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Understanding the scaling-up of a Circular Economy (CE) through a strategic niche management (SNM) theory: a socio-political perspective from Quebec

Chedrak Chembessiⁱ¹, Christophe Beaurainⁱ, Geneviève Cloutierⁱⁱ,

ⁱLaboratoire de Géographie Physique et Environnementale (University of Limoges - France)

ⁱⁱCentre de recherche en Aménagement du Territoire et Développement Régional (Laval University – Canada)

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¹ Corresponding Author – chedrak.chembessi@unilim.fr / chedrak-sylvain-de-rocher.chembessi.1@ulaval.ca

Understanding the scaling-up of a Circular Economy (CE) through a strategic niche management (SNM) theory: a socio-political perspective from Quebec

Abstract

This paper examines the public policy mechanisms that are involved in the development of a circular economy (CE) in Quebec. The article uses an analytical framework of niche management to explore institutional frameworks in which the CE is expanding in Quebec. The data used for this analysis was collected through semi-structured interviews with 36 stakeholders involved in the CE project in the region of Kamouraska (Quebec). Our study reveals important changes to Quebec's regulations that encourage CE development. It underlines/emphasizes that coercive measures (laws and regulations) as well as incentives (public funding, fiscal measures, technical support, coordination, etc.) contribute to the adoption and dissemination of a CE. However, such public policy schemes have been supported by the collective and sustained commitment of economic and institutional actors in the territories. Consequently, the main difficulty in implementing these public policy schemes is trying to combine the multiple resources and skills of stakeholders operating at different spatial scales. As a result, a focus on local contexts and stakeholder values helps define and strengthen the strategic framework for a CE.

Keywords: Circular Economy – Public Policy – Territories – Collective Action – Transition

1. Introduction

Global economic development has led to a growing demand for natural resources and energy, leading to effects such as increased greenhouse gas (GHG) emissions, waste production, and climate change [1, 2]. Therefore, both public and private actors are getting involved in the potential ecological transformation of society [3,4]. The recent emergence of a circular economy (CE) is part of this aim [5,6,7,8]. A CE aims to reduce the ecological, economic, and social burdens of production and consumption [9,10,11]. It implies the development of a new industrial system through looped production and consumption cycles that is not reliant on the extraction of non-renewable resources [7,8,12,13]. A CE is “the new solution to the challenges of sustainability of human systems on the planet, in a situation of increasing scarcity and fluctuating resource prices [...]” [14]. As such, a CE involves the ecological transition of an entire economic system [15,16].

Developed through various strategies over the last few decades (economy of functionality, industrial ecology, eco-conception, recycling, reuse, etc.), a CE is focused on promoting the efficient use and productivity of natural resources, improving waste management, and reducing pollution [11,17,18] from product design to production and consumption [6,11, 19]. Thus, a CE requires changes in practice at multiple levels or scales: micro, meso and macro [20,21,22]. With this perspective, many studies have focused on both the drivers and barriers in the transition from traditional practices to a CE [5,21,22]. The results from these studies underscore the diversity of issues that are involved in this transition, with a strong focus on technical, organizational, and economic issues. However, this transition also relies on social and political dynamics [20, 22], which require further attention.

This paper aims to address the political and social dynamics at play in the transition towards a CE. Our study focuses on public policies for a CE in Quebec, based on the resources and skills of stakeholders who are involved in the process. The complementary resources and skills, which are part of both the provincial initiative and local CE experiments, affect public policy mechanisms and project’s coordination. Our study uses an analytical framework inspired by the literature on strategic niche management (SNM) [23,24,25] to understand the interdependencies between the components of a system and their effects. To better illustrate the multidimensional nature of the transition to CE, we took a case study approach and used semi-structured interviews that were conducted between 2018 and 2020, with 36 stakeholders engaged in the CE project in the region of Kamouraska. This CE project was chosen because of its importance and notoriety in Quebec. Moreover, it is recent—initiated in 2016—and allows for the accurate identification of factors involved in its emergence and success.

In the next section, we describe the theoretical framework for the study (section 2). In section 3, the materials and methods are presented. Section 4 presents observations made about transition towards CE in Quebec. Finally, section 5 discusses and draws lessons from these results.

2. Strategic niche management as an analytical framework

To understand the institutional process of the CE in Quebec, this article applies the analytical framework of strategic niche management (SNM) [23,24]. Building on previous transition experiments [25,26,27], the literature on SNM implies that transition experiments rely on mutual understanding between stakeholders, as well as their shared resources, skills, institutional arrangements, common values, and beliefs, among others [28,29,30]. Authors also show that transition experiments require that a diverse group of actors are all committed towards sustainable development and practices [31,32]. Moreover, they assume a progressive adoption of institutional rules to coordinate the activities and perceptions of stakeholders for transition experiments [33,34,35].

Transition experiments are characterized by their ad hoc nature and their capacity to get a variety of actors who are not used to working together to cooperate [36,37]. These experiments, which are planned and implemented outside institutional frameworks, provide experimenters with the chance to establish rules of their own [35,38,39]. Those participating in transition experiments are also characterized by a will to contribute to the learning process [40,41,42], initiate change [43,44] and challenge a well-established system [45,46]. Hence, transition experiments are particularly influenced by bottom-up and top-down pressures between participating actors [45,47] and their social interactions [33,38,48]. To induce a change towards sustainable practices, transition experiments require a collective process [23]. This calls for the adoption of new public policies or for changes to existing ones [49,50].

Based on these observations, SNM offers an interesting perspective for analyzing change processes in patterns of production and consumption. It provides a historical and evolutionary perspective of CE development in Quebec by providing a systemic analysis of the interactions, resources, and skills of stakeholders. By highlighting institutional dynamics and the complementary resources involved in building and expanding the experiments, this analytical framework reinforces the hypothesis that transition experiments are multidimensional [51] and incremental [52]. This analysis also underscores the role those public actors play during the transition. Indeed, one frequent criticism of sustainable transition research is the underestimation of the role of public actors [53,54]. Public actors are indispensable for defining institutional rules [31] and for achieving long-term transformative change [23]. In addition, the evolution of and interaction between institutional rules at multiple spatial scales, which characterize their influence during the transition, remain insufficiently analyzed. This article focuses on these different elements.

3. Materials and Methods

Data were collected from two main sources: public policy documents (laws, decrees, government strategies, road maps, regional development plans, etc.) and semi-structured interviews with CE project stakeholders in the region of Kamouraska (Quebec).

Public policy documents were used to identify the existing coercive and incentive tools that structure the institutional framework for CE development in Quebec. These documents highlight the legal competencies and responsibilities of the stakeholders. In addition, information in the documents can help design an intervention plan for the different actors, particularly the major political steps/strategies for those in the government, in the implementation of a CE in Quebec. The public policy documents can also shed light on some important lessons that can lead to a better understanding of the current CE in Quebec.

Semi-structured interviews were conducted to measure the performance and results of public policy schemes. The data collected from 36 stakeholders aimed to demonstrate the different aspects of the progressive institutionalization of a CE in Quebec and investigate the effectiveness of public policy mechanisms. The interviews allow us to address the operational framework of CE in the territories, while studying the actions and solutions that were implemented by territory actors to optimize the institutional framework of the CE. These data reveal the operational issues involved in applying public policy measures to CE implementation.

The CE project in the region of Kamouraska was selected for several reasons: its recency, the diversity of actors involved and its notoriety in Quebec. The Kamouraska CE project emerged in 2016 through a particular context, which involved the modification of Quebec's residual materials management policy, the implementation of the first public subsidies for a CE in Quebec and the integration of the CE into the local land use planning policy of Kamouraska. This project therefore presents an opportunity to analyze key issues and identify prospects for action in the progressive institutionalization of a CE in Quebec.

The interviews were conducted between March 2018 and June 2020. Each interview took 60 minutes or more. A total of 36 stakeholders were interviewed (Table 1), selected according to several criteria: profile (project organization, public organization, non-profit partner organization, territorial and local authorities, companies), size (large companies, small and medium-sized companies) and sector of activity (agriculture and fishing, manufacturing, services). Through interviews with these actors, we were able to record their perceptions and the issues facing the CE project.

Table 1: Study Participants

Categories	Number of Respondents	Number of Interviews
Project Organization	4	8
Local Partner Organization	4	4
Local Authorities	6	6
Large Enterprises	8	12
Small and Medium Enterprises	6	6
Social Economy Enterprises	4	4

Public Organizations	R&D	4	4
Total		36	44

The first set of data that was collected shows the territorial dimension of public policy mechanisms. Following the first round of interviews, some stakeholders were interviewed again. Two interviews were conducted with each of the four stakeholders from the project organization, and two interviews were also conducted with representatives from four large companies. These additional interviews with the representatives from the large companies aimed to understand their role in public policy changes involving the CE, as the companies challenge regulations related to their business sector that limit circularity initiatives (material and energy-flow recovery, eco-design, economy of functionality, etc.). The questions for these interviews were organized in a grid according to the drivers, barriers, and institutional changes in the implementation of the CE in Quebec. The questions were related to four different themes: territories, actors, network, and institutions (Table 2). Question in the territory theme involve those that pertain to local features specific to Kamouraska, while question in the actor category range from their motivations to their knowledge. Network refers to diversity of stakeholders, collaborations, coordination, power relations, etc. Questions about institutions were related to environmental regulations, influence of the territorial organization, public funding, research and development, public support of governance.

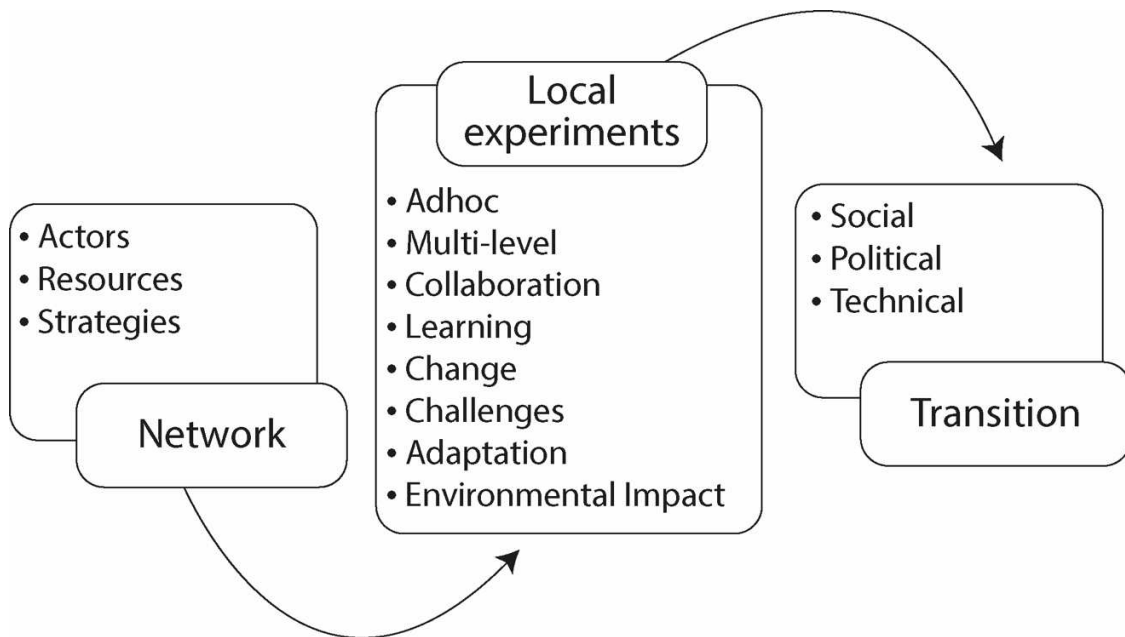
Table 2: Interview Themes

Themes	Content of Question
Territory	Geographic proximity Local commitment Territory leadership Local public policies Territory specificities Territory resources
Actors	Knowledge of stakeholders Entrepreneurial value Environmental value Motivation Internal environmental challenges Internal environmental initiatives
Network	Previous collaborations Diversity of stakeholders Social interactions Stakeholder recruitment Trust Leadership Participation (Role)

	Periodic meetings Information exchange (material and immaterial) Conventional regime (charter - contract - confidentiality agreement) Coordination Transparency Asymmetry of information Monitoring Co-learning Autonomy Duration Long-term intention Expected incentives
Institutions	Environmental regulations Influence of the territorial organization Public funding Research and development Public support of governance

Data were analyzed in strict compliance with confidentiality agreements made with stakeholders. All participants in the study were anonymized and each interview was analyzed and interpreted individually. All individual analyses were compared to develop a general understanding of the CE institutionalization in Quebec. Although the interviews were transcribed in their entirety, we do not present any verbatim quotes in our results. Each interview was immediately transcribed and were comprehensively analyzed using a grid developed from the literature on strategic niche management and transition theory (Figure 1). The analysis focused on the observation of specific facts related to the studied theme and provides a way to understand the dynamics that exist within an ecosystem of actors [55].

Figure 1: Analytical framework



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This analytical framework was used to understand the institutional and relational processes of local transition experiments and the role of the actors involved to reveal their spatial scale or temporal dimension of transition experiments. The first level is about the actors' network. It allows to characterize and analyze the economic profile, the cognitive and organizational capabilities (resources), and the individual and collective strategies of the actors. The second level determine the relational nature of the experiments. It is used to analyze experiments at local scale. The analysis underlines the ad hoc nature of the initiatives, the interactions with other spatial scales (meso, macro), the degree of collaboration between the stakeholders, the learning, the changes, the adjustments, the environmental impact, etc. Finally, the third level of the analytical framework identifies the dimensions of transition that are impacted by the experiments. It helps to measure the political, social, and technical consequences and perspectives of the experiments.

4. Findings

In Quebec, the CE first appeared in public discourse in the mid-2010s. However, the first public policies and mechanisms aimed at changing production and consumption patterns emerged in the late 1970s. These institutional arrangements included specific practices that now relate to CE, such as recycling and waste management. One amendment to the 1972 Environment Quality Act [56], a pioneer piece of legislation in Canada, urged the adoption of solid waste regulation, including the closure of landfills, limitations on the number of disposal sites and the standardization of disposal methods [57]. These measures have been

gradually reinforced following amendments to Quebec's Residual Materials Management Policy (RMMP). Along with these adaptations at the provincial level, new measures are also being implemented at the local level.

4.1. Integrated Waste Management Policy

In Quebec, the amendment to Section VII of the Environment Quality Act in 2010 launched the institutional promotion of sustainable production and consumption practices. However, CE issues require long-term processes to be formalized at the institutional level. In fact, the first measures adopted in 1972 were almost exclusively about integrated waste management. More institutional leadership was integrated into waste management towards the end of the 1980s, when Quebec's policymakers decided to overcome a century of unsustainable waste management policies that focused on the acquisition of land for public dumps or waste incineration. Landfills are associated with numerous environmental and social issues for local populations, and the safety control measures for these sites are no longer sufficient. Given these challenges, the Quebec government was obligated to quickly implement preventive measures to divert as much waste as possible from landfills [58]. Quebec implemented regulations on the contribution to landfills and the incineration of residual materials, with the goal of closing several smaller landfills and creating new larger landfills that serve large geographic areas [59]. Residual material management is now emerging as a new area of political action that can be used to respond to the large quantities of waste that are generated, and the environmental and social impacts associated with their disposal in landfills or incinerators.

The integrated waste management policy in Quebec underwent several changes that defined the broader scope of interventions around economic activities. This policy led to the implementation of the Quebec Residual Materials Management Policy (RMMP), which launched the sustainable transition in the practices carried out/enacted by Quebec companies. However, the RMMP is rather coercive, and not specifically dedicated to creating a CE [60]. This policy imposes major restrictions on the disposal of certain materials such as paper-cardboard, wood, and organic materials. And the RMMP complements the approximately thirty existing Canadian and Quebec laws that govern the environmental impact of industrial activities [61]. The strengthening of the legislative framework for waste management reflects the institutional dynamic of the transition to a CE. However, the rapid development of integrated waste management practices in Quebec is in large part due to businesses, territorial communities, and technological advances made in the early 1990s [59]. The lack of consistency and solidity in the integrated waste management policy and the repeated improvement delays led businesses and communities to step in. Thus, companies and local authorities developed local projects for the recovery and valorization of residual materials [56,57].

More specifically, Quebec companies have gradually implemented various initiatives for the optimal management of their waste materials. In the mid-2000s, experiments led to the emergence of industrial synergies in specific industrial zones, industrial ports, and regions [62]. A number of these industrial synergies became more robust at the turn of the 2010s. In fact, several Quebec municipalities adopted waste management plans to measure and

characterize the waste produced in their territory. In addition, regional waste management plans (RWMPs) are now dedicated to improving the region's performance in terms of recycling and the recovery of waste. The disposal of residual materials is only the final step in the waste management process for municipalities. Thus, the most recent RWMP in Kamouraska Region, adopted in 2016, explicitly prioritizes CE development (Table 3).

Table 3: Some regulatory RWMP measures related to the CE in Kamouraska

Actions	Types of Materials
Must recycle or recover septic tank sludge	Organic materials
Must recycle building concrete, brick, asphalt, and wood used in municipal contracts	Waste from construction, renovations, and demolitions
Adopt or modify municipal laws and rules to prohibit disposal of residential waste	Solid waste

© Kamouraska RWMP, 2016-2020

The industrial synergy and other local experiments in the recovery of waste materials appear to be decisive factors in the progressive institutionalization of a CE in Quebec. Indeed, these local experiments demonstrate new ways to integrate environmental constraints in economic activities. They offer the opportunity to influence the behaviors of businesses related to waste management standards, pollution, technological risks, water consumption, emissions, and the discharge of contaminants, among others. These local experiments also help to identify the potential barriers in the Environmental Quality Act that impact the implementation of certain integrated resource management projects. In fact, several local industrial synergies were not successful because of difficulties obtaining the permits or certificates required by section 22 of the Environment Quality Act. These failed experimental projects led the Quebec government to implement a new timeframe for certificate of authorization requests for CE projects, among other changes to the institutional framework.

Two major lessons can be learned from the regulatory process for the implementation of a CE in Quebec. First, existing environmental legislation, although not directly related to the CE, has encouraged CE projects in the territories. Second, local experiments have prompted the development of new regulations that contribute to large-scale CE implementation. Businesses and local authorities stand out as leaders in the transition towards a CE, and as key players in the establishment of CE public policies. However, the limited resources of small and medium-sized businesses and local authorities have led the government to identify new ways in which they could reinforce the CE transition. The Quebec government has therefore started providing incentives (financial assistance, technical expertise, government assistance, etc.) to local businesses to support the adoption and development of CE practices.

4.2. Incentives for CE development in Quebec

In Quebec, CE practices have long been directly initiated by companies with the support of some local authorities through local industrial synergy experiments that were developed in the mid-2010s. These companies and local authorities were involved in funding, research and development, and projects' coordination. However, as concerns about their capacity to support the transition to a CE grew, the idea of having shared complementary resources between the public agencies, policymakers and stakeholders took hold. This complementarity is particularly evident in the funding, technical expertise, and coordination of local projects. Thus, revisions to several strategic public policy documents (waste management, green technologies, the environment, sustainable development, etc.) in 2016 allowed public policymakers to institutionalize direct interventions for local CE experiments.

4.2.1. Funding programs to support CE transitions

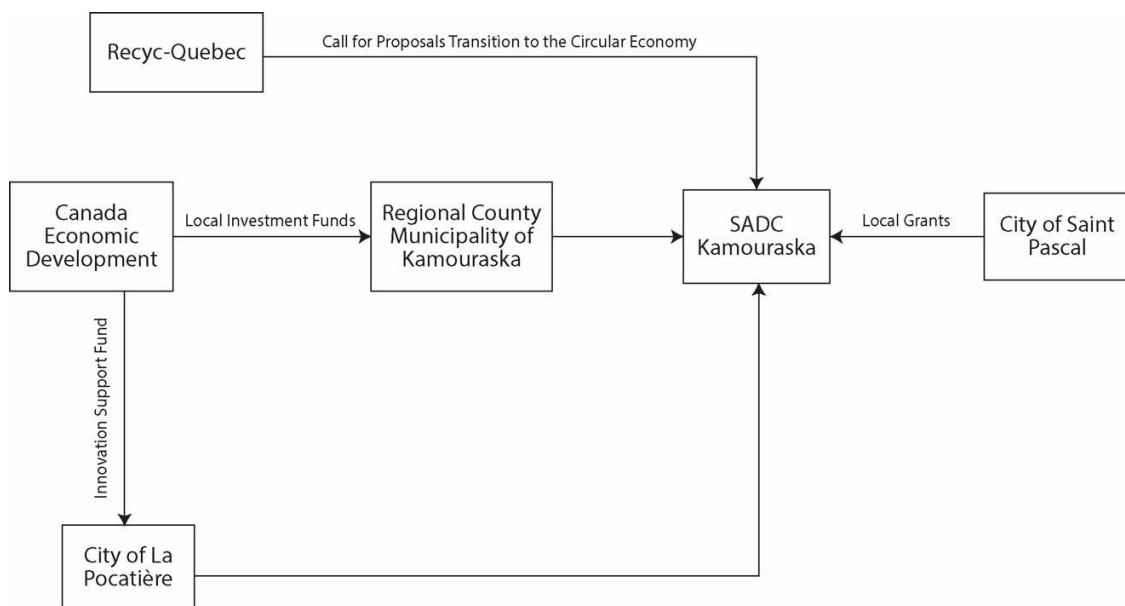
Our analysis of the institutionalization process of the CE in Quebec highlights the importance of local experiments in the development of interventions and support mechanisms by public agencies. Local experiments have revealed the need for financial support from the province to accelerate the CE transition in industrial practices. In fact, public financial aid has long been absent from CE projects in Quebec. Existing financial programs do not focus specifically on a CE but rather energy efficiency, improved transportation of goods, biomass valorization, and GHG emission reductions, among others. Thus, most local CE experiments have relied on private funding or public subsidies to support the growth of local businesses or innovation projects. Nevertheless, the strong presence of Small and Medium Enterprises (SME) with limited resources and the urgent need for a large-scale transition towards sustainable economic practices in Quebec has led to the implementation of funding programs from the Quebec government and its partner organizations. In the Kamouraska region, several public organizations have gradually committed to funding the local CE project (Figure 2).

The funding programs in the Kamouraska region encourage businesses and territories to develop CE initiatives. They target, among other things, recovery practices for recyclable materials (paper, cardboard, plastics, glass, metal), the flow diagnostics for certain businesses and municipalities, equipment acquisition and the search for new outlets for residual materials. Fourteen local CE initiatives were funded by the Quebec government between 2016 and 2018, in addition to a more recent funding program launched in spring 2020. This financial support is intended for organizations that are well-positioned with the industries in their territory to play a facilitating role in the implementation of a CE. To achieve this, economic development organizations (chambers of commerce, etc.), business groups (industrial parks, sectoral groups), territory organizations (administrative regions, RCMs, cities, etc.), and environmental and social organizations (regional environmental councils, non-profit organizations, social economy organizations, inter-municipal waste management organizations, etc.) are supported by public funds. This financial support has

helped to make Quebec businesses, particularly SMEs and local authorities, more interested in implementing or maintaining their local experiments. Indeed, it has stimulated the launch of certain projects that were not previously planned and helped launch certain local experiments that were shown by feasibility studies to have low economic profitability.

This shows that public funding plays an important role in motivating stakeholders, especially for experiments where the economic incentive is uncertain. The analysis also highlights the complementary nature of project funding. This complementarity mobilizes three categories of actors: government agencies, territory communities, and businesses (Figure 2). Government corporations, sectoral ministries, and communities often offer financial support for specific issues. In addition to Quebec's public agencies, the transition to a CE also relies on financial support from federal agencies. In the Kamouraska region, for example, financial assistance from Canada Economic Development (CED) through the Local Investment Fund (LIF) contributed to the implementation of a CE project. These public funds helped pay for communications and the organization of specific events such as seminars and workshops for business recruits.

Figure 2: Public funding for the CE project in the Kamouraska region



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These financial incentives influence the behavior of local businesses, especially managers of SME. The projects in the territories have revealed that certain businesses stop participating due to financial reasons. Companies, especially SME, do not have the financial resources necessary for the technical expertise, a salary for a project coordinator, paid seminars, and new equipment, etc. These constraints have led public agencies to integrate strategic support by mobilizing territory stakeholders, launching, and coordinating some local CE projects.

4.2.2. Public coordination and technical assistance

In Quebec, the coordination, and technical aspects of the first local CE experiments were handled by independent organizations for long periods of time. Although these organizations supported local stakeholders in the implementation of CE initiatives, local projects still required the skills of public organizations. Thus, regional county municipalities (RCM) and local authorities play significant roles in the structuring and coordinating of networks for CE's local projects. These public organizations are involved in the recruitment of businesses to integrate networks of local actors. The public organizations' involvement helps keep stakeholders motivated. It also helps stimulate inter-firm communication and ensures the recruitment of new actors for implementing and transitioning to CE at local level. The example of Kamouraska shows that territory authorities offer interesting perspectives for mobilizing local businesses. They have in-depth knowledge of their territories and know most of the businesses operating in the area. The constant interaction with local businesses appears to be important for gaining support for local CE experiments. Moreover, the territory authorities act as a bridge to other public organizations, particularly for research and development projects.

Indeed, local experiments, such as in Kamouraska, have shown that there are major technical issues involved in these initiatives, particularly in the recovery of waste materials and in eco-design. Businesses, particularly SMEs, do not always have sufficient human, economic and technical skills, or the resources to assess the technical feasibility of various projects. Public actors play an important role in flow diagnoses, technical trials, and the identification of new opportunities to strengthen CE initiatives within companies and in the territories. Local experiments have helped to define a new direction for institutional dynamics: to offer the technical expertise needed (to territorial actors through college and university research centers and government corporations) to identify technical solutions for stakeholders of the local CE experiments.

Hence, at least five research centers – all public – are involved in the Kamouraska region project. As mentioned, complementary actors are needed for the coordination of and technical expertise for a CE transition. The creation of the Quebec Taskforce for a Circular Economy in 2018 takes the approach of mobilizing a plurality of actors to facilitate a better understanding of issues related to a CE and to develop tools to help implement initiatives. The establishment of an interdepartmental CE committee that consists of twelve ministries and public agencies is helping to coordinate individual and collective efforts for a common understanding of issues about the CE at a larger scale. Thus, the various local CE experiments have progressively contributed to defining the different pillars of public action necessary to strengthen CE development in Quebec (Figure 3).

Figure 3: Overview of public strategies for CE development in Quebec

Integrated Residual Material Management Policy	Beyond Laws and Regulations	Towards a National Circular Economy Strategy
<ul style="list-style-type: none"> • Environmental Quality Act • Polluter-Pays principle for solid waste management • Extended Producer Responsibility Principle 	<ul style="list-style-type: none"> • Structuring and coordinating local CE networks • Technical expertise: research and development assistance • Implementation of funding program “Transition to the circular economy” 	<ul style="list-style-type: none"> • Public consultation on a circular economy roadmap • Reinforcing the commitment of sectorial ministries to address CE’s implementation issues • Public support of various local projects

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The tools that are used can be considered a form of institutional innovation. The rise in the number of local experiments demonstrates the interest in developing a common framework to implement and monitor CE projects in Quebec. Public strategies are enhancing the capabilities of multiple local actors to develop CE projects. And local experiments, such as the one in Kamouraska, serve as frameworks for learning about, identifying, and redefining public action. Local CE experiments are helping to integrate the CE into environmental public policy in Quebec.

4.3. Local CE experiments in Quebec: insights from Kamouraska

Kamouraska, a semi-urban region located in eastern Quebec, has seen the systematization of agriculture and forestry since the 1960s, as well as the development of manufacturing activities in the transportation and service sectors. This economic development has contributed to a profound economic and environmental transformation in the territory. Local actors must therefore respond to the ecological issues they now face due to this local economic development. In Kamouraska, environmental management regulations introduced by the Quebec government, such as integrated waste management, led local actors to implement the first CE initiatives. These initiatives essentially aimed to educate the population of Kamouraska on the reduction of waste, recycling, and a resource and transfer center dedicated to the storage and valorization of residual materials. In addition, local municipalities focused on raising awareness of and promoting domestic and community composting, co-composting, and biological recovery practices in partnership with local agricultural farms. These initiatives have been implemented as effective recovery measures, but they are strongly influenced by the semi-rural context of Kamouraska. The region is characterized by low population density and a lack of large-

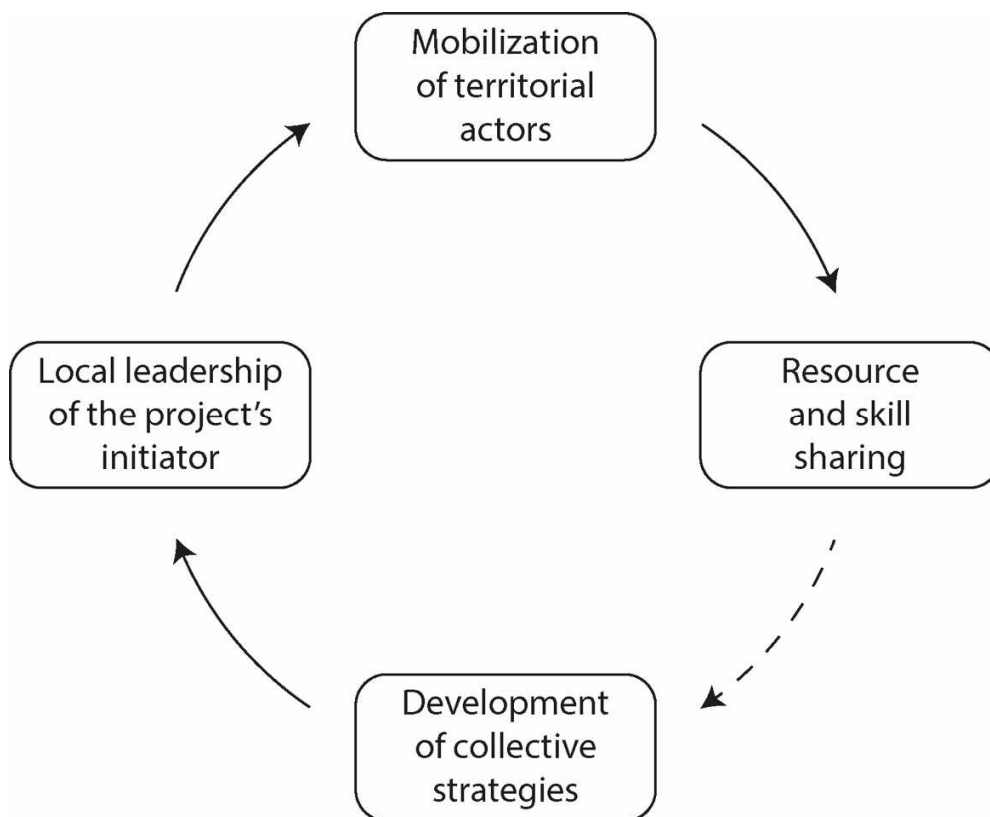
scale waste collection, transportation, and treatment facilities. In addition, the semi-rural context fosters complementarity and cooperation among stakeholders, due to their strong social interactions and shared values. Thus, the waste recovery measures adopted in the Kamouraska region, and in several other regions of Quebec, can help the government to define and consolidate management methods that are adapted to rural or semi-urban environments [59]. Territory stakeholders must redesign the territory's economic model when it comes to the revitalization and attractiveness of Kamouraska. They have been experimenting with new approaches to meet local issues, such as reconciling economic development with the preservation of the local environment. Indeed, the first waste management initiatives that were developed no longer adequately respond to the preservation of Kamouraska's natural environment.

There are many issues that threaten the preservation of Kamouraska's natural capital. The intensive exploitation of multiple mining, forestry and agricultural resources has generated disastrous environmental impacts (various types of pollution, soil and subsoil degradation, disruption of the groundwater cycle and degradation of the quality of watercourses, coastal erosion, etc.). For this reason, local actors have progressively worked towards a CE project that maintains the environmental quality of their territory. More than forty local actors were involved in the valorization of various territorial resources through CE project. These actors mainly consisted of local companies, local authorities, community organizations, research centers and technical partners. Their commitment is supported by an individual and collective vision of conciliation between economic development and environmental preservation. 52 industrial synergies were developed between the region's industries, businesses, and institutions. More than 337 tons of material flow (wood, cardboard, ferrous metals, glass, foam, ashes, fabrics, food residues, etc.) were exchanged. This local CE project allow companies to save annually an average of 950 USD by avoiding landfill or waste material treatment costs. Environmental benefits are determined by the greenhouse gas emissions that were prevented and the quantities of materials that were not landfilled. Based on a methodology developed by the CTTÉI, more than 302 tons of greenhouse emissions are annually prevented. Approximately 96 tons of material have been diverted from landfill annually, which also helps preserve biodiversity. Not only do industrial synergies contribute to improving the living environment, but some also help support companies specialized in local recycling, community organizations and contribute to the environmental education of the population.

The first consultations and actions for this project occurred in 2013 under the leadership of the local development organization named “Société d'aide au développement des collectivités (SADC)”. Due to a lack of regulatory obligations and incentives for businesses to implement CE projects and a lack of guidance in public policy documents, various organizational, regulatory, and economic constraints delayed the structuring of local CE project's network. Therefore, the local CE network was not actually created until 2016. Four major factors helped mobilize local actors and create the local CE network at that time: 1) the integration of a CE in Kamouraska's 2016 land use plan, 2) the support of local authorities for recruiting businesses, 3) the public subsidies obtained by SADC to ensure the coordination of the network, and 4) the commitment of research centers to provide technical expertise to stakeholders. These allowed for interactions between local CE

experiments and the established institutional framework, making local CE experiments less at odds with the institutional framework. Although they can be considered as having emerged from outside the institutional framework, local CE experiments are developing in a complementary way with a more global institutional framework. The CE project is a space for complementarity and the collaboration of local actors. The previous collaborations between these actors, who have known each other for years, are important for territorial mobilization. Their social proximity reinforces their commitment to the CE project. This highlights those social interactions between stakeholders play an important role in local experiments. In the Kamouraska CE project, the mobilization of local actors is also supported by the leadership of SADC. As a project initiator, SADC coordinates the network and helps actors to pool their resources and skills, allowing them to identify effective strategies. In fact, local experiments require governance that ensures stability, robustness, and sustainability [63]. Local experiments require multiple/several phases to be implemented. In the Kamouraska CE project, there are four of these phases (Figure 4).

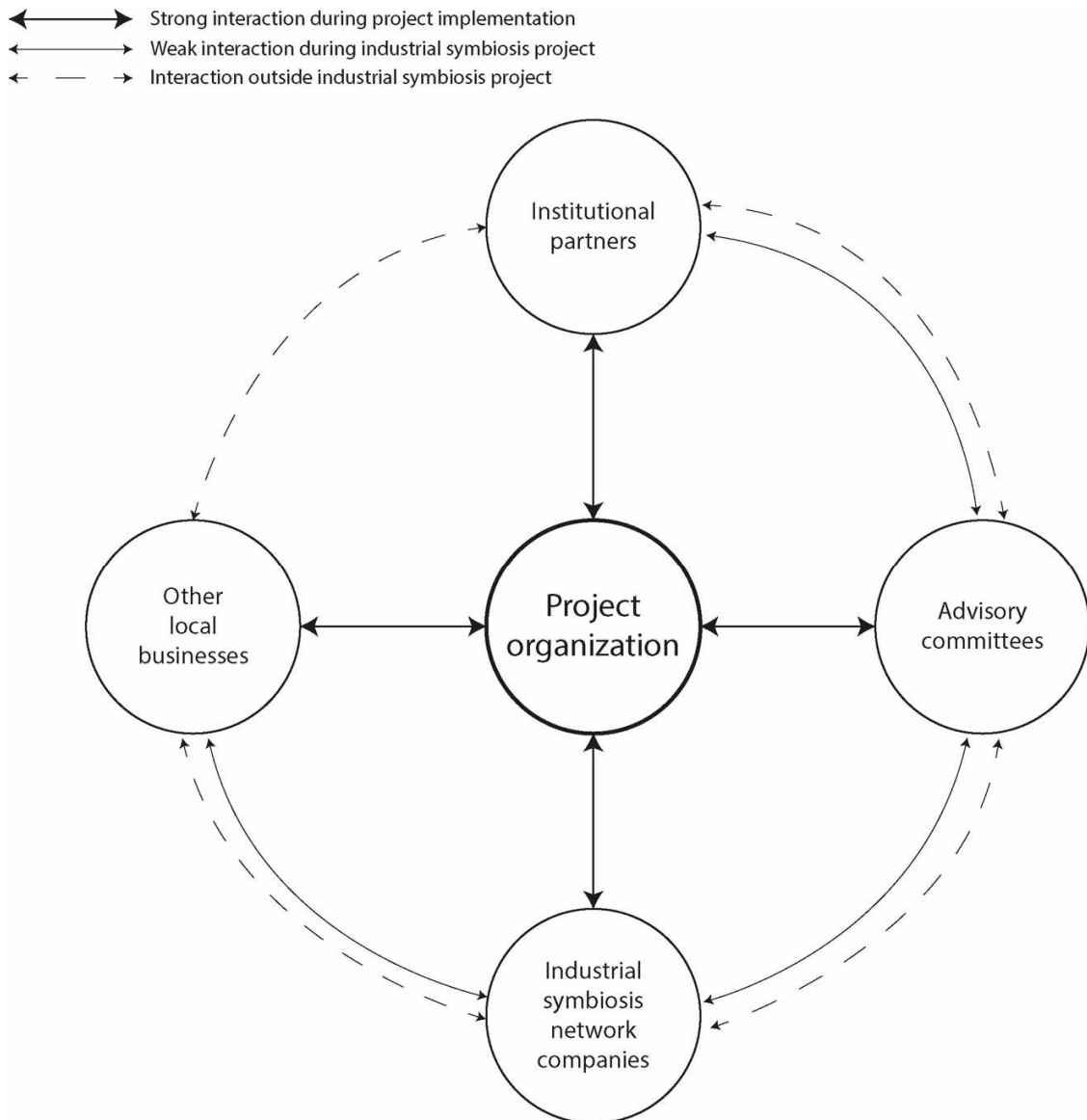
Figure 4: CE implementation process in Kamouraska



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This process activates the skills and resources of each stakeholder, giving them key roles in local experiments. An analysis of the CE project in Kamouraska identified five major

Figure 6: Centrality of CE implementation in Kamouraska



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Despite this kind of SADC's centrality or domination in CE project's in Kamouraska, stakeholders are consulted to discuss plans concerning the development and sustainability of CE project. The two major cities in the region (La Pocatière and Saint Pascal) make significant changes in their administrative constraints to help solve problems faced by the project. Also, they have increased their role in company recruitment for the project. Their presence in the network offers the chance to include the CE in the territory's sustainable planning. Local experiments can then be implemented around the progressive mobilization of some actors, while key stakeholders, notably local authorities, businesses, and partners, commit their resources and skills. The various elements related to the CE project in

Kamouraska demonstrate that local transition experiments require a diversity of stakeholders to work together to gain progressive control of the issues. A collective process that involves active participation at the local or territory level is necessary for the implementation of a CE. This reiterates that the institutionalization of a CE in Quebec requires strategies at different scales.

5. Discussion

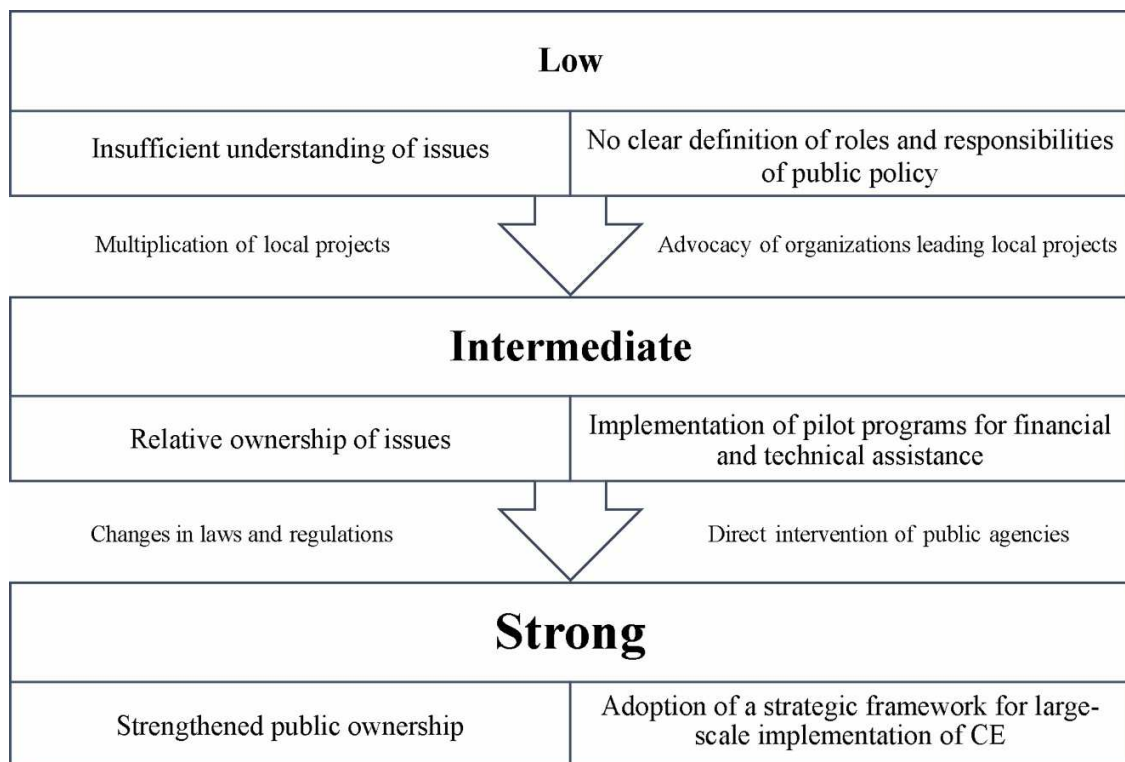
The process of institutionalizing a CE in Quebec is complex. This complexity is apparent in the literature about sustainable transitions [25,45,47] and the implementation of CEs [64,65]. The non-linear and sometimes conflicting nature of transitions [48] is evident in the CE development in Quebec. Transition experiments involve a cyclical process on various levels: stimulating niche development at the micro level, finding new attractors at the macro level by developing a sustainability vision, creating diversity by setting up experiments, and selecting successful experiments that can be scaled up [47]. Local CE experiments and their institutionalization are somewhat related to complex systems of power relations and differentiation [45].

Institutionalizing a CE in Quebec involves multiple phases and interactions (or power relationships) between different systems of actors. The institutionalization of the CE first started through 1980s policies on environmental quality and later, waste management. However, the public's focus was not specifically on the implementation of a CE. Local experiments, particularly those organized by industries to respond to environmental constraints, were therefore the decisive factor for introducing the CE into the discourse of political organizations. In this way, the first local CE experiments in Quebec were implemented without a specific institutional framework. These initiatives were implemented by local actors to preserve environmental quality, as in many other transitions experiments [36,47,66]. Local experiments therefore enable the activation or change of the institutional dynamics associated with environmental issues. This institutional dynamic can occur in three phases that are characterized by different levels of understanding and commitment (Figure 7).

The first phase, defined here as "weak", refers to the political status quo. During this phase, public policies are based on an insufficient understanding of the issues. A complementarity of resources and skills of public agencies, at the national scale and among local experiment stakeholders, is almost non-existent. Local experiments emerge without a clear definition of the roles and responsibilities of public policy strategies that target the issues. In the second phase, defined here as "intermediate", local experiments are well-established and can activate dynamics at the institutional level. In this phase, the number of local experiments multiply, which due to organizational, regulatory, and economic constraints, demand more public support. Thus, local experiments allow for public policymakers to have some ownership of the issues that are targeted. Public actors can offer funding and technical expertise for the project's development. During this phase, a certain complementarity of resources and skills emerges between public agencies and local stakeholders. Local actors work to activate the skills and resources of public agencies to improve the local

experiments. The third and final phase, defined here as "strong", is characterized by the direct intervention of public policies in local experiments. During this step, public agencies develop a stronger understanding of the issues and proceed to address them. They can also create a strategic framework to scale-up local experiments. The aim here is to connect local experiments with the macro-societal objectives of public policies. This results in the complementary mobilization of the resources and skills of public agencies and local experimenters that transition managers can rely on.

Figure 7: The three phases of CE institutionalization in Quebec



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These three phases are socio-technical and depend on the cultural context. The environmental values of local actors are important to shaping the transition and its institutionalization. Environmental and legislative rules can constrain local actors from implementing various initiatives, but the ecological values of these actors determine new experiments that can address these constraints. Therefore, while transition experiments rely on the cognitive dynamics of individuals, organizations, and the system of actors [46,49,50,66], values and norms are highly influential factors. The willingness of local actors to initiate and contribute to change can shape the emergence and progressive institutionalization of transition experiments. Local experiments were developed and maintained over time according to the values and motivations of stakeholders. Local experiments encouraged a transition by attracting new actors from different scales, particularly actors from public agencies. The growing number of public and private

organizations involved in the CE in Quebec illustrates the impact of local experiments. The popularity of these experiments can encourage public agencies to integrate the CE transition into their policies. Public subsidies, technical expertise, and support for CE projects point to the impact that local experiments have had on public policies. It is also fundamental to consider the cultural context, and the changes in the values and norms of actors (public, private, citizens, community, etc.) involved in the transition [67]. Indeed, at the national level, the mechanisms of influence could be interpreted as changes in values or the interactions between local actors [68]. Our example shows that local experiments can change the way environmental problems are addressed, by contributing to the development of a macro view of transitions. They appear as trial-and-error mechanisms (Do it yourself) and drivers that achieve political and social change and overcome institutional rigidity. Moreover, our case study demonstrates that local experiments also contribute to paradigm changes through learning, appropriation/ownership, and institutionalization mechanisms.

Learning is achieved by communicating and disseminating ideas, therefore enhancing further learning over time [69]. The various interactions between actors contribute to this process. The mechanisms for learning are undeniably linked to the cultural context. However, the definition of the cultural context is not part of a structuralist or sociological perspective [31]. Indeed, the example of the CE transition in Quebec demonstrates that the institutional foundations (rules, values, objectives, etc.) are constantly being discussed among the actors involved. The transition, in other words, is more than the pre-existing social dynamic. As is the case for the institutionalization of a CE in Quebec, transitions point to the power relationships and varying levels of influence within a collective action. In fact, power relationships appear already in the bottom-up and top-down pressures between 'experimenting' actors [45,47]. Transition experiment stakeholders need to reduce the imbalances and power relations that may exist among actors [45]. The experiments must therefore legitimize all stakeholders through a common framework of rules for collective action. Conceptualizing the possible relationships between individual interest and collective action could help to legitimize the relational and institutional nature of the transition. Because this legitimization is part of a long process [28,38,48], the institutional and relational dimensions are still limited in Quebec's CE development, despite it being several years since the first CE experiments. Because they are still in the early stages of development local CE experiments are not enough to systematically institutionalize the operational framework and fully define the relational aspects of the transition to a CE.

6. Conclusion

Our analysis demonstrates the importance of actors interacting at different scales for the progressive institutionalization of a CE in Quebec. This institutional process involves a socio-political dimension that reimagines public action within the territory. First, public policies set an agenda for environmental issues. Second, local experiments help local actors respond to public policies. Finally, lessons learned from local experiments help to define a more specific institutional and relational framework. Changes in the practices initiated at local level can have positive effects on new public agency strategies that can accelerate or

reinforce the transition at different scales. This socio-political process also refers to the cultural context as well as the values and complementary resources and skills from a plurality of actors (political, public, private, community, citizens, etc.) operating at different spatial scales.

And the important role of local experiments in the scaling-up of CE in Quebec reflects the consideration of the territory as an endogenous factor in the ecological transition process. The socio-political process could not exist without a real consideration of territories, especially their specificities, and of the ecosystems of actors through the interactions between them at different levels. Scaling up therefore means an increasing of territorialized CE implementation with probably measurable technical-economic, environmental, and social benefits. Hence, the behavior of actors is a major lever for the institutionalization of the CE. This institutionalization takes place in a space of collective action, learning and value creation for all. It requires the observation of networks, the discovery and perception of a social phenomenon that occurs within territorial ecosystems of actors.

However, this process also reveals the power relationships between stakeholders. This means transitions unfold through a collective process that involves established dominant actors as well as those in previously marginal positions in the establishment of public policies. The example of the CE in Quebec suggests the need for a complementarity between actors to integrate sustainable practices for the consumption and production of goods. Through this complementarity, the rigid nature of public strategies can be overcome. Public strategies are part of a collective process that encourage the connections between individual interests and common objectives. However, this transition has many challenges, including the sometimes important technical or organizational barriers for changes in practices, the real environmental impacts of CE, etc. Overcoming these issues is crucial to the development/establishment of a pragmatic process for the system's transition, the success of local experiments, and the institutionalization of a CE.

References

- [1] T. Almeida, L. Cruz, E. Barata, I.-M. García-Sánchez, Economic growth and environmental impacts: An analysis based on a composite index of environmental damage. *Ecological Indicators*, 76 (2017) 119–130 <https://doi.org/10.1016/j.ecolind.2016.12.028>
- [2] X. Jiang, C. Green, The Impact on Global Greenhouse Gas Emissions of Geographic Shifts in Global Supply Chains. *Ecological Economics*, 139 (2017) 102–114 <https://doi.org/10.1016/j.ecolecon.2017.04.027>
- [3] J. Pan, 2019. From Ecological Imbalance to Ecological Civilization: The Process of China's Green Transformation Over 40 Years of Reform and Opening Up and Its Outlook. *Chinese Journal of Urban and Environmental Studies*, 07, 1950007 <https://doi.org/10.1142/S2345748119500076>
- [4] L. Pereira, T. Karpouzoglou, N. Frantzeskaki, P. Olsson, Designing transformative spaces for sustainability in social-ecological systems. *Ecology and Society*, 23 (2018), <https://www.jstor.org/stable/26796848>.
- [5] F. Blomsma, M. Pieroni, 2019. Developing a circular strategies framework for

- manufacturing companies to support circular economy-oriented innovation. *Journal of Cleaner Production*, 241, 118271. <https://doi.org/10.1016/j.jclepro.2019.118271>
- [6] P. Ekins, T. Domenech, P. Drummond, *The Circular Economy: What, Why, How and Where*. Background Paper for an OECD/EC Workshop, 82 (2019) <https://doi.org/10.1787/f0c6621f-en>
- [7] K. Hobson, ‘Small stories of closing loops’: Social circularity and the everyday circular economy. *Climatic Change* 163 (2019) <https://doi.org/10.1007/s10584-019-02480-z>
- [8] W. Stahel, *The Circular Economy*, First edition, Routledge, 2019.
- [9] D. Cooper, T. Gutowski, *The Environmental Impacts of Reuse: A Review*. *Journal of Industrial Ecology*, 21 (2017) 38–56 <https://doi.org/10.1111/jiec.12388>
- [10] P. Rathore, S. Sarmah, 2020. Economic, environmental, and social optimization of solid waste management in the context of circular economy. *Computers Industrial Engineering*, 145, 106510. <https://doi.org/10.1016/j.cie.2020.106510>
- [11] R. Rocca, C. Sassanelli, P. Rosa, S. Terzi, *Circular Economy Performance Assessment*. In P. Rosa S., Terzi (Eds.), *New Business Models for the Reuse of Secondary Resources from WEEEs: The FENIX Project*. Springer International Publishing, 2021 pp. 17-33 https://doi.org/10.1007/978-3-030-74886-9_3
- [12] M. Braungart, W. McDonough, W. Cradle to Cradle. *Remaking the Way We Make Things*. Vintage, 2010.
- [13] J. Korhonen, A. Honkasalo, J. Seppälä, *Circular Economy: The Concept and its Limitations*. *Ecological Economics*, 143 (2018) 37–46 <https://doi.org/10.1016/j.ecolecon.2017.06.041>
- [14] L. Beaulieu, D. Normandin, Introduction. In S. Sauvé, D., Daniel M. McDonald (Eds.), *L’économie circulaire. Une transition incontournable*. Presses Universitaires de Montréal (PUM), Montréal, 2016, pp. 13-22.
- [15] B. Baldassarre, M. Schepers, N. Bocken, *Industrial Symbiosis: Towards a design process for eco-industrial clusters by integrating Circular Economy and Industrial Ecology perspectives*. *Journal of Cleaner Production*, 216 (2019) 446–460 <https://doi.org/10.1016/j.jclepro.2019.01.091>
- [16] S. Waddock, *Achieving sustainability requires systemic business transformation*. *Global Sustainability*, 3 (2020) <https://doi.org/10.1017/sus.2020.9>
- [17] C. Sassanelli, P. Rosa, P., R. Rocca, S. Terzi, S, *Circular economy performance assessment methods: A systematic literature review*. *Journal of Cleaner Production*, 229 (2019) 440–453. <https://doi.org/10.1016/j.jclepro.2019.05.019>
- [18] C. Vinante, P. Sacco, G. Orzes, Y. Borgianni, 2021. *Circular economy metrics: Literature review and company-level classification framework*. *Journal of Cleaner Production*, 288, 125090. <https://doi.org/10.1016/j.jclepro.2020.125090>
- [19] M. Antikainen, A. Aminoff, O. Kettunen, *Circular Economy Business Model Innovation Process – Case Study*. In G. Campana, R. Howlett, R. Setchi, B. Cimatti (Eds.), *Sustainable Design and Manufacturing*. Springer International Publishing, 2017. pp. 546-555 https://doi.org/10.1007/978-3-319-57078-5_52
- [20] A. de Jesus, P. Antunes, R. Santos, S. Mendonça, *Eco-innovation in the transition to a circular economy: An analytical literature review*. *Journal of Cleaner Production*, 172 (2018) 2999–3018. <https://doi.org/10.1016/j.jclepro.2017.11.111>
- [21] A. de Jesus, S. Mendonça, *Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy*. *Ecological Economics*, 145 (2018) 75–89

<https://doi.org/10.1016/j.ecolecon.2017.08.001>

[22] J. Kirchherr, L. Piscicelli, R. Bour, Barriers to the Circular Economy: Evidence from the European Union (EU). *Ecological Economics* 150 (2018) 264–272 <https://doi.org/10.1016/j.ecolecon.2018.04.028>

[23] R. Hoogma, M. Weber, B. Elzen, Integrated Long-Term Strategies to Induce Regime Shifts towards Sustainability: The Approach of Strategic Niche Management. In M. Weber, J. Hemmelskamp (Eds.), *Towards Environmental Innovation Systems*. Springer-Verlag, 2005, pp. 209–236 https://doi.org/10.1007/3-540-27298-4_12

[24] J. Schot, F. Geels, Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technology Analysis Strategic Management*, 20 (2008), 537–554. <https://doi.org/10.1080/09537320802292651>

[25] E. Susur, A. Hidalgo, D. Chiaroni, A strategic niche management perspective on transitions to eco-industrial park development: A systematic review of case studies. *Resources, Conservation and Recycling*, 140 (2019) 338–359 <https://doi.org/10.1016/j.resconrec.2018.06.002>

[26] H. Tian, Z. Wang, Chinese green process innovation in automotive painting: The strategic niche management perspective. *International Journal of Environmental Science and Technology*, 17 (2020) 993–1010. <https://doi.org/10.1007/s13762-019-02530-0>

[27] J. Wittmayer, N. Schöpke, F. Steenbergen, I. Omann, Making sense of sustainability transitions locally: How action research contributes to addressing societal challenges. *Critical Policy Studies*, 8 (2014) 465–485 <https://doi.org/10.1080/19460171.2014.957336>

[28] L. Fuenfschilling, An institutional perspective on sustainability transitions. 2019.

[29] R. Hoogma, R. Kemp, J. Schot, B. Truffer, *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*. Routledge, 2002 <https://doi.org/10.4324/9780203994061>

[30] R. Kemp, D. Loorbach, J. Rotmans, Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development & World Ecology*, 14 (2007) 78–91 <https://doi.org/10.1080/13504500709469709>

[31] F. Geels, From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, 33 (2004) 897–920 <https://doi.org/10.1016/j.respol.2004.01.015>

[32] M. Martiskainen, The role of community leadership in the development of grassroots innovations. *Environmental Innovation and Societal Transitions*, 22 (2017) 78–89 <https://doi.org/10.1016/j.eist.2016.05.002>

[33] R. Kemp, D. Loorbach, Transition management: A reflexive governance approach. In J-P. Voss, D. Bauknecht, R. Kemp, *Reflexive governance for sustainable development*. Edward Elgar Pub, 2006, pp. 103–130

[34] D. Loorbach, N. Frantzeskaki, W. Thissen, A Transition Research Perspective on Governance for Sustainability. In C. Jäger, J. Tàbara, J. Jaeger (eds) *European Research on Sustainable Development*. Springer, Berlin, Heidelberg, 2011 pp. 73–89 https://doi.org/10.1007/978-3-642-19202-9_7

[35] O. Osman, K. Ibrahim, K. Koshy, M. Muslim, The institutional dimension of sustainability: Policy response for enhanced practice at Universiti Sains Malaysia. In P. Corcoran, B. Hollingshead, H. Lotz-Sisitka, A. Wals, J. Weakland (Eds.), *Intergenerational learning and transformative leadership for sustainable futures*. Wageningen Academic

- Publishers. 2014 pp. 175-188. https://doi.org/10.3920/978-90-8686-802-5_11
- [36] H. Bulkeley, *An urban politics of climate change: Experimentation and the governing of socio-technical transitions* Routledge. 2015
- [37] H. Bulkeley, V. Castan Broto, *Government by experiment? Global cities and the governing of climate change*. *Transactions of the Institute of British Geographers*. 38 (2013) <https://doi.org/10.1111/j.1475-5661.2012.00535.x>
- [38] F. Bauer, L. Fuenfschilling, *Local initiatives and global regimes – multi-scalar transition dynamics in the chemical industry*. *Journal of Cleaner Production*, 216 (2019) 172–183. <https://doi.org/10.1016/j.jclepro.2019.01.140>
- [39] F. Nevens, N. Frantzeskaki, L. Gorissen, D. Loorbach, *Urban Transition Labs: Co-creating transformative action for sustainable cities*. *Journal of Cleaner Production*, 50 (2013) 111–122 <https://doi.org/10.1016/j.jclepro.2012.12.001>
- [40] J. de Kraker, *Social learning for resilience in social–ecological systems*. *Current Opinion in Environmental Sustainability*, 28 (2017) 100–107 <https://doi.org/10.1016/j.cosust.2017.09.002>
- [41] P. Plummer, K. Poeck, *Exploring the role of learning in sustainability transitions: A case study using a novel analytical approach*. *Environmental Education Research*, 27 (2021) 418–437 <https://doi.org/10.1080/13504622.2020.1857703>
- [42] B. van Mierlo, P. Beers, *Understanding and governing learning in sustainability transitions: A review*. *Environmental Innovation and Societal Transitions*, 34 (2020) 255–269 <https://doi.org/10.1016/j.eist.2018.08.002>
- [43] D. Loorbach, N. Frantzeskaki, F. Avelino, *Sustainability Transitions Research: Transforming Science and Practice for Societal Change*. *Annual Review of Environment and Resources*, 42 (2017) 599–626 <https://doi.org/10.1146/annurev-environ-102014-021340>
- [44] F. Sengers, A. Wieczorek, R. Raven, *Experimenting for sustainability transitions: A systematic literature review*. *Technological Forecasting and Social Change*, 145 (2016) <https://doi.org/10.1016/j.techfore.2016.08.031>
- [45] K. Kok, A. Loeber, J. Grin, 2021. *Politics of complexity: Conceptualizing agency, power, and powering in the transitional dynamics of complex adaptive systems*. *Research Policy*, 50, 104183. <https://doi.org/10.1016/j.respol.2020.104183>
- [46] S. Laakso, R. Aro, E. Heiskanen, M. Kaljonen, *Reconfigurations in sustainability transitions: A systematic and critical review*. *Sustainability: Science, Practice and Policy*, 17 (2021) 15–31 <https://doi.org/10.1080/15487733.2020.1836921>
- [47] J. Rotmans, D. Loorbach, *Complexity and Transition Management*. *Journal of Industrial Ecology*, 13 (2009) 184–196 <https://doi.org/10.1111/j.1530-9290.2009.00116.x>
- [48] F. Geels, 2020. *Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics, and neo-institutional theory*. *Technological Forecasting and Social Change*, 152, 119894 <https://doi.org/10.1016/j.techfore.2019.119894>
- [49] S. Axon, 2020. *The socio-cultural dimensions of community-based sustainability: Implications for transformational change*. *Journal of Cleaner Production*, 266, 121933 <https://doi.org/10.1016/j.jclepro.2020.121933>
- [50] S. Grenni, K. Soini, L. Horlings, *The inner dimension of sustainability transformation: How sense of place and values can support sustainable place-shaping*. *Sustainability*

- Science, 15 (2020) 411–422 <https://doi.org/10.1007/s11625-019-00743-3>
- [51] A. Cherp, V. Vinichenko, J. Jewell, Integrating techno-economic, socio-technical, and political perspectives on national energy transitions: A meta-theoretical framework. *Energy Research & Social Science*, 37 (2018) 175–190 <https://doi.org/10.1016/j.erss.2017.09.015>
- [52] J. Stiles, Strategic niche management in transition pathways: Telework advocacy as groundwork for an incremental transformation. *Environmental Innovation and Societal Transitions*, 34 (2020) 139–150 <https://doi.org/10.1016/j.eist.2019.12.001>
- [53] F. Geels, J. Schot, The dynamics of transitions: A social-technical perspective. In J. Grin, J. Rotmans, J. and J. Schot (Eds), *Transitions to sustainable development: new directions in the study of long-term transformative change*. Routledge, 2010 pp.11-104
- [54] F. Geels, Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy*, 39 (2010) 495–510 <https://doi.org/10.1016/j.respol.2010.01.022>
- [55] B. Kogut, Qualitative comparative analysis of social science data. In *The Oxford Handbook of Comparative Institutional Analysis*. 2010
- [56] M. Olivier, *Matières résiduelles et 3 RV-E*. Third Edition, Productions Jacques Bernier. 2010
- [57] A. Le Goff, *L'écologie industrielle et territoriale comme outil pour l'atteinte des objectifs fixés par le plan d'action 2011-2015 québécois pour la gestion des matières résiduelles*, Université de Sherbrooke. 2012
- [58] F. Quintus, *Les enjeux de l'enfouissement des déchets: Quelle place aux perceptions des risques dans la procédure québécoise d'évaluation environnementale? Étude du cas de l'agrandissement du site d'enfouissement sanitaire Argenteuil Deux-Montagnes*, UQAM. 2007
- [59] K. Masson, *La gestion des matières résiduelles en milieu rural—Le cas pratique de la MRC de La Vallée-de-La-Gatineau*, Université de Sherbrooke, 2009
- [60] M.-L. Molaison, *Étude du modèle d'affaires de la symbiose industrielle de Brome-Missisquoi, selon la perspective du système d'activité*, Université de Sherbrooke, 2009 <http://hdl.handle.net/11143/8932>
- [61] M. Maltais-Guilbault, *L'écologie industrielle au Québec: Identification de pistes pour développer ce modèle d'innovation pour les entreprises*, Université de Sherbrooke, 2011 <http://hdl.handle.net/11143/7312>
- [62] S. Beaudin-Quintin, *Diagnostic des synergies et symbioses industrielles existantes dans la MRC de Pierre-De Saurel*, Université de Sherbrooke, 2011
- [63] J. Cramer, *How Network Governance Powers the Circular Economy*. Amsterdam Economic Board. 2020.
- [64] G. Dijkema, M. Xu, S. Derrible, R. Lifset. Complexity in Industrial Ecology: Models, Analysis, and Actions. *Journal of Industrial Ecology*, 19 (2015) 189–194 <https://doi.org/10.1111/jiec.12280>
- [65] C. Velte, R. Steinhilper, *Complexity in a Circular Economy: A Need for Rethinking Complexity Management Strategies*. 2016
- [66] P. Bögel, K. Pereverza, P. Upham, O. Kordas, Linking socio-technical transition studies and organisational change management: Steps towards an integrative, multi-scale heuristic. *Journal of Cleaner Production*, 232 (2019) 359–368 <https://doi.org/10.1016/j.jclepro.2019.05.286>

- [67] B. Turnheim, F. Berkhout, F. Geels, Evaluating sustainability transitions pathways: Bridging analytical approaches to address governance challenges. *Global Environmental Change*, 35 (2015) 239–253 <https://doi.org/10.1016/j.gloenvcha.2015.08.010>
- [68] T. Coenen, W. Haanstra, A. Jan Braaksma, J. Santos, 2020. CEIMA: A framework for identifying critical interfaces between the Circular Economy and stakeholders in the lifecycle of infrastructure assets. *Resources, Conservation and Recycling*, 155, 104552 <https://doi.org/10.1016/j.resconrec.2019.104552>
- [69] G. Cloutier, M. Papin, C. Bizier, Do-it-yourself (DIY) adaptation: Civic initiatives as drivers to address climate change at the urban scale. *Cities*, 74 (2018) 284–291 <https://doi.org/10.1016/j.cities.2017.12.018>