wastewater to the central wastewater treatment plant, i.e., compliant with 'column A' of the National Technical Standard No.40 (QCVN 40:2011/BTNMT), they will get a 50% reduction on the IZIC's wastewater treatment fee. With this regulation, several enterprises are mobilized to apply innovative technologies (such as reuse for cooling, washing and watering). A respondent from an enterprise mentioned that with the regulations "affecting the costs, enterprises automatically save water... and reaching column A for a 50% discount on price encourages enterprises to treat wastewater to get it to a better quality".

## 3.6 DISCUSSION

The three industrial zones analysed all have limited institutional capacity for identifying, collaborating around and resolving collective problems related to water use efficiency. This limited capacity to develop trusted relations, access knowledge, and mobilize resources necessary for problem solving and the strategic development of water use efficiency (Cohen-Rosenthal, 2000; Koop et al., 2017; Wang et al., 2017) undermines their efforts to either shape or comply with macro level rules and norms governing the development of water reuse. The findings in particular show that (1) the meso level institutional capacity in Vietnam remains dependent on, and is in fact constrained by, the hierarchical institutional environment of the Vietnamese state, and (2) the interplay between meso level capacities further amplifies these constraints. In light of these findings, we argue that opportunities still remain for industrial zones to expand their institutional capacity for developing water use efficiency strategies with non-state actors and client firms.

First, our results demonstrate that the centralized structure of the Vietnamese state constrains all three institutional capacities of industrial zones. The high reliance of industrial zones on macro-level provincial and national level executive institutions, notably DONRE and MONRE, in addition to macro-level political institutions through the Provincial People's Committee, limits the extent to which industrial zones can foster relations (both in and outside the state) that might help them with technological innovation, regulatory compliance and/or greater efficiency in dealing with high levels of state bureaucracy. Faced with this system of centralized planning, regulation and policy supported by judicial enforcement (Benedikter & Nguyen, 2018), industrial zones are provided a set of goals for water use efficiency, and industrial symbiosis more broadly, but are not afforded the means to develop the meso-level institutional capacities necessary for achieving these goals. In line with KimDung et al. (2018), the industrial zones we examined are faced with a form of administrative decentralization or 'captured collaboration' (Bruun & Rubin, 2022) that gives them legislated responsibility to innovate, but does not provide them support for gaining the necessary knowledge, relations or mobilization capacity for innovation. Furthermore, the lack of support by macro-institutions to foster meso-level institutional capacity undermines the influence of industrial zones over policy and/or regulation that could enable the adoption of water efficiency technologies. Despite the multiple branches of government and different levels of decision making in Vietnam, any form of deliberation related to policy and/or regulatory reform still relies on the tacit support of the central government (Dieu et al., 2020). These results indicate that the development of institutional capacities is not only functional - in terms of raising awareness, coordinating and organizing industrial ecology and symbiosis (see Mortensen & Kørnøv, 2019; Pham et al., 2022) - but also fundamentally political. Without a shift from planning, regulation and policy supported by judicial enforcement to facilitating policies to build the institutional capacities needed for context specific innovation, innovation for (e.g., water use efficiency) in industrial zones may continue to be tenuous.

Second, the results show that the interplay between meso level institutional capacities reinforces the way in which the macro level institutional environment constrains the institutional capacity of the studied industrial zones. As a result, we observe a reinforcing dynamic (building on Boons and Spekkink 2012; Healey et al. 2003) that further undermines the institutional capacity of industrial zones to act without consent of the state or influence the macro level institutional environment to support their efforts in water efficiency innovation. Reaffirming the observations of others (e.g., Gibbs, 2003; van Leeuwen et al., 2016; Yoon & Nadvi, 2018), this reinforcing dynamic in turn undermines the development of trust and cooperation needed by industrial zones for developing shared water use efficiency strategies. For example, because relational capacity is limited to fostering trust and mutual understanding with lower levels of government, access to knowledge is limited as well, which in turn limits the knowledge base to act upon. Similarly, the results show how the weak capacity to build trust and mutual understanding and share knowledge with non-state actors is restricting opportunities to mobilize actors beyond the government. This weak relational and knowledge capacity reduces the possibility to engage and/or create (i.e., mobilize) opportunity structures, including legal and/or financial instruments that might assist industrial zones in incentivizing client firms to work towards water use efficiency strategies. This also means that focusing on enhancing one capacity, e.g., knowledge capacity, is not enough to overcome the constraining influence of the macro level institutional environment. Enhancing the institutional capacity of industrial zones in a centralized political setting therefore requires fundamental change at the macro level as well.

These findings open up the debate over how the institutional capacity of Vietnamese industrial zones can be enhanced to foster the level of innovation needed for achieving goals like water use efficiency. We argue there are at least three possible, albeit speculative, approaches for doing so.

First, drawing on lessons from other sectors in Vietnam (KimDung et al., 2016b; Tariq et al., 2018), co-innovation and co-management of water use efficiency strategies could be pursued that expand the institutional capacity of industrial zones. Both co-innovation and co-management would require the state actors to enable industrial zones to improve their relational capacity with a view to accessing new knowledge and technologies. It would also enable them to not only exploit opportunity structures related to planning and regulation, but also engage in their formulation and design. Enhancing the institutional capacities of industrial zones through co-innovation and co-management are, however, only likely to be effective if central government supported greater devolution of control over industrial water use to industrial zones and local authorities. Interestingly, such reforms have been taken in the wider Vietnamese water sector at national and water basin scales leading to improved coordination, decision-making and improved water quality (Grafton et al., 2019). Integrating industrial water use in these reforms, with a focus on enhancing institutional capacities for enhanced deliberation (see Bruun and Rubin, 2022), may be a promising first step to improving industrial water use efficiency.

Second, taking inspiration from Benedikter (2016), opportunities for change do still exist in the Vietnamese state for initiating more decentralized collaboration with non-state actors. All three of the industrial zones we analysed could be more effective in shaping their institutional context if they could develop their relational, knowledge and mobilization capacity to engage with the motivations, norms and abilities of actors operating in non-state networks (Korbee et al., 2019; Phuong et al., 2018). This could mean getting involved in networks of domestic and national universities, networks of international firms (Truong & Rowley, 2017), and/or create links with international regulatory networks including influential norm setting bodies such as voluntary environmental certifications and/or the International Standards Organization (Daddi et al., 2016; Geng et al., 2009). While these relations may not deliver much support in the short term, they are likely to offer a greater set of opportunities for innovation over the long term.

Finally, despite the lack of capacity to shape their macro-institutional setting, our results do demonstrate that industrial zones have some capacity to coordinate relations with client firms and the lowest level of government to instigate change. There is also some indication, as seen in the cases of Long Hau and Tan Thuan, that industrial zones can internally mobilize their client companies to develop or adopt water use efficiency strategies through their own regulatory and economic incentives (in line with Lüdeke-Freund et al., 2019). This influence exists in spite of not having (as we outline above) the capacity to influence the wider (macro level) institutional context in which this remit is shaped. While still highly speculative, recognizing these strengths highlight the potential of greater decentralization and even devolution of industrial zones for co-producing and implementing new water use efficiency strategies (Moretto et al., 2018). As outlined above, however, such devolution is likely to still rely to some degree on macro institutional support for new forms of co-innovation and co-management of water use efficiency strategies.

## 3.7 CONCLUSION

Our analysis highlights how innovation processes go far beyond the deontic logic of assessing the effectiveness of prescriptive rules and norms aimed at fostering industrial ecology. Instead, we show that industrial ecology goals, such as water use efficiency, requires explicit attention to the way in which macro level institutions shape the institutional capacity of industrial zones. This is especially the

case in centralized states like Vietnam where macro institutions focused on centralized planning and management and hierarchical decision making constrain meso-level institutional capacities necessary for achieving industrial ecology outcomes. We also show that centralized macro-institutions affect relational, knowledge and mobilization capacities more or less equally, and in doing so constrain the range of innovation strategies industrial zones can take. To overcome these constraints, political and institutional change such as greater devolution through more deliberative approaches to industrial ecology are required that both enhance institutional capacities of industrial zones and local level government to engage in water use efficiency innovation – including the possible mobilization of non-state actors and client firms within industrial zones.

Our results contribute to debate on the interaction between macro level institutions and meso level institutional capacity within the field of industrial ecology and symbiosis. Further application of the institutional capacity framework is needed to better understand the relative role of macro level institutions and meso level capacities and how their interaction affects the design and uptake of processes in support of industrial symbiosis goals like water use efficiency. The framework could be used to better understand how actors, like industrial zones, can engage in the design of rules, regulation or codes of conduct. It could also be used to assess what capabilities are needed in order to respond to both public policy and regulation as well as private regulation such as standards and certification. In either application a deeper understanding of how macro level institutions, institutional capacity, and their interplay in furthering the goals of industrial ecology, is central.

# Chapter 4

# No rationality withoutcapacity: Understanding the failed application of economic instruments in Vietnamese industrial zones

**Abstract**

Economic instruments aim to ultimately incentivize industrial firms to adopt more efficient technologies or processing practices and/or the industrial zones in the redesign of water infrastructure for recycling, reuse or sharing between their clients. The research of this policy instrument has been relatively limited on understanding the institutional capacity of the industrial zones and their clients necessary for compliant technologies, infrastructures or practices. This research uses the institutional capacity assessment framework to examine the effects of implementing economic policy aimed at promoting water use efficiency in two Vietnamese industrial zones. The article draws upon the interviews, observation and a review of official documentation to show the degree to which perceptibly rational responses are dependent on these actors' wider institutional capacity to enable innovation and change. The findings contribute to ongoing debate on the effectiveness of economic environmental regulation in Vietnam and the ongoing challenges of the Vietnamese government in not only prescribing ambition, but also enabling capacities for innovation and ultimately compliance.

**Keywords:** institutional capacity; water use efficiency; industrial ecology; economic instruments; innovation; Vietnam.

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## 4.1 INTRODUCTION

Industrial zones account for 6.5% of total surface and groundwater use in Vietnam (NER, 2018), yet remain highly inefficient with very limited application of water reuse methods and technologies. At the same time, water is becoming scarcer as industrial, urban and agricultural demand grows, water quality declines due to pollution and salt water intrusion, and growing regulatory restrictions are placed on ground water extraction (Tran et al., 2022; Tran et al., 2021). Given projections for the continued expansion of industrial zones in Vietnam, greater attention is needed on both technological and policy innovations that can scale up water use efficiency (Massard et al., 2018; Velenturf & Jopson, 2019), including a range of reuse, recycling and/or water sharing strategies (e.g., Massard et al., 2018; Trinh et al., 2013).

To implement water use efficiency, regulatory and economic instruments are needed to enable both individual firms and the industrial zones to innovate (Rosenblum, 2021). State regulatory instruments typically include nationally or regionally defined water quality standards that set limits on (pollutive) parameters and/or requirements for reuse and/or recycling of grey water streams (e.g., Massard et al. 2018; Salgot & Folch, 2018). They may also mandate water transfer volumes between areas of water surplus and deficit at various scales (e.g., Long et al., 2018; Vásquez-Lavín et al., 2020). These regulatory instruments may be complimented with economic instruments that either tax or set a market price on pollutive or inefficient water practices (Du & Li, 2020; Guo et al., 2018). Both regulatory and economic instruments aim to ultimately incentivize industrial firms to adopt more efficient technologies or processing practices and/or the industrial zones to advance industrial symbiosis (see Chertow, 2007) principles in the (re)design of water infrastructure for recycling, reuse or sharing between their clients.

The kinds of regulatory and economic instruments outlined here assume that firms and industrial zones will respond rationally – that is, that they are self-interested and will innovate and comply in order to maintain economic benefits and/or minimize economic losses (Connelly et al., 2012). However, compliance with these policy instruments, especially when requiring innovation in water reuse technologies, infrastructures or industrial organization is also dependent on a range of factors that go beyond a cost/benefit rationality. This is particularly the case in circumstances where there are no off-the-shelf technologies or strategies for implementing water reuse efficiency or when the innovations required remain highly uncertain (see for e.g., Massard et al, 2018). Instead, we argue 'rational' actors can only employ rational behaviour when they have the capacity to do so.

Institutions setting incentives for rational behaviour play an important role in shaping eco-innovation (Henrysson & Nuur, 2021). However, in the context of technologies for industrial symbiosis, aiming for example at improved water use efficiency between firms, rationality is dependent on institutional capacities - that is capacities for mobilizing the relations, resources and knowledge necessary for compliant technologies, infrastructures or practices to be realized (Connelly et al., 2012; Renzetti, 2005; Trang et al., 2023; Wang et al., 2017). Understanding the degree to which industrial zones can rationally respond through innovation in turn requires understanding their institutional capacity to negotiate the conditions under which economic instruments are set and applied for environmental reform.

In this article, we examine the effects of implementing economic policy aimed at promoting water use efficiency in two Vietnamese industrial zones. Located in Ho Chi Minh City, each of these industrial zones represent different responses to the wastewater levy implemented by the Ho Chi Minh City (HCMC) People's Council and People's Committee in 2018 (Decision No.2129/QD-UBND). In first instance, Hiep Phuoc Industrial Park and Tan Thuan Export Processing Zone attempted to influence

the levy's design. After that failed, they responded by absorbing the levy as a cost of production but in different ways. Both hoped that their strategies would help promote the implementation of the technological innovations for enhancing water use efficiency. However, as this article shows, their combined lack of success demonstrates the degree to which perceptibly rational responses are dependent on these actors' wider institutional capacity to enable innovation and change. More broadly the results contribute to ongoing debate on the effectiveness of economic environmental regulation in Vietnam and the ongoing challenges of the Vietnamese government in not only prescribing ambition, but also enabling capacities for innovation and ultimately compliance.

The following two sections elaborate the institutional capacity framework and methodology use to collect our data. We then describe the implementation of economic instruments for wastewater management in the Ho Chi Minh City before presenting our empirical analyses of the Hiep Phuoc Industrial Park and Tan Thuan Export Processing Zone. Finally, we discuss different strategies to promote the implementation of innovation approaches for water use efficiency and to deal with the increasing-cost through the compliance with economic instruments designed.

## 4.2 INSTITUTIONAL CAPACITY

Institutional capacity refers to the ways in which industrial actors can resolve barriers to solving problems that stand in way of achieving individual or collective goals like water use efficiency (Spekkink, 2013; Wang et al., 2017). Emerging from the wider literature on deliberative governance (Healey et al., 2017), institutional capacity focuses on how actors develop relations that enable deliberation, mutual understanding and influence policy processes (Deutz & Ioppolo, 2015). In doing so, institutional capacity places attention on the ways actors "reassess their purpose and goals and come to see their interests and problems as interconnected, possibly leading to a shared strategic vision on how these interests and problems should be addressed." (Boons and Spekkink, 2012, p. 63). The approach, as such, draws attention away from questions of compliance or non-compliance as a measure of success, and instead places attention on the set of opportunities that can be considered "feasible under the institutional and physical restrictions they are faced with" (ibid., p. 63).

The concept of institutional capacity has been developed in the context of industrial symbiosis between firms seeking to innovate and/or coordinate activities that can lead to improved environmental performance - including resource efficiency (de Abreu & Ceglia, 2018). In addition to the development of strategic visions of technical and organizational dimensions of industrial symbiosis, institutional capacity places attention on the active development of networks between interdependent public and private actors in and around industrial zones (Zhong and Mol 2010). It also places attention on the role of trust developed through broadly defined learning platforms (Boons & Spekkink, 2012; de Abreu & Ceglia, 2018) and the importance of an enabling environment that stimulates the development of these capacities to emerge and be sustained (Boons & Howard-Grenville, 2009; Ferreira et al., 2019; Trang et al., 2023).

We build on the framework of Boons and Spekkink (2012), which identifies relational capacity, knowledge and mobilization capacities for industrial symbiosis (see Figure 4.1). We apply the framework to assess the ways in which these capacities affect the strategies of industrial zones to comply with economic policy instruments promoting industrial symbiosis approaches to water reuse. In doing so the framework helps explain how the industrial zones respond to the levy by showing how the interaction between those three capacities determine why a particular strategy is implemented in the industrial zone.

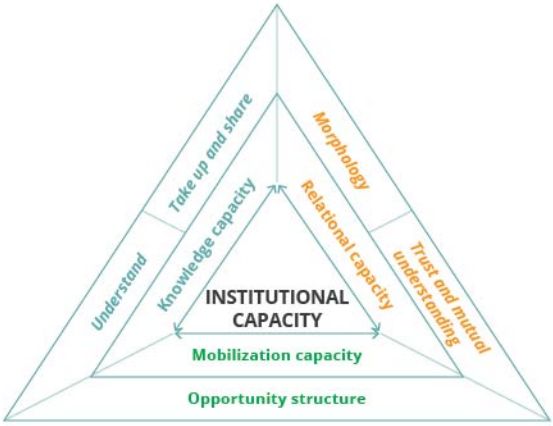


***Figure 4.1*** *Institutional capacities framework.*

Knowledge capacity refers to the ability of the industrial zone to acquire relevant information to develop compliance strategies that contribute to enhancing water efficiency. We assess knowledge capacity by analysing how industrial zones understand how the levy design may influence their strategy for incentivizing their client firms in developing water use technological innovations (Harrison & Corley, 2011). Following Abreu & Ceglia (2018), we also investigate methods and the extent to which industrial zones knowledge is taken up and shared between industrial zones, their client companies, and governmental actors in developing new water use efficiency strategies to comply with the levy.

Relational capacity refers to the actions industrial zones take to establish and maintain trust and mutual understanding within their wider networks in order to affect the development and implementation of technological, infrastructural or organizational innovations (Boons and Spekkink, 2012). We assess relational capacity by focusing on how trust and mutual understanding between industrial zones, firms and public actors at multiple levels of government enable or undermine their ability to stimulate water efficiency (ibid.). We first examine the morphology of networks in terms of the number and intensity of relations the industrial zones develop with key actors, including firms and public actors at multiple levels of government (Barry, 2012; Healey et al., 2003). Following de Abreu & Ceglia (2018) and others (e.g., Veselovsky et al., 2015), we then explore how these relations foster trust and mutual understanding with actors to engage in risky transactions that would be too costly in the absence of strong personal and professional relationships and mutual trust.

Finally, mobilization capacity refers to the ability of industrial zones to identify and involve multiple actors to support collective goals like water use efficiency (Boons & Spekkink, 2012; Healey et al., 2003). This includes the ability of actors like industrial zones to attract resources and ultimately employ opportunity structures for technological, infrastructural or organizational innovation and, consequently be able to respond to the incentives placed on them by economic instruments. This may involve influencing government actors to change standards that undermine the reuse of water between sectors, or private actors providing financial resources necessary for funding or incentivizing cross sectoral innovation between their client firms (Boons & Spekkink, 2012). Applied in the context of the HCMC wastewater levy, we examine both how industrial zones use different opportunity structures to engage with government and their clients to mobilize actors and resources necessary for compliance and to contribute to developing technical innovations for water use efficiency.

## 4.3 METHODOLOGY

Data was collected on the institutional capacities of Hiep Phuoc Industrial Zone (IZ) and Tan Thuan Export Processing Zone (EPZ), two industrial zones subject to the resolution and decision of HCMC People's Council and People's Committee for increasing the industrial wastewater discharge levy in 2018. Table 4.1 presents details on the key characteristic of both industrial zones (see also Trang et al. 2023). These two industrial zones were selected for their representative interest in two innovative water use efficiency strategies. At the time of the research, Hiep Phuoc expressed interest in developing rainwater harvesting and Tan Thuan in water reuse technologies. Tan Thuan expressed preference to reuse wastewater after treatment because it offers an additional potential income stream. By contrast, Hiep Phuoc opted to develop rain water harvesting because it does not require advanced treatment technologies and in the further development of the Industrial Zone, space could be allocated to this technology. Both approaches meet the objectives of the wastewater discharge levy.

Comparing these cases enabled us to draw out differences between strategies for innovation and compliance to the levy (following Kumar, 2014). Data was elicited through semi-structured interviews, observation and document review. Information obtained from in-depth interviews was complimented by observations made during visits to the industrial zones and through attendance at four stakeholder meetings in 2019. Respondents were selected based on a stakeholder workshop in 2018. Subsequently nine key informants' interviewers were conducted with administrators, client forms and technicians in both industrial zones. Four additional interviews were conducted with representatives of Ministry of Natural Resource and Environment (MONRE), Ho Chi Minh City Export Processing and Industrial Zones Authorities (HEPZA), Department of Natural Resource and Environment (DONRE) in 2019. The interview questions focused on their institutional capacity to select and implement compliance strategies to the wastewater levy (see Appendix 1). Interview data was supplemented with a review of legal documents and the by-laws of both industrial zones to further assess how the levy was translated into practice. These legal documents are derived from the website of governmental organization and from representatives of industrial zones via email.

**Table 4.1** Key characteristics of industrial zones (developed from Trang et al., 2023)

| Key characteristic | Hiep Phuoc IZ | Tan Thuan EPZ |
|---|---|---|
| Area of industrial zone | 1686 ha (including ports) | 300 ha |
| Province | Ho Chi Minh | Ho Chi Minh |
| Main water issues | Salt water intrusion, raising water demand | Salt water intrusion, raising water demand |
| Type of companies | Mechanics, electricity - electronics, rubber - plastics, food processing | Food processing, construction material (except cement and steel), logistic and ancillary industries |
| Number of enterprises (% of foreign investors) | 117 (8% foreign investors) | 199 (85% foreign investors) |
| Capacity of wastewater treatment plant | 12000 $m^3$/day | 15000 $m^3$/day |
| Water supply system | SAWACO and Nha Be supplies 40000 $m^3$/day | Nha Be supplies 14000 $m^3$/day |

## 4.4 ENVIRONMENTAL ECONOMIC POLICY INSTRUMENTS IN POST-SOCIALIST VIETNAM

The Vietnamese government introduced economic policy instruments after a first round of economic reform (Đổi Mới) in 1986 and further market reforms in 1989 aimed at increasing efficiency and macroeconomic stability (Shultz & Peterson, 2019; Turner et al., 2019 ; Wescott, 2003). From the early 2000s, attempts to use economic instruments to incentivize environmental objectives were introduced across a range of sectors including agriculture, forestry and heavy industry (e.g., Ngoc, 2017). The first of these was an environmental protection charge for urban wastewater in 2003 through the collection of both industrial wastewater and domestic wastewater fees (ibid.). These levies aimed to redistribute costs to industrial and domestic water resource users contributing to poor water quality.

While the mandate to use economic instruments was provided by the national government, applications of wastewater fees were decentralized to Provincial People's committees with the ambition of addressing urban pollution. In 2017, the Ho Chi Minh City People's Council released Resolution No. 54/2017/QH14, which allowed for the fees and charges for industrial wastewater to be implemented by HCMC DONRE. This led to the Resolution No.02/2018/NQ-HĐND, which in turn stipulated an environmental protection charge for industrial wastewater in Ho Chi Minh City at a fixed rate of 1,500,000 VND per year (US$63 per year) for a total wastewater volume of under 5m³/day. If the wastewater volume is greater than 5m³/day this fee is calculated as:

$F = (f \times K) + C$

where F is the payable fee (in VND), f = 1,500,000 VND (US$63), K is the discharge coefficient = [Wastewater discharge (m³/day)]/5, C is the variable payable fee.

C is calculated through the following equation:
C (VND) = Total amount of wastewater (m³) x Contaminant content in wastewater (mg/L) x $10^{-3}$ x Environmental protection fee rates for industrial wastewater of pollutants discharged into the environment (VND/kg).

The revenues from the levy were transferred to the budget of the city and designated for (1) investment in prevention, restriction and control of environmental pollution caused by wastewater by the Ho Chi Minh City People's Council and (2) the implementation of 'technological solutions' for wastewater treatment (as further stipulated in Decree No.154/2016/ND-CP).

The implementation plan for the levy outlined a range of measures designed to stimulate innovation in Decision No.2129/QD-UBND, including water saving, reuse wastewater after treatment, limiting wastewater discharge and restricting environmental pollution. A guiding principle was also to ensure fairness and equality in setting obligations for paying any fees. The Department of Science and Technology (DOST) was designated to assess the effectiveness of levy collection activities and adjust the variable payable fee as needed. The Decision did not, however, provide any outline of what support would be provided by the state, either in terms of knowledge, finance, or supporting regulation beyond the levy itself.

There has been ultimately limited impact of the wastewater levy in industrial zones in terms of stimulating improved water use efficiency. As Ngoc (2017) explains, while these policies have been based on the wider polluter pays principle, the pricing level of the wastewater charges has been too low. As a result, the industrial zones have accepted payment rather than avoiding the additional cost by complying with the guidelines set out by the HCMC People's Committee. Efforts to realign the pricing of the levy

by DOST have been made. However, as reflected in the 30-year history of economic mechanisms in Vietnam (Phuong & Richard, 2011; Turner et al., 2019 ), such recalibration was not high enough to create effective incentives for improved performance.

As seen in other parts of Asia, realizing the theoretical advantages of economic approaches to wastewater management need more than improved pricing alone (Zhong and Mol, 2010). By examining the institutional capacities of Hiep Phuoc and Tan Thuan we shed light on the challenges industrial zones face in responding to ineffective economic incentives.

## 4.5 RESPONSES TO THE WASTEWATER LEVY

Due to the higher demand of water use in the industrial sector and future water challenges, industrial zones are interested in technological innovations for enhancing water use efficiency. In responding to the levy, the industrial zones are expected to invest in these technologies to secure both economic efficiency and meet environmental goals in the future. However, when the wastewater levy was brought in, both industrial zones realized that the levy would not help them shape the activities of their client firms to implement innovative water efficiency technologies. As a consequence, the industrial zones made a failed attempt to lobby for changes to the wastewater levy and subsequently decided to pass on the cost to their clients; but without any clear strategy on how the levy would foster water reuse innovation. These decisions reflect, as we now go to argue, not a lack of willingness to 'act rationally' in response to an economic governance instrument, but their weak institutional capacity to both coordinate innovation in spite of the levy and lobby the government for changes in the design and content of the levy.

### 4.5.1. Response 1: Influencing the levy's design

The first strategy adopted by both industrial zones was to influence the design of the levy in order to improve its effectiveness for setting incentives for water reuse innovation. They did this by engaging the HCMC People Council and People Committee in discussions about potential modifications to the levy's design. Despite having adequate knowledge of the levy and giving feedback on setting an effective cost for inefficient water use, neither industrial zone was effective in changing the levy. Their lack of success in influencing the government can be explained by their lack of institutional capacity to effectively engage, mobilize and influence the hierarchical decision-making processes of the HCMC government.

Both industrial zones clearly demonstrated knowledge about how the levy would affect them when interviewed. They argued, for instance, that the levy should focus less on the quantity and more focus on the quality of discharged wastewater after treatment. As one respondent explained, "right after the wastewater from the central treatment plant is discharged, it must go through the meter of DONRE to measure the flow (quantity) and pollutant concentration (quality). Then the government will charge the fee based on the quantity of the wastewater discharged" (Interview #8). They went on the point out that because the system is closed - meaning there are DONRE monitors one flow of wastewater after treatment - industrial zones cannot reuse wastewater before this measurement is taken. However, because the levy is focused on quantity only, they bear a cost no matter what the water quality is, which devoid the levy of providing any incentive for investing in improved water quality before treatment. Regardless of the quality, "they still have to pay the fee for the levy" (Interview #5, 6, 7, 8). Furthermore, the lack of a focus on quality disincentivizes innovations that increase the volume of water in the system, such as rainwater harvesting.

In contrast to the apparent knowledge capacity of industrial zones, they demonstrate weak relational capacity to influence the levy's design. Respondents from the industrial zones and the government alike indicated a lack of trust and understanding between them. This lack of trust undermines any attempt of industrial zones to engage in discussions on the current levy, or invest in efforts for redesigning the levy - even when they have a legal right to give feedback. Respondents noted, for instance, their involvement in a workshop organized by HCMC People Council one month before the levy was promulgated. Despite sharing their concerns to the authorities their comments were not incorporated. As expressed by industrial zone administrators, we as "the end-users affected by the levy [,] are not fully heard by the authority, and not convinced they will make any changes" (Interviews #5, 8). The respondents also expressed frustration that they were not consulted when the levy was drafted, nor did they know it was created in the first place. From their perspective the workshops held in the design phase were performative in nature; organized "to legitimize the promulgation process" rather than illicit useful feedback from industrial zones (Interviews #5, 8). In addition to illustrating the strongly hierarchical structure of the Vietnamese state (see also Trang et al., 2023), the lack of trust and understanding between industrial zones demonstrates the lack of relational capacity afforded by the state for the development of technical innovation strategies.

Finally, despite demonstrating knowledge about the water system and technological innovations (e.g., wastewater reuse, rainwater harvesting, etc.), both Hiep Phuoc and Tan Thuan lack the mobilization capacity to exploit the prevailing opportunity structures to influence the design of the levy. Industrial zones could not influence the levy's design because they do not have capacity to use the engagement with HCMC People Council and People Committee to mobilize support for changing the levy's design that hinders the implementation of water technological innovation to avoid costs imposed by the levy. Several respondents argued that "government still has a process to record the opinions of stakeholders on legal documents"... but in fact, "it is only a formality"... (Interviews #5, 8, 9, 10, 11, 12, 13). This demonstrates how the hierarchical relationship with the state and the centralized process of planning, regulation and policy (see also Trang et al., 2023) inhibit the way in which industrial zones are able to mobilize support for implementing water use efficiency.

#### 4.5.2. Response 2: Bearing costs rather than innovating

The failed attempts by both industrial zones to influence the design of the wastewater levy led them to internalize the cost of the levy, but without stimulating water efficiency innovation. The experiences of Hiep Phuoc demonstrate that while they do have the institutional capacity to internally develop the trust and opportunity structures necessary for paying the levy, this payment does not translate into innovations to improve the quantity or quality of wastewater.

Hiep Phuoc Industrial Park has a long history of implementing an 'environmental protection fee' and 'wastewater treatment fee' as part of their centralized wastewater treatment system that collects and treats 12000m$^3$ wastewater per day. These internal charges were opportunity structures established by the industrial zone before the HCMC wastewater levy. They were also set in negotiation with their clients based on a joint understanding of the water reuse activities of their clients - including intra-plant water reuse for industrial cleaning, sanitary services, and in the primary production processes of the factories. As a manager at Hiep Phuoc said "we understand the existing infrastructure of industrial enterprises and the extent they reuse water in their area..." (Interview #5). The implementation of these internal charges demonstrates a clear capacity for setting their own regulation for using the service fees to share the cost of central water treatment, and in this sense, the potential to effectively implementing the new levy.

In addition to these internal charges, Hiep Phuoc had an opportunity to negotiate the HCMC wastewater levy with their clients. An interviewee argued that "Hiep Phuoc talked to us about the increase in the wastewater treatment fee"... "we should share the increased-cost with them" (Interview #9). Their close relations with their clients did nevertheless enable them to understand that the additional cost of the new wastewater levy would not affect wastewater practices. First, they anticipated that the levy was set too low to stimulate the adoption of new technologies. As an administrator at Hiep Phuoc argued "investments in infrastructure and updating technology of enterprises are far higher than bearing the cost required from this levy" (Interview #5). Second, they anticipated that the focus of the levy on the quantity rather than quality of wastewater would ultimately undermine the ability to mobilize their clients to innovate. The price, they and their clients responded, "would have to be higher than the cost of inaction or the continued use of new water sources". This was further confirmed by one client firm who explained that such pricing is necessary because "the use of treated reused water in their production process would require advanced, and expensive, water treatment technology" (Interview #9, 12). Additionally, the centrally managed water treatment facility of Hiep Phuoc has reached the maximum capacity of their own saving and treatment technologies can deliver.

In sum, Hiep Phuoc demonstrates that they do have the relational capacity to engage their clients and the knowledge and mobilization capacity to establish effective pricing mechanisms for poor waste water conduct within the parameters of current used water efficiency technologies and practices by clients. Based on these capacities the industrial zone was able to pass on the levy to their client firms - all of which remain non-compliant with the wastewater goals of HCMC People's Committee. However, the case also demonstrates that the design of the levy does not afford Hiep Phuoc to develop and/or employ their institutional capacity to achieve these goals.

The case of Tan Thuan export processing zone similarly demonstrates that the institutional capacity exists to develop internal rules, in this case requirements for wastewater quality. However, in contrast to Hiep Phuoc, they are not able to effectively pass on the costs to their clients, nor are they able to use either these standards or the levy for stimulating clients to adopt improved wastewater practices.

Tan Thuan's stimulates firm level treatment to reach a level of quality prescribed by their own internal standards before being collected and processed in the central wastewater treatment plant and subsequently discharged into the river. Tan Thuan knows that 50 percent of their client firms are not able to treat the wastewater properly to meet its regulation and, as a result will have to pay an internally collected wastewater fee. They are also aware that these same firms discharge a high amount of wastewater largely because of the high cost of innovation required for these firms to invest in water treatment technologies. As one representative from Tan Thuan argued, their clients do not invest in these technologies because the ongoing cost of maintenance and repair will result in "a shortfall in [their] ...budgets" (Interview #8). Similar to Hiep Phuoc, Tan Thuan has not invested in improving their centralised water treatment facility or water reuse technologies - largely because regulation, and the new wastewater levy, remains focused on quantity rather than quality. The result is that the internal water quality standards and fees aimed at individual firms and the new HCMC levy have not stimulated innovation to change wastewater practices.

The failure to engage half of their clients with their internal system of standards and incentives has meant their implementation of the HCMC remains limited. The reticence of Tan Thuan to even discuss the new levy results from a lack of trust and understanding between them and their clients, largely arising from the failed implementation of their own internal system. On this basis, they assume that

firms not meeting their own standard are hostile to any further negotiation over not only paying the new levy or investing in further water efficiency or treatment technologies. As a representative of Tan Thuan argued, "we have to fight with investors here, anyone who increase payment, they all oppose" (Interview #8). The firms interviewed confirmed this lack of engagement, arguing further than they have no trust that the industrial zone has the capacity to fairly assess water quality or use the fee for enabling them to meet the Industrial Zone's water quality standards. They also agreed that the HCMC water levy poses an additional cost that they will be forced to bear given their own lack of capacity, and the lack of capacity of the industrial zone, to link to the relevant expertise needed for (1) designing cost effective technologies and/or (2) water use efficiency technologies between firms at the scale of the industrial zone.

In contrast to their limited relational capacity with their clients, Tan Thuan does have a close relationship with the industrial zone authority. In lieu of negotiating compliance or enabling innovation amongst their clients, officials at Tan Thuan instead report consulting the Ho Chi Minh City Export Processing and Industrial Zones Authority (HEPZA) to strengthen their ability to enforce the new wastewater levy. By mobilizing the regulatory authority of HEPZA to announce the new wastewater levy, Tan Thuan hopes to overcome their own weak regulatory position and enable cost sharing with their client firms. Despite using the authority of the HEPZA, however, the capacity of Tan Thuan to enable innovation by fostering trust and knowledge exchange was not improved. As a respondent from the IZ argued, while they had experiences with wastewater reuse for irrigation, "the reuse of water is not approved by the authorities, we do not share any specific information with the enterprises" (Interview #8).

In sum, in contrast to the goals of the wastewater levy, Tan Thuan bore the cost themselves while, like Hiep Phuoc, not improving industrial water quality or quantity. The lack of relationship capacity with its client firms prevented Tan Thuan from creating opportunity structures to mobilize their clients to share the costs of the HCMC levy. And despite having stronger relational capacity with the government, they were not able to mobilize the government to help create support for the clients either. This lack of institutional capacity to engage the clients left Tan Thuan with no other choice than to bear the costs themselves.

## 4.6 DISCUSSION

Our results show that the HCMC wastewater levy failed to promote water efficiency innovations in both of the industrial zones studied. We further show that both industrial zones responded 'rationally' to the implementation of the new levy in terms of weighing the cost of payment versus innovation (Connelly, 2012; Requate, 2005). However, this rational behaviour was not in line with achieving the wider goals set out by the HCMC People's Committee when designing the levy. The failure of the levy to stimulate innovation could, as such, be seen as a design flaw or market failure - i.e., the levy for inefficient water use and poor water quality was not optimally set. The problem with such an explanation is that this explanation reduces the agency of the industrial zones to 'price takers' who internalize the cost of non-compliance and bear no ambition for change. Our results instead point to a more nuanced picture. Both industrial zones demonstrate an internal ambition and capacity to set incentive mechanisms for stimulating innovation in recognition of the long-term cost of poor water efficiency. They are nevertheless unable to translate this rationality and related capacities to develop strategies for complying with the water efficiency ambitions of the externally set HCMC wastewater levy.

We argue that the experiences of both Hiep Phuoc and Tan Thuan show that 'rational' actors can only employ their rationality for objectives, such as innovation and compliance, when they have the institutional

capacity to do so. Said differently, the industrial zones studied do not exhibit a requisite level of capacity to foster levels of trust that allow them to make use of opportunity structures for fostering innovation and compliance (Boons & Spekkink, 2012; Granovetter, 1985). We will first reflect on the limited institutional capacity exhibited by the industrial zones before outlining a new agenda for supporting the development of institutional capacities in order to more effectively employ economic instruments in Vietnam - a country, as we also show, that has had limited success in implementing economic instruments to stimulate environmental innovation.

First, the current institutional capacities demonstrated by industrial zones for implementing existing wastewater policies, levies and collective wastewater infrastructure are not aligned to translating and/or implementing external incentives to stimulate innovation amongst their clients. The existing capacities of Hiep Phuoc and Tan Thuan enabled them to set goals and price poor water quality within their jurisdiction. They also demonstrate, albeit in a limited way, the 'external' relational capacity to engage the government in discussions on the ineffectiveness of the new wastewater levy (cf. Bertello et al., 2022; Collins & Hitt, 2006). This external relational capacity - linked to wider notions of social or political capital - enable access to decisions makers and decision-making processes at higher levels of government (see Ngo, 2020). However, reflecting findings in Vietnam and other parts of Asia (Lai et al., 2005; Trang et al., 2023; Zhong & Mol, 2010; Tran et al., 2023) neither industrial zone was able to translate these capacities into any form of innovation. They were not able to mobilize either their direct supervisors at HEPZA or those responsible for the HCMC wastewater levy to better support their efforts in realigning the design of the levy to set more effective incentives for changing wastewater use, treatment and reuse internally. They were also not able to adjust the levy to build on their existing standards and levy systems, or mobilize their clients to seek out new methods or strategies for water treatment or reuse.

Second, we observe that relational capacity, in particular the development of trust with client firms, is key for establishing a starting point for implementing economic instruments for wastewater innovation. When confronted with the HCMC levy, both industrial zones did demonstrate knowledge on what improvements were needed to their wastewater systems and which innovative technologies would be most suitable for improvement - both centrally and within their clients - in line with wider ambitions for industrial ecology. They also demonstrate, linked to our observations above, relatively weak external relational capacity because of lack of trust and understanding between them and HCMC People Council and People Committee. We also argue that the industrial zones demonstrate mixed 'internal' relational capacity to engage clients when translating the externally derived wastewater levy. On the one hand, Tan Thuan did not engage clients out of a fear of opposition, while Hiep Phuoc was able to establish trust through previous long-term engagement with clients. In line with the wider literature (Boons & Spekkink, 2012; Costa & Ferrão, 2010), this indicates that internal relational capacity for building trust appears essential for developing long term mobilization capacity for establishing and exploiting opportunity structures, such as economic incentives, in the pursuit of industrial symbiosis outcomes.

Finally, the results show that the success of economic instruments, like the HCMC water levy, cannot be left to 'arms-length' implementation. Instead, setting incentives for innovation also requires support to the knowledge, relational and mobilization capabilities. This observation, we argue, holds significant consequences for how economic instruments are designed and implemented (Dubois & Eyckmans, 2014; Xenarios & Bithas, 2012). Instead of only prescribing incentives through economic instruments, the Vietnamese state also has to establish a parallel programme of developing the capabilities of industrial zones to internally establish trust and coordination to stimulate clients to develop new wastewater innovations.

The design of such a program could focus directly on the institutional capacities outlined in the framework presented in this article. For instance, the government could (1) support industrial zones to develop the mobilization capacity to develop opportunity structures that establish information exchange between client firms on water reuse technologies. They could also (2) enable industrial zones to develop internal trust (underlying relational capacity) with clients through enhanced transparency over the collective impacts and costs of poor water quality, as well as the potential for secondary earning models for the onward sale of treated water and/or any nutrients extracted (see for e.g., Haddaway et al., 2019). Relatedly they could (3) enable greater external trust (also linked to relational and mobilization capacity) with government institutions by affording direct and iterative input to the design of regulation and wastewater policy ambitions. The government could also (4) establish a parallel system of knowledge exchange nationally and internationally for industrial zones and their client forms to process their own innovation strategies for water use efficiency and/or wastewater treatment. They could also (5) provide more opportunity structures for industrial zones and clients by establishing more specific financial supports for enhancing water use efficiency in the industrial zones.

## 4.7 CONCLUSION

Regulation in Vietnam remains limited even 30 years after their introduction because of the limited capacity of economic actors to innovate in working towards compliance. The limited application of economic instruments questions the role of government in not only prescribing goals through regulatory and economic instruments, but also enabling the capacities of industrial zones to develop strategies of water technological innovations to comply with these instruments.

By analysing the knowledge, relational and mobilization capacity, we show in a more precise way the kinds of support that is needed to enable innovative strategies development to achieve the goal of economic instruments in Vietnam. In summary, by fostering mobilization capacities for engaging firms in innovation, the requisite trust with both governments and firms that underpin enhanced relational capacity and, relatedly, access to the necessary knowledge capacity for new technologies and strategies of innovation. Establishing such a program would move the Vietnamese state beyond arms-length incentives for innovation to develop programs of engagement that afford industrial zones and their client firms the means by which economic and environmental rationalities for compliance to cleaner water policy goals can be achieved.

Our results have wider relevance for other countries which also face ineffective (environmental) outcomes of economic instruments. While economic instruments are expected to be an incentive to encourage polluting firms to achieve an environmental goal, their effectiveness relies on the firm behaving as a rational actor (Milliman & Prince, 1989; Ramanathan et al., 2017). Rational theory is based on the assumption that polluters are always self-interested, rational actors that try to minimize their benefit loss (Connelly, 2012). The institutional capacity framework can be used to explain why an economic instrument fails to achieve an environmental goal. It also provides potential steps to develop a program of support to enhance relational, knowledge and mobilization capacity of polluters to translate the environmental incentive into innovation strategies to achieve an environmental goal. Further research could build on these findings by exploring how the potential steps might improve institutional capacity of firms and industrial zones contribute to the implementation of economic instruments to achieve water use efficiency.

# Chapter 5

# Beyond compliance: public voluntary standards and their effect on state institutional capacity in Vietnam

**Abstract**

Public standards have been relatively limited researched on the institutional capacity of public authorities, especially who develop and implement the standards to address complex challenges like the promotion of industrial ecology and industrial symbiosis for enhancing resource use efficiency. This research uses institutional capacity assessment framework to examine the ways in which a voluntary public standard for certifying eco-industrial parks affected the Vietnamese state's capacity to coordinate and implement industrial ecology. The article draws upon the interviews, focus groups and a review of official documentation to show that the benefits of public standards extend beyond compliance to the enhancement of state capacities to coordinate complex policy domains such as industrial ecology. The findings contribute to provide a basis to redesign standard setting processes to move beyond end-user compliance and can provide insights to how public actors can more effectively address 'systemic' sustainability challenges – from circular economy ambitions to the Sustainable Development Goals.

**Keywords:** institutional capacity; public voluntary standard; water use efficiency; industrial ecology; compliance; Vietnam.

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## 5.1 INTRODUCTION

Environmental voluntary standards are designed to incentivize compliance to certifiable requirements for environmental conduct and performance either in the absence or in explicit support of public regulation (Bartley, 2014; Tuczek et al., 2018). They are developed and applied by both private actors, such as NGOs and private companies, and public actors, such as national governments and international organization, across a broad range of resource and service sectors (Auld et al., 2018; Tröster & Hiete, 2018; Zeng et al., 2021). Their voluntary status means they are used to stimulate environmental performance, by guiding compliance with fragmented public regulation (Renckens, 2020) and/or establishing legitimate forms of production to meet market demand in the absence of credible public regulation (e.g., Zhang et al., 2019).

Private voluntary standards and certification have been widely researched, including their effect on both their uptake by target actors and their effect on state rule making and governance (Anh et al., 2011; Gulbrandsen, 2014; Kalfagianni et al., 2020; Ponte et al., 2021; Vandergeest et al., 2015). Research on public certification standards, while having received relatively less attention, has focused on their use by national governments to (1) guide end users through regulatory compliance (Samerwong et al., 2018; York et al., 2018), (2) create vanguard objectives that extend beyond legislation (Daddi et al., 2016), (3) foster legitimacy by states for products in export markets (Samerwong et al., 2018) and/or (4) reclaim rule making authority back from private certification initiatives (Giessen et al., 2016). The motivations and capacity of target groups to comply with public voluntary certification standards have been a key focus of this research (Da Silva et al., 2019; Samerwong et al., 2020; Tröster & Hiete, 2018), as well as the interplay between these standards and public regulation (Gulbrandsen, 2014; Ponte et al., 2021). What remains less clear, however, is the effect these public certification standards have on the institutional capacity of public authorities themselves, especially those in the global South, who develop and implement these standards to address complex challenges like the promotion of eco industrial park and industrial resource exchange (symbiosis) to enhance energy and resource use efficiency.

An eco-industrial park (EIP) refers to a group of enterprises getting involved in cleaner production, making effective use of natural resources and entering into manufacturing cooperation and affiliation in order to tighten resource flows to promote economic, environmental and social efficiency in these enterprises (Dong & Chuc, 2018; Massard et al., 2018). Developing EIPs can also contribute to addressing 'systemic' sustainability challenges – from circular economy ambitions to the Sustainable Development Goals. Take for example Vietnam, where the development of industrial zones first only focused on attracting domestic and foreign investment and developing production and business efficiency, neglecting the environmental consequences of industrial development. Since 2016, the Vietnamese state has sought to transform existing industrial zones into eco industrial parks with the goal of reducing pollution, ensuring economic and social benefits, and sustainable development. In 2018, this objective was formalised through Decree 82/2018/ND-CP (or 'Decree 82') on the Management of Industrial Parks and Economic Zones, which established criteria for a public voluntary certification for the investment, development and application of new forms of management and technology to promote EIPs.

In this article, we examine the development of Decree 82 to understand the ways in which different stages of developing a voluntary public standard can affect the Vietnamese state's capacity to coordinate and implement EIPs. This standard codified under Article 42 of Decree 82, was instigated by the United Nations Industrial Development Organization (UNIDO) with the Vietnamese Ministry of Planning and Investment (MPI) (UNIDO, 2018). In the process of developing the standard, multiple

governmental Ministries and Departments responsible for investment, financing, environment, social security of eco-industrial park formation were involved. The aim of this article is to assess how the institutional capacity of these governmental bodies was affected through their involvement in the development of a public standard and the effect of this capacity on supporting systemic and inter-ministerial support for transformation towards industrial symbiosis.

Institutional capacity refers to the ability of private or public actors to work through a system of rules, norms, values to achieve a specified collective goal (Fresneda Fuentes & Hernández Borreguero, 2018; Johansson et al., 2017; Willems & Baumert, 2003). To realize EIPs and enhance effective use of natural resources in the processing and manufacturing sectors (Nguyen & Ye, 2015), coordination is needed both between: 1) firms coordinating by-product exchange and utility sharing and 2) government bodies across multiple levels controlling rules and resources needed to enact this exchange and sharing (Jiao & Boons, 2017; Spekkink, 2013). As earlier research has shown, institutional capacity is considered to be key for acquiring resources, accessing knowledge for improving environmental performance, and developing the relations and coordination necessary for establishing and using opportunity structures for developing EIPs (Boons & Spekkink, 2012; Healey et al., 2003; Wang et al., 2017).

The following two sections present the institutional capacity assessment framework used in our analysis and our methodology for data collection. We then outline the content of the Decree 82 before presenting our empirical findings. The article concludes with a discussion of these findings, reflecting on wider significance of understanding the effect of public voluntary standards on the institutional capacity of public authorities in Vietnam and beyond.

## 5.2 INSTITUTIONAL CAPACITY

Institutional capacity refers to the ability of private or public actors to work through a system of rules, norms, values to achieve a specified goal (Boons & Spekkink, 2012; Johansson et al., 2017). Institutional capacity, as a framework of analysis, has been developed in close association with the wider academic concepts of industrial ecology and symbiosis (Neves et al., 2020; Nguyen & Ye, 2015) to understand government and inter-firm cooperation for linking industrial processes through by-product exchange and utility sharing to achieve resource efficiency (Jiao & Boons, 2017; Spekkink, 2013). Industrial ecology and industrial symbiosis are related terms focused on collective approaches for industries to exchange raw materials, energy, water, and/or by products (Baldassarre et al., 2019). An eco-industrial park is considered a model for eco-efficiency at the industrial zone scale by establishing collaboration to implement resource exchange between firms (Massard et al., 2018).

In this article, we extend the institutional capacity framework to understand the effects of standard creation on those responsible for defining and implementing them. In doing so we go beyond the deontic logic of compliance to prescriptive rules and norms (Ostrom & Basurto, 2011), to emphasize the capacities needed for shaping the rules, norms and values that enable learning, and foster trust and collaboration between rule making public actors. We apply an institutional capacity framework to understand how the design of Decree 82, which provides a framework for the voluntary certification of EIPs, affected the institutional capacities of government bodies responsible for supporting development of eco industrial parks. Based on the definitions from Healey et al. (2003), Boons and Spekkink (2012) and Trang et al. (2022), this framework is comprised of relational, knowledge, and mobilization capacities (as summarized in Figure 5.1).

Relational capacity refers to the ways in which public or private actors affect trust and mutual understanding between themselves and other actors related to industrial resource efficiency (Healey et al., 2003; Wang et al., 2017). We apply relational capacity to understand how government actors engaging in standard development enhance their trust and mutual understanding between themselves and both non-state private actors and other parts of government (Watkins et al., 2015). Here we examine which different government bodies expanded or reduced their range of relationships with other public and private actors through the design and formalization of Decree 82 (Yoon & Nadvi, 2018). We then analyze the morphology of these relationships by identifying the types and spatial and temporal elements of interaction among government and other actors in their networks to understand how, where and when governmental actors interact with other actors, e.g., via official document, face-to-face discussion, three times a year (Domenech & Davies, 2011; Yoon & Nadvi, 2018). Finally, we explore the integration or 'depth' of the new collaborations by examining the effect of standard development on trust and mutual understanding within these networks (e.g., de Abreu & Ceglia, 2018).

Knowledge capacity refers to the ability to identify and acquire the knowledge necessary for implementing EIPs (Barry, 2012). We use this capacity to assess how the development of Decree 82 affected how knowledge was developed and exchanged between government bodies in order to align policy support for both technological and organizational innovation (e.g. Lai et al., 2014). Following Healey et al. (2003) and De Abreu and Ceglia (2018), we first analyze the extent to which key actors were open to applying existing and new knowledge in providing the definition and developing standard criteria of EIP. We then analyze how the frames of reference of these actors, including problems, opportunities and interventions, affected the identification of these knowledges (Healey et al. 2003). Finally, we examine the ways in which the knowledge of these actors was integrated either directly in Decree 82, or in legislation and policy supporting its implementation.

Mobilization capacity refers to the ability of public and private actors to enable "collective action based on the existence of a shared strategic vision and the presence of actors within the community that are willing and able to take the lead" (Spekkink 2015, p. 134). We apply mobilization capacity to identify the extent to which government actors were, through their involvement in the definition of criteria set out in Decree 82, better able to engage and motivate industrial zones and industrial companies to support implementation. We first examine the opportunity structures - such as rules, norms and incentives - that enable both government and private actors to support the design and adoption of eco- industrial parks (Boons & Spekkink, 2012; Healey et al.). We then examine the extent to which government actors reshape eco-industrial park regulation and policy in response to voluntary standard development. Following Wickham (2009), we do this by focusing on the ways government actors understand the effectiveness of current regulations, and communicate the benefits of eco-industrial park certification to industrial zones. By providing these opportunity structures governments mobilize actors in their network to support voluntary compliance to certification criteria. Second, we examine the repertoire of mobilization techniques (see Healey et al. 2003) applied by government to mobilize support for the design and implementation of Decree 82. Finally, we analyze the emergence of change agents through the development of Decree 82 – that is, key persons or organizations that provide leadership by motivating other actors to align their actions to the achievement of a specified goal.

Healey et al. (2003) and Boons and Spekkink (2012) also emphasized that to analyse institutional capacity the interaction between relational, knowledge and mobilization capacity is relevant. They describe how, for example, significant knowledge and relational resources help to mobilize actors to achieve a shared goal. From their research, they concluded that the starting point for changing or

improving institutional capacity is first a changed relational capacity, after which knowledge capacity and mobilization capacity follow. In addition, Boons and Spekkink (2012) argue that the most significance capacity is mobilization capacity, because the active participation of actors relevant to the exchange of resources or materials is an essential condition for making it happen. In this article, we are not only exploring the interaction between the three capacities, but will also analyze the chronological order of this interaction. We examine which capacities are more prominent when, and how - through interaction - they become cumulative over time throughout different stages of the promulgation process of Decree 82.

## 5.3 METHODOLOGY

Eco-industrial parks offer an exceptional case for understanding the effect of public standards on state institutional capacity because of the degree of systemic or inter-ministerial coordination it requires. To analyse the effect on state institutional capacity we compared the experiences of four purposefully selected industrial zones in Southern Vietnam. Two of these industrial zones located in the Can Tho province (Tra Noc 1 and 2) were selected that joined the UNIDO led pilot for implementing Decree 82. A further two industrial zones located in Ho Chi Minh City (Hiep Phuoc and Tan Thuan) were selected that chose not to join the UNIDO pilot project. These four case industrial zones enabled us to identify and record a variation of experiences of key provincial and national level government actors involved in developing and implementing Decree 82.

The data for this case study research was collected from December 2018 to December 2019 and consists of semi-structured interviews and a review of official documentation. Face-to-face, in-depth, semi-structured interviews (see Appendix 1 for an overview and interview questions asked) were conducted with Representatives from Ministry of Natural Resource and Environment (MONRE) and MPI who both participated directly in the promulgation of Decree 82 and EIP standards. Other actors involved in the development of Decree 82 were also interviewed, including the Can Tho Export Processing Zone and Industrial Zone Authority (CEPIZA), the Tra Noc Industrial Zone Infrastructure Company (Tra Noc IZIC) and industrial enterprises operating in Tra Noc 1 and 2 industrial zones. In addition, we interviewed representatives of two other Industrial Zones Infrastructure Companies of Hiep Phuoc and Tan Thuan Industrial Zone of Ho Chi Minh City and the Ho Chi Minh City Export Processing Zone and Industrial Zone Authority (HEPZA) to better understand the influence of Decree 82 on (1) promoting resources efficiency in EIPs, (2) overcoming difficulties and challenges relate to implementing eco-industrial park criteria, and (3) the identification of compliance areas that require further state support.

Interview questions focused directly on perceived changes to the institutional capacity of government actors during the design and promulgation of Decree 82 following the framework outlined above. All interview transcripts were analyzed by deductively coding based on the themes of relational, knowledge, mobilization capacity and the dimensions of each capacity as presented in the previous section and Figure 5.1. Unclear or irregular data from the interviews were triangulated with government regulation and reports from UNIDO, MPI and, where possible, the academic literature.

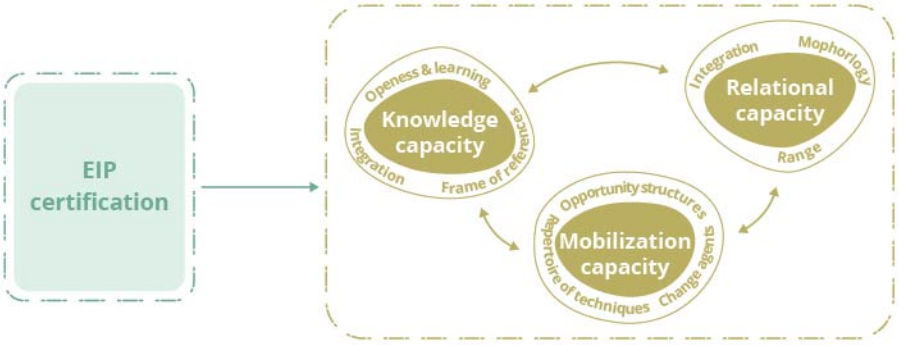


***Figure 5.1*** *Influence of eco-industrial park certification on governmental institutional capacity.*

## 5.4 DECREE 82

Decree 82 defines industrial symbiosis in EIPs as "cooperation between enterprises... to optimise the use of input and output factors, such as raw materials, water, energy, wastes and waste products... and build networks" for developing shared infrastructure, improving technological innovation and promoting business and production efficiency (Article 2, Decree 82/2018/NĐ-CP). The five voluntary criteria for certifying EIPs set out in Article 42 are: (1) Compliance with regulation and ISO management internal management systems; (2) Provision of basic environmental management utilities and services (3) Awareness and application of effective resource use cleaner production; (4) Allocation of land for greenery, traffic works and public utilities in conformity with national construction standards (5) Minimum number of enterprises in industrial parks shall plan to participate in industrial symbiosis (see Box 5.1). These criteria include guidance for investors to comply with legislation in the development of shared infrastructure, and basic utilities, as well as thresholds for the proportion of companies in these parks to be aware of and apply cleaner production technologies, green construction standards and the application of industrial symbiosis strategies.

**Box 5.1** Criteria for determination of eco-industrial parks stipulated in Article 42, Decree 82/2018/NĐ-CP

1. Investors developing infrastructure and enterprises within industrial parks shall strictly comply with legislative regulations on business, environmental protection and labour; may be encouraged to apply the production and environmental management system conforming to relevant standards of International Organization for Standardization (ISO).
2. Investors developing infrastructure of industrial parks shall provide basic services in these industrial zones under the provisions of law, including: basic utilities (e.g., electricity, water, information, fire prevention and control, etc.) and other related services.
3. At least 90% of enterprises in an industrial park are aware of effective use of resources and cleaner production while at least 20% of them apply measures for effective use of resources and cleaner production, reform and improve management approaches and manufacturing technologies to reduce wastes, pollutants and reuse wastes and scrap.
4. A minimum of 25% of the industrial park land shall be reserved for greenery, traffic works and public utilities in conformity with construction standards issued by the Ministry of Construction.
5. At least one industrial symbiosis shall be affected and at least 10% of total number of enterprises in industrial parks shall plan to participate in industrial symbioses.

Article 43 outlines the process and incentive structures for eco-industrial park certification, including self-assessment of compliance to the specified criteria. The certification process is voluntarily initiated by the industrial zone's management board who applies to the four designated key Ministries; MPI, MONRE, the Ministry of Industry and Trade (MOIT) and the Ministry of Construction (MOC). After assessing compliance, eco-industrial park certification can be awarded, affording tax incentives on income, export and import duty as well as land rent exemptions and relief. Certified industrial zones also have access to preferential loans from the Vietnam Environment Protection Fund, the Vietnam Development Bank to "construct technical infrastructure of industrial parks, implement cleaner production methods, efficiently use resources and industrial symbiosis solutions" and "priority in providing information related to the technology market and the possibility of cooperating in effecting industrial symbioses in the scope of production and business activities of these enterprises" (Article 43, Decree 82/2018/NĐ-CP).

Chapter 5 of Decree 82 also provides an overarching set of guidelines for distinguishing the authority and responsibilities of eleven Ministries, the Government Inspectorate, the Provincial People's Committees and the industrial zone Management boards. These guidelines, in addition to the criteria in Article 42 and the incentive structure in Article 43, were the focus of negotiation in the development of Decree 82. They are also the focus our analysis on whether and how this negotiation affected the institutional capacity across these different parts of government during the problem identification, experimentation and promulgation phases of developing the Decree.

## 5.5 CHANGING INSTITUTIONAL CAPACITIES

The promulgation process of decree 82 was divided into three phases: (1) problem identification, (2) experimentation and (3) promulgation. We use the institutional capacity framework to understand how, during the three phases of the design of Decree 82, this regulation changed the institutional capacity of the government to support the development and implementation of eco-industrial park in Vietnam.

### 5.5.1 Problem identification phase

The main goal of UNIDO in the problem identification phase was to create a common understanding of the principles of industrial symbiosis and industrial ecology that would underlie the criteria and incentives of Decree 82. They did this by bringing together four key Ministries with the Vietnam Environmental Protection Fund to develop a common understanding of industrial symbiosis, industrial ecology and its relevance for developing a voluntary certification for EIPs. As we will show in this section, by participating, these Ministries had the opportunity to expand both their knowledge and relational capacity.

During the problem identification phase particular emphasis was given to introducing the concept of industrial ecology and industrial symbiosis, both of which were new to many of the Ministries involved. Subsequently staff from the Ministries reported seeking expert knowledge that could improve their understanding of the challenges industrial zones face in complying with eco industrial park requirements. As Respondent #1 reported, "the concept of eco-industrial parks has [been] introduced to the government and helps them to think about industrial symbiosis". Through their involvement with UNIDO, the Ministries were also challenged to identify technologies for reducing and reusing waste and energy that could enable a minimum number of enterprises to comply with industrial symbiosis goals under Decree 82. As outlined by Respondent #3, this in turn led to demand for ways to "continuosly monitor the improvement of energy and water use efficiency".

The focus on collective solutions to industrial waste and resource use in turn enabled these Ministries to identify knowledge resources that would be more relevant to Vietnamese industrial zones for understanding industrial ecology - including solutions for resource reuse, energy and water use efficiency (UNIDO & MPI, 2018). Knowledge resources were disseminated through a series of workshops run in Can Tho, Da Nang and Ninh Binh in 2016 by MPI, who brought in experts from both the Vietnam Cleaner Production Centre and international experts from SOFIES - an international sustainability project management and consulting firm from Switzerland. The workshops enabled MPI to make decisions on the content of the criteria and incentives in Decree 82. For instance, a representative from MPI (interviewee #4) described how "based on feedback from industrial zones" they "recognized that industrial symbiosis and industrial ecology is not only related to technology". It also involves finance regulations and incentives needed to stimulate coordination of how technologies are implemented and used.

During this initial phase the ministries were also exposed to new knowledge sources relevant for industrial symbiosis and industrial ecology. The same UNIDO workshops also brought in experts from international organizations including the Global Environment Fund, World Bank, German Corporation for International Cooperation (GIZ), private consulting companies such as PricewaterhouseCoopers France, and international and national universities including the University of Cambridge, University of Ulsan and ETH Zurich. These international organizations introduced new knowledge related to industrial symbiosis and industrial ecology that went beyond the prevailing technical focus of industrial organization and industrial environmental management in Vietnam. For example, European-based experts introduced new forms of inter-firm collaboration, and experts from China, Korea and the US introduced new approaches for policy design and planning relevant for implementing industrial symbiosis and industrial ecology.

The problem identification phase also brought opportunities for different government actors to expand their frames of reference for defining both problems and solutions. High ranking Ministry officials were given the opportunity to visit EIPs in Japan (Fukuoka, Kawasaki) and China (Yixing, Tianjin and Beijing) in 2016 and 2017. As respondent #5 argued "They were confronted with experiences of using different mixes of policy instruments for incentivizing industrial zones to include goals on renewable energy and integrating technologies for solid waste treatment and air pollution and the role of networks between industrial enterprise for fostering shared management strategies there". All of these points contributed directly to the development of Article 42. But importantly, also enhanced the capacity of Ministry officials to identify and source relevant knowledge that could ultimately assist in the development of EIPs.

In addition, the workshops and visits in this initial phase also enhanced the relational capacity for cooperation between different ministries and industrial zone authorities. Participants had opportunities to discuss and share information about the implementation of EIP and also used these deliberations to draft Article 43 – such as the need for expanded relationships with domestic and international experts and donors. In particular, MPI expanded and strengthened the range of their relationships with, for example, UNIDO, the Global Environmental Fund, and the State Secretariat for Economic Affairs, Switzerland. At the same time, other key ministries involved indicated that their trust in the capacity and responsiveness of industrial zones also improved through the problem identification phase. As the respondent #3 explained:

"Normally, the ministries just have annual training programs, but only for industrial zones authorities, and then let them spread to industrial zones. But for this project, we directly come to the industrial zones, see, discuss and share [information and experiences] about the benefits of improving resource efficiency with them every 3 months".

Finally, the problem identification phase also enabled key Ministries to recognize the ongoing guidance, to provide an "opportunity structure", for industrial zones to achieve eco-industrial certification. In particular the Ministries became more aware that setting high-level criteria alone would not increase compliance. As a representative from MONRE (#2) explained, "the criteria... still [need] to be more developed to avoid [being too] general... [for this they need to] take into account... multi - disciplines" which, they concluded, requires further guidance by the government through instruments like policy "circulars". Recognition of the need for these circulars represents greater awareness by MONRE on the needs of industrial zones. Once developed, the circulars supported the implementation of Article 43 in practice by, for example, providing guidance around key incentives such as preferential loans. However, no link was made by any of the respondents on how the implementation of these circulars enhanced the scope and range of relations with domestic and international actors, or enhanced their ability to identify the knowledge needed for complying with the criteria of Article 43.

### 5.5.2 Experimentation phase

The experimentation phase of Decree 82 was based around pilot programs designed to implemented and assess the benefits of cleaner production and resource efficiency and provide evidence to the MPI when drafting Articles 42 and 43. This experimentation phase enabled various Ministries to enhance their mobilisation capacity in four key ways.

First, the four key Ministries contributing to the development of Articles 42 and 43 were confronted with the challenges industrial zones faced with existing regulation related to energy and resource efficiency and reuse. By directly visiting the four industrial zones participating in the experimentation phase, the Ministries better understood why current regulation was ineffective by becoming more aware about how regulation constrained progress towards eco-industrial zone development. As argued by an industrial zone authority representative (interviewee #5), MONRE recognized the inadequacy of mandatory policies that did not enable new resource efficiency practices to be put in place. This further enabled them to identify key motivational programs support for industrial zones to adopt cleaner production and efficient use of resources and provided further support for them to develop preferential loans from state financial institutions such as the Environmental Protection Fund.

Second, when designing the criteria in Article 42 and Article 43, the government applied different mobilization techniques to support the design and implementation of Decree 82. Government actors were confronted with the need for improved coordination between government bodies to mobilizing resources in support of industrial zone compliance. In response the MPI established a series of steering committee meetings designed to enable greater cross-level coordination between national government (MPI, MONRE, MOST), local authorities (e.g., the Ho Chi Minh City People's Committee and the Industrial Zone Authorities), research and academia, international development organisations (UNIDO, GEF, SECO), banks and firms operating in industrial zones. This included discussions on policies and guidelines relevant for EIPs spread amongst different Ministries and the need for common methodologies for identifying and engaging relevant and motivated stakeholders. Through this process the various Ministries involved were also confronted with the need to develop a common set of criteria for stimulating cooperation between enterprises and setting incentives such as preferential access to funding. As outlined by one respondent from MPI (interview #4) "this activity contributes to help [us] to think about and build the incentives to certification of eco-enterprises for enterprises that participate in cleaner production, efficient use of resource and industrial symbiosis" – which in turn helped them to jointly define the incentive structure set out in Article 43.

Third, the process of defining Article 42 and 43 also enabled the key Ministries to develop opportunity structures that enabled them to mobilize industrial zones to think through solutions for enhanced resource efficiency and cleaner production. MPI used a survey of 60 companies to explore synergistic strategies for shared energy and water use, as well as the recycling and reuse of chemicals. Through this survey the Ministry was able to stimulate greater understanding by firms of the constraints and opportunities for implementing shared waste or by-product reuse strategies. MPI also subsequently fed the knowledge gained on from this survey back into the design of Article 42 and 43. As a respondent from MPI (Interviewee #3) argued, the survey enabled us to not only "develop the details of the criteria" it also enabled MPI to better define what industrial symbiosis and industrial ecology means when answering questions firms have related to "what is an eco-industrial park"? Following the survey, the other activities such as the expert group meeting were organised in 2018 to engage different levels of government, industrial zones and enterprises to better define the roles and support provided by different levels of government in in implementing and managing EIPs. A representative from HEPZA (interviewee #10) confirmed this by explaining how these discussions also fed back into "defining the specific responsibilities and authority of Ministries and Industrial Zone Authorities under Decree 82".

Fourth, MPI enhanced their mobilization capacity by identifying change agents in the experimentation phase. These change agents include the Ministries involved in the UNIDO project (MPI, MONRE, MOST and MIT) who, as interviewee #4 explained, gave "comments for this design of Decree 82". More importantly, however, MPI and other ministries identified their own role in developing EIPs, which included enabling firms to better understanding key concepts of resource use efficiency and how to develop compliance strategies. For example, MONRE decided through this process to prepare Circulars for guiding reuse of waste and energy, and MOST decided to develop technical guidance to industrial zones for inspecting and evaluating the reuse of waste.

### 5.5.3 Promulgation phase

By July 2018 the Ministries moved to promulgate the eco-industrial certification scheme under Decree 82. This phase required both the Ministries and the Industrial Zone Authorities to not only understand the challenges of implementing eco industrial park principles, but also to ensure that existing policies and regulation across the full spectrum of government was aligned to support the implementation of Decree 82. As respondent #5 explained, they were faced with having to formalize "the definition of eco-industrial zones, [as well as the] criteria and incentives needed to integrate into the national regulation to embed the development of EIPs with central policy system". In doing so the Ministries involved enhanced their mobilization capacity, which in turn positively affected other institutional capacities.

First, the Ministries developed a series of Circulars designed to guide the implementation of Decree 82. These Circulars, as one respondent from MONRE (interviewee #1) argued, are important because they "serve as national technical guidelines for both industries and government authorities". This meant that when writing these circulars, the Ministries were forced to understand how their existing regulations and policies affect the capacity of industrial zones to develop strategies for industrial symbiosis and ecology and, as such, compliance to Decree 82. This led to Ministries stipulating the need for those working in government to review and evaluate and adjust legal documents when conflicts of ambiguities emerge. As the respondent #8 outlined, the Circulars enabled "companies interested in achieving that certification, [to overcome being] hesitant and [enabling them] to start the [certification process]". By adjusting these legal documents, the Ministries provided opportunity structures to mobilize industrial zones, not only enabled investments and compliance to Decree 82 - but also improved the governance of resource use efficiency in a wide range of industrial zones across the country.

As a representative from MPI (interviewee #3) argued, "the national EIP guidelines provide a mechanism to operationalize the development of EIPs in Vietnam and its institutional framework in more than 300 industrial zones across the country".

Second, during the promulgation phase the government bodies involved realized the need for a new formation of the National Steering Committee, the Central Management Agency of the IZs, and the Development Center of IZs in each province, and coordinating the transition of industrial zones to eco-industrial zones. The idea for this committee was first raised during an intensive two-week training in Switzerland in 2019 and then elaborated through discussions with UNIDO and World Bank. The committee, Central Management Agency and Development Centres provided a new means of not only establishing but continually reflecting on the effectiveness of the eco-industrial zone program as a whole, including the iterative adjustment of regulation and policies to guide and support the transition to certification under Decree 82. It also enabled the Ministries to ensure that industrial ecology principles became more widely employed than only within the certified industrial zones. The knowledge gained from the initiation and experimentation phase were, as such, shared more consistently between government departments and with industrial zones, which has in turn set a basis upon which to maintain and improve knowledge and mobilization capacities into the future. In addition, the MPI also more clearly understood their role in in steering this transition as a change agent – again building on the previous two phases. A representative from MPI (interviewee #4) argued "we saw a faster decision and promulgation process of this decree compared to other policies, within a year". Not only has this surprised those working in MPI, they already see opportunities for using the capacities they had developed during the development of Decree 82 to revise or develop new policies into the future.

## 5.6 DISCUSSION

Our results demonstrate the effect of developing a voluntary public standard for certifying eco-industrial park on the institutional capacity of the Vietnamese government. In doing so we show how the impact of public standards can extend far beyond the linear, deontic logic of rule compliance (Ostrom & Basurto, 2011). These results also go beyond an understanding of effect in terms of institutional interplay between standards, policy and regulation – commonly understood in terms of driving alignment or a 'ratcheting up' of stringency (e.g. Anh et al., 2011; Gulbrandsen, 2014; Ponte et al., 2021). Instead, we observe four ways in which public standard creation affects the institutional knowledge, relations, and mobilisation capacities within the Vietnamese state with positive consequences for achieving eco industrial park beyond the certification program alone.

Our results first demonstrate the role public standards play in enhancing the capacity of the state to better coordinate eco industrial park when faced with new, fragmented or complex regulation and policy. The standards and certification mechanism outlined in Articles 42 and 43 of Decree 82 provided a 'boundary object' (see Dong & Chuc, 2018) around which government actors were confronted with eco industrial park by creating a common set of principles, criteria and incentives for other government actors (including relevant Ministries and Industrial Zone Authorities). The standard setting process forced those Ministries involved in setting these standards to identify policies and regulation that were either not aligned or created confusion amongst industrial zones in terms of the goals and/or sources of support for implementing energy and resource efficiency strategies. The process of developing Decree 82 also enabled them to enhance their capacities for gathering knowledge, mobilizing other parts of government to change policies and regulation, build relations in and outside of Vietnam, and ultimately change their own policy processes to enable industry zones to learn and comply with

ambitions for eco industrial parks. Seen as such, these public actors did not only 'learn' about institutional limitations, as is commonly observed, but also developed a converging set of capacities that hold the potential for extending the overall ability of the state to govern sectors beyond energy and resource efficiency of eco industrial parks.

We also observe a chronological effect of public standard development on the institutional capacity of the Vietnamese government. Similar to Boons and Spekkink (2012), who argue that relational and knowledge capacity are the starting point for institutional capacity change, we found that Decree 82 first enabled the knowledge and relational capacity of the state. Across the three phases of problem identification, experimentation and promulgation we observe how different parts of the Vietnamese government gained new knowledge on industrial ecology when faced with defining principles, criteria and the incentive structures. Reflecting the findings of others (see Tollefson et al., 2009; Gale & Haward, 2011; Gulbrandsen, 2014; Lister, 2011), the definition, testing and experimentation of standards enabled the government to not only transfer knowledge to industrial zones. However, it also enhanced the capacity of Ministries and the Industrial Zone Authorities to create new opportunities for iterative knowledge exchange around the achievement of eco industrial park that would not have otherwise taken place (cf. private standards - Martinez & Poole, 2004).

Third, our analysis indicates that the different demands of the different phases of standard setting led to different knowledge needs. This meant that the Ministries and Industrial Zone Authorities moved beyond exchange and learning around the definitions of eco industrial park, to establishing ongoing problem-oriented knowledge exchange in the experimentation and promulgation phases. Confronted with the problem-oriented knowledge exchange required the concurrent improvement of relational capacity as these state actors sought national and internationally partners who could assist with innovations for technology, policy and incentive structured for promoting industrial ecology. This combination of knowledge and relational capacity together enhanced the mobilization capacity of the state by strengthening the incentive structures for industrial zones and enterprises to comply with existing regulation. This demonstrates the different ways in which these actors use prevailing opportunity structures to mobilize other government bodies to engage with industrial zones to comply with Decree 82.

Finally, we find that enhancing institutional capacity of public actors that define public standards can enable states to develop and employ new ways of organizing and performing industrial coordination, especially in complex policy areas, such as eco industrial park, that are covered by multiple parts of government. While compliance by industrial zones remains the functional goal of these public standards, the improvements to state institutional capacity enabled by these public standards - across the key phases of problem identification, experimentation and promulgation - demonstrates their broader and potentially more systemic impact. Enhanced institutional capacity, as such may be even more important than other observed effects of public standards – including guiding regulatory compliance (Samerwong et al., 2018; York et al., 2018), creating vanguard objectives (Daddi et al., 2016), fostering legitimacy (Samerwong et al., 2018) and/or reclaiming rule making authority (Giessen et al., 2016). This recognition holds opportunities for more explicitly using the standard setting processes as a means of coordination rather than just for the technical definition of principles and criteria. The three institutional capacities outlined in this article could then be used as a set of 'input' criteria to organize internal interaction between different parts of government and between government and supportive non-state actors (Mena & Palazzo, 2012). By making capacity development a goal of public standards, albeit a non-assessed goal, the role of public standards in complex environmental governance settings can be far more precise than is currently the case.

While focused on the development of a public standard, our results also hold relevance for understanding the wider institutional effects of private standards (building on, for example, Gulbrandsen 2014). The effects of private voluntary standards have predominantly focused on state rule making and governance (e.g., Bartley, 2011), as well as (albeit in limited way) the capabilities of end-users (Samerwong et al. 2020). Applying the institutional capacity framework outlined in this paper for to these effects of private standards on state actors remains an open question. Given these state actors play a far lesser role in the development of private standards their impact on governmental institutional capacity may be limited. However, extending the chronological perspective developed here, the effects of private standards on the institutional capacities of the state may occur at different moments in the process of compliance or standard revision. Such analysis could extend a wider understanding of the how changing institutional capacities in response to standards (both public and private) can enable of achievement of the complex goals beyond, as argued above, the deontic logic of rule compliance.

## 5.7 CONCLUSIONS

Based on our assessment of how the institutional capacity of the Vietnamese state changed as a result of the development of Decree 82, we conclude that the benefits of public standards extend beyond improving end-user compliance with environmental standards, the focus of much of the current literature. Furthermore, we develop an improved understanding of how public standards can enhance the capacity of state actors to develop the kind of inter-ministerial coordination needed for engaging in complex transitions to industrial ecology. These findings, as such, hold relevance for understanding the effect of certification and standards in other fields beyond standard compliance alone.

More specifically we show that an institutional capacity offers a framework for understanding how standards improve coherence between different parts of government when faced with fragmented and complex regulatory settings. The approach also provides a basis to redesign standard setting processes to move beyond end-user compliance to create a systemic approach for enhancing the capacity of public actors to engage with industrial ecology and develop eco-industrial park, that require coordination across multiple policy domains. From this perspective, institutional capacity, and its relation to rule making in general terms, can provide insights to how public actors can more effectively address 'systemic' sustainability challenges – from circular economy ambitions to the Sustainable Development Goals.

What potential institutional capacities are affected by public (and private) standards addressing these wider challenges are an area if further research. This could include further investigation on the effects of the public standard and how enhanced capacities affect their implementation in practice. We also see opportunities for extending the framework to examine the effect of voluntary private standards on the state.

# Chapter 6

# Discussion and Conclusion

## 6.1 GENERAL DISCUSSION

This thesis has examined the ways in which institutional capacity influences the achievement of water use efficiency, as an example of industrial ecology and industrial symbiosis, in Vietnamese industrial zones. More specifically, using the case of Vietnamese industrial zones, which increasingly compete for water with growing urban populations and the agriculture sector (Giuliani et al., 2019; Ray & Shaw, 2019), the thesis has demonstrated that both the degree and form of industrial symbiosis and industrial ecology is shaped by the interactions between different levels of institutions and the institutional capacities of key actors across these levels.

Recalling Wang et al. (2017) and Song et al. (2018), industrial symbiosis assumes that relations among industrial enterprises are essential for enabling the flow of materials and resources, including by products, water and energy. However, the field of industrial symbiosis predominantly focuses on the relations between industrial enterprises – that is, those that are directly responsible for or have control over these material flows. Such analysis constitutes both the micro and meso level – that is, relations within and between firms often operating in the context of an industrial zone. Meanwhile, industrial ecology not only focusing on relations on industrial zones and firms level but also at system level, among industrial system and the natural system and/or city system (Li, 2017). Water use efficiency contributes to the achievement of industrial symbiosis and/or industrial ecology that depending on the strategies and the boundary or the level of this implementation (Jia et al., 2016).

Additionally, following Boons and Spekkink (2013), industrial symbiosis is dependent on the capacity of actors operating across these institutional levels to not only respond to incentives and/or comply with rules and regulation, but also create opportunities for innovation, including water use efficiency innovations (see also Boons & Spekkink, 2012; Vahidzadeh et al., 2021; Wang et al., 2017). Also, improved water use efficiency through industrial ecology requires realistic stragegies for building capacities and relations for enabling the circular water flows (Mavropoulos & Nilsen, 2020). How exactly the institutional capacities of actors at meso and macro institutional levels affect how, where, by whom in what form industrial symbiosis can be achieved has been the common focus of the four preceding empirical chapters.

In summary, each of the chapters focused on different interactions between institutional-levels and institutional capacities. Chapter 2 focused specifically examined the enabling roles of industrial symbiosis networks in promoting water use efficiency that extend beyond meso-level inter-firm relations to wider extra-firm policy, societal, economic and knowledge networks in Vietnam. Chapter 3 explored ways in which this institutional capacity is affected by the macro-institutional hierarchy of the centralized Vietnamese state. Chapter 4 showed how perceptibly rational responses to economic policy instruments are dependent on these actors' wider meso level of institutional capacity to enable innovation and change. Finally, Chapter 5 showed how the macro level capacity of state actors needed for engaging inter-ministerial strategies for industrial ecology can be stimulated through the development of public standards for eco-industrial zones. Not only have these chapters shown interactions between institutional capacities and institutions at different levels exist, but also that these are interactions are both multiple and highly dynamic.

This final chapter, discusses these overall observations by addressing the three main questions posed in Chapter 1. First, how does the interaction between different capacities influence the implementation of industrial water use efficiency in Vietnamese industrial zones? Second, how do institutions affect the institutional capacities of industrial zones to implement industrial water use efficiency in Vietnam?

And third, how do institutional capacities of the Vietnamese state and industrial zones influence institutions that support the implementation of industrial water use efficiency? Based on the answers to these questions an overall theoretical reflection is given on how institutional capacity can offer a more dynamic understanding of institutional change towards industrial symbiosis and industrial ecology.

## 6.2 KEY FINDINGS OF THE THESIS

### 6.2.1 Positive vs. negative reinforcement between institutional capacities

The first major finding of this thesis is that while interactions between institutional capacities can be both positively and negatively reinforcing. Positively reinforced institutional capacities enable actions towards industrial water use efficiency, while negatively reinforced institutional capacities also undermine the realization of industrial water use efficiency. More specifically, the results demonstrated a range of negative interactions as a result of centralized institutions undermining the development trust and cooperation to develop shared water use efficiency strategies. The second major finding is that, following Boons and Spekkink (2012), there is an order to the interaction between institutional capacities that enable actors at the meso level to overcome the constraints placed on them by centralized macro institutions of the state. In short, by enhancing relational capacity (enabling trust) knowledge capacicty (specifically mutual understanding) and mobilization capacity (new opportunities structures) can be developed to enable individual and collective strategies for water use efficiency to be developed within industrial zones. Three observations from the preceding chapters support this claim.

First, in line with Boons and Spekkink (2012) and Healey et al. (2003), the results repeatedly show the various ways in which knowledge, relational and mobilization capacities interact with each other. For example, industrial zones demonstrate a level of internal relational capacity to engage clients when translating the externally derived wastewater levy, which in turn enabled them to enhance their knowledge and mobilization capacity to establish effective pricing mechanisms for poor wastewater conduct (Chapter 4). The combined effect of the three capacities meant they were able to set this pricing mechanism within the parameters of current used water efficiency technologies and the existing practices of their client companies. Furthermore, the analysis of public standard development in Chapter 5 indicates that improvements to relational capacity can lead to improvements in knowledge and mobilization capacity. The results also showed that relational capacity changed the nature of knowledge exchange and learning over time - from an initial focus on the definitions of eco-industrial parks to a later focus on problem-oriented knowledge exchange through experimentation in the promulgation phases of the standard. The combination and accumulation of knowledge and relational capacity together enhance the mobilization capacity to strengthen the incentive structures for industrial zones and enterprises to comply with existing regulation and employ new ways of organizing and performing industrial coordination. The results reinforce their observation that not one, but all three capacities, in interaction with each other, are essential for industrial zones to identify, negotiate, develop trust and implement water use efficiency strategies.

Second, the chapters variously show how interactions between the three capacities are limited by centralized policy and decision making in Vietnam. A constant theme running through the empirical chapters is that industrial zones cannot act without the consent and support of the state to develop new strategies for water efficiency innovation and industrial ecology - as also observed by others (van Leeuwen et al., 2016; Yoon & Nadvi, 2018). Because these centralized institutions weaken rather than strengthen key institutional capacities, such as mutual understanding of each other's interests,

trustable and open relationships between stakeholders to share and collectively produce knowledge around key industrial ecological issues remain limited. Following Boons and Spekkink (2012), the absence of liberal institutions that enable open communication undermine the internalisation of knowledge and willingness of public and private actors to collaborate in the development of shared strategies for water use efficiency.

For example, as shown in Chapter 3 and Chapter 4, the limited relational capacity to foster interaction between industrial zones and lower levels of government has in turn created barriers to the exchange of information. This in turn affects industrial zones access to the knowledge and their capacity to build trust and mutual understanding with higher levels of government. As a result, industrial zones are not able to develop the opportunity structures that support the design and adoption of water use efficiency technology at industrial zone level. As shown in Chapter 4, industrial zones are interested in enhancing the quality of the wastewater they reuse, while the government does not have the regulation for guiding reuse, and undermine efforts to enhance water quality by focusing on the reduction of wastewater discharge. This 'negative reinforcement' dynamic is furthermore shown in Chapter 3 by the weak capacity of industrial zones to build alternative networks of trust and mutual understanding and sharing of knowledge with non-state actors. This in turn reduces their opportunities to engage and/or create (i.e., mobilize) opportunity structures, including legal and/or financial instruments, that might assist industrial zones in incentivizing client firms to work toward water use efficiency strategies.

Despite the considerable evidence of negative reinforcement dynamics, however, positive reinforcement dynamics do still appear possible. As shown in Chapter 5, the order with which capacities are developed and exercised affects how and when they can cumulatively interact. In the case of developing public standards for eco-industrial zones, the development of knowledge and relational capacity by state actors were a pre-requisite for the public standard to enable mobilization capacity both in terms of linking to other public actors (Ministries and Departments) and industrial zones. Such 'ordering' supports Boons and Spekkink (2012), who identified the starting point for the change of institutional capacity to usually be relational and knowledge capacity. By enhancing these two capacities, opportunity structures can be created that strengthen the mobilization capacity of the government and industrial zones alike. For example, the knowledge capacity of the government cumulatively increased across the three phases of problem identification, experimentation and promulgation. The improved knowledge capacity also enhanced the mobilization capacity of the government to create new opportunities for iterative knowledge exchange around the achievement of eco industrial park that otherwise would not have taken place.

### 6.2.2 Macro and meso institutions shape institutional capacities

The results also show that institutions both enhance and undermine the institutional capacity necessary for industrial water use efficiency. The empirical chapters show how the interactions between these three capacities and the prevailing macro and meso institutions (through the policy instruments they employ) affect institutional capacities. The results show, albeit to a limited extent, that positive reinforcing relationship between the meso-level institutions can enable the development of industrial zone capacities for developing water use efficiency strategies. The clearest example of this was the development cost sharing to comply with the Ho Chi Minh City wastewater levy (Chapter 4). Nevertheless, the results also show that macro institutions, such as the development of public standard for eco-industrial park certification (Chapter 5), ultimately reinforces the states control over the extent to which industrial zones are able to engage in innovation processes for developing new water use efficiency strategies. The following identifies three specific ways in which macro and meso institutions differentially enable and undermine the capacity to develop a requisite level of institutional capacity to support water use efficiency innovation.

First, meso-level institutions reflect the level of institutional capacity exhibited by the industrial zones to stimulate both compliance and innovation. However, the results show that compliance to these rules and norms is largely performative in nature - meaning they enable the industrial zones to cope with changing demands and regulation from higher levels of governance without stimulating innovation towards water use efficiency, a part of industrial ecological outcomes (Bertello et al., 2022; Ngo, 2020). It is precisely the focus on strategies of compliance that undermine any ambition to innovate. To illustrate, Chapter 4 outlines how the Hiep Phuoc Industrial Zone was able to implement regulation for their clients to share the cost of the wastewater levy set by the government in Ho Chi Minh City. The industrial zone was able to respond to the levy by using their relational capacity to engage their clients and re-negotiate an onward payment to cover the additional cost. Hiep Phuoc also demonstrated the capacity for setting up an opportunity structure through establishing their own regulation for using service fees to share the cost. At the same time, however, these meso-level institutions reflect the limitations of relational and mobilization capacity. While the translation of the Ho Chi Minh City water levy into a service fee reflects a capacity of industrial zones to comply through cost sharing, the application of a levy did not enable industrial zones to develop their capacity to innovate wastewater practices.

Second, the institutional capacities of industrial zones for developing strategies for water use efficiency are heavily conditioned by macro-level institutions of the state. Furthermore, the focus on 'administrative' collaborations with government (as seen in other sectors in Vietnam, e.g., KimDung et al., 2016), which are largely devoid of content or reflection on strategic needs of industrial zones, means there is limited to no support for acquiring knowledge, relationships or capacity to create more opportunity structures for enhance water use efficiency strategies (Chapters 3 and 4). The strong reliance of industrial zones on macro institutions (regulations, rules and norms from DONRE, MONRE, Provincial People's Committee) limits the relational capability of industrial zones to foster relations with non-state actors could help them to implement technological innovation, achieve regulatory compliance and/or deal with high levels of state bureaucracy. Industrial zones are prescribed goals for water use efficiency and contributes to industrial ecology and industrial symbiosis implementation. However, they are not afforded the means to develop their institutional capacity needed to achieve these goals. The industrial zones are as such faced with a form of administrative decentralization (Bruun & Rubin, 2022), giving them statutory responsibility for innovation, but not the necessary knowledge, relationships, or capacity to create opportunity structures for innovation.

Finally, in spite of evidence of macro institutions constraining the institutional capacity of Vietnamese industrial zones, there is also evidence of positive effects on institutional capacity. As shown in Chapter 5, the development of Decree 82 enables Ministries to enhance their capacity for setting codes, standards and rules for industrial ecology and industrial symbiosis. They developed (1) their knowledge in order to tackle the challenges of eco industrial park development; (2) their relational capacity to cooperate between different ministries and industrial zone authorities and (3) their mobilization capacity to provide opportunity structures for industrial zones to achieve eco industrial park certification. These results show, albeit tentatively, that the macro institutions such as the development of public standard, enabled state actors to develop the knowledge, relational and mobilization capacities to overcome fragmentation of policies and regulations across the various Ministries. It remains unclear, however, whether and to what extent these capacities within the state also extend to supporting meso-level institutions and actors that can foster innovation in the process of complying to these eco-industrial zone standards.

### 6.2.3 Institutional capacities variously affect meso and macro institutions

The third major finding of this thesis is that the institutional capacity of actors at both meso and macro levels appear, albeit tentatively, to affect the development of meso and macro institutions aimed at enabling industrial symbiosis and ecology strategies for improved water use efficiency. Evidence from the empirical chapters indicate both positive and negative effects of enhanced institutional capacity on both meso and macro institutions at both levels. Whether positive or not, these findings support Wang et al.'s (2017) claim that institutional capacity building not only contributes to resolving economic and technological problems related to industrial symbiosis, but also policy problems. They also support Boons and Spekkink's (2012) claim that enhanced relational capacity can influence policy processes that either enabling or inhibit the development of industrial symbiosis and industrial ecology.

Positive reinforcing effects of macro institutional capacity on macro institutions observed in this thesis points to a systemic understanding of capacity, institutions and innovation. Emphasizing the role of capacities to shape institutions challenges the dyadic understanding rule-compliance - that is, two parties engaged in rules set independent of and exerting power over practices (Thiemann & Lepoutre, 2017). As shown in chapter 5 of the thesis, the development of institutional capacity can also enable multiple policy actors to directly shape the goal and content of institutions, including their means of control. As illustrated above in section 6.2.2, the ordered interaction of knowledge and relational capacities enabling mobilization capacity can empower policy actors to overcome the institutional fragmentation undermining problem identification and implementation in Vietnam (see for e.g. Kissinger et al., 2021). This observation has wider implications for moving rule setting and rule compliance as an end goal in complex policy issues such as the implementation of industrial ecology. Instead, it points to the capacities as 'means' or pre-requisite condition for not only the design of institutions, but also their effectiveness to shape or co-produce compliance and innovation (Samerwong et al., 2018; York et al., 2018). While a tentative observation, based only on the findings of Chapter 5, it opens up the possibility to rethink how rule-compliance can be understood and governed.

Negative reinforcing effects were also observed between macro institutional capacity improving the capacity of macro institutions to guide and support the implementation of the public standard for eco-industrial zones. Also building on the observation in 6.2.2, the results show how meso institutional capacity can undermine the design and implementation of meso institutions, such as setting economic incentives for industrial zones to enhance water use efficiency. As shown in Chapter 4, the limited institutional capacity of industrial zone infrastructure company explains to a large extent why they were unable to implement the levy. But it also showed that the industrial zone infrastructure company also lacked the capacity to engage with the government at the macro level to influence the design of what they experienced as a poorly designed instrument. This case again, in line with Phuong et al. (2018), emphasizes how limited meso-level institutional capacity undermine attempts to shape macro institutions characterized by a strongly hierarchical structure and centralized process of planning, regulation and policy.

## 6.3 THEORETICAL REFLECTIONS

### 6.3.1. Five dimensions of dynamic interplay

The findings of this thesis outlined above point to the importance of understanding the dynamic interplay between multiple levels of institutions and institutional capacity in the pursuit of water use efficiency, a part of industrial ecology and industrial symbiosis. These findings, as such, extend the

observation that industrial water use efficiency are not limited to the implementation of technologies, but instead fundamentally dependent on (1) relationships between enterprises and industrial managers within industrial parks and (2) relationships between enterprises and industrial parks with a wider set of actors embedded in cross-level policy, economic and social networks (Boons & Spekkink, 2012; Vahidzadeh et al., 2021; Wang et al., 2017). The findings also point to the fundamental dynamic interplay between institutions and institutional capacity in supporting industrial ecology and industrial symbiosis which water use efficiency is part of those (Boons & Spekkink, 2012; Saavedra et al., 2018; Wang et al., 2017). Such a dynamic understanding of institutions and institutional capacity, the following argues, has the potential of opening up new ways of understanding industrial symbiosis and ultimately enabling systemic change towards industrial ecology.

Based on these empirical results of this thesis the dynamic interplay between institutions and institutional capacity can be characterized through five dimensions. First, dynamic interplay is characterised by the constant interaction between knowledge, relational and mobilization capacities. Second, while the order of this dynamic interplay is not fixed, there is a tendency for relational capacities to catalyse knowledge and mobilisation capacities, which in turn create and/or perpetuate the relations needed for industrial symbiosis (cf. Wang et al., 2017). Third, dynamic institutional capacities can enable a range of opportunity sets (building on Boons and Spekkink, 2012), to emerge through which actors can identify opportunities for innovation towards industrial symbiosis, Fourth, dynamic interplay between institutional capacities is dependent to a large extent on macro institutions, and to a lesser extent on meso-level institutions. Finally, feedbacks between capacities and between capacities and institutions can lead to both positive and negative reinforcement that either limit or enable innovations towards industrial ecology and industrial symbiosis.

The following further elaborates these empirically derived dimensions of dynamic interplay to propose a new dynamic model of institutional capacities. Coming full circle, this model responds to the theoretical proposition outlined in Chapter 1 that patterns of interactions between institutions and institutional capacities can be identified and generalised (as illustrated in Figure 1.2 on page 12 of this thesis). By elaborating a model of dynamic institutional capacities, this thesis contributes a means of understanding new ways of enabling transitions to industrial symbiosis and ultimately enabling systemic change towards industrial ecology.

### 6.3.2 A dynamic institutional capacity model

The dynamic institutional capacity model, illustrated in 6.1, shows how institutional capacities and institutions interact in continual multiple directions across macro, meso and micro levels. These interactions can be seen separately - between capacities or between levels. However, as argued above, these interactions between institutional capacities can perpetuate new relations and opportunity sets, and may also lead to positive or negative reinforcement. Seen as such, these interactions are linked in through "dynamic pathways" - either within an institutional level (red arrows in Figure 6.1) or between levels (green arrows in Figure 6.1). These pathways open up the possibility to trace out how the development and/or employment of institutions or institutional capacities at one institutional level can have an effect on both institutional capacities and institutions at another level. In turn, they enable identifying combinations of interactions that lead to positive reinforcement pathways that support innovation towards industrial ecology and industrial symbiosis, or negative reinforcement pathways that undermine innovation towards industrial ecology and industrial symbiosis.

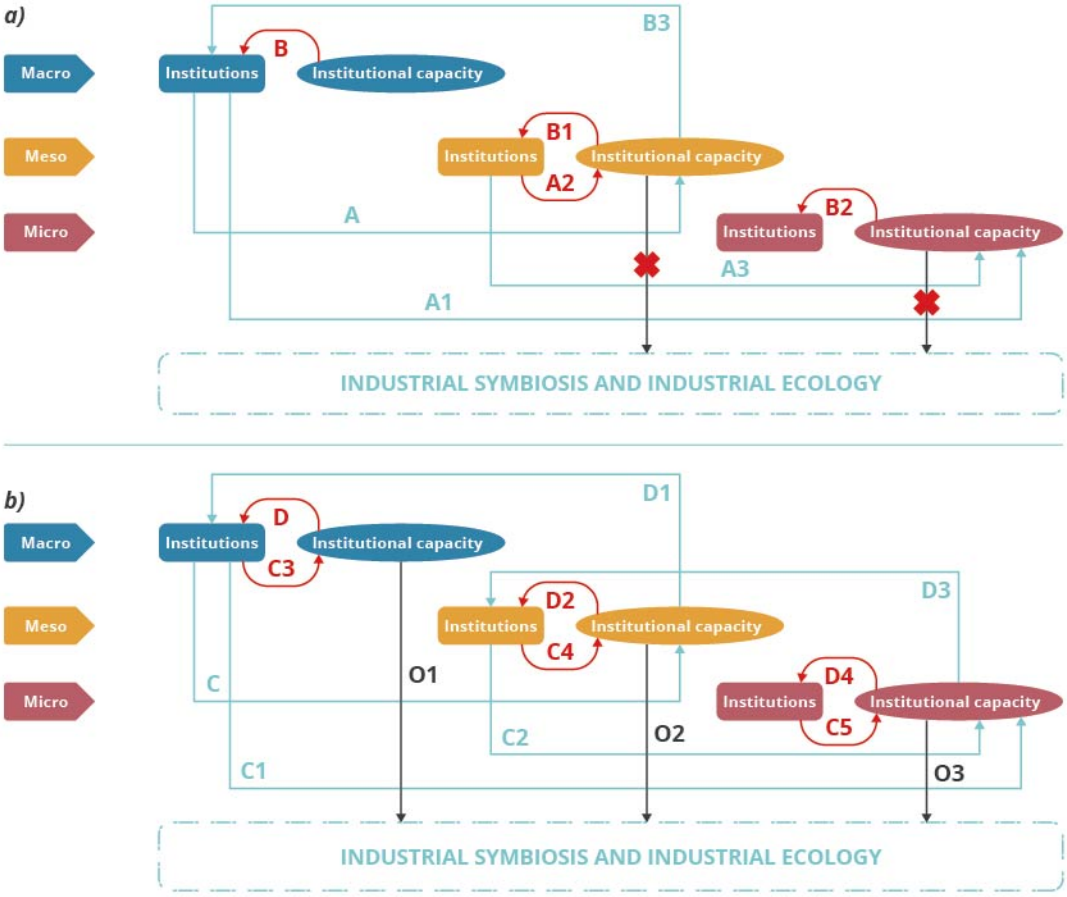


***Figure 6.1*** *Dynamic institutional capacity model for industrial symbiosis and industrial ecology development. Notes: Sub Figure a. illustrates negatively reinforcing pathways. Sub Figure b. shows positively reinforcing pathways. A and B arrows presents the undermining relations of institutions on institutional capacity and institutional capacity on institutions, respectively. C and D arrows illustrates the reinforcing relations of institutions on institutional capacity and institutional capacity on institutions, respectively. O arrows describes the industrial symbiosis and industrial ecology outcomes of changing and improving institutional capacity at different levels. Red crosses indicate where industrial symbiotic and industrial ecology outcomes are undermined or blocked.*

The dynamic interaction between institutions and institutional capacities leading to negative reinforcement, as various observed throughout the preceding chapters, is illustrated in Figure 6.1a. Arrows A and A1 represent the dominant effect, as seen in the case of Vietnam, of macro level institutions on the meso and micro level institutional capacity. In short, these institutions prescribe enforce rules and norms that assume industrial zones and their client firms have the knowledge, relational and mobilization capacity necessary for developing technological innovations toward industrial symbiosis. The misalignment with institutional capacities at the meso and micro levels can also in turn undermine the effective design and implementation of institutions at these same levels (as illustrated by arrows B1 and B2). And because these meso and micro institutions do not reflect the

institutional capacities, they are in turn less likely to set rules and norms that effectively shape the knowledge, relational and mobilization capacity necessary for building trust and mutual understanding, as well as shaping the exchange between firms in such a way to mobilize the development of symbiotic exchange between firms (as illustrated by arrows A2 and A3). This cascade of negatively reinforcing interactions between institutions and institutional capacities can become a systemic barrier for industrial ecology development if capacities are also not developed to overcome constraints to changing the macro institutions at the start of the pathway (indicated by arrow B3).

The negatively reinforcing pathway outlined here reflects wider debates on industrial system change. First, it shows that the role of macro level (centralized) policy and regulation are not just exogenous "drivers" of industrial system change (Patanakul & Pinto, 2014; Tudor et al., 2007). Instead, macro institutions shape but are also shaped by institutional capacities. Second, the model shows that institutional capacities can be shaped in ways that both undermine and enable new practices and technologies to be developed and implemented, as well as enable changes in the institutions that those carrying capacities are subject to. This dynamic nature of institutional capacities enriches a relational institutional perspective to industrial symbiosis and industrial ecology by (1) explaining why symbiosis does not occur and (2) identifying leverage points (following Haller et al., 2022) for systemic change that enable desirable outcomes to be reached. While not empirically observed in this thesis, these fundamental insights open up the possibility to identify how positively reinforcing pathways comprised of interactions between institutions and institutional capacities could contribute to industrial symbiotic and industrial ecology outcomes.

What then might a positively reinforcing pathway made up of interactions between institutions and institutional capacity look like? Figure 6.1b provides a broad schematic of the potential interactions across macro, meso and micro levels, and highlights the further potential for all three levels to mutually reinforce innovations supporting industrial symbiosis (Arrow O1, O2 and O3). Central to these pathways are reinforcing interactions between institutions and institutional capacity within each level - as illustrated by the paired notation of D-C3 at the macro level, D2-C4 at the meso level and D4-C5 at the micro level. For example, meso institutions that reinforce collaborative relations within industrial zones can lead to the development of new water use efficiency strategies, such as cascading or water reuse between firms. At the same time, internal rules and norms at the firm level may be in turn reinforced by the engagement with knowledge programs at the industrial zone level (arrow C2). The same can be imagined between the macro and meso level. Such a pattern is also supported by the findings of this thesis where Chapter 5 showed internal reinforcement within the macro level (D-C3). If this then leads to support for the meso level (represented by arrow C) then learning, trust and innovation within eco-industrial parks could be a positively reinforcing step in the pathway.

A further key set of interactions to form a positively reinforcing pathway are feedbacks from lower to higher institutional levels. To illustrate, reinforcing institutional capacities at the micro and meso levels can support, for instance, improved knowledge and/or collaborations with key actors that provide opportunities for accessing knowledge and financial support for industrial ecology and industrial symbiosis development. Enhanced institutional capacities cannot only enable more effective implementation of or compliance to regulation, but also enable actors within these levels to shape the rules and norms (i.e., institutions) at higher levels (as illustrated by arrows D1 and D3 in Figure 6.1b). If these feedbacks are made possible, then higher level institutions can in turn not only focus on compliance, but also on providing support to the development of institutional capacities for knowledge creation, relations building and mobilizing opportunities for innovation and change.

In summary, the value of the dynamic model is to understand how continual multiple interactions between macro, meso and micro institutions and institutional capacities can either reinforce or undermine systemic change. It also identifies a theoretical basis to understand the kinds of changes needed to support systemic change for innovation by supporting institutional capacities, not just developing institutions aimed at technological transfer and rule compliance.

## 6.4 POLICY RECOMMENDATIONS

The thesis has emphasized institutional capacity is considered to be a means of understanding the development of water use efficiency and industrial ecology. A principal recommendation for both state and non-state actors, who desire to work towards resource use efficiency enhancement and industrial ecology development, is a new way of understanding and ultimately enabling systemic change towards industrial ecology by understanding the dynamic institutional capacity model that show how institutional capacities and institutions interact in continual multiple directions across macro, meso and micro levels. The dynamic institutional capacity model shows that not only macro institutions can reinforce or undermine the institutional capacities of actors, but also that institutional capacity can reinforce or undermine institutions that provide the foundation for designing and promulgating regulations that foster industrial ecology. These interactions can be seen as linked in through what can be called "dynamic pathways" - either within an institutional level or between levels.

First, because of the failure of economic instrument implementation in Vietnam for 30 years, affirming the argument from previous research (Phuong & Richard, 2011; Turner et al., 2019 ), the thesis demonstrated that a higher price is not enough to enable the implementation of water use efficiency strategies in industrial zones. Building on the dynamic institutional capacity model, the government should actively initiate a pathway that will support industrial zones' capacities, for instance, by enhancing the mobilization capacities to engage clients in innovation by increasing trust between government and clients (relational capacity) and, relatedly, ensure access to the necessary knowledge (knowledge capacity) for new technologies and strategies of innovation that directly lead to industrial ecology development.

Second, for the implementation of a public eco industrial park standard, as in chapter 5 shown enhanced institutional capacity of the state could to further develop the kind of inter-ministerial coordination needed for engaging in complex transitions to industrial ecology. Institutional capacity framework could then be used to understand a dynamic pathway that can help to redesign the standard-setting processes to move beyond end-user compliance to create a systemic approach for enhancing the capacity of public and target actors. This creates opportunities for more explicitly using the standard processes as a means of coordination rather than just for technical definition of principle and criteria to engage with industrial ecology and develop an eco-industrial park. The dynamic institutional capacity model can provide insights to how public actors can more effectively address 'systemic' sustainability challenges - from circular economy ambitions to the Sustainable Development Goals, by understanding that multiple pathways exist rather than it always being a hierarchical waterfall of central regulations that are expected to influence the lower levels and generate end-user compliance.

Third, and most importantly, the thesis has shown the significant undermining effect of centralized macro institutions on the institutional capacity of industrial zones. Although there are several policies and regulations that state to encourage the implementation of water use efficiency, the centralized

planning and management and hierarchical decision-making of Vietnamese state in fact limits the relational, knowledge and mobilization capacity of industrial zones to implement water use efficiency strategies. The dynamic institutional capacity model provides a new approach to achieving industrial ecology and industrial symbiosis by not only focusing on setting macro rules and norms, but also developing a pathway by establishing institutional capacity support programs at meso and micro level. This would help move the Vietnamese state to go beyond arms-length incentives for innovation to develop programs of engagement that afford industrial zones and their client firms the means by which economic and environmental rationalities for compliance to cleaner water policy goals can be achieved. Supporting the relational capacity of industrial zones might result in building more trust between industrial zones and the government, which would in turn enable reinforcing pathways between industrial zone and firm institutional capacity levels (meso and micro levels) and the government (macro level) by allowing feedbacks of the target actors like industrial zones to be acknowledged by the state. This leads to improve the design of the economic instrument to encourage industrial zones to think about innovative strategies for enhancing water use efficiency or to develop a set of standards specifying the quality of treated water to be used for different purposes, e.g., irrigation, sanitation, cleaning or even domestic and industrial supplied water.

## 6.5 FURTHER RESEARCH

There are at least three further areas of further research that can extend the empirical and theoretical insights developed in this thesis.

First, further research could focus on the interplay between micro level institutions and institutional capacity. In doing so attention should be given to the dynamic interactions between micro level institutions and institutional capacity to build a more comprehensive understand of the conditions that influences and enable water use efficiency and industrial ecology development, or other complex sustainability goals at the level of individual firms.

Second, future research could apply the dynamic institutional capacity model outlined above to other complex sustainability challenges beyond industrial symbiosis. This recommendation assumes that the model represents more fundamental processes of system change and innovation that can be applied to areas as diverse as natural resource management, circular economy, biodiversity restoration and climate change governance and innovation.

Third, and finally, the dynamic institutional capacity model could also be applied to better understand the effect of different policy instruments in driving processes of systemic change. By doing so the dynamic institutional capacity model could be developed as an evaluation tool for assessing the effectiveness of economic and market-based instruments in the field of industrial ecology and beyond.

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# APPENDICES

## APPENDIX 1. LIST OF INTERVIEWS

**Table A.1.1** Interview information

| Organization | Expertise of interviewee |
|---|---|
| Ministry of Natural Resource and Environment (MONRE) | Environmental quality management, environmental policy |
| | Environmental quality management |
| | Environmental monitoring and standard |
| Ministry of Planning and Investment (MPI) | Industrial management and planning |
| | Eco-industrial park consultant |
| Department of Natural Resource and Environment (DONRE) - Water Resource Division | Former Head of Division |
| | Water management |
| Department of Natural Resource and Environment (DONRE) - Environmental Protection Agency (EPA) | Environmental Protection Fee |
| Department of Natural Resource and Environment (DONRE) – Environmental Protection Fund (EPF) | Fund for wastewater treatment plant development |
| Ho Chi Minh City Export Processing Zone and Industrial Zone Authority (HEPZA) | Industrial zone management, environmental management |
| | Industrial zone management |
| | Environmental management |
| Long An Economic Zone Authority (LAEZA) | Industrial zone management, environmental management |
| Can Tho Export Processing Zone and Industrial Zone Authority (CEPIZA) | Industrial zone management |
| Hiep Phuoc Industrial Zone Infrastructure Company | Industrial zone management |
| | Environmental management |
| | Environment management |
| Tan Thuan Export Processing Zone Infrastructure Company | Vice-Director |
| | Environment management |
| Long Hau Industrial Zone Infrastructure Company | Head of environmental division |
| | Environment management |
| Tra Noc Industrial Zone Infrastructure Company | Project management, water technology and management |

| Organization | Expertise of interviewee |
|---|---|
| Saigon Water Company | Engineering Management |
| | Water management |
| Can Giuoc District People's Committee | Environment management |
| Nha Be District People's Committee | Environment management |
| Trang Company, Hiep Phuoc Industrial Zone | Energy and environmental management |
| Xuan Mai Paper Company, Hiep Phuoc Industrial Zone | Environmental management |
| Ty Cao Thang Company, Hiep Phuoc Industrial Zone | Company manager |
| Holcim Cement Company, Hiep Phuoc Industrial Zone | Production Division |
| Hai Thanh Company, Hiep Phuoc Industrial Zone | Environment Management |
| Mega Viet Phat Company, Long Hau Industrial Zone | Quality Assurance Division |
| May mac Duc Company, Long Hau Industrial Zone | HSE Division |
| Quoc Toan Company, Long Hau Industrial Zone | Director |
| Lotte Logistic Company, Long Hau Industrial Zone | Head of Mechanical-Electrical Division |
| Anpha AG Company, Long Hau Industrial Zone | Human Resource Division |
| Vina Astec Company, Long Hau Industrial Zone | Environment Management |
| Topcake Company, Long Hau Industrial Zone | Head of Mechanical-Electrical Division |
| Phan Sinh Company, Long Hau Industrial Zone | Administration Division |
| Magic Vina Company, Long Hau Industrial Zone | Maintenance Division |
| Chubu Rika Company, Long Hau Industrial Zone | Director |
| Nissey Company, Tan Thuan Export Processing Zone | Maintenance Division |
| Bao bi Gia Phu, Tan Thuan Export Processing Zone | General Affair Division |
| FAPV Company, Tan Thuan Export Processing Zone | Environmental management |
| De Linh Company, Tan Thuan Export Processing Zone | Engineering Division |
| UACJ Company, Tan Thuan Export Processing Zone | Energy and environmental management |
| CX Technology Company, Tan Thuan Export Processing Zone | Environmental management |
| COCHI Company, Tra Noc Industrial Zone | Energy and environmental management |
| Vinamilk Company, Tra Noc Industrial Zone | Energy and environmental management |
| Western - Saigon Beer Company, Tra Noc Industrial Zone | Energy and environmental management |
| Resident 1 | In Can Giuoc district |
| Resident 2 | In Can Giuoc district |
| Resident 3 | In Nha Be district |
| Center for Environmental Technology and Management (ETM) | Director |

**Table A.1.2** Interview questions

| Chapter | Questions |
|---|---|
| Chapter 2 | **General questions**<br>- What are current environmental problems in water use in IZ? Could you comment and think it is the most serious problem?<br>- For the current environmental problems that mentioned before, what are available solutions and regulations to address?<br><br>**Collaborations among different stakeholders**<br>Because of the above environmental problems in water use in IZ, it is important and necessary to make the transition towards sustainable water supply in IZ. Beside technological innovations, this transition process towards IS requires collaboration and participation among different stakeholders in order to apply the technological solutions in reality. We make a map of existing relations of water use in IZ (Figure 1) because we would like to know which stakeholders and which relationships are important for making the transition works. |

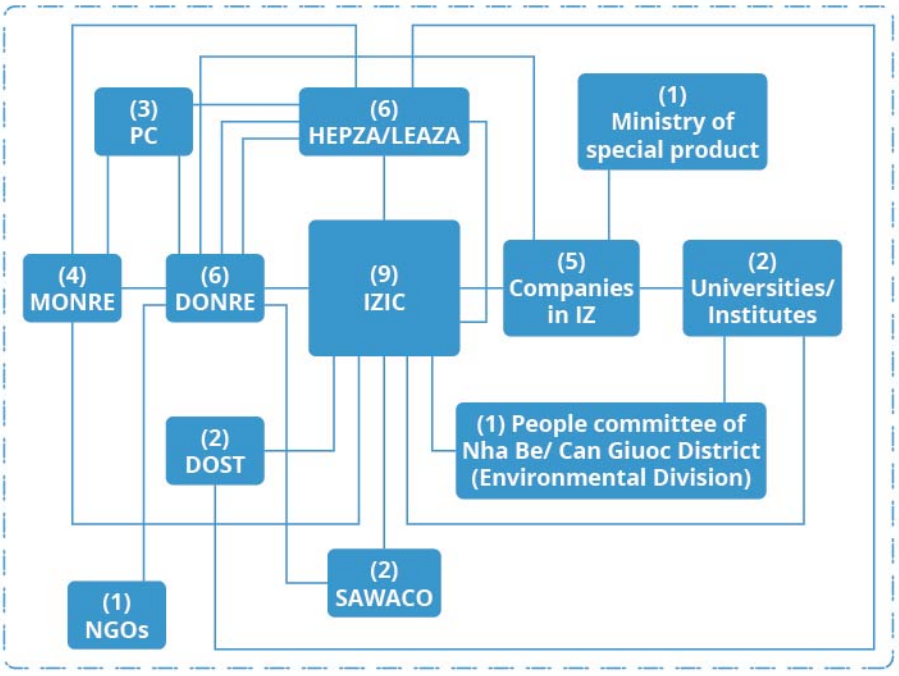


**Figure 1** Map of existing relations of water use in IZ.

Note: (1) to (9) represent the number of relations among different stakeholders in regulation of water quantity and quality in IZ.

o Policy actors: People committee of HCMC and Long An, Hiep Phuoc/Long Hau IZ, IZIC, HEPZA/LEAZA, SAWACO, DONRE, MONRE, DOST and Ministry of special product;

o Economic actors: IZIC, HEPZA/LEAZA, SAWACO and companies in IZ;

| Chapter | Questions |
|---|---|
| Chapter 2 | o Social actors: Resident of Nha Be/Can Giuoc District;<br>o Knowledge actors: Universities/Institutes<br>- Could you please tell me whether it is a good map? Who and which organization should to be added, especially for the transition towards water use efficiency and industrial symbiosis?<br>- What kinds of collaboration are important to make the transition happens?<br>- What types of actors are important to make the transition happens?<br>- Who will benefit most from the transition towards water use efficiency and industrial symbiosis in IZ in next 5 years?<br>- Who will bear the initial cost for the transition? How can this transition be organized to be fair among all actors involved?<br>- If this is win - win project, is there any voluntary collaboration that will be established or it is essential to provide policies and regulations from the authorities to make the transition towards water use efficiency and industrial symbiosis?<br>- If this is not win - win project, is there any voluntary collaboration that will be established or it is essential to provide policies and regulations from the authorities to make the transition towards water use efficiency and industrial symbiosis?<br><br>**Policy and regulation information**<br>In order to make the transition towards sustainable water use in IZ works, the interference of policy and regulation from the authorities is very important especially in case of several companies will not get any benefit from these technical applications in practice.<br>- If the transition towards water use efficiency and industrial symbiosis just works between different companies in IZ, do you think it is necessary to provide them the regulation or policy? What are the existing policies/regulations/procedures in water use in IZ?<br>- If several companies will not get benefit from this project, how do the authorities enforce, convince or encourage them to participate the transition towards water use efficiency and industrial symbiosis?<br>- Who will take the lead to make the transition works? Who will organize the collaboration and what will this look like? |
| Chapter 3 | **Relational capacity**<br>- According to you, which organizations/individuals involved in the implementation of industrial water use efficiency strategies?<br>- Which organizations/individuals were affected the implementation of industrial water use efficiency strategies?<br>- How often were discussions of the implementation of industrial water use efficiency strategies?<br>- In what form was the communication of the implementation of industrial water use efficiency strategies made (in formal document or through face-to-face meetings) and how industrial zones affect trust and mutual understanding between themselves and other actors, including government, NGOs, and private firms?<br>- Which agency plays a more important role in the implementation of industrial water use efficiency strategies? |

| Chapter | Questions |
|---|---|
| Chapter 3 | - How are the comments and feedback of agencies/organizations in the implementation of industrial water use efficiency strategies handled?<br>- Which agency/organization has the highest power in the implementation of industrial water use efficiency strategies? Specifically, how does their power manifest?<br><br>**Knowledge capacity**<br>- What knowledge and experience did your organization have in order to improve the water use efficiency?<br>- How are these knowledge/experiences of water use efficiency and innovations shared within your organizations and other organizations?<br>- What knowledge/experiences do your organization find lacking to improve the water use efficiency? Do you find these knowledge/experiences important? Why?<br>- Which activities and relations your organization employ to access the required knowledge?<br><br>**Mobilization capacity**<br>- Does your agency/organization have a close relationship with the Ministries and People's Council/People's Committee of Ho Chi Minh City? Does the People's Council/People's Committee have a financial support mechanism/policy for the IZs/EPZs in renewing technologies related to industrial water use efficiency?<br>- Which agencies/organizations are able to provide financial support to the IZ/EPZ to implement technological innovation related to industrial water use efficiency?<br>- How your organization engages with government and non-government actors to support water use efficiency implementation?<br>- Your agency/organization has a decisive role in amending policy and regulation in order to strengthen the implementation of technological innovation related to water/wastewater of the IZs/EPZs?<br>- What measures are used in your agency/organization to encourage/promote technological innovation related to industrial water use efficiency of the IZs/EPZs?<br>- Who plays the most important role in encouraging/promoting technological innovation related to industrial water use efficiency of the IZs/EPZs? |
| Chapter 4 | **Relational capacity**<br>- According to you, which organizations/individuals involved in the promulgation of Resolution No.02/2018/NQ-HĐND and Decision No.2129/QD-UBND on adjusting the environmental protection fee for discharged wastewater in Ho Chi Minh City?<br>- Which organizations/individuals were affected when issuing Resolution No.02/2018/NQ-HĐND and Decision No.2129/QD-UBND?<br>- How often were discussions during the promulgation of this resolution and decision made?<br>- In what form was the communication during the promulgation of this resolution and decision made (in formal document or through face-to-face meetings)?<br>- Which agency plays a more important role in the process of making these resolutions and decisions?<br>- How are the comments and feedback of agencies/organizations in the process of promulgating this resolution and decision handled?<br>- Has there been a change in the relationship of agencies/organizations during the issuance of this resolution and decision? If yes, please specify how to change?<br>- Which agency/organization has the highest power in the process of promulgating these resolutions and decisions? Specifically, how does their power manifest? |

| Chapter | Questions |
|---|---|
| Chapter 4 | **Knowledge capacity**<br>- What knowledge and experience did your organization have in order to improve the water use efficiency as well as to comply with the wastewater levy in Resolution No.02/2018/NQ-HĐND and Decision No.2129/QD-UBND?<br>- How are these knowledge/experiences of water use efficiency and innovations shared within your organizations and other organizations?<br>- What knowledge/experiences do your organization find lacking to improve the water use efficiency? Do you find these knowledge/experiences important? Why?<br>- How does this lack of knowledge/experience influence the compliance with wastewater levy?<br><br>**Mobilization capacity**<br>- According to you, the issuance of Resolution No.02/2018/NQ-HDND and Decision No.2129/QD-UBND on adjusting environmental protection fees for industrial wastewater in Ho Chi Minh City has contributed to promoting technological innovation (rainwater harvesting, wastewater reuse after treatment in IZs/EPZs)? Why?<br>- In your opinion, what is the purpose of issuing this resolution and decision?<br>- In this resolution and decision, is the role of each agency/organization in encouraging/ promoting the innovation of water/wastewater technology in IZs/EPZs?<br>- Does your agency/organization have a close relationship with the People's Council/ People's Committee of Ho Chi Minh City? Does the People's Council/People's Committee have a financial support mechanism/policy for the IZs/EPZs in renewing technologies related to water/wastewater (rainwater harvesting, wastewater reuse after treatment)?<br>- Which agencies/organizations are able to provide financial support to the IZ/EPZ to implement technological innovation related to water/wastewater (rainwater harvesting, post-treatment wastewater reuse)?<br>- Are there any legal/policy documents issued after the issuance of this resolution and decision to encourage/promote the implementation of technological innovation related to water/wastewater in IZs/EPZs? (Rainwater harvesting, reuse of wastewater after treatment)?<br>- How does your organization/organization respond to these newly issued resolutions and decisions? (For example, recruiting more personnel, meeting management requirements, etc.)<br>- Your agency/organization has a decisive role in amending this resolution/decision in order to strengthen the implementation of technological innovation related to water/wastewater of the IZs/EPZs (rainwater harvesting model or reuse of wastewater after treatment)?<br>- What measures are used in your agency/organization to encourage/promote technological innovation related to water/wastewater of the IZs/EPZs (rainwater harvesting or reuse of wastewater after treatment) to respond to/deal with the resolution/decision on adjustment of environmental protection fees for industrial wastewater?<br>- Who plays the most important role in encouraging/promoting technological innovation related to water/wastewater of the IZs/EPZs in order to respond/ cope with this wastewater levy? Specifically, what is their roles? |
| Chapter 5 | **General questions**<br>- Does your organization know/hear about the decree 82 before it publishes?<br>- What are the aims of Decree 82 on eco-industrial park (EIP) and why was the decree developed?<br>- How the EIP and criteria of EIP (describe in Decree 82) can promote eco-industrial park? |

| Chapter | Questions |
|---|---|
| Chapter 5 | **Questions on Institutional Capacity**<br>**Relational capacity**<br>- Which organizations/individuals are involved with IZIC/your company/your organization during the project of EIP and before and after release of EIP and criteria of EIP in decree 82?<br>- What is the role of MPI/MONRE/PC/UNIDO/DONRE/IZA/GEF/SECO/IZIC/enterprises and the relation between your organization and during the promulgation of decree 82?<br>• How many times do you communicate? In what way do you communicate in the activities related to the promulgation of decree 82?<br>• How these organization support IZIC/your company to support the promulgation of decree?<br>• How your organization participate in the publication of EIP and criteria of EIP in decree 82?<br>• What are the contributions and feedbacks of your organization in the process of promulgating the criteria on eco-industrial parks specified in Decree 82? Are these contributions and feedback recognized and implemented?<br>• Your organization are capable of self-changing and implementing solutions related to improving resource efficiency as well as achieving eco-industrial park criteria and after the promulgation of Decree 82? To what extent can this ability be achieved?<br>• With the eco-industrial park project and the criteria for eco-industrial parks promulgated in Decree 82, has the relationship between the MPI/UNIDO/MONRE/DONRE/GEF/SECO and IZA/Infrastructure Company/enterprises changed compared to before? Specifically, please specify how to change?<br>**Knowledge capacity**<br>- Did your organization participate in the promulgation process of the standard? If yes, what did your organization learn from this?<br>- What knowledge and experience did your organization have in order to improve the resource efficiency as well as to meet the criteria for eco-industrial parks in the process of promulgating Decree 82 and criteria on eco-industrial zones are specified in Decree 82?<br>- How are these knowledge/experiences of EIP shared within your organizations and other organizations?<br>- In the process of promulgating the criteria on eco-industrial parks specified in Decree 82, what knowledge/experiences do your organization find lacking? Do you find these knowledge/experiences important? Why?<br>- How does your organization supplement these missing knowledge/experiences? How does this lack of knowledge/experience influence the achievement of eco-industrial park criteria specified in Decree 82?<br>- Do your organization cooperate with other agencies to share and learn from experiences related to solutions related to eco-industrial park development during the participation in the process of promulgating criteria on eco-industrial parks regulated in Decree 82?<br>**Mobilization capacity**<br>- Did your organization know in advance that the contents of eco-industrial parks and eco-industrial park criteria in Decree 82 would be published?<br>- How does your organization contribute and influence the development and issuance of the contents of the eco-industrial park and the criteria of the eco-industrial park in Decree 82?<br>- Are the concepts and contents of eco-industrial parks and criteria of eco-industrial parks in Decree 82 easy to understand and apply, are there any inappropriate contents? Why? Can industrial zone comply with these criteria? |

| Chapter | Questions |
|---|---|
| Chapter 5 | - Does the government have any support to help the industrial park/enterprise meet the criteria of the eco-industrial park in Decree 82?<br>- What additional support does industrial zones need from the state when they want to meet the criteria of an eco-industrial park in Decree 82 and certify an eco-industrial park?<br>- Do you think that the eco-industrial park criteria promulgated in Decree 82 have a role in promoting activities to improve resource efficiency and promote achievement of criteria and certifications in the future? Why?<br>- So how did governmental organizations promote themselves when participating in the promulgation process of Decree 82?<br>- What advantages and disadvantages of your organization recognize to develop the achievement of eco-industrial park certification specified in Decree 82?<br>- What advantages and disadvantages do your organization see that industrial zones would face when they want to meet the criteria for eco-industrial parks and eco-industrial park certifications specified in Decree 82?<br>- Does the government have clear preferential policies and guidelines for infrastructure companies/enterprises to meet the criteria for eco-industrial parks and eco-industrial park certifications specified in Decree 82?<br>- What measures do governmental organizations use to promote industrial zones to develop eco-industrial parks?<br>- Who is the most important actor/ organization promoting EIP?<br>- Does your organization realize that you are change agent in these activities related to EIP development? |

## APPENDIX 2. LIST OF WORKSHOPS AND STAKEHOLDER MEETINGS

**Table A.2.1** Workshops and stakeholder meetings details

| Time | Name |
|---|---|
| 9th July, 2015 | International workshop on Enabling Vietnamese Delta Industry by realizing sustainable fresh water supply |
| 9th March, 2016 | Kick-off workshop on "Enabling sustainable industrial development in Vietnamese Delta's: Reducing, Recycling and Multi-sourcing industrial water |
| 4th July, 2017 | International workshop on Enabling sustainable industrial development in Vietnamese Delta's: Reducing, Recycling and Multi-sourcing industrial water (The first phase) |
| 13th and 14th December, 2018 | Stakeholder workshop on Enabling sustainable industrial development in Vietnamese Delta's: Reducing, Recycling and Multi-sourcing industrial water |
| 22nd October, 2019 | Stakeholder meeting at Long Hau Industrial Zone on the factors that influence the implementation of industrial water technological innovations |
| 22nd October, 2019 | Stakeholder meeting at Hiep Phuoc Industrial Zone on the factors that influence the implementation of industrial water technological innovations |
| 23rd October, 2019 | Stakeholder meeting at Tan Thuan Export Processing Zone on the factors that influence the implementation of industrial water technological innovations |
| 23rd October, 2019 | Stakeholder meeting at Ho Chi Minh City Export Processing Zone and Industrial Zone Authority (HEPZA) on the factors that influence the implementation of industrial water technological innovations |

## SUMMARY

The Mekong River Delta region of Vietnam faces a range of transboundary water challenges which make the region susceptible to large scale water scarcity due to the impact of climate change and hydropower development. At the same time, as a result of rapid urbanization and industrialization, the Mekong Delta of Vietnam is also facing higher water demand and poorer water quality. Industrial demand is expected to be increase dramatically over the next 30 years in response to a planned 150% expansion of industrial zones in the country. This means that far greater attention is needed to address three main challenges to reducing industrial water use in Vietnamese industrial zones: (1) improving currently poor levels of industrial water efficiency; (2) addressing overall levels of industrial water consumption; and (3) increasing levels of untreated wastewater from manufacturing and processing activities for reuse in domestic and agricultural applications.

Depending on the strategies and the boundary of the implementation, water use efficiency contributes to the achievement of industrial symbiosis and industrial ecology. Three current strategies are considered to improve water use efficiency in Vietnam are: (1) demand minimization; (2) wastewater minimization; and (3) "multi-sourcing". However, the implementation of these strategies has, however, remained highly technical in nature while there has been limited focus on the industrial actors, including industrial zones, have the necessary capacity to innovate. The development of these strategies is first dependent on the ways in which collaborations emerge between industrial actors. Second, the emergence of collaborations needed for industrial ecology and industrial symbiosis are in turn dependent on the wider institutional setting within which industrial ecology and industrial symbiosis emerges. Third, and finally, the creation of opportunities to develop industrial ecology and industrial symbiosis strategies relevant to enhancing water use efficiency relies on a requisite level of 'institutional capacity' of those actors involved.

Institutional capacity is a function of not only the individual attributes of knowledge, relational and mobilization capacities, but also the interplay between them. Institutions can, albeit often imperfectly, shape the institutional capacity of actors (across macro, meso and micro levels) to comply with rules and norms related to industrial ecology and industrial symbiosis. It is unclear, however, why some certain institutions reinforce institutional capacity of actors and others or undermine their capacity. In addition, virtually no attention has been given to the effects of macro-level institutions on macro-level institutional capacity as well as the design and implementation of institutions/instruments at meso and micro levels. Furthermore, the ways in which Vietnamese Industrial Zones are situated within a context of a centralized and hierarchical state system and how the extent to which these institutions enable or constrain industrial capacity to respond key resource challenges (e.g., water scarcity and pollution) also remains unclear.

The thesis introduces a dynamic institutional capacity model to understand the ways in which interactions between institutions and institutional capacities affect the potential for systemic innovation towards industrial water use efficiency in Vietnam. The four chapters focused on different interactions between institutional-levels and institutional capacities.

Chapter two applies Social Network Analysis to compare the networks of three industrial zones - Hiep Phuoc, Long Hau, and Tan Thuan. By applying social network analysis, the structure, strength and content of relations of actors within the industrial zone network is determined, including the relative influence of actors within the network, and relatedly, possibilities for collective action needed for enabling industrial water symbiosis outcomes. These results provide a basis not only for strengthening the empirical evidence on the importance of network ties in shaping industrial innovation but also for

the empirical evidence on the importance of network ties in shaping industrial innovation but also for a more fundamental understanding of the types of capabilities needed for both government and industry to utilize a wider range of relationships that go beyond purely material ones.

Chapter three then analyses the interplay between macro level institutions and meso level institutional capacity in Vietnam to understand the conditions under which industrial water symbiosis can emerge. In this chapter the institutional capacity framework is elaborated further and employed to assess the relational, knowledge, mobilization capacities of three industrial zones and the ways in which these institutional capacities are affected by the hierarchical regulatory and political structure of the centralized Vietnamese state. The results of this chapter show the value of institutional capacity as a framework for assessing processes of technical innovation for industrial ecology and industrial symbiosis, especially in the context of centralized states.

Chapter four examines the effects of implementing an economic policy aimed at promoting water use efficiency in two Vietnamese industrial zones. Located in Ho Chi Minh City, each of these industrial zones represent different responses to the wastewater levy implemented by the Ho Chi Minh City People's Council and People's Committee in 2018 (Decision No.2129/QD-UBND). The institutional capacity framework is used to understand why this new macro level institutions fails to affect the institutional capacity of the two Industrial Zones. Chapter 4 contributes to ongoing debate on the effectiveness of economic environmental regulation in Vietnam and the ongoing challenges of the Vietnamese government in not only prescribing ambition, but also enabling capacities for innovation and ultimately compliance.

Chapter five examines the development of Decree 82 to understand the ways in which different stages of developing a voluntary public standard affects the Vietnamese state's capacity to coordinate and implement EIPs. This standard codified under Article 42 of Decree 82, was instigated by the United Nations Industrial Development Organization (UNIDO) with the Vietnamese Ministry of Planning and Investment (MPI) (UNIDO, 2018). In the process of developing the standard, multiple governmental Ministries and Departments responsible for investment, financing, environment, social security of EIP formation were involved. The aim of this chapter is to assess how the institutional capacity of these governmental bodies was affected through their involvement in the development of a public standard and the effect of this capacity on supporting systemic and inter-ministerial support for transformation towards industrial symbiosis and industrial ecology.

The final chapter, chapter 6 answers the research questions for this thesis. It also introduces a dynamic model to understand the interaction between macro, meso and micro institutions and the institutional capacity of actors at different levels. It makes a distinction between pathways of interaction between institutions and institutional capacity that undermine or strengthen progress towards industrial symbiosis and industrial ecology. It shows that while the institutions and institutional capacity interact in complex ways, it is possible to identify different co-existing pathways that ultimately shape the outcome of industrial symbiosis and industrial ecology. The concluding chapter ends with policy recommendations for economic instrument and a public eco-industrial park standard implementation, and provides a new approach by not only focusing on setting macro rules and norms, but also developing a pathway by establishing institutional capacity support programs at meso and micro level in which Industrial Symbiosis and Industrial Ecology is implemented in Vietnamese Industrial Zones.

## SAMENVATTING

Het deltagebied van de Mekong-rivier in Vietnam heeft te maken met meerdere grensoverschrijdende waterproblemen, omdat het gebied gevoelig is voor grootschalige waterschaarste als gevolg van de klimaatverandering en de ontwikkeling van waterkrachtcentrales. Tegelijkertijd is er door de snelle verstedelijking en industrialisatie in de Mekongdelta in Vietnam ook sprake van zowel meer vraag naar water als een slechtere waterkwaliteit. Naar verwachting zal de industriële vraag als gevolg van een geplande uitbreiding van de industriegebieden de komende dertig jaar met 150 procent toenemen. Er zijn drie belangrijke uitdagingen bij het terugdringen van het industriële watergebruik in Vietnamese industriegebieden: (1) de huidige lage industriële waterefficiëntie verbeteren; (2) het hoge industriële waterverbruik verminderen; en (3) toenemende huishoudelijk en agrarisch hergebruik van onbehandeld (vervuild) afvalwater van productie- en verwerkingsactiviteiten.

Afhankelijk van een strategie kan efficiënt watergebruik bijdragen aan het bereiken van industriële symbiose en industriële ecologie. Er wordt momenteel gekeken naar drie strategieën om het watergebruik in Vietnam efficiënter te maken: (1) vermindering van de watervraag; (2) vermindering van de hoeveelheid afvalwater; en (3) verkrijgen van water uit meerdere bronnen. Bij de uitvoering van deze strategieën is er echter vooral gekeken naar technische oplossingen, met weinig aandacht voor de industriële actoren, waaronder industriegebieden, en of die wel over de nodige capaciteiten beschikken om te innoveren. De ontwikkeling van deze strategieën hangt allereerst af van de manier waarop samenwerkingsverbanden tussen industriële actoren tot stand komen. Vervolgens is het ontstaan van samenwerkingsverbanden die nodig zijn voor industriële ecologie en industriële symbiose weer afhankelijk van het bredere institutionele kader waarbinnen industriële ecologie en industriële symbiose ontstaan. En tot slot moeten de betrokken actoren over een minimaal niveau van 'institutionele capaciteit' beschikken om strategieën voor industriële ecologie en industriële symbiose te kunnen ontwikkelen die relevant zijn voor efficiënter watergebruik.

Bij institutionele capaciteit gaat het niet alleen om kennis, relationele en mobilisatiecapaciteiten als losse factoren, maar ook om de wisselwerking daartussen. Instanties kunnen met hun regels de institutionele capaciteit van actoren (op macro-, meso- en microniveau) vormgeven, alhoewel niet altijd optimaal, om te voldoen aan regels en normen met betrekking tot industriële ecologie en industriële symbiose. Het is echter onduidelijk waarom bepaalde instanties en hun regels de institutionele capaciteit van actoren versterken of juist ondermijnen. Daarnaast is er nauwelijks aandacht voor de invloed van grote instanties en regels op macro niveau op de institutionele capaciteit op macroniveau en het ontwikkelen en implementeren van instanties/instrumenten op meso- en microniveau. Ook is nog onduidelijk welke plaats de Vietnamese industriegebieden innemen binnen de context van een gecentraliseerd en hiërarchisch staatsbestel, en in hoeverre deze instanties met hun regels het vermogen van de industrie bevorderen of belemmeren om te reageren op belangrijke uitdagingen op het gebied van hulpbronnen (zoals waterschaarste en vervuiling).

In dit proefschrift wordt een dynamisch institutioneel capaciteitsmodel geïntroduceerd om te begrijpen hoe interacties tussen instanties, regels en institutionele capaciteiten invloed hebben op het potentieel voor systemische innovatie richting efficiënt watergebruik door de Vietnamese industrie. De vier hoofdstukken gaan in op verschillende interacties tussen institutionele niveaus en institutionele capaciteiten.

In hoofdstuk twee wordt een sociale netwerkanalyse uitgevoerd om de netwerken van drie industriegebieden, Hiep Phuoc, Long Hau en Tan Thuan, te vergelijken. Door middel van een sociale

netwerkanalyse worden de structuur, kracht en inhoud van de relaties van actoren binnen het netwerk van industriegebieden bepaald, waaronder de relatieve invloed van actoren binnen het netwerk, en daarmee samenhangend de mogelijkheden voor de benodigde collectieve actie om industriële watersymbiose mogelijk te maken. Deze resultaten vormen een basis voor het versterken van het empirisch bewijs van het belang van netwerkrelaties bij het vormgeven van industriële innovatie, en daarnaast voor een meer fundamenteel begrip van de soorten benodigde capaciteiten bij de overheid en de industrie om gebruik te maken van een breder scala aan relaties die louter het materiële niveau ontstijgen.

Hoofdstuk drie analyseert vervolgens de wisselwerking tussen instanties en regels op macroniveau en institutionele capaciteit op mesoniveau in Vietnam om inzicht te krijgen in de voorwaarden voor het ontstaan van industriële watersymbiose. In dit hoofdstuk wordt het theoretische kader voor institutionele capaciteit verder uitgewerkt en toegepast om na te gaan welke capaciteiten de drie industriegebieden hebben op het gebied van relaties, kennis en mobilisatie, en hoe deze institutionele capaciteiten worden beïnvloed door de hiërarchische regelgeving en politieke structuur van de gecentraliseerde Vietnamese staat. Uit de resultaten van dit hoofdstuk blijkt de waarde van institutionele capaciteit als theoretisch kader voor het beoordelen van processen van technische innovatie voor industriële ecologie en industriële symbiose, vooral in de context van gecentraliseerde staten.

Hoofdstuk vier gaat over de effecten van de implementatie van een economisch beleid dat is gericht op het bevorderen van efficiënt watergebruik in twee Vietnamese industriegebieden. Deze industriegebieden in de stad Ho Chi Minh vertegenwoordigen verschillende reacties op de afvalwaterheffing die in 2018 is ingevoerd door de Volksraad en het Volkscomité van Ho Chi Minh-stad (Besluit nr. 2129/QD-UBND). Het theoretisch kader voor institutionele capaciteit wordt gebruikt om te begrijpen waarom deze nieuwe regels rondom afvalwaterheffing (komend van macroniveau) geen invloed hebben op de institutionele capaciteit van de twee industriegebieden (op mesoniveau). Hoofdstuk 4 draagt bij aan het debat over de effectiviteit van economische milieuregelgeving in Vietnam en de voortdurende uitdagingen voor de Vietnamese overheid om niet alleen de ambitie voor te schrijven, maar ook capaciteit voor innovatie en uiteindelijk naleving mogelijk te maken.

Hoofdstuk vijf onderzoekt de ontwikkeling van Verordening 82 om te begrijpen wat voor invloed de verschillende ontwikkelingsstadia van een vrijwillige publieke standaard hebben op de capaciteit van de Vietnamese staat om eco-industriële parken (EIP's) te coördineren en te implementeren. De Organisatie van de Verenigde Naties voor Industriële Ontwikkeling (UNIDO) heeft in samenwerking met het Vietnamese ministerie van Planning en Investeringen (MPI) het initiatief genomen voor deze standaard, die is gecodificeerd in artikel 42 van Verordening 82 (UNIDO, 2018). Bij de ontwikkeling van de standaard waren meerdere ministeries en departementen betrokken die verantwoordelijk waren voor investeringen, financiering, milieu, sociale zekerheid en EIP-vorming. Het doel van dit hoofdstuk is nagaan hoe de institutionele capaciteit van deze overheidsinstanties werd beïnvloed door hun betrokkenheid bij de ontwikkeling van een publieke standaard en het effect van deze capaciteit op de ondersteuning van systemische steun bij meerdere ministeries voor de transformatie naar industriële symbiose en industriële ecologie.

In het laatste hoofdstuk, hoofdstuk 6, komen de antwoorden op de onderzoeksvragen uit dit promotietraject aan de orde. Dit hoofdstuk introduceert ook een dynamisch model om de wisselwerking tussen macro-, meso- en micro-instanties en regels, en de institutionele capaciteit van

actoren op verschillende niveaus beter te begrijpen. Er wordt onderscheid gemaakt tussen belemmerende en versterkende interactietrajecten tussen instanties en hun regels en institutionele capaciteit bij de vooruitgang naar industriële symbiose en industriële ecologie. Ook wordt aangetoond dat het, ondanks de complexe interacties tussen instanties, regels en institutionele capaciteit, mogelijk is om verschillende naast elkaar bestaande trajecten te identificeren die het uiteindelijke resultaat van industriële symbiose en industriële ecologie vormgeven. Tot slot bevat het laatste hoofdstuk beleidsaanbevelingen voor een economisch instrument en een publieke standaard voor eco-industriële parken. Het biedt een nieuwe aanpak, niet alleen gericht op het vaststellen van macroregels en -normen, maar ook op de ontwikkeling van een traject door institutionele capaciteitsondersteuningsprogramma's op meso- en microniveau, waarin industriële symbiose en industriële ecologie worden geïmplementeerd in Vietnamese industriegebieden.

## ABOUT THE AUTHOR

Tran Thu Trang was born in Hanoi, Vietnam in 1986. Upon completing her bachelor's in Environmental Science at Vietnam Academy of Agriculture in 2008, she worked at the Department of Natural Resources and Environment (DONRE) and School of Environmental Science and Technology, Hanoi University of Technology. She had scholarship to move to Thailand in August 2009 to acquire her Master of Science in Environmental Engineering and Management at Asian Institute of Technology (AIT). After graduating in 2011, she started to work as a lecturer at Van Lang University, Ho Chi Minh City, Vietnam. In 2016, he secured funding from the Netherlands Organization for Scientific Research (NWO) under the Enabling sustainable Industrial development in Vietnamese delta's: Reducing, recycling and multi-sourcing industrial water (ENTIRE) project to start her PhD at Wageningen University and Research. After finishing her PhD, Trang will continue her professional career as a researcher and lecturer at the Faculty of Environment, Van Lang University, Ho Chi Minh City, Vietnam.

Besides working, Trang enjoys spending time being with her family, participating and learning self-development and social activities. She desires to contributing positively to ensure the green and happy environment for people worldwide.

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- Co-organized a workshop entiled "Enabling sustainable industrial development in Vietnamese delta's: reducing, recycling, and multi-sourcing industrial water – THE FINAL REPORT" (2020)

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