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Overcoming Circular Economy Challenges in Port Areas: An Institutional Perspective

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ABSTRACT: *The implementation of circular economy practices is a current and important topic. Despite extensive research on CE barriers in various industries and countries, there is limited discussion on circular economy challenges in port areas. This paper aims at empirically studying circular economy implementation, its associated obstacles, and the levers to overcome them by mobilizing institutional theory. To this end, we studied six cases of companies, located in a port area in France, that have implemented circular economy in their practices. We deployed a qualitative case study methodology. As results, we have identified 41 challenges divided into 5 groups: (1) economic-financial-market, (2) organizational-managerial-cultural, (3) technical-technological, (4) regulatory-governmental, (5) supply chain. The results were then interpreted through the lens of institutional theory. We found that institutional mechanisms - coercive, normative, mimetic, and informal instruments - can be mobilized so as to meet each of the challenges.*

KEYWORDS: circular economy, port, challenges, institutional theory, circular supply chain, institutional mechanisms

INTRODUCTION

Interest in adopting a circular economy (CE) has increased, particularly in the context of the COVID-19 pandemic (Ibn-Mohammed et al., 2021). Establishing a CE is considered the surest way to achieve more sustainable development (SD) (Geissedoerfer et al., 2017). The European Commission adopted a CE Action Plan for a clean and competitive Europe in 2020, resulting in the focus of European Nations on SD, industry, waste recycling, and sustainable product design (European Commission, 2020).

France enacted two laws dedicated to CE and climate and resilience in 2020 and 2021, marking support for this movement. These laws challenge businesses and consumers on the one hand and port facilities on the other. Ports host activities with significant impacts on the environment and must consider

environmental protection through incentives for companies to fully play their role in SD (Cerceau et al., 2014; Vejvar et al., 2017).

CE is receiving considerable attention from ports because of the negative externalities of industrial and logistics activities. French ports are no exception and are integrating CE into their development strategy to become major players in circular supply chains (Mankowska *et al*., 2020). To this end, a dynamic acceleration of CE within French ports is envisaged thanks, to significant government funding by 2024 (De Lorgeril, 2020). In response to regulatory pressures, ports have adopted measures, plans, and incentives in accordance with social and environmental responsibility approaches. Several ports in France are already on the path of ecological transition thanks to CE and industrial and territorial ecology (ITE) practices. They are real players in ship waste recycling, treatment, and recovery. Many examples include the ports of Marseille-Fos (Cerceau et al., 2014), Dunkirk (Beaurin and Brullot, 2011), Strasbourg (Duret et al., 2018) and Le Havre (De Lorgeril, 2020). This represents an opportunity for French ports to achieve "clean port" status and thereby stand out and improve their competitiveness relative to other European ports (Rainaud, 2021). The transformation of seaport business models towards CE is a new area of research (Mankowska et al., 2020). The operational deployment of a CE goes through the companies located in these ports, which operate as facilitating institutions. However, companies face obstacles or challenges that hinder the deployment of CE-related activities (Mishra et al., 2022).

The literature on the challenges of CE within seaports is insufficient. This study, conducted on the challenges related to CE implementation within a French seaport, fits in this context. This paper responds to the call by Mankowska et al. (2020) for research on the transformation of ports through CE. This paper proposes to examine such challenges and address the following two issues. First, how companies can engage in CE and thus enroll in a favorable and effective trajectory? Secondly, what's the role of institutions, particularly ports, so as to better understand the challenges faced by firms in operationalizing CE? In this regard, institutional theory has emerged as a relevant analytical framework to describe how organizations develop and refine their practices to gain legitimacy, especially through corporate social responsibility (CSR) (Sundström and Mickelsson, 2020; Tyrowicz et al., 2020) and CE (Do et al..2022). The objective of this research is to examine how companies engage in CE practices and the associated challenges they encounter, as well as the role of ports in addressing these challenges.

Our research follows an exploratory logic, using the case method to study a particular French port. The primary contribution of our research concerns the identification of challenges faced by companies and the link between these challenges and institutional mechanisms, we propose a specific research model for this purpose. In addition, we present the different levers that can be used to meet these challenges. After an analytic literature review, we explain the research methodology and present the empirical framework. Then, we present the results, and finally, discuss them before proposing a research model.

LITERATURE

Circular economy: origins and operating principles

CE is an economy built from production-consumption societal systems that maximize the service produced from the linear flow of material and energy flows between society and nature (Korhonen, 2018) and is a concept inspired by SD literature (Homrich et al., 2018). The implementation of a CE comprises different approaches, including ITE (Murray et al., 2017). CE and ITE have the same fundamental aim: reducing the environmental impact of industrial and economic activities.

A more detailed analysis reveals different levels of action, objectives, and tools (Fernandes, 2021; Murray et al., 2017). Thus, CE is apprehended at a global scale and ITE at a local scale (Bruel et al., 2019, p.5). The aim is primarily legislative for CE (changing practices) and operational for ITE (carrying out actions). For CE, resource management is purely economic, whereas it is both economic and participatory for ITE. Finally, while CE does not claim a specific methodology, ITE is based on an industrial and territorial metabolism and is quantitatively focused (Chertow, 2000). In the rest of this article, we use both terms – CE and ITE – depending on the perspectives adopted by the authors we refer to in our literature review.

The institutional framework as a key to understanding

For several years the institutional theoretical framework has structured understandings of socially and environmentally responsible behavior, or the lack thereof, on the part of organizations (Campbell, 2006; Brammer et al., 2012). Thus, while economic conditions (such as financial performance and competitive market structure) influence behavior in this area, existing institutional mechanisms can play a mediating role and facilitate favorable SD and CSR actions (Campbell, 2007). Meyer and Rowan (1977) point out that organizational structures are put in place in response to expectations external to the organizations. Organizations seek legitimacy from society and then adopt collective rationality: isomorphism (Di Maggio and Powell, 1983). Institutional isomorphism is a process of homogenization that leads companies to become similar to each other, in line with the maturity of the organizational field. Thus, addressing sustainability, CSR (Miska et al., 2016), and more recently, CE (Fisher and Pascucci, 2017; Dubey et al., 2018) has become unavoidable in the strategy and structure of organizations.

The institutional mechanisms in action in the process of institutional isomorphism are threefold: coercion, linked to formal (e.g., legislative apparatus) or informal (from society) pressures; mimicry (when organizations, faced with uncertainty, copy each other) and normative pressure (when members of the same profession work to define common bases for their activities and working conditions in order to gain legitimacy). Institutional theory thus provides a powerful framework for understanding the socially responsible behavior of organizations.

Institutional barriers from linear economy need to be overcome or modified to foster the deployment of a CE (Fischer and Pascucci, 2017). For example, Zheng et al. (2017) highlight the importance of institutional pressure in the deployment and diffusion of “eco-friendliness” practices by demonstrating the positive impact of the three forms of isomorphism – normative, coercive, and mimetic (Di Maggio

and Powel, 1983). The latter allows for a better understanding of the force currently at play in this linear economy – CE duality. For Fischer and Pascucci (2017), new institutional arrangements are emerging with CE deployment. Laws or rules defined at the national or supra-national level make it possible to initiate behavioral changes among businesses or consumers. This is shown, in particular, by Alonso-Almeida and Rodríguez-Antón (2020) and Camilleri (2020) in their analysis of the European Union's CE policy, or Simpson (2012) in his study of the impact of European recycling laws. Institutions, to paraphrase North (1990, p.107), are levers enabling industrial and societal transformations as "the underlying determinant of the long-run performance of economies." Through trade agreements and property rights, fiscal tools, norms, laws, beliefs, or shared customs, it is possible to facilitate institutional change that is conducive to a CE (Henrysson and Nuur, 2021; Schultz et al., 2019). Institutional theory thus offers us an interesting framework for understanding CE-related challenges in the sense that "it also allows for a spatial contextualization of both the drivers for and the consequences of changing practices and routines related to CE" (Schultz et al., 2019, p.8).

Operational challenges posed by circular economy

CE-related challenges are numerous and are subject to different classifications. Several challenges are listed in the literature. These challenges are listed in matrix below:

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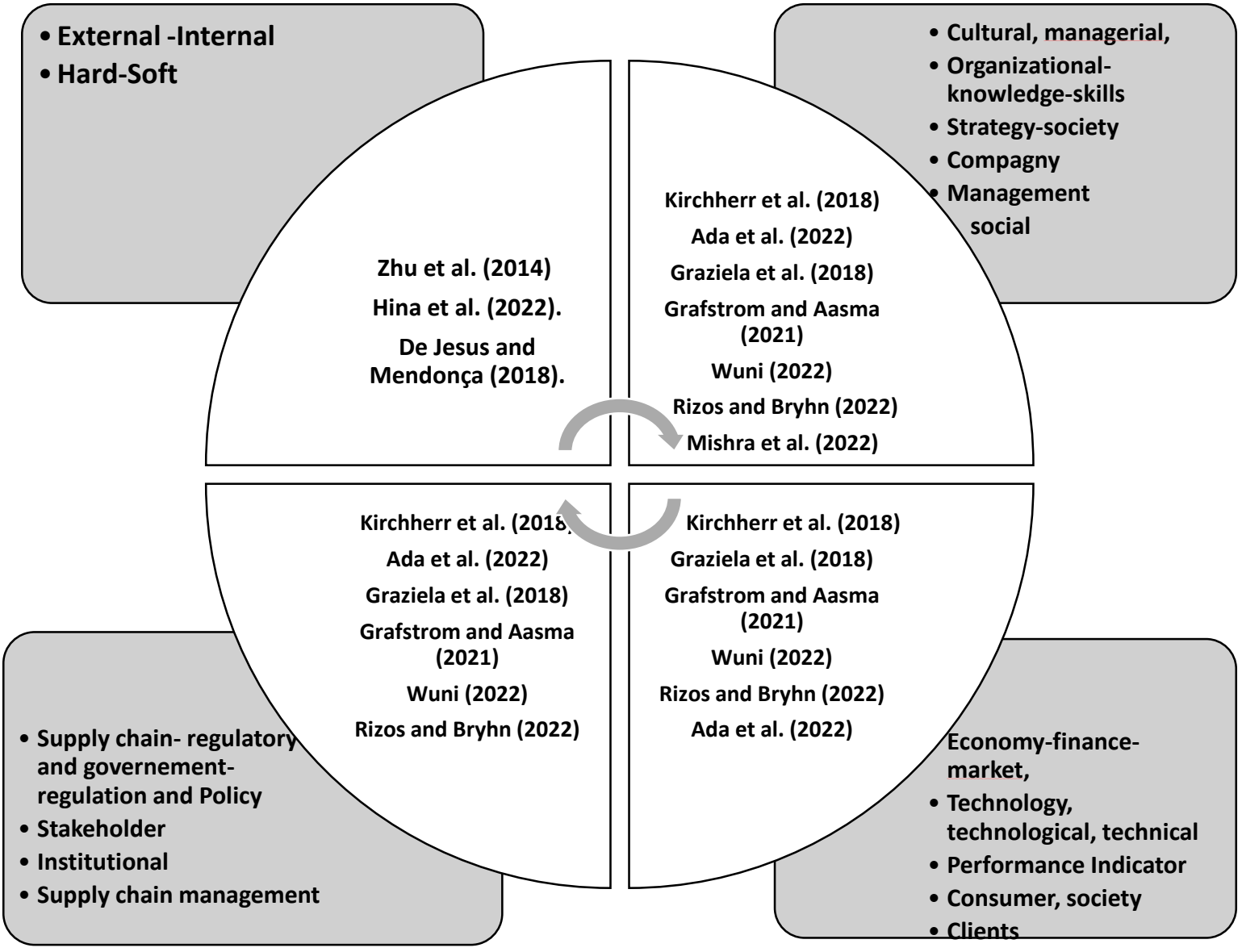
Matrix 1. The different challenges related to circular economy adapted from: Zhu et al. (2014); Hina et al. (2022); De Jesus and Mendonça (2018); Kirchherr et al. (2018); Ada et al. 2022; Graziela et al. 2018; Grafstrom and Aasma (2021; Wuni (2022); Rizos and Bryhn (2022); Mishra et al. (2022).



Economic, financial and market challenges

Although technical solutions are available, companies encounter several obstacles to implementing CE practices. One such barrier is the high initial investment required, coupled with limited access to finance (Grafström and Aasma, 2021; Hina et al., 2022; Feng and Lam, 2021). The cost of virgin raw materials is often lower than recycling or using waste materials, making it a challenge for CE (Kirchherr et al., 2018; Hart et al., 2019; Oluleye et al., 2022). Moreover, the prices of both virgin and recycled materials are subject to constant fluctuations, indicating the immaturity of the recycled materials market (Baldassarre et al., 2022; Wuni, 2022).

A significant economic challenge is the uncertainty surrounding the financial viability of reused products and circular investments (Hina et al., 2022), which is due to unstable market demand (Do et al., 2022) and low economic incentives, as well as increased research costs (Ada et al., 2021; Rizos and Bryhn, 2022). Financial viability refers to whether an initiative or project is economically feasible and sustainable over the long term. In the context of CE, financial viability is a critical consideration because CE practices often require significant investments in new technologies, infrastructure, and business models. Circular investments refer to investments made in CE initiatives, such as the development of circular products and services, the implementation of new recycling or upcycling processes, or the creation of circular business models.

Recycled materials are dependent on past consumption, and price volatility is greater, creating uncertainty and reducing the willingness to invest in recycled materials markets (Grafström and Aasma, 2021). Furthermore, the high capital required to develop CE and acquire new technologies (Vanner et al., 2014) results in high costs of secondary materials, which reduces the demand for secondary products (Oluleye et al., 2022).

Mishra et al. (2022) have noted that customers are unwilling to pay higher prices for eco-friendly packaging. Additionally, the trafficking of virgin materials can lead to economic disadvantage (Guo et al., 2016; Campbell-Johnston et al., 2019). The long-term return on investment for CE projects is also a significant barrier to their implementation (Hart et al., 2019). To overcome these challenges, tax incentives can be utilized to reverse the linear economic logic and align with a CE approach.

Supply chain challenges

Rizos and Bryhn (2022) note that the availability of recycled, repaired, or refurbished waste is affected by the insufficient amount of waste collected. The quality and traceability of raw materials pose supply issues that require logistical integration for local transport and distribution networks (Do et al., 2022). The implementation of CE faces challenges in accessing original components and spare parts for repair, refurbishment, and extension, which affects the quality of refurbished products (Rizos and Bryhn, 2022). A lack of integration of traceability processes and waste stream monitoring is also highlighted (Oluleye et al., 2022).

Mankowska et al. (2020) point out the uncertainty surrounding return flows from individual consumers. Moreover, if one of the links in the supply chain fails, such as a missing product in its production chain, it can severely impact the entire chain (Zhu and Coté, 2004). The supply and demand for by-products are subject to the primary production activities of firms, and shortages or partner disengagement present risks to the supply chain (Gabor et al., 2018). Instabilities in traded substance flows that do not adjust to supply and demand also pose risks (Dong et al., 2013).

Wuni (2022) notes a lack of a reverse logistics network and facility, appropriate partners, insufficient suppliers of circular materials and products, and an incomplete supply chain network. The complexity and scope of the supply chain, which includes manufacturers, suppliers, and reverse logistics companies, increase uncertainty and costs (Wuni, 2022). Poor cooperation along the supply chain is also highlighted by Grafström and Aasma (2021).

Organizational, managerial, and cultural challenges

ITE requires suitable organizations (Merlin-Brogniart, 2017) and underlying trust (Bansal and McKnight, 2009) to foster vertical and horizontal collaboration between companies along the supply chain (Hart et al., 2019). Trust between stakeholders is a critical skill and information-sharing facilitator that is essential for collaborative relationships (Gabor et al., 2018). However, information sharing is a significant challenge for IS (Zhu and Côté, 2004; Shahbazi et al., 2016) and requires a shared vocabulary, especially concerning information about industrial metabolism.

Furthermore, some companies are reluctant to share information, hindering collaboration with other companies (Hina et al., 2022; Ada et al., 2021; Rizos and Bryhn, 2022; Mankowska et al., 2020). There is a lack of in-house expertise on environmental issues (Zhu and Geng, 2013), and a lack of appropriate training and technical skills to support circular technologies (Feng and Lam, 2021). Hina et al. (2022) highlight the need to train employees in new circular production and sales operations. Other priorities often take precedence over implementing CE practices. Lack of knowledge and skills in CE (Ada et al., 2021), lack of time and resources to collect necessary data and establish new processes for measuring environmental impacts (Rizos and Bryhn, 2022), and a lack of interest in recycled and remanufactured products (Wuni, 2022) are challenges to implementing CE practices within companies. A lack of new processes to produce new products, a lack of experience with new circular models, a difficult change of environmental culture (Rizos and Bryhn, 2022; Mankowska et al., 2020), and a lack of willingness to engage (Graziela et al., 2018) are barriers to circular economy.

Grafström and Aasma (2021) point to an environmentally resistant corporate culture. The lack of clear definitions of indicators for assessing circular economy performance is an obstacle to waste management in the construction industry. Increased organizational processes and workload, inadequate organizational resources and capacity, and complex administrative requirements and legal procedures are barriers to circular economy (Wuni, 2022). A lack of commitment, support, and leadership from senior management prevents strategic planning and the allocation of resources to make plans for the transition to circular economy.

Furthermore, Hart et al. (2019) note a lack of collaboration and transparency between the functional units of a company on the path to circularity. The lack of a partnership culture (where companies are not used to sharing information, especially with their competitors), and infrastructural limitations (especially among service providers) slow down companies' deployment of industrial symbiosis approaches (Tudor et al., 2007). Competition, the search for competitive advantage, and competitiveness are barriers to the development of a circular economy culture (Baldassarre et al., 2022).

Technological and technical challenges

Technological challenges are often cited as major barriers to implementing circular economy practices (Do et al., 2022). They constitute 35% of the most frequently mentioned challenges in the literature (De Jesus and Mendonça, 2018). Technology is a crucial element and a prerequisite for developing circular economy practices, which involve redefining business processes to create closed-loop systems where waste becomes raw material (Gruner and Power, 2017; Kirchherr et al., 2018; Campbell-Johnston et al., 2019; Feng and Lam, 2021). However, this condition is not yet being fully met (Kirchherr et al., 2018; Hart et al., 2019). The technical challenges faced by companies are multifaceted and include issues with the quality, availability, cost, complexity, and quantity of industrial by-products (Densley et al., 2017). Technical challenges are also encountered during recycling procedures due to the composition of product materials (Rizos and Bryhn, 2022). Indeed, there is often a lack of technological resources within companies (Zhu and Geng, 2013) and a lack of technical know-how for solid waste treatment and recycling (Graziela et al., 2018; Grafström and Aasma, 2021).

Quality problems with recycled materials arise due to the difficulty of separating waste. For example, post-consumer plastic waste is widely available but is often contaminated, leading to significant quality problems (Baldassarre et al., 2022). The uncertainty of technological progress is also a risk for companies investing in automated processes (Hina et al., 2022). Wuni (2022) notes the complexity of transferring techniques to circular economy practices and the complexity of construction products and projects.

The reuse of different qualities and quantities of waste involves the collection, separation, and return of reusable waste into new production processes, and companies may struggle to assess the quality of such waste products for reuse in technical processes (Campbell-Johnston et al., 2019). In some contexts, technological limitations force firms to reject waste reuse based on quality, while in other cases, technical advances promote synergistic projects (Guo et al., 2016). However, other attempts at synergy fail because by-products do not meet the required technical specifications (Morales et al., 2019). This presents challenges for companies in terms of new technologies being required to improve material efficiency, and there is a need for technological innovation to reduce businesses' dependence on landfills (Taddeo et al., 2017; Richter et al., 2016).

Regulatory and government challenges

Regulatory barriers refer to obstacles related to policy and the regulatory environment that can hinder the implementation of circular economy practices. These barriers include a lack of

policies to support the transition to a circular economy, poor institutional infrastructure, and overly harsh laws that need to be changed to promote collaboration and the use of recycled materials (Kirchherr et al., 2018; Grafström and Aasma, 2021).

The legislative framework, regulations, and standards for energy, handling, use, and recycling of residues are barriers to implementation, especially in medium, small, and micro enterprises (Morales et al., 2019).

Technical support and specific training programs are not provided by regulatory authorities to offer recyclable solutions (Mishra et al., 2022). Hart et al. (2019) note a lack of regulatory limitations (insufficient incentives from public authorities to motivate industry).

METHODOLOGY

Study context: The Port of La Rochelle and its ecosystem

The Atlantic Port of La Rochelle (APLR) is located on the Atlantic coast and is connected to the major European and worldwide ports. It is a multi-purpose logistics platform recognized locally and internationally and plays an important role in the economic and logistic relay for the surrounding regions (Concertation Publique Port Horizon, 2025). APLR is the leading French port and the second most important European port for the import of forest products and paper pulp accounting for 59% of traffic, and the sixth major French seaport.

APLR has integrated actions related to environmental protection into its new national port strategy. Economic competitiveness is no longer the only way to gain a competitive advantage. In fact, APLR has demonstrated sensitivity to the protection of the environment and biodiversity for several years. Its operational commitment of the APLR to SD has enabled it to obtain ISO 9001 (quality), ISO 45001 (safety), and ISO 14001 (environment) certification for all of its activities, as well as meeting ISO 26000, the international standard for CSR.

In response to a call for expressions of interest for a project financed by several institutional actors, APLR decided to deploy a circular economy (CE) in its port area. APLR is also involved in projects related to sustainable development outside its port perimeter, including as a member of the La Rochelle Territory Zero Carbon Consortium and the Matières Energies Rochelaises (MER) association. APLR supports the SD Charter developed by the Maritime Union.

To deploy CE actions, APLR recruited a facilitator as early as 2016, using the public funding made available. In 2019, the MER association was created, which fully implements the ITE approach in the port area. This approach differentiates it from other CE projects at the national level. The MER aims to promote the deployment of the ITE in the port area and more broadly, CE, as well as to follow and animate the association's SD charter. The ecosystem in which the port's companies operate (Fig. 1) shows the interactions between the different actors in the ITE approach.

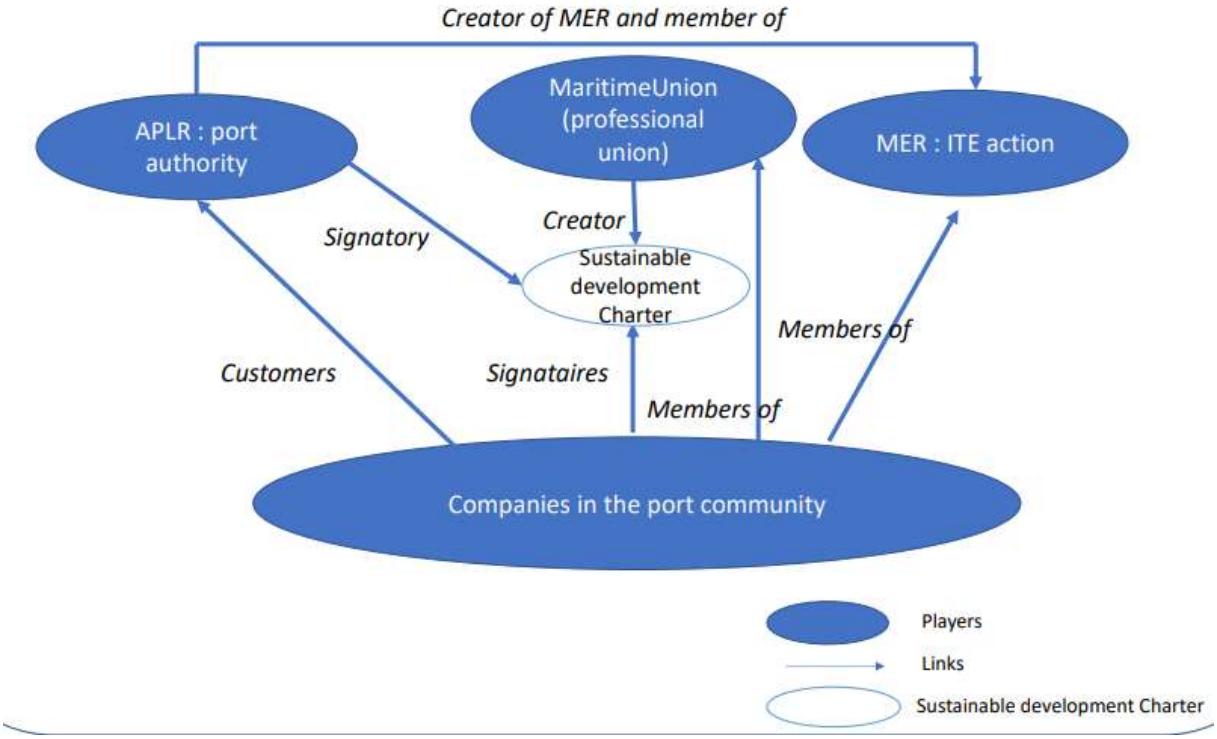


Figure 1: Ecosystem of companies in the port area within the ITE framework

METHODOLOGY

For this research, we conducted a qualitative case study (depicted in Fig. 2) with the objective of understanding the challenges faced by businesses. We followed a deductive approach to do so (Sheppard, 2020). According to Miles and Huberman (2003, p.172), "qualitative studies are often set up to explore a new field, to build or emerge a theory about that field." We analyzed the cases of six companies located in the port area and involved in the circular economy (CE) deployment project at APLR. These companies are responsible for the operational phase of this project and are assigned to various activities (Table 2).

Case study	Business sector Number of employees	Job title of the interviewees	Duration of the interviews	Other material collected
Alpha	Harbor quay cleaning 18 employees	Deputy director Chief Financial Officer	1 hour 27 mins 1 hour 20 mins	Annual reports ;Observations ; Website Article from the professional union Articles from local newspaper …
Beta	Waste collection, recycling, treatment, and recovery 70 employees	Sales manager	1 hour 27 mins 2 hours 05 mins	Observations Website Articles from local newspaper
Gama	Metal treatment and recovery 100 employees	Unit manager Logistics manager	1hour 1 hour 50 mins	Observations Website Articles from local newspaper Video
Zeta	Port infrastructure construction and development	Engineering manager	1 hour 1 hour 11 mins	Observations Website Articles from local newspaper Video
Delta	Industrial and marine electrical installation 30 employees	Chief executive Storeman	45 mins 1 hour 15 mins	Observations Website Articles from local newspaper Video
Theta	Demolition waste processing 500 employees	Platform manager	1 hour	Observations Articles from local newspaper
Other stakeholders	**Description**	**Job title of the interviewee**	**Date of the interviews**	
Maritime union	Professional union	General secretary	1 hour	Documents
Matières Energies Rochelaises) MER	ITE action	Facilitator	1 hour 20 mins 1 hour 1 hour 4 mins	

We collected primary data through semi-structured interviews with representatives of the six companies studied, as well as with the circular economy (CE) project facilitator and the secretary of the Maritime Union. The interviews lasted a minimum of one hour and were conducted at one-year intervals. We also used secondary data such as steering committee reports, press articles, and information from the port website for the analysis.

Content analysis was the technique selected for analyzing our data (Sheppard, 2020). We conducted the analysis using Nvivo 12 Plus software and applied it to the collected documents and transcribed interviews (Sheppard, 2020). We first conducted an intra-case analysis to describe each case, followed by an inter-case analysis

RESULTS

The different challenges highlighted are economic, organizational, and technical in nature (Table 3).

Economic-financial-market challenges

The results of our analysis reveal various economic and financial challenges related to the implementation of circular economy practices. For example, during the implementation process, Alpha needed to purchase a new sweeper, which required a significant investment. As the Deputy Director of Alpha stated: "We made a big bet because it's an investment. In terms of investment, it's the second sweeper."

Beta faced a different challenge related to the acquisition of new technologies for cardboard waste recycling, which is excessively expensive. As the Sales Manager stated: "It's large pulpers that are needed to put the recycled material back in, which is not complicated in itself, but it's a heavy investment, and it takes time to build factories, especially in France, and I'm not going to tell you about the regulations and legislation." As a result, Beta was unable to engage in waste recycling, particularly cardboard recycling.

Another challenge faced by Alpha in implementation CE practices is that its network water consumption costs have unexpectedly increased due to high water consumption required to avoid mixing waste collected on the docks. As explained by one of Alpha's representatives: “It is that we sort waste, so it is done by sweepers and between two waste collections we have to clean the sweepers. This cleaning has an impact on water and washing tracks because the more we wash, the more we use the washing tracks, and the more we have to reprocess the soiled waste. So, the water consumption of my washing station has increased, has been multiplied by two.” The best sorting requires washing of the sweepers at each collection of waste to avoid mixing and, simultaneously, complicating their recycling.

Beta is facing falling prices for cardboard waste due to foreign policy decisions on European cardboard waste. It is also impacted by the decline in the business of its suppliers, who have been affected by the economic downturn. In addition, Beta is facing a slowdown in its supplies and activities due to the economic situation. As the Sales Manager explained: "In this case, we

can see that when there is an economic slowdown, we have less waste to process. Yes, in a period of recession or a drop-in economic activity, there is a drop in the production of goods, and therefore a drop in the volume of waste. It is correlated."

Moreover, Beta is also facing the saturation and disruption of the recycled cardboard market for the sale of these recycled cardboards. As the Sales Manager explained: “So in fact, the markets are saturated, and we don't know what to do with them in Europe. If you see our site today, we are saturated with cardboard because obviously in Europe, we are not organized to recycle such a large quantity of cardboard which used to go to China, and the paper mills can't cope with it, so we store.

In addition, Beta is constrained to seek new outlets, new customers and new markets for the sale of secondary raw materials: “The market for cardboard, plastic and paper recyclables is disrupted by China. We are looking for new sectors in other Asian countries and in France or Europe” (Sales Manager). Furthermore, access to technology for the regeneration of cardboard waste and other waste to overcome dependence on the outside is very expensive for Beta.

Gamma and Delta have invested heavily in equipment to reduce their water and energy consumption. As the General Manager of Gamma explained: “We did an audit of the company’s network, which was very expensive, 200,000 euros. After the audit, we moved on to the operational phase. We have invested 1 to 2 million euros per year financed by the result”.

For Delta, the installation of skips for waste recovery requires a monthly rental that involved financial outlays: “We have a cost and we can show you the invoices of what it costs us, the monthly rentals of the boxes” (Storekeeper). The crushing of raw materials is also excessively expensive for Theta: “there are still costs linked to crushing, because [it] is relatively expensive, there are big machines, and moreover, when we break it takes time, and there are big quantities. There is the personnel and the material, there are still costs and fixed expenses, which mean that if we look around, we will break even” (Platform manager).

The competitive game is, for companies like Theta, characterized by indirect competition for quarry materials and bias against the use of recycled materials. Moreover, this competitive game causes the prices of recycled materials to fall in relation to the prices of quarry materials. This is the case of theta which competes with quarry materials. Its indirect competitor is quarry materials. To overcome this competition, Theta is forced to set prices below the price of quarry materials.

The use of recycled materials is a financial risk for Zeta since it invests financial means for the purchase of recycled materials whose benefits are not visible in the short term and the recycled material may not react as expected. Moreover, Zeta has suffered from the immaturity of the market for recycled materials, which has slowed down its use: “Because the market today is not yet fully mature. The system is being put in place it is not yet mature but it is growing” (Engineer). In its quest for innovative solutions that integrate environmental parameters, Zeta spends large sums of money and sometimes faces financial risks as a result of its use of recycled

materials: “Faced with difficulties, this requires finding new solutions and can also sometimes have significant budgetary impacts” (Engineer).

Organizational- managerial - cultural challenges

The analysis reveals organizational, managerial, and cultural challenges of logistical nature related to waste management (internal and external) and of human resources nature related to the metabolization of CE deployment and personnel training. For Alpha, the logistical activities of the port still do not make it easy to sort recycling materials. As the Deputy Director explained: “There are emergency phenomena that also take over. What is an emergency phenomenon? It’s when a ship has just finished working, and it is imperative to come and clean up so that the unloading company can work safely to free the ship. We are not going to ask the question... the priority is to secure the site and free the ship as soon as possible. This necessarily takes precedence over the recycling phenomenon, which is logical because we are now entering the risk phenomenon”.

CE deployment implies for some companies to provide a lot of work, reflection, and time to exchange information and participate in meetings, like Alpha and Zeta. As an Engineer at Alpha stated: “I can't permanently build networks and animate networks. We can't disperse ourselves too much. So today, you must not be lazy, you have to go there, you have to take charge and look for new solutions that actually better for the environment. And that's extra work” (Engineer).

CE implementation, for Alpha, is also time-consuming for the companies. They are forced to recruit and train personnel in environmental management, create sharing networks, and look for new solutions: “It generates a little more work because as Joel said, instead of making a platform, they make one waste after another, at a time, so it generates a little more reflection, reorganization, but they played the game well” (Administrative and financial manager).

There are various problems related to the organization and collaboration of actors engaged in the management of waste sorting and removal. Other challenges faced by companies include the lack of feedback on the use of recycled waste, which creates skepticism, as seen in the case of Zeta: “I have a recycled material. That's fine! But the question is what do I do with it? And today, in fact, it’s true that we don’t have a lot of feedback” (Engineer). In addition, Zeta encounters other difficulties such as the lack of time to form its network of exchanges on recycled waste, the performance of additional work for the search for innovative solutions on the use of recycled waste, the difficult definition of environmental objectives in sustainable constructions and the lack of initial training on environmental issues in the field of construction.

In the implementation of CE practices, Gamma had to train its personnel to improve their skills in environmental management. It also recruited new qualified personnel in SD. Finally, Theta faces prejudices on the quality of recycled materials. As the Platform Manager explained: “In fact there are many people who remain on the idea that recycled is of poor quality”.

Technical and technological challenges

The lack of technology for the regeneration of recycled cardboard waste poses a real challenge for companies such as Beta: “We don't know how to recycle it, so we have a real problem, which is unfortunately more than a temporary one, because before we get organized in Europe to create new cardboard regeneration plants, because we don't know the technology (Sales manager).

Zeta faces a lack of technical support for the use of recycled materials and is confronted with the problem of the quality of recycled materials. Zeta had tried to use recycled materials for the construction of its car parks and roads. But was confronted with the quality of these recycled materials. Therefore, it had to go back to quarrying materials

Moreover, Theta faces lack of technical tools for the effective control waste rubble quality and the analysis to prove the good quality of the recycled materials: “At the visual level we have nothing as tools to really control the rubble during the deposits” (Platform manager). In addition, Theta, requires perpetual technical analysis from its customers: “That is the main obstacle, but we try to make up for that by doing analyses every year. As soon as we have a new crushing operation, we do an analysis, so it is currently underway, and we send it to our customers to prove that our product is of good quality” (Platform manager).

Alpha also faces difficulties in recycling 100% of the waste due to the complexity: “It is important to know that on the same dock, there can be two types of loading and unloading of products. For the same dock, to be more explicit, there can be an unloading of fertilizer and an unloading of cake. So, two products that if they are mixed, we cannot finally revalue them. Therefore, I don’t think we will be able to recycle 100%, unfortunately … But to reach 100% of revalorization, I don’t know if it is feasible” (Deputy Director).

Regulatory and government challenges

Beta is subject to the decisions of external politicians who no longer wish to take back cardboard and other waste, or rather take it in smaller quantities and of better quality. As the Sales manager explained: “But it is more related to the sector of activity in which one works. Today, if you want, there is a crisis with the Chinese for recyclable materials. Today the Chinese who took 30 million tons of European/American cardboard per year are only taking back 5 million this year. They have decided to no longer take cardboard waste, plastic waste as well, PE films, packaging films, therefore very little over-packaging and of top quality”.

Zeta, although filled with a desire to substitute quarry materials for recycled materials, has some reservations due to of the lack of technical supervision, the lack of formalization and regulatory standards for recycled materials and the problem of their quality in relation to quarry materials: “The difficulty we have, it's good to know, is that often the use of these new materials or recycled materials is not technically supervised" (Engineer).

Supply chain challenges

Beta is facing huge amounts of recycled waste to manage due to falling prices for recycled waste: "We currently have this crisis on cardboard and plastic, which means that we don't know what to do with the sorted materials. In any case, we have overstock so we can no longer buy them back" (Sales manager).

The transport of certain waste such as polystyrene is very expensive for Beta due to its low density. "This is another problem, the material is recyclable, but we cannot transport empty. It costs too much. We are not going to bring 100 kg of materials in full. If you want the cost of transport, it is calculated according to what we transport too. If we transport 12 tons of materials, that's fine. If we transport 500 kg, it's on a pro rata basis, it's going to be very expensive for the customer just to process 500 kg" (Sales manager).

Beta depends on the activities of its suppliers and may suffer from the volumes of activity of Alpha, which may pose a problem of availability of waste materials.

Some of the challenges encountered can be seen in the quantities of waste supply. Indeed, some companies do not necessarily receive the desired quantities of waste, such as Gamma, which receives quantities of pallets lower than its request and continues to obtain supplies from other suppliers. As the Logistics Manager stated: "No, we take the stock they have to give us. If there are 50 pallets or 30 pallets, we take what they have to give us. We're not picky"

Theta is heavily dependent on the activities of its suppliers for demolition waste: "There are also variations in construction sites. For us, these are the main difficulties. We are dependent on the construction sites. If there are none, it is true that our activity is a little slower. When there are various construction sites in the sector, our activity increases and overall, it remains stable" (Platform manager).

CHALLENGES				
Economic/financial/market/	**Organizational/managerial/cultural**	**Technical/technological**	**Regulatory/government**	**Supply chain**
(1) Significant investments to acquire adequate equipment (2) Costly technology (3) Competition with quarry materials (4) Falling prices for secondary raw materials: challenge found in the study (5) Economic climate and downturn: challenge found in the study (6) Expensive technology (7) Costly waste processing (8) Disorganization of the recycled market (9) Immaturity of the recycled materials market (10) Saturation of markets for some recycled waste (11) The need for new markets (12) Financial risk-taking to test recycled materials: challenge found in the study (13) Increase in network water consumption charges	(14) Time-consuming deployment of CE (15) recruitment and training of staff; (16) lack of feedback.; (17) Lack of time to create networks: challenge found in the study (18) Lack of initial training (19) Difficult to define objectives for building green worksites: challenge found in the study (20) A lot of effort, work and reflection time: challenge found in the study (21) Training and continuous monitoring of staff (22) New recruitment: challenge found in the study (23) Coordination and organization with clients (24) Prejudices about recycled materials	(25) Lack of technology adapted to the recycling of some of the waste (26) Complexity of the waste. (27) Constant technical analysis. (28) Technical choice of non-recycling of waste: challenge found in this study (29) Complexity related to waste mixtures (30) Poor quality of recycled products (31) Lack of waste control technology: challenge found in the study	(32) External policy decisions: challenge found in this study (33) Lack of regulatory standards (34) Lack of regulatory standards for technical supervision (35) Lack of formalization	(36) Insufficient quantity of new products (37) Availability of waste materials (38) Insufficient quantity of waste (39) Decrease in the volume of waste supplies (40) Overstock of recycled waste (41) Transport of certain waste

Role of other ecosystem players

MER

The role of the MER association, financed by its member organizations (companies in the port area and APLR), is therefore to respond to the needs of the companies and to continue the actions they have initiated. In addition, MER ensures the deployment of synergies between the organizations and identification of new opportunities, assists in the search for financing, supports the different members in their various approaches, and promotes good practices through the sharing of experiences, visits, and information via different tools (such as website, emails, and social networks). Alpha, Beta, Delta, Gamma, Theta, and Zeta are members of the MER association and have been supported by its facilitation (detection of synergies, advice on the implementation of good practices, and identification of positive effects of actions).

Maritime Union

The Maritime Union represents the economic fabric of the port. Through its chairman, it is now an integral part of the MER office as a member. It has played an important role in the deployment of the ITE approach. Indeed, its role has been to raise awareness and encourage companies to participate in the project, especially those who have signed the SD charter.

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APLR has been the project leader and is also a member of the MER board through the Director of Strategy and Ecological Transition. It has chaired the different steering committees, closely following the feasibility and achievement of the different synergies. It fully plays its role in ecological transition.

DISCUSSION

In this section, we discuss the results by linking them to our theoretical framework and identify variables that allow us, in the context of CE, to address the challenges faced by companies in this area. To this end, we develop our research proposal and build our model. Based on this analysis, we propose a research model that links the different institutional mechanisms to the challenges, supported by five proposals.

Economic, financial, and market challenges

The main economic challenges identified relate to the low price of virgin raw materials compared to secondary raw materials, which do not favor CE practices. Indeed, the competitive game is biased because it does not incorporate the negative externalities generated by the exploitation of raw materials. Campbell (2007) emphasizes that the competitive distortion hinders the deployment of socially and environmentally responsible practices and that only adequate institutional conditions can make it possible to achieve the desired behaviors in this area (for example, legislative and regulatory pressure, or pressure from NGOs and consumers).

Solutions to support the investment required for the transition to CE can be identified, such as the provision of support financial aid via public or parastatal organizations and tax credits to

encourage companies to change their economic model. Coercive pressure can be exerted at the European Union and French state levels through the legislative apparatus and aid earmarked for CE-related investments (Camilleri, 2020). However, although necessary, this pressure is not sufficient (Schultz et al., 2019; Alonso-Almeida and Rodríguez-Antón, 2020). Furthermore, the immaturity of the market for recycled materials requires changing customers' perceptions of the quality of these materials. These informal institutional instruments are as important to fostering CE approaches as the more formal measures, as pointed out by Schulz et al. (2019). These elements lead us to formulate the following research proposal:

Proposal 1 - Coercive pressure and informal instruments are the institutional mechanisms needed to overcome economic challenges.

Organizational, managerial, and cultural challenges

There are several organizational challenges, including the emergence of new material flows, the necessary reorganization of flows in general, and the facilitation of interactions between actors more specifically. This concerns both internal and external logistics management. The involvement of top management is essential for both teams and suppliers to work toward the CE model and mediate the various institutional pressures (Dubey et al., 2019). We identify new organizational challenges, namely the lack of initial training of staff in sustainability and CE. Companies lack the time to create networks for sharing experiences to improve CE practices. The deployment of CE is time-consuming and requires a lot of effort, time, and reflection. Furthermore, in the field of construction and building, it is difficult to define clear objectives for building green sites. Companies are obliged to recruit new qualified personnel.

Circular practices require normative measures such as staff training and communication (Campbell, 2006). The actors initiating CE projects (funding bodies, ITE approaches facilitators) must support companies through training and experience exchanges (visits) between companies. Port ecosystems are proving to be particularly dynamic frameworks in this respect and thus encourage mimetic pressure (Acciaro, 2015). For example, by promoting exchanges of experience or by offering conferences and training. The existence of an SD charter bringing together the companies of the port contributes to the normative pressure and encourages the deployment of CE practices. We thus formulate the following research proposal:

Proposal 2 Normative and mimetic pressure are the institutional mechanisms needed to overcome organizational challenges.

Technological, and technical challenges

The technological challenges we identified point to the importance of technologies for deployment of CE, as already highlighted in the literature by several authors (Rizos et al., 2022; Wuni, 2022). Recycling waste cardboard and materials requires advanced technologies. These should address the use of certain non-recyclable materials and regulate the market in favor of CE (Fischer and Pascucci, 2017). The accentuation of research and development for adequate processes and tools is an essential lever to overcome technological challenges. It concerns fostering innovation through CE, which policymakers should encourage through the funding of

research on technological innovation (Henrysson and Nuur, 2021). We thus formulate our third research proposal as follows:
Proposal 3 Normative pressure is an institutional mechanism to overcome technological challenges.

Regulatory/government challenges
The regulatory and governmental challenges identified in this study highlight the need for strengthened and robust regulatory standards. Similarly, we find that policy decisions in one state on waste can negatively impact CE practices in another state. We agree with the work of Kircherr et al. (2018) who encourage the need for unified regulations. CE is global in scope, which means that all countries need to agree on standards to foster experience sharing and collaboration across borders. On the other hand, the lack or inadequacy of regulatory standards for the management of waste, including building demolition waste can deter businesses in the momentum of the green transition to CE (Wuni, 2022). Standards represent a directive for action for them. We thus formulate then the following research proposal:

Proposal 4 – Coercive pressure is necessary to enhance the operationalization CE.

Supply chain challenges
The implementation of CE in the port of La Rochelle is facing several challenges related to the supply chain. Although companies are willing to participate in CE implementation in this port, they are faced with the problem of transporting and collecting waste on the quays. Some are unable to obtain sufficient supplies to ensure their recycling activities. Others have overstocks of recycled waste due to lack of buyers.

We formulate then the following research proposal:
Proposal 5 – Informal instruments are necessary to overcome the problems related to supply chain challenges, in the implementation of CE.

Research model proposal
Our research proposals enable us to provide a research model that links institutional mechanisms and the challenges of CE operationalization (figure 2).

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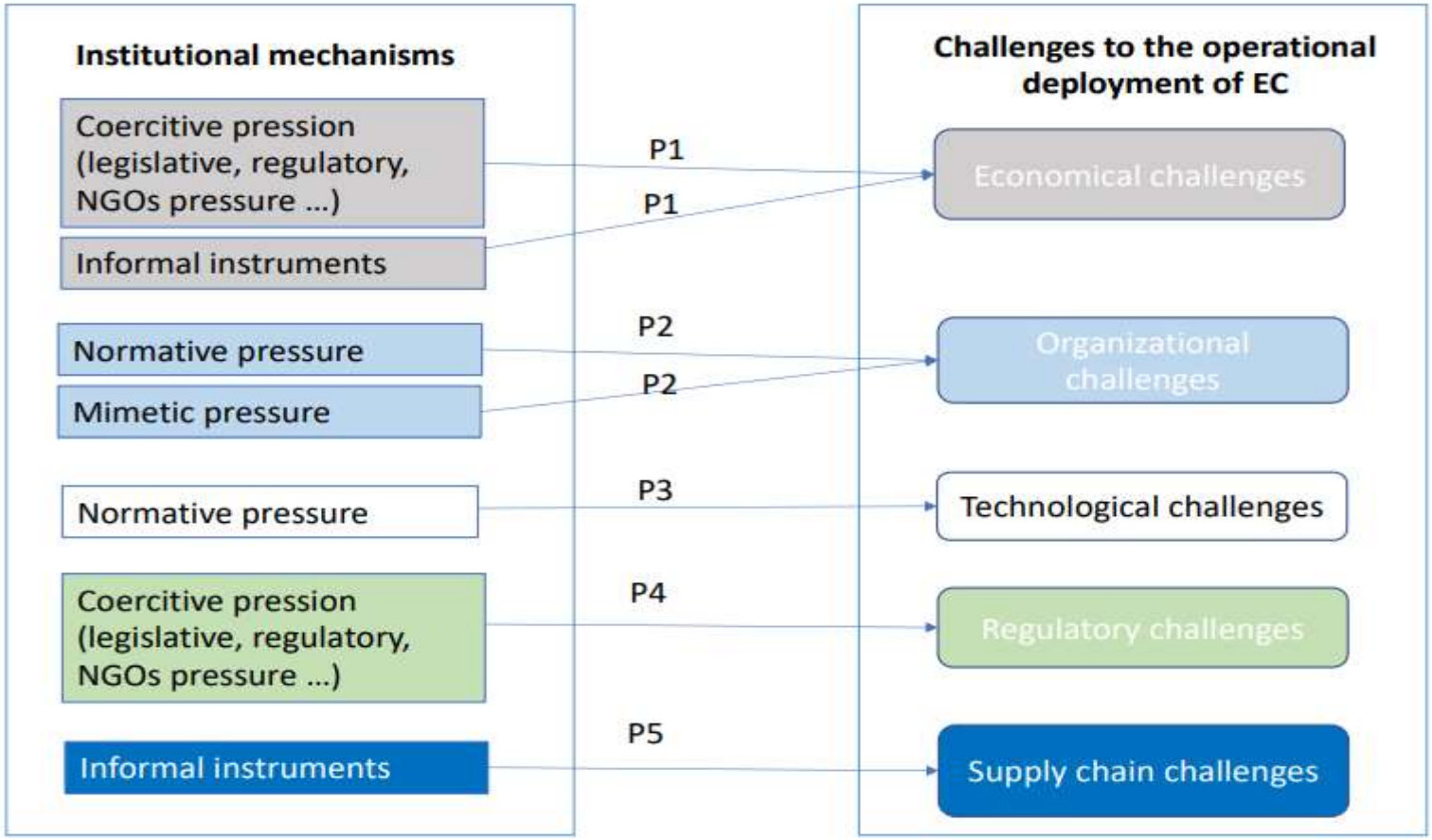

Figure 2: Research mode

Implication to research and practice

Theoretical contributions

This study contributes to the current knowledge on the challenges of implementing CE within companies in a port area. These challenges highlight the difficult nature of CE (Wuni, 2022). The detailed study of barriers supports a theoretical understanding of the challenges to implementing CE in ports (Mankowska et al., 2020).

In the context of CE operationalization, we have identified 41 challenges grouped into five clusters: economic-financial-market, organizational-managerial-cultural, technological - technical, regulatory-government and supply chain. Among these 41 challenges, we have identified 10 new challenges not yet identified in the existing literature. These include lowering the price of recycled materials to compete with virgin materials. This study shows that this fact is not a general one and that the sector of activity can play a role in the cost of recycled products. The challenge of the economic situation is also a new challenge identified in this study. Indeed, the guarantee of certain CE activities may be confronted with an economic recession that puts a brake on activities in general.

The economic situation leads to a decrease in activities and, in turn, a decrease in waste as a source of revenue. Indeed, the supply and/or demand for by-products is subject to the primary production activities of companies. In the event of a shortage of a partner, there could be risks to supply chains (Gabor et al., 2018).

Financial risk-taking is also a new challenge in this work that the literature has not yet identified. Companies certainly have the will to practice CE but are confronted with the lack of time, effort and reflection to create a network of partners and collaboration. These challenges pave the way for the important role that institutions, especially ports, have to play in initiating and encouraging companies to practice circularity. The lack of initial training on environmental issues, a challenge not identified in the literature, can violate circular practices and create resistance to change in business models (Grafström and Aasma, 2021).

Another challenge observed in this study is the difficulty of achieving 100% recycling due to losses during dockside waste collection. Due to port security issues during loading and unloading, it is impossible to give importance to waste separation. The technical choice of non-recycling is quickly made. This situation reveals the inability of ports to fully recycle their waste.

CE implementation requires waste quality control technology. The absence of this control technology is a loss of time for waste recyclers. This challenge is missing in the existing literature.

The responses to these challenges rely on various levers. Firstly, the ITE approach is a catalyst and brings companies together to deploy a CE approach, thus reinforcing the findings in the

literature (De Jesus & Mendonça, 2018; Graziela et al., 2018; Hart et al., 2019; Schulz et al., 2019). Secondly, our research identifies the major role played by institutions in the operationalization of CE within firms via different forms of institutional pressures that respond to the challenges faced. Moreover, the port domain is a sector that is highly conducive to CE development via its rich ecosystem that is highly sensitive to environmental concerns.

Managerial contributions

From a managerial point of view, our research raises awareness of the need for organizations to take into account the possible challenges in CE deployment. It also allows us to identify solutions to address them. Among the latter, we can mention the importance of training, exchanges between actors of the same ecosystem, the facilitation of an ITE approach, and the necessary support of institutional actors to assist companies on the path to ecological transition.

The companies surveyed belong to different sectors of activity. They do not all face the same challenges. Challenges with regulatory standards were found in only three out of six cases, notably among waste recyclers. This sector is heavily dependent on regulations. Furthermore, it is an illusion to think that ports will achieve full recycling of waste and by-products. Safety measures take priority over recycling.

This study shows that the port areas, despite the diversity and multitude of companies installed, can undertake and carry out CE projects. The port of La Rochelle, thanks to a SD charter previously established and signed by 22 companies, has easily mobilized companies to engage in CE practices. However, this charter cannot help companies to meet the challenges linked to CE. This study shows the catalytic role of the ports in CE approaches, the means put in place, the mobilization made to become clean ports. The results of this study can be used by port companies and port institutions that have similar potential and face similar challenges. These results will help them to draw up their strategic development plans.

CONCLUSION

This research into the implementation of the circular economy within the companies of a French port has enabled us, within an exploratory framework, to highlight the challenges posed by the operationalization of CE from an institutional perspective. To our knowledge, little research has focused on this level of analysis, and our contributions are both theoretical and managerial, highlighting several challenges that companies can encounter, as well as the role of port and government institutions in addressing these challenges.

Moreover, the implementation of CE practices faces various challenges, including supply chain and logistics management, regulatory standards, technologies, among others. Coordinated efforts from stakeholders, such as producers, suppliers, consumers, businesses, research institutions, investors, and policymakers, are necessary to address these challenges.

Future research

Our article opens many future research perspectives, allowing us to overcome certain limitations. Thus, in a future study, we would like to conduct complementary case studies on other ports to specify the effect of institutional variables on the different challenges and thus be able to enrich our research model with the benefit of a larger sample. A second research perspective consists in replicating the research protocol in another sector of activity such as textiles or agribusiness (Nattassha et al., 2020) in order to strengthen our model beyond the possible contingency of the port sector.

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