The Transformative Capacity of Public Sector Organizations

in Sustainability Transitions: A Conceptualization

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Abstract

Although public sector organizations (such as municipalities, executive agencies, and publicly controlled utilities), are pivotal in sustainability transitions, a conceptualization of their transformative capacity is underdeveloped. Several strands of literature have started to pay attention to the concept of 'capacity', but these remain disjointed. Conducting a literature review, the present paper identifies variations and understudied aspects of the concept. It proposes a holistic conceptual framework based on three elements: their organizational roles, resources, and skills. Hence, the transformative capacity of a public sector organization is defined by the interaction between its purposeful enactment of various roles when exercising change agency, and by the deployment and development of its dynamic skills, when mobilizing the internal and external resources at its disposal. The framework offers the opportunity for a granular understanding of what specific combinations of those elements are at play in the implementation of highly diverse sustainability actions. This has important theoretical and empirical implications, as well as practical implications for more targeted transformative capacity-building efforts.

Keywords: sustainability transitions, eco-innovation, transformative innovation, socio-technical systems, climate, capacity, dynamic capabilities, climate, governance.

JEL: O31; O33; O38; Q01; Q28; Q58; Z18

Highlights

- Enacting sustainability transitions requires capable public sector organizations (PSOs)
- We review the literature for clues about the concept of transformative capacity
- We identify some common trends, but also thinness, in the literature
- We develop a holistic conceptual framework about transformative capacity,
- based on the interaction between various roles, resources, and skills of the PSO
- Understanding diversity of those interactions is key for targeted capacity building

1. Introduction

Sustainability transitions are complex processes that require purposive and directional action in order to transform current unsustainable socio-technical systems. Recent years have seen a growing number of public strategies and goals for the mitigation of GHG emissions, which hinges on implementation. The enactment of green sustainability transitions and the achievement of any specific goals for GHG emission reduction is inherently related to the capacity of organizations to undertake such actions. However, the capacity of organizations is often taken for granted.

This paper focuses specifically on the capacity of public sector organizations (PSOs) for implementing green sustainability transitions. PSOs are created with the overall purpose of delivering solutions to collective problems, and to serve the public interest. PSOs are a central building block of the state, implementing governmental policies in many different forms, scales, and levels of intervention. In other words, public sector organizations are a linchpin between the ambitions and reality of those green plans. However, their pivotal role in sustainability transitions depends on their transformative capacity, and this concept is in need of conceptualization.

Recently, three strands of literature have directed attention to this matter. The **innovation policy literature has paid attention to** public innovation in specific mission-oriented agencies (a specific set of public sector organizations) and has also started to consider their dynamic capabilities of state's entrepreneurial initiatives (Breznitz, Ornston et al. 2018) (Kattel and Mazzucato 2018) (Kattel, Drechsler et al. 2022). However, this literature tends to examine executive agencies without including other crucial public sector organizations such as municipalities or publicly controlled utilities, nor does it consider their capacity in the context of policy mixes (Rogge and Reichardt 2016) (Weber and Rohracher 2012).

Similarly, **the literature on public governance and public administration** has increasingly paid attention to the problem-solving capacity of the modern state (Lodge and Wegrich 2014), focusing on policy capacity in a multi-level context (Wu, Ramesh et al. 2018). Particular attention has been paid to the problem-solving capacity related to the nature and complexity of grand challenges as wicked problems that need collective problem-solving (Termeer, Dewulf et al. 2016) (Head 2018). However, this literature seems to be more interested in general questions about the overall capacity of the state than on the specific and current transformative thrust of public sector organizations in green sustainability transitions.

For its part, the **sustainability transitions literature** has been increasingly focusing on change agency in processes of sustainability transitions (Köhler, Geels et al. 2019) (Kivimaa, Boon et al. 2019) (Geels 2020), particularly in urban contexts (Wolfram 2016) (Castan Broto, Trencher et al. 2019) (Hölscher and Frantzeskaki 2020). This relevant literature emphasizes how transformative capacity is exercised in a contextualized and distributed manner, which is key to the overall governance of sustainability transitions. However, the literature tends to focus on the system level (mostly looking at governance or policy capacity overall) rather than specifically examining public sector organizations as key organizations in charge of actual transformative action.

Taken together, while this growing body of literature has made relevant contributions, it remains fragmented and disjointed when it comes to defining and operationalizing 'transformative capacity' of public sector organizations in sustainability transitions. Hence, there is a need to take stock of these recent advances, searching for their commonalities and differences, and building a coherent approach from them, in order to move forward this promising research agenda (Haddad, Nakić et al. 2022).

The present article has two main objectives. Firstly, it reviews the three above strands of literature to identify and classify key conceptual developments. In doing so, it analyzes how scholars have dealt conceptually with the notion of 'capacity' and the related notion of 'capability' in studies of PSOs and sustainability transitions. We highlight conceptual variations and commonalities, as well as understudied aspects. Secondly, we move this research agenda forward by proposing a holistic conceptual framework for PSO's transformative capacity in sustainability transitions. By bringing disjointed aspects together and elaborating on underdeveloped aspects, the conceptual framework identifies promising topics for further research in this field.

With these objectives in mind, this paper addresses the following two main research questions: What are the various conceptual approaches and key aspects in studies about public sector organizations' capacity in sustainability transitions? And, how can we conceptualize the transformative capacity of public sector organizations in sustainability transitions, to advance a research agenda on this crucial topic?

The paper proceeds as follows. The next section explains the methodological approach and the data used in this literature review. Section 3 analyses the findings from the literature review according to the items defined in the code book for the analysis. Section 4 discusses these findings, identifying two areas of thinness in the literature that can be explored further. Following that, Section 5 develops two building blocks for a conceptual framework. Section 6 answers the research questions, considers the novel contribution of these building blocks, and suggests future lines of theoretical and empirical research.

2. Method and data in this literature review

There are various types of literature reviews (Grant and Booth 2009) (Gough, Thomas et al. 2012). A useful approach distinguishes between four different overall goals (Paré, Trudel et al. 2015); namely, whether the literature review ultimately aims at summarizing prior knowledge; data aggregation or integration; explanation building; or critical assessment of extant literature. Each of these overall goals require different methodological strategies.

In this paper, we conduct a "theoretical review", which is a specific type of review that has the goal of explanation-building according to Paré et al. and corresponds to what other authors have termed as "narrative review" (Petticrew and Roberts 2008), or "meta narrative review" (Gough, Thomas et al. 2012).

We follow Paré et al.'s understanding that a theoretical review "(…) goes beyond merely assembling and describing past work. The primary contribution and value of this type of review lies in its ability to develop novel conceptualizations or extend current ones by identifying and highlighting knowledge gaps between what we know and what we need to know" (p. 188). As such, this type of review focuses on the conceptual aspects of previous literature in order "to provide a context for identifying, describing, and transforming into a higher order of theoretical structure and various concepts, constructs or relationships" (p. 188). The overall objective is to identify gaps, showing the 'thinness' in the crossing-fields (as the intersection of various literature) that deal with the topic under study; in our case, the capacity of public sector organizations in sustainability transitions.

The notion of 'capacity' has been dealt with by different strands in the literature in different contexts, and using different terms and notions (see below). Our literature review aims to identify the general trends in

the literature, as well as current gaps as unexplored possibilities. The findings of the literature review will serve to suggest several aspects for developing a conceptual framework that delves into those unexplored possibilities. "A theoretical review brings together diverse streams of work and uses various structured approaches such as classification systems, taxonomies and frameworks to organize prior research effectively, examine their interrelationships, and discover patterns or commonalities that will facilitate the development of new theories" (Pare, p. 188).

In order to secure the methodological quality of this theoretical literature review, we paid particular attention to the rigor, internal consistency, and relevance of the process and outcomes of this review (Paré, Trudel et al. 2015). We provide a detailed account of these key matters in Appendix 1, as well as the criteria used in the process. In so doing, we comply with the features of a "theoretical review" according to the guidelines in the literature (Petticrew and Roberts 2008) (Paré, Trudel et al. 2015).

Our review was undertaken in four steps, as illustrated in Figure 1.

Figure 1: The four steps in the literature review process
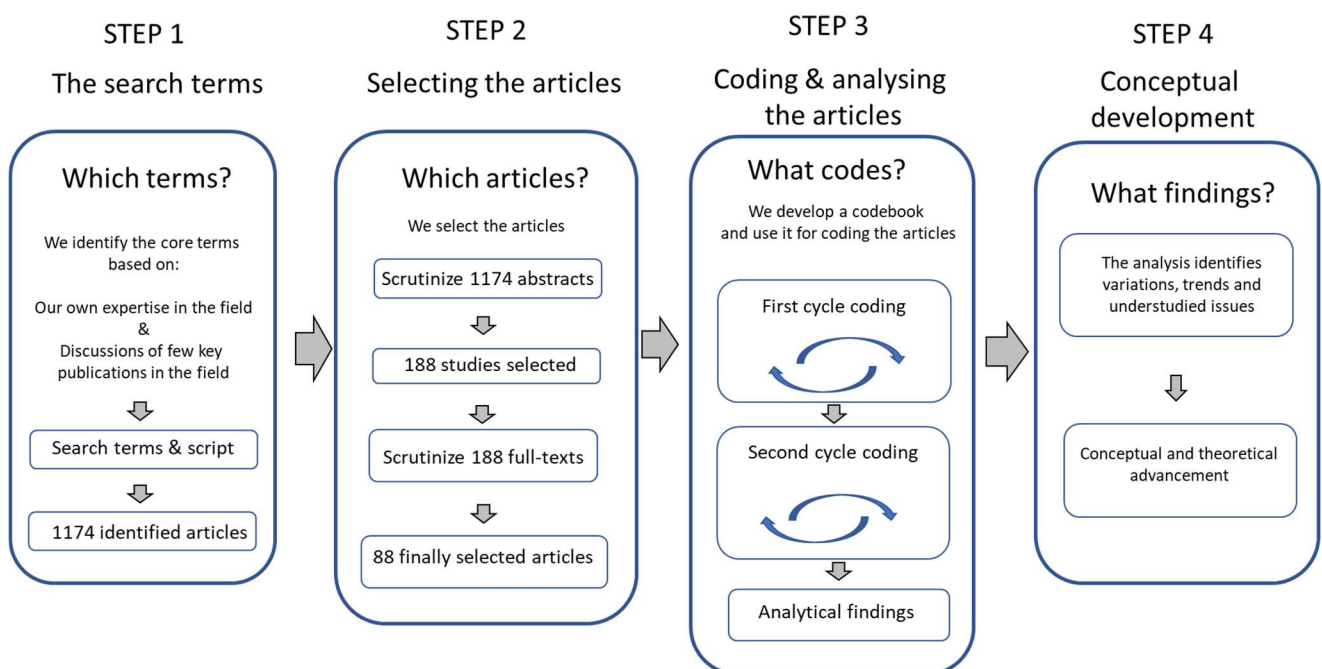
In Step 1, we identified a list of core search terms, based on which we conducted a bibliographic search. Appendix 1 explains in detail this Step 1: the search terms, the decisions in the search, the databases used, the time span, and the search script. In order to identify core terms, we reverted to two sources: our own expertise in the field, and a number of relevant background texts (See Appendix 2). In several iterative meetings, the research team and the expert librarians brainstormed and discussed the core search terms and their overall logical interactions. This served to provide a final list of search terms, and to undertake a script-based search in Scopus and Web of Science bibliographic databases with a time span from January 2000 to October 2021, yielding 1174 publications (see appendix 1 for more details). This time period (2000–2021) is highly relevant due to the fact that the turn of the millennium represented a watershed in terms of how social, political, and academic debates have addressed the grand challenges of climate change and environmental sustainability.

In Step 2, we screened the titles and abstracts of the 1174 publications before arriving at our final selection. We conducted the selection in various sub-steps. Firstly, we carefully screened the titles and abstracts of the articles and made a selection according to an explicit inclusion and exclusion criteria that relate to our research goals (see the inclusion and exclusion criteria in Appendix 1). We used inter-coder procedures so that each abstract was rated by two coders, who are researchers in the team. When there were divergent views on whether or not to include a publication, a third coder resolved the matter. The inclusion and exclusion criteria were carefully discussed and refined to ensure the research team had a calibrated understanding of them. This resulted in the exclusion of 985 studies. In the second sub-step we uploaded full-texts of the remaining 188 articles to a dedicated software program and engaged in a further selection based on reading the full paper, not just its abstract. The full-text selection was based on the same exclusion criteria as in the screening (see Appendix 1), which resulted in a final selection of 88 studies for review (see the list of selected publications in Appendix 2).

In Step 3, each of the finally selected 88 publications underwent two coding cycles using specific coding procedures. Coding the content of each article systematizes different elements, making it possible to engage in an interpretative analysis of the content in an organized manner. It usually involves two or more coding cycles, as "qualitative inquiry demands meticulous attention to language and deep reflection on the emergent patterns and meanings of human experience" (Saldaña 2009) (p. 10). In the first cycle we coded according to some core dimensions that we deduced from our previous knowledge of the theme, combined with dimensions we identified inductively from an initial scoping of the literature. Based on that, we gathered data in an orderly manner from all the reviewed publications, one-by-one. Once finalized, the data induced a collective reflection among the researchers in the team about the patterns and topics emerging from it. These preliminary findings prompted us to engage in a second cycle coding, in which we focused in more detail on clarifying some aspects that were still unclear from the first coding cycle, and on trying to establish overall relationships between the various dimensions. The final codebook includes nine dimensions, five of which are about the conceptualization of 'capacity', the main focus of our 'theoretical review' – a specific type of literature review (see details in the Appendix 1). We followed a 'magnitude coding' and 'structural coding' approaches; magnitude coding is about identifying whether or not a dimension under study is apparent in the reviewed publication (see tables in Appendix 1), and, if so, structural coding is about how/which specific aspects of that dimension were mentioned in the text (Saldaña 2009).

3. Analysis and findings of the literature review

This section examines various important aspects of how the literature has conceptualized 'capacity'. We summarize and analyze the findings in four sub-sections. The first sub-section examines the levels of agency in the publications reviewed. The second sub-section focuses on a second important dimension – the conceptual differences in the literature about the notions of 'capacity' and 'capability' – as core terminology. Sub-section 3.3 examines how the literature has addressed the concept of transformative capacity. From these findings, our analysis in Section 3.4 analyzes three important elements that emerge from the literature (see Step 3 described above): the roles, the resources, and the skills/capabilities related to capacity.

3.2 On levels of agency and capacity

The level of agency is a paramount dimension for understanding the different ways in which the literature conceptualizes 'capacity'. This dimension classifies the reviewed publications according to whether they refer to the governance capacity level, the policy capacity level, or the organizational capacity level (see Appendix 1 with regard to the coding). Whereas most reviewed publications refer only to one of these three levels, a few studies refer to several levels at once (Newman, Perl et al. 2013) (Westerhoff, Keskitalo et al. 2011), and some others do not refer to any specific level. In the following we examine how the literature has approached each of these agency levels.

At the governance agency level, the literature refers to **governance capacity** from a system perspective. However, there are at least two variations about how governance capacity is generally understood. Firstly, for some authors, governance capacity is about the wider context where capacity is exercised (Bryan 2016). "The institutional perspective on governance capacity reflects an indication of how (new) modes of governance will (probably) influence the institutional arrangements of policy making – i.e. relationships between public and private actors, rules of the game, division of resources – in such a way that a certain capacity to produce 'policy successes' is to be expected in the foreseeable future" (Arts and Goverde 2006) (p. 76). Secondly, for other authors, governance capacity is conceptualized differently; namely, it is about the capacity of the system as a whole, rather than the system as an institutional context where the capacity of other agency levels takes place. "Yet governance capacity goes beyond individual, organisational and relational capacity to describe how these manifest in the capacity of the governance system as a whole, including actors, their positions, roles and strategies, networks and coalitions, discourses, governance cultures and institutional arenas, to operate as a collective actor" (Hölscher 2020) (p. 53). Hence, this second approach, on the system-as-a-whole perspective on capacity, is very encompassing.

Other reviewed publications focus on the policy agency level, studying **policy capacity**, which refers to policies defined and developed by governments. Hence, policy is governmental action. This manifests itself often at the national level of policy-making, but often also in a multi-level policy perspective of policies, particularly given the international emission reduction goals set up in relation to various inter-national cooperation arrangements (Westerhoff, Keskitalo et al. 2011). Some of these are concerned with aspects of implementation, examining policy capacity mostly in terms of the organizational capacity of public administration for implementing policy goals (Takao 2012) (Ryan 2015) (Marquardt 2017) (Kattel and Mazzucato 2018). Others are more concerned with specific aspects of policy capacity, like analytical policy capacity (Elgin and Weible 2013) (Oliphant and Howlett 2010), in accordance to general models of policy capacity suggested by the public administration literature (Wu, Ramesh et al. 2018).

Last but not least, at the organizational level, **organizational capacity** has to do with specific public sector organizations' capacity in sustainability transitions. Here the studies consider capacity in two terms. The first is in intra-organizational terms (within the organization), studying, for example, aspects related to capacity building in public sector organizations (George and Reed 2016). This capacity within public sector organizations has to do with innovative ideas and experimentation from within the organization that go beyond the organizations' own routines (Grotenbreg and van Buuren 2018) (Huang 2021). Secondly, the literature about organizational capacity also looks at the inter-organizational aspects of capacities, understanding that their transformative action takes place in relation to other organizations: "To support and build competences for system change, organisations not only need to develop inter-organisational capacities to create cultures of cooperation, but they also need to develop intra-organisational capacity to create organizational commitment and support to enact alternative policy goals and practice" (Bos and

Brown 2014) (p.189). This aspect is also associated with public sector organizations' intermediary, collaborative, and enforcing activities (Chaudhury 2020), such as when the administrative capacity of the municipality as an organization influences the scope of local governments environmental collaborative networks, which in turn, are key for achieving sustainability transitions (Hawkins, Krause et al. 2018), or when different degrees of success across municipalities are related to their internal units' capacity (or capacity constrains) to secure, comply, and develop sustainability initiatives in a multilevel context (He and Hultman 2021) (Homsy and Warner 2015).

3.2 On 'capacity' and 'capability' concepts

Some of the reviewed publications use the concept of 'capacity', whereas others use the concept of 'capability'. In this sub-section, we examine the main conceptualization of these two terms, identifying their overall background and their general trends. We also identify a recent trend in the literature regarding how those two terms relate to each other, which is particularly fruitful for further developing the conceptual framework.

Figure 2: Use of the concept 'capacity', 'capability', and 'transformative capacity' in the reviewed literature
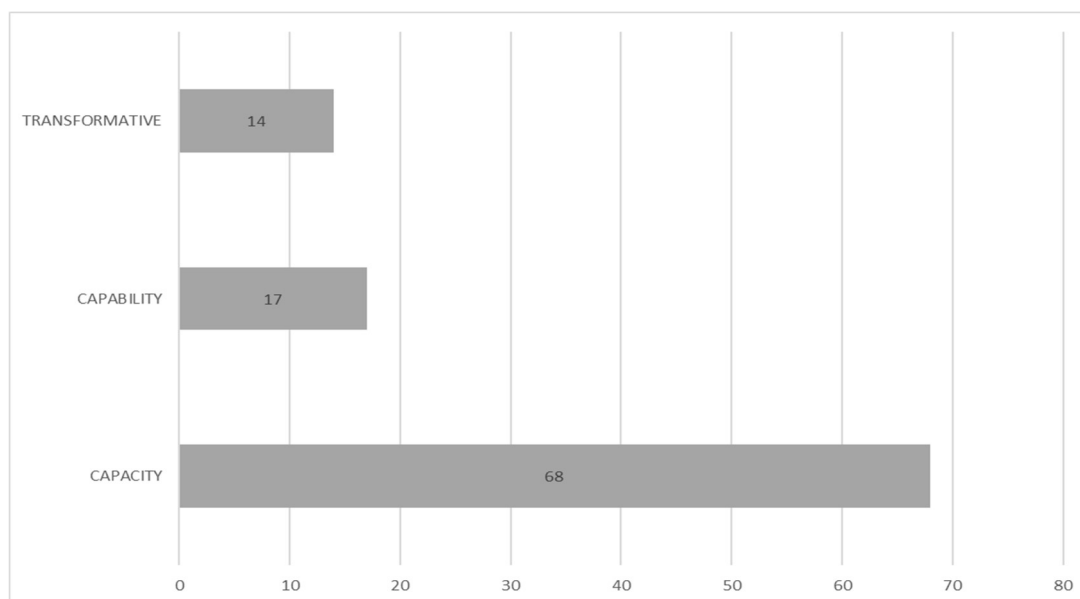
As we can see in Figure 2, 'capacity' is the most extensively used term in the literature, as it is the main concept in 68 out of the 88 publications we have reviewed. From these publications, we can identify at least two approaches about 'capacity'. In the first approach, authors refer to capacity in terms of 'potential', or 'maneuvering space', as opportunities to be materialized (Olazabal and Pascual 2015), often in relation to resources (George and Reed 2016). Capacity is seen as the overall potential of an organization as its 'license to operate' given its resources, which are typically defined by its institutional positioning/situation in a given context (Pelling, High et al. 2008). Hence, in that sense, the capacity of a public sector organization refers to its overall potential according to its situated resources – such as legal

mandate, available financial resources, legitimacy, or human resources – allowing for autonomous action (Royles and McEwen 2015). As an example of the latter, capacity has been defined as the potential of an organization resulting from the combination of available resources given by its context, such as human resources or financial resources (Homsy and Warner 2015) (George and Reed 2016).

In a second approach, authors have referred to capacity in more action-oriented terms, such as when considering that the capacity of a public sector organization in sustainable transition is essentially related to their own ability to enact action (Förster, Downsborough et al. 2021) (p. 209). Hence, capacity is less about the potential according to its positioning and the availability of its situated resources, and more about the abilities of experimenting, learning, adapting when taking action (Borgström 2019). This approach focuses on the agents' ability to connect, their ability to combine exploitation and exploration, their ability to improve routines or services, or their ability to learn (Gieske, van Buuren et al. 2016) (Fiorino 2001), It also includes abilities related to experimenting (Borgström 2019), stewarding, unlocking, and orchestrating (Pedde, Kok et al. 2019). Likewise, there is an important reflexive element in this approach, as capacity also refers to the agents' ability for self-assessing and developing further their own abilities (Meijer 2018), and ability to actualize goals and strategies (Dent 2017). This approach implicitly suggests a dynamic perspective, as the capacity of an organization may accrue or diminish over time, depending on the extent to which deliberate and continuous efforts inside the organization are made to sustain and develop the organization's own abilities.

Shifting focus to the notion of 'capability', this term appears much less frequently than 'capacity' in the literature. Most scholars using the term 'capability' have drawn from the strategic management literature in business studies to define the concept (Stenzel and Frenzel 2008) (Lieberherr and Truffer 2015) (Hartman, Gliedt et al. 2017) (Mousavi and Bossink 2020) (Zapata-cantu and González 2021). The influential notion of 'dynamic capabilities' developed in the mid-1990s in the field of strategic management was developed to study individual private firms' differential ability to create value and profit (Teece, Pisano et al. 1997). In the context of sustainability transitions, Lieberherr and Truffer (2015), for example, studied the dynamic capabilities of public utilities and defined those capabilities "… as organisational and strategic routines that enable organisations to create, evolve and recombine resources (ranging from physical assets to competences such as specific skills) to generate new "value-creating" strategies and even change the market…" (p. 103). It is worth noting that the literature on capabilities focuses more on the skills of the organizations, as practices, processes or routines to engage in action. For this reason, this literature is very close to the 'developing their own skills' approach on capacity mentioned above (Stenzel and Frenzel 2008).

Last but not least, our review shows that few recent publications use both concepts (capacity and capability). They tend to conceptualize capabilities as the organizations' skills, abilities, or competences to perform certain diversified tasks, and see them as constitutive elements of capacity. Hence, the capacity of a public sector organization is seen "… as a set of resources and capabilities central to perform policy functions" (p. 215) (Förster, Downsborough et al. 2021). Thus, resources are different than capabilities, as capabilities refer to skills, abilities, or competences, in the form of practices and processes inside the organization. "Investigating capacities means to unveil how actors are able or not to make use of their resources to achieve a certain outcome. An agent's capacity is not necessarily equivalent to its resources. This is an important aspect, because resources as such are not enough to foster or prevent policy implementation. Actors need to be able to utilize their resources such as trained staff, finance or information" (Marquardt 2017) p. 232.

Following from this, we can see that capacity is about the interaction between resources (as situated assets internal and external to the organization) and skills (as the dynamic (cap)abilities, or competences, in the form of procedures and practices inside an organization). Figure 3 visualizes this.

Figure 3: Resources and skills in the literature: Constitutive elements of the capacity of public sector organizations
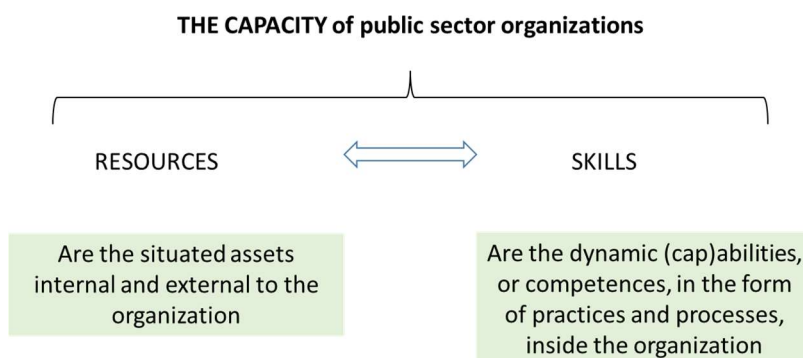
3.3 What is transformative in the 'transformative capacity' concept?

At this point, it is important to pay particular attention to the studies that explicitly mention the concept of 'transformative capacity'. Two initial observations from our findings are that those publications are quite recent (mainly from 2019 onwards), and most of them refer to transformative capacity in urban contexts and cities (Castan Broto, Trencher et al. 2019) (Borgström 2019). How does the literature define 'transformative capacity'? One of the most explicit definitions is provided by Wolfram: "urban transformative capacity is defined here as the collective ability of the stakeholders involved in urban development to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across multiple complex systems that constitute the cities they relate to" (Wolfram 2016) (p. 126). In a similar vein, "Transformative capacity can then be understood as the ability to turn transformative potential into transformative impact." (Strasser, de Kraker et al. 2019) (p. 7), where 'transformative impact' is the width, length, and depth of institutional change towards sustainability in a socio-technical system. The focus on 'transformative' as a move from potential to real impact is also associated to notions of power, which are understood as the capacity of agents to act differently to the existing status quo, and to initiate institutional transformation (Avelino and Wittmayer 2016).

Hence, 'transformative' has to do with transformative agency leading and triggering institutional and system-wide transformation. The literature examines this in various flavors. Some studies have focused on policy capacity for transformation, which "is about creating conditions that enable transformative processes to emerge from existing social, technical, ecological and economic systems." (Förster, Downsborough et al. 2021) (p. 214), and this relates to "'preparing the system for change' [which] is among the most central tasks of government by creating strategic agency" at different levels (Förster, Downsborough et al. 2021) (p. 216). Another part of the literature emphasizes transformative capacity being essentially related to several public and private agents interacting in processes of co-creation of transformation (Sillak, Borch et al. 2021). Most relevant is that co-production of transformation is about various roles of state and non-state actors. In the process of co-producing transformative agency, the

respective roles of state actors and of non-state actors vary according to whether the transformative initiatives are led by state actors or by grass-root movements (Novalia, Rogers et al. 2020) (p. 3).

From these findings we observe that the 'transformative' aspect of transformative capacity is generally associated with the definition and exercise of specific purposeful tasks for path-deviant systemic transformation, and is also generally associated with transformative agents' performance of specific roles in their action of transforming institutions. Agents of change (public sector organizations entrusted to take action – in our case) enact specific roles when fostering change away from the status quo, and into path-deviant system transformation.

3.4 Roles, resources, and skills

Following the findings above, we can identify three core elements regarding the transformative capacity of public sector organizations in sustainability transitions. The first element refers to the findings from the previous sub-section regarding the 'transformative' in 'transformative capacity'; namely, the various roles that public sector organizations (PSOs) might play in their exercise of the many tasks required for engaging in transformation. The second and third elements emerge from the findings in Sub-section 3.2, which concern, firstly, the various situational resources that are available and that are mobilized by PSOs; and, secondly, the set of various dynamic skills (as (cap)abilities and competences), which refer to the routines and practices of the organization to organize itself in exercising transformative agency. Figure 4 offers a visualization of these three elements.

Figure 4: The three elements of public sector transformative capacity: Roles, resources and skills.
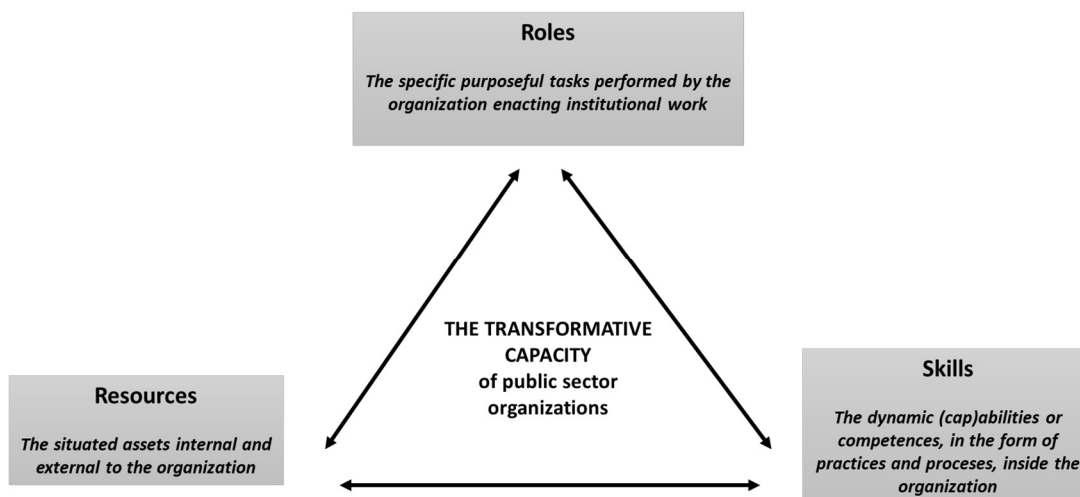
Identifying these three elements allowed us to engage in a second-cycle coding, examining more precisely what roles, resources, and skills are mentioned in the literature in relation to PSO transformative capacity.

The roles of public sector organizations are a constitutive element of their transformative capacity. We define roles here as the variety of specific purposeful tasks that an organization performs enacting institutional work in processes of sustainability transitions. Transformative capacity requires purposeful enactment and is about working towards institutional change (more about this in the following sections).

Overall, we note that the literature dealing explicitly with the roles of public sector organizations in relation to transformative capacity in sustainability transitions is scarce, since most mentioning tends to be implicit. This is somewhat surprising. The few reviewed publications that explicitly mention the roles in transformative capacity tend to underline that the role of actors changes through time and that the roles are defined and performed in interaction with each other (Fischer and Newig 2016). The literature also notes that the dialogue and controversy-based context around the divergent logics between change-oriented actors and incumbents is important in terms of how public sector organizations define their roles (George and Reed 2016) (Meijer 2018) (Hessevik 2021). The present study has taken a careful look at how the implicit mentioning of roles takes place, since most of the papers about capacity typically refer to the purposefulness and logic of action of public sector organizations for sustainability transitions.

In order to study what roles of public sector organizations are mentioned in the literature, our second coding cycle defined a specific coding structure for that, in two steps. Firstly, we coded the roles mentioned in the literature according to a typology of 14 different roles based in a combination of deductive and inductive approaches inspired by a recent study (Borrás and Edler 2020), and by interacting with the reviewed literature.[1] The list and definitions are provided in Appendix 1. Secondly, acknowledging their different transformative character, we ordered these roles in three groups according to the guidance provided by the literature of institutional work. Institutional work is "the purposive action of individuals and organisations aimed at creating, maintaining and disrupting institutions" (Lawrence and Suddaby 2006) (p. 215), an approach that is particularly relevant for studying how organizations engage in transformative processes in sustainability transitions (Beunen and Patterson 2019). Naturally, organizations' institutional work towards maintaining, changing, or disrupting can take place at various levels, as suggested by (Kivimaa, Boon et al. 2019). The results are shown in Figure 5.

Figure 5: The various roles of public sector organizations in sustainability transitions according to the literature reviewed.

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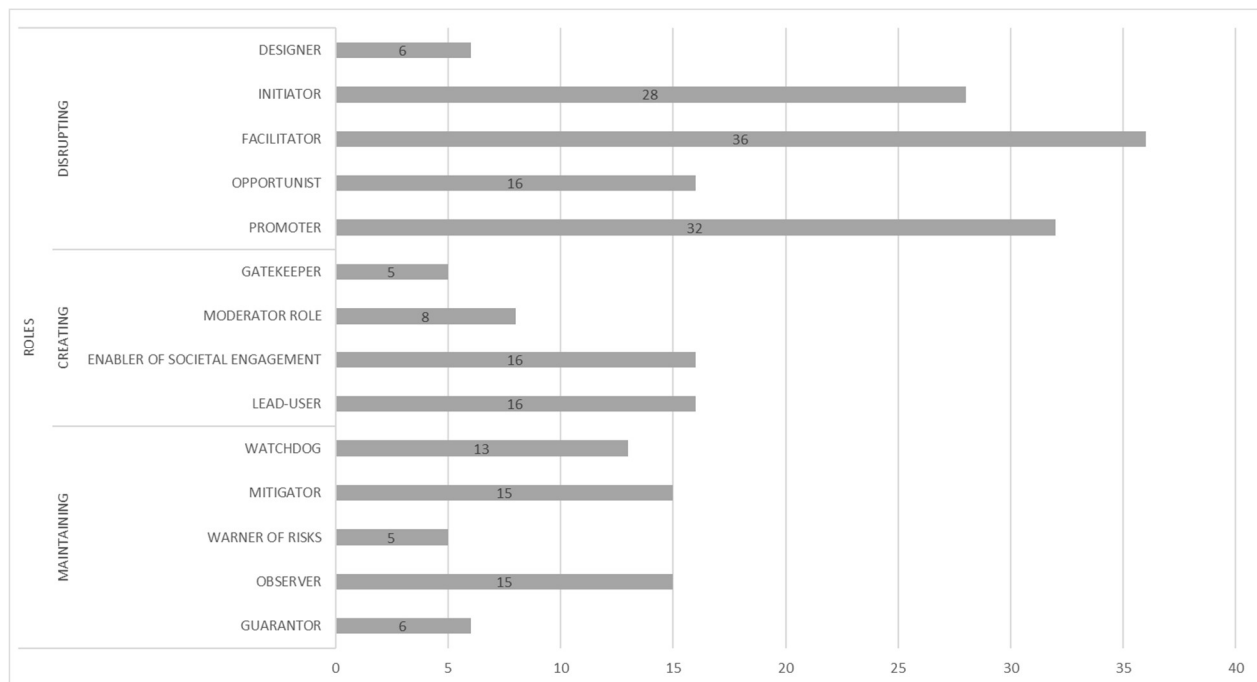
[1] For information about how the coding was done, please read the Method section of this paper.

Appendix 1 provides a definition of each of these 14 roles based on the literature upon which we have based the coding of the publications reviewed here, together with a justification of why these roles have been clustered under the three overall forms of 'institutional work': roles maintaining institutions, roles changing institutions, and roles disrupting institutions.

Figure 5 shows the findings in our 88 reviewed publications. The first remark is that when discussing transformative capacity of public sector organizations, the literature tends to underline roles associated with disrupting institutions. This is the case of roles like 'facilitator', 'promoter' 'opportunist', 'initiator' and 'designer', which, overall, aim to disrupt existing trends and current order by challenging current rules and by actively supporting alternative institutions. To a lesser degree, the literature also pays attention to other sets of roles that relate to institutional work towards creating new institutions, such as 'lead-user', 'enabler of societal engagement', 'moderator role', or 'gatekeeper', when the public sector organization aims to create new dynamics and trends. Finally, it seems that the literature pays less attention to roles related to maintaining institutions, such as 'guarantor', 'observer', 'warner of risks', 'mitigator', or 'watchdog'; however, those types of roles are also relevant for sustainability transitions, as they aim to stabilize change once it has been achieved.

Perhaps most importantly, our findings show that the literature tends to treat those roles in a prescriptive manner, suggesting the roles that public sector organizations should take, instead of studying empirically what roles have public sector organizations actually performed. This is important, as we still need to understand what specific combinations of roles public sector organizations actually play in the exercise of their transformative capacity in processes of sustainability transitions. We revert to this observation in subsequent sections of this paper.

RESOURCES

The second element of capacity identified in the literature are resources, which we define as the set of material or immaterial assets that are explicitly available (and perceived to be available) for an organization, either internally or externally to the organization. When coding what specific resources are mentioned, we observe that the literature tends to mention at least eight different types of resources: physical resources, human resources, financial resources, knowledge resources, legitimacy resources, mandate/remit resources, network resources, and cultural resources. We explain the coding in Appendix 1. As shown in Figure 6, the literature mostly emphasizes physical resources (natural resources, energy resources, etc.), human resources (staff, man-power, personnel, etc.), and financial resources (budget, funding, etc.), as important resources for the transformative capacity of public sector organizations in sustainability transitions. The organization's knowledge resources (technical expertise, information and data sources, etc.) and mandate/remit (the legal and regulatory status) are mentioned less often. Finally, the organization's network resources (contacts, access to decision-making, relational and inter-organizational resources), cultural resources (public administration/bureaucratic culture, general organizational culture in the society), and legitimacy resources (reputation, social acceptance, social authority, trustworthiness) are mentioned less often in the literature.

Figure 6: The various resources of public sector organizations in sustainability transitions according to the literature reviewed.
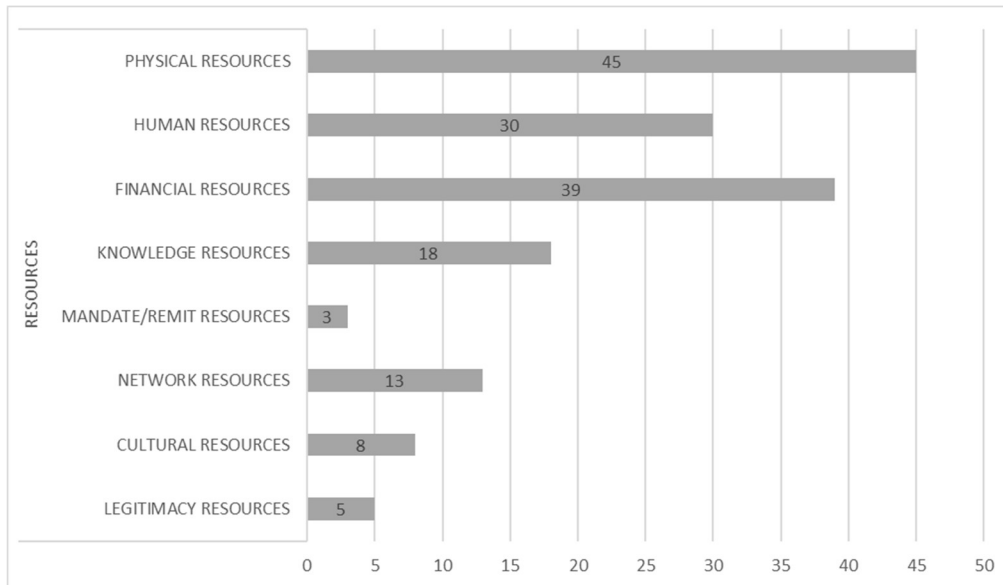
SKILLS

The third element of transformative capacity of public sector organizations in sustainable transitions is the set of skills of public sector organizations. Following previous discussions, skills are defined here as the set of dynamic (cap)abilities or competences, in the form of practices and processes, inside the organization. Hence, skills refer to the organization's specific abilities practiced through practices, procedures, routines, etc. in the daily working of the organization. These skills are dynamic because they tend to adapt. Naturally those practices, procedures, etc., have to do with the various ways in which the organization mobilizes and utilizes the available resources. The literature reviewed here focuses on various skills at the organizational level, and we have coded and clustered them into four distinct sets of skills: analytical skills, operational skills, coordination skills, and learning and reflection skills. We start by noting that the organization-level literature emphasizes the importance of the ambidexterity of organizations in terms of combining explorative and exploitative skills (Gieske, van Buuren et al. 2016), which relate respectively to what we term analytical skills and operational skills. **Analytical skills** refer generally to exploring, studying, and interpreting. Some reviewed studies refer to analytical aspects as "the ability of organisations to produce valuable research and analysis on topics of their choosing" (Oliphant and Howlett 2010) (p. 439); and hence, to their ability to produce/use original and relevant new knowledge and advice for public action (Gieske, van Buuren et al. 2016), which often entails mobilizing knowledge (as a resource) inside and outside the organization (Grotenbreg and van Buuren 2018). Analytical skills relate as well to the public sector organizations ability to develop new ideas and visions, that allow new forms of public innovation (Meijer 2018), including futuring and anticipatory skills in various forms, engaging in and making sense of foresight exercises, future-scenario building, simulation models, or similar anticipatory tools (Pedde, Kok et al. 2019), as well as the ability to develop imaginaries in relation to socio-technical transformations (Pigott 2018) (Moore and Milkoreit 2020).

Figure 7: The various skills of public sector organizations in sustainability transitions according to the literature reviewed.
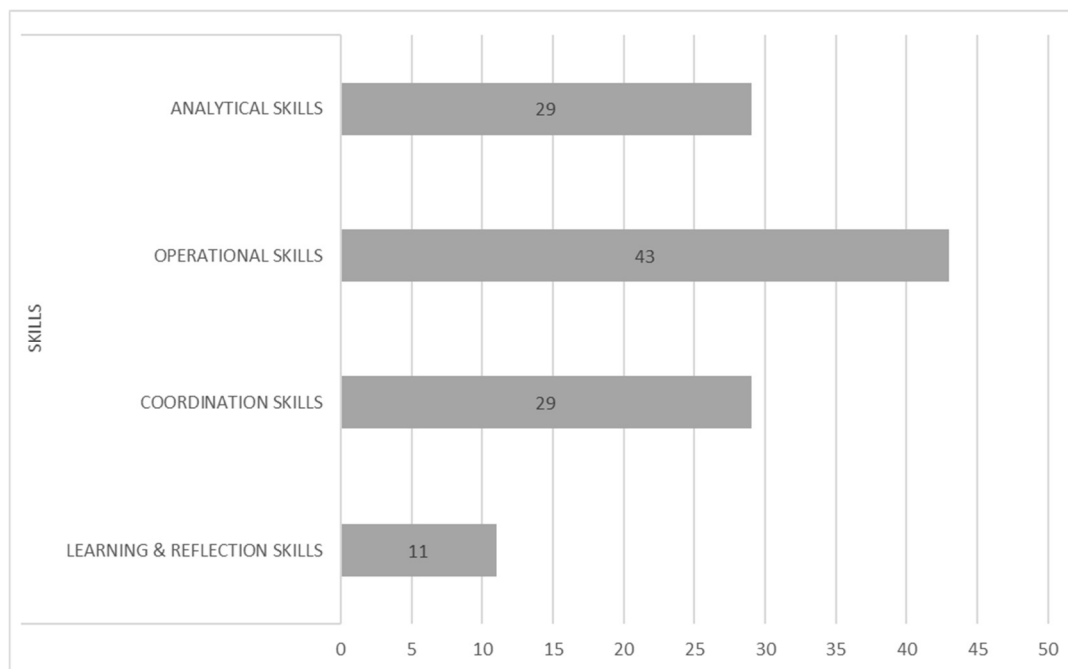
The second set of skills emerging from the reviewed literature is the **operational skills**, which refer to the set of abilities of the organization to put in place the practical operation needed for transformative action. These skills refer to the ability of a public sector organization for executing and exploiting the possibilities by specific initiatives in actionable ways (Spyridaki, Kleanthis et al. 2020), as well as their ability to secure legal enforcement (Borzel and Buzogany 2019) (Bowen and Panagiotopoulos 2020) (He and Hultman 2021). Operational skills have also been termed administrative or managerial skills (Li and Chan 2009) (Schmid and Bornemann 2019), as they refer to the practical organizing of action. Overall, operational skills refer to the probity of public sector organizations' action, ultimately linked to "effective reporting, monitoring, verification, and sanction mechanisms" (Tao and Mah 2009) (p. 183).

Coordination skills is the third set of skills identified in our literature review, and these are mentioned in various manners. They are defined as the ability of public sector organizations to develop and engage in inter-organizational collaboration with other public organizations in the governance of environmental sustainability (Mu, Jia et al. 2018) (Bissix and Rees 2001). Coordination skills are also referred to as the ability of public sector organizations to stimulate and orchestrate multi-stakeholder participation, communication and engagement (George and Reed 2016), and/or their ability to take an active part in governance networks (Hessevik 2021) or social innovation networks (Strasser, de Kraker et al. 2019). Some other authors have emphasized PSO coordination skills in terms of their ability to engage in multi-level interactions across government levels.

The fourth set are **learning and reflexivity skills**, understood as skills related to a public sector organization's ability to develop and incorporate new understandings and adjust its own action accordingly. Learning can take place at various levels, namely, at the level of the concrete public sector organization, which is not only related to reflection about the effects of specific policy instruments (emissions trading, funding, green procurement, etc.), or administrative practices, but also about problem-definitions, goals, and overall strategies (Fiorino 2001). Hence, learning skills are about PSOs engaging in at least three levels

of learning and reflection (Borrás 2011). These levels are: governmental learning, taking place mainly inside the organization, about its own practices and routines in implementing policy instruments/initiatives; policy network learning, which takes place inside-out and outside-in the public sector organization engaging with relevant stakeholder networks, collectively learning about the overall policy-mix/overall initiatives' effects and failures; and a wider social learning that mainly takes place outside-in the public sector organization, engaging in wider societal interactions, collectively learning about transformational system failures (Weber and Rohracher 2012). Naturally, learning skills encompass aspects of organizational adaptation and re-consideration (Monstadt and Wolff 2015).

4 Discussion: Two unexplored opportunities and thinness in the literature

Our findings above have identified a series of features and commonalities, as the literature tends to cluster around certain core analytical dimensions and elements. However, taken together, we also observe two important unexplored opportunities and thinness in the literature.

The first set of unexplored opportunities has to do with the interactions across the levels of transformative agency, understanding the embeddedness of public sector organizations transformative capacity, a topic that remains thinly explored. While it is true that most literature repeatedly mentions and acknowledges the multi-level nature of sustainability transitions, there are limited empirical studies about the multi-level anchoring of PSOs transformative capacity. This refers to at least two things. Firstly, it has to do with the interactions between the transformative capacity of PSOs in the context of the governance capacity and policy capacity in the system they are embedded in. Secondly, it relates to another important 'thinness' in the literature; namely, the individual level of transformative agency, as the literature reviewed has not really mentioned aspects related to the transformative capacity of individuals (the persons) that populate the organizations.[2] This thinness requires a more consistent approach to the interactions across the levels of transformative agency. Seeking inspiration from generic studies of policy capacity (Wu, Ramesh et al. 2018), the next section discusses the interaction across these levels.

The second set of unexplored opportunities has to do with the interaction among the roles, resources, and skills of public sector organizations. Starting with the interaction between resources and skills, most of the reviewed publications refer either to capacity in terms to access to resources, without mentioning the organizations' capabilities (as the abilities, competences, skills, etc. internal to the organization), or they mention capabilities/skills without mentioning resources. However, one must consider the possible situation whereby some resourceful public sector organizations (with access to substantial amounts of resources) might lack the skills to use those resources. The opposite might also be relevant; namely, public sector organizations with limited resources might still have the skills to mobilize those few resources. These remarks indicate that there is currently an incomplete picture about how resources and skills interact. This is partly due to the current approach of skills-only or resources-only disregarding possible empirical variations in similar conditions, such as when organizations with access to similar resources have very different skills and are therefore able to utilize and mobilize these resources differently.

Regarding the roles, we saw earlier that the literature of transformative capacity points at the importance of roles in the purposeful nature of transformative agency. The availability of resources and skills in the

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[2] See next section for a discussion of this matter.

organization might not be sufficient for transformative capacity without the organization performing specific roles when enacting change agency. This is because enacting the transformative capacity of agency requires public sector organizations to be specific in their purpose of inducing socio-technical change (acceleration and destabilization) with the aim of transforming current unsustainable forms of production and consumption. In other words, public sector organizations that have the necessary resources and skills, but do not have the purposeful willingness to perform roles that enact transformation, will not have transformative capacity, and vice-versa.

These two areas of thinness in the literature provide the grounds to develop some building blocks of a conceptual framework that advances the research agenda for studying in a more detailed manner the transformative capacity of public sector organizations in sustainability transitions.

5 Exploring interactions: Two building blocks for advancing a conceptual framework studying empirically transformative capacity

We generally define transformative capacity as the exercise of transformative agency, triggering socio-technical system-wide transformation through active engagement in transition pathways (which relate both to accelerating and maintaining the uptake of new more sustainable configurations, as well as disrupting existing unsustainable ones).

Following from the analysis and discussions above, this paper suggests that such conceptualization requires two considerations, as two building blocks.

The first building block is about the interactions across levels of agency. As seen above, previous studies mention that public sector organizations are embedded in multi-level contexts. Most of the literature focuses on governance, policy, and organizational levels, whereas the reviewed studies do not pay much mention to the individual level. Hence, in order to understand the embeddedness of PSOs, it is relevant to define transformative capacity in each of these levels of agency. As Table 1 below shows, the transformative capacity at governance level is the collective transformative capacity of the overall socio-technical system (formed by ecology of organizations and society-government-industry configurations). The transformative capacity at the policy level is the institutional set-up in terms of policy goals, policy strategies and plans, policy instruments and mixes, etc. The transformative capacity at the organizational level is related to how a specific organization purposefully performs specific roles exercising change agency, deploying and developing its dynamic skills when mobilizing the internal and external resources at its disposal. The fourth agency level is the individual-person level, which concerns the transformative capacity of an individual person acting as a consumer, as a leader, as an engaged citizen, etc. The individual level of transformative agency has been recently studied by examining the reluctance of civil servants to engage individually in transformative agency (Braams, Wesseling et al. 2022), a paper published after our encompassing literature review. Table 1 summarizes these definitions.

Table 1: The (three + one) levels of agency and corresponding definitions of transformative capacity

	What transformative agency	*What transformative capacity*
Governance level	The socio-technical system is understood as the ecology of organizations and their complex interactions (society-industry-government configurations) defined by sectoral, historical and geographical specificities.	The overall collective transformative capacity of the ecology of organizations and their interactions.
Policy level	The institutional set-up setting up the framework for action, defined by policy goals, policy instruments, policy mixes, etc.	The transformative capacity of the institutional set-up in terms of policy goals, policy strategies and plans, policy instruments and mixes, etc.
Organizational level	One specific organization: public, private, or private-non-profit organization	The transformative capacity of a specific organization in terms of how it engages in institutional and system-wide transformation, by purposefully performing specific roles exercising change agency, and by deploying and developing its dynamic skills when mobilizing the internal and external resources at its disposal.
Individual level	One individual person	The transformative capacity of an individual person acting as a consumer, as a leader, as an engaged citizen, etc.

Given the thinness of the literature, it is paramount to understand the embedded nature of public sector organizations' transformative capacity in the constant interactions across agency levels. Conceptually, it is possible to pre-define at least three possible forms of interactions: top-down, bottom-up and middle-out, where the transformative capacity of public sector organizations is key in different ways. These three forms of interactions might co-exist simultaneously. **Top-down interactions** are those where the transformative capacity is essentially located at systemic or policy levels, trickling down where the public sector organizations operate; for example, when a new set of policy goals and policy-mixes (like for example policy-defined transformative missions) set up some transformative pathways. In that situation, the transformative capacity of public sector organizations is key because these top-level defined goals/instruments have to be implemented. This requires public sector organizations' transformative capacity, as they are to fulfill the transformative roles entrusted and expected of them by mobilizing their situated resources and by developing specific skills to put them at work.

The interaction across levels can also take place in a **bottom-up** manner. This can occur, for example, when a behavioral change in consumption patterns sets up transformative pathways in motion putting pressure for specific responses and initiatives at public sector organization levels, or when a specific person (innovation entrepreneur, or social entrepreneur) actively induces some transformations towards sustainability setting in motion a number of requirements upwards in the system. For example, when the creation of energy communities in a local area requires the municipality to respond to potential obstacles posed by traditional administrative approvals, find new ways around regulatory uncertainties, or settle local disputes with incumbents. Here, the capacity of public sector organizations in these bottom-up interactions is key because public sector organizations are the linchpin between the individual and the system level, and can effectively accelerate or 'kill' green transitions. Hence, the PSOs must take a clear stance about their own purposeful transformative role (or not) when addressed by these
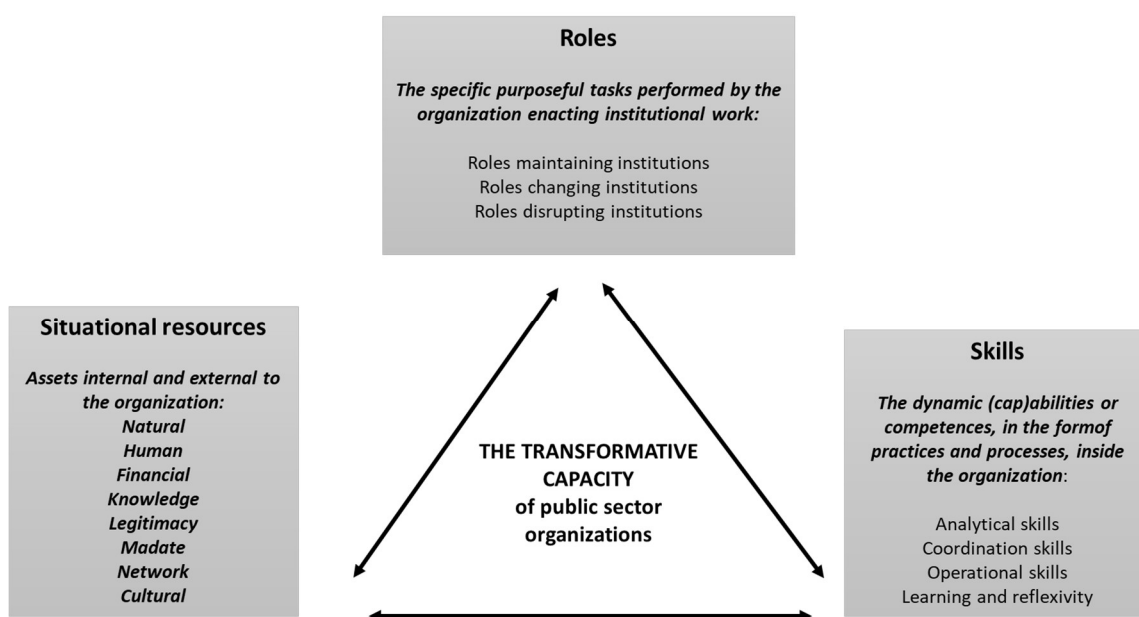
individuals/individual trends, and mobilize their own resources and skills to effectively respond to these bottom-up requests.

Third, **middle-out interactions** are when the public sector organizations are themselves the initiators of transformation upwards and downwards simultaneously. These can include situations where a public sector organization initiates transformations by changing, in important ways, some of their own procedures or practices in order to take advantage of some opportunities emerging by mobilizing existing resources inside and outside their own organizational borders. An example is when an administrative unit in a municipality engages actively with sustainable procurement approaches, exhibiting transformative capacity, as it performs a number of roles that disrupt and change institutions, mobilizes existing resources, and develops new routines breaking new grounds from its traditional practices in public procurement. Hence, in the middle-out form, public sector organizations are not necessarily 'complying' with requests from the top-down system level (policy-defined missions, policy mixes, specific system-related initiatives, etc.), nor responding to societal demands; they are in the driving seat of transformation.

It is important to understand that we do not expect (nor suggest prescriptively) that these interactions need to be hierarchically ordered. In other words, we do not expect/wish them to be system-initiated with top-down dynamics. Sustainability transitions take place in multiple possible pathways and dynamics. What we do say is that the transformative capacity of public sector organizations is invariably a linchpin in those different possible pathways, due to their obligation to serve the public interest, and their pivotal situation in socio-technical systems.

The second building block of a conceptual framework for the empirical study of the transformative capacity of public sector organizations in sustainability transitions is about the interactions among the roles, the situational resources, and the dynamic skills/capabilities of PSOs themselves. This concerns investigating how these three elements interact and finding out what combinations of elements emerge from empirical studies. Figure 8 summarizes the various specific roles, resources, and skills we identified in the literature review.

Figure 8: The three core constitutive elements of transformative capacity: various roles, resources, and skills.

Roles

The specific purposeful tasks performed by the organization enacting institutional work:

Roles maintaining institutions
Roles changing institutions
Roles disrupting institutions

Situational resources

Assets internal and external to the organization:
Natural
Human
Financial
Knowledge
Legitimacy
Madate
Network
Cultural

THE TRANSFORMATIVE CAPACITY
of public sector organizations

Skills

The dynamic (cap)abilities or competences, in the form of practices and processes, inside the organization:

Analytical skills
Coordination skills
Operational skills
Learning and reflexivity

Examining the interactions between these three elements is paramount in order to disclose the specific way in which the transformative capacity of public sector organizations in sustainability transition processes unfolds in real terms. Empirical studies need to unveil what specific combinations of roles, resources and skills are most often at play. Each initiative or action towards sustainability transitions requires public sector organizations to have transformative capacity; however, according to the nature of that initiative, the public sector organization capacity would need different roles, different resources, and different skills/dynamic capabilities.

An example could be the transformative capacity of national maritime agencies in the greening of the fleet. These agencies register and approve merchant ships under their respective flags and have responsibility for enforcing national regulations and international conventions for maritime safety and environmental protection (Lister, Poulsen et al. 2015). Greening the world fleet requires widespread introduction of low emission fuels in order to replace the current fossil-based maritime socio-technical system (Geels 2002). National maritime agencies do not have any experience with the approval of other fuel types, which come with new and often considerable risk types (Balcombe, Brierley et al. 2019). To facilitate a maritime sustainability transition, the national agencies need to devise and define new safety standards for ship designs and operations. Their transformative capacity concerns new combinations of roles, resources, and skills. It would need to combine its traditional roles – such as warner (identifying risks), watchdog (ensuring compliance), and observer (monitoring course of events) – with new roles like initiator (identifying early opportunities using its own knowledge to define new maritime safety standards for the new ships) and facilitator (actively supporting specific dynamics towards new international safety standards for the new ships). The maritime agencies will probably also need new situational resources, such as new technical knowledge and data about this new type of ships, and access to new networks of experts in this specific field; and they would also need to develop new operational skills to define new procedures for the approval, reporting, and verification of safety onboard innovative low-emission ships.

Conceptually, we expect that transformative capacity requires all three constitutive elements (roles, resources and skills) to be present in a variety of combinations, according to the nature of the transformative initiatives at hand. Weak transformative capacity is about the scarcity of some specifically important element for that specific type of green initiative.

Hence, the extent to which a public sector organization has sufficient transformative capacity is not about an all-in-one binary yes/no answer; instead, it is about the degree of suitability of the specific combinations of roles/resources/skills of that public sector organization, for the specific nature of the transformative initiative it has engaged (or wishes to engage) with.

6 Conclusions

We started this paper by acknowledging the relevance of public sector organizations (PSOs) in processes of sustainability transitions and green innovation. We observed that there is disjointed treatment of the concept 'capacity'. Hence, we have conducted a careful literature review asking what the various conceptual approaches and key aspects in studies about public sector organizations' capacity in sustainability transitions are, and how we can conceptualize the transformative capacity of PSOs in sustainability transitions. We carried out a 'theoretical review', which is a specific type of literature review focusing on conceptual aspects. Our aim has been to identify and analyze previous conceptualizations in the literature, detecting their differences and trends; as well as to discover existing unexplored opportunities for further conceptual development. With this purpose in mind, our review coded and

analyzed the selected literature (88 publications), by focusing on the following core conceptual aspects: the level of agency and capacity in the literature (policy capacity, governance capacity, and/or organizational capacity); the conceptual differences in the definition and use of the concepts 'capacity' and 'capability'; what the literature considers 'transformative' in the concept of 'transformative capacity'; and how the literature deals with the roles, resources, and skills when conceptualizing the transformative capacity of PSOs.

Our findings show that the literature exhibits some trends and commonalities. Firstly, regarding the levels of agency, we notice that most reviewed publications refer to one level of agency, even though most recognize the multi-level nature of capacity. Secondly, we found that the literature extensively uses the notion of 'capacity', and less so the notion 'capability', and tends to have two understandings of capacity – namely, as the potential of an organization (its 'license to operate') given its resources; and as an action-oriented understanding of capacity as the organization's own ability to act. The latter is a more dynamic approach that overlaps with the influential notion of 'dynamic capabilities' in strategic management studies, which refer to the ability or skills of an organization as sets of organizational practices and processes. We also observe that few recent publications refer to both notions. This suggests to us that the capacity of a public sector organization is associated with both the internal and external resources of an organization given its situated position in a socio-technical system, and its own skills, as the practices and processes inside the organization when acting. In other words, the capacity of a public sector organization is related to its resources and its skills.

Our third finding concerns how the literature sees 'transformative' when conceptualizing 'transformative capacity'. We can see that the literature focuses on the purposefulness of exercising change agency: actively triggering institutional and system-wide transformation, moving away from the status quo. Path-deviant systemic change occurs through directionality and determination, and therefore, the literature associates that to the performance of various roles enacting that directionality.

This brings us to our fourth finding. The analysis above let us identify three core elements in the transformative capacity of PSOs; namely, the various roles that public sector organizations enact when exercising change agency, the internal and external resources available to them, and their skills as (cap)abilities in the form of internal procedures and routines. Based on that, we carried out a second cycle of coding, digging deeper in search of what specific roles, resources, and skills the literature tends to focus on. The result is visualized in Figure 8. We identified at least 14 different types of roles in the literature, all of which are related to purposeful change agency, which we clustered in three groups according to the suggestions of 'institutional work' theory; namely, roles about maintaining institutions, roles about changing institutions, and roles disrupting institutions. We found that the literature refers mostly to eight types of internal and external resources available to PSOs given their contextual situation (natural resources, human resources, financial resources, knowledge resources, legitimacy and public support resources, the mandate/remit of the organization as a resource, network resources, and cultural resources). Finally, we found several types of skills in the literature, which we aggregated into four overall types: analytical skills, coordination skills, operational skills, and learning and reflexivity skills.

Following from the above, this paper makes at least three concrete contributions. First, our careful conceptual literature review brings forward some general trends and patterns in the literature. Step by step, our analysis shows there are various conceptualizations and also some clearly emerging trends. This review enabled us to make a second contribution; namely, the identification of two important 'thinnesses' as unexplored opportunities in the literature. One thinness has to do with the underdevelopment of a multi-level perspective on transformative capacity, particularly when considering the transformative

capacity of public sector organizations, embedded as they are in very different, yet quite specific, governance and policy contexts. The other thinness concerns the underdevelopment of a more dynamic perspective on transformative capacity by examining the interactions among roles, resources, and skills.

Therefore, the third and most important contribution of this paper is to provide a holistic perspective on the interaction among roles, resources, and skills in the enactment of transformative capacity for sustainability transitions. The core of our triangular model is the understanding that transformative capacity is the way in which an organization purposefully enacts various specific roles when exercising change agency, mobilizes some specific internal and external resources at its disposal, and deploys and develops some specific dynamic skills as practices and routines inside the organization. We acknowledge that climate actions are highly diverse, as are the socio-technical systems and the politico-administrative and socio-political context in which a public sector organization is embedded. Hence, our framework offers the opportunity for further empirical research, with a more granular understanding of what specific combinations of transformative capacity elements are at play. This is an important theoretical implication of our analysis and our framework.

Our findings also have important practical implications. The framework of roles, resources, and skills can be developed as a powerful self-reflective tool for policy-makers and leaders of public sector organizations, who are currently searching for concrete clues in order to make their organizations fit-for-purpose in green sustainability transitions. Our framework offers an actionable approach to such processes of self-reflection, which must be highly contextualized to the needs and realities of these organizations, given their diversity as organizations, and given the diversity of their climate plans and their implementation. More concretely, the framework can be used to identify specific elements (roles, resources, skills) that need to be strengthened as a stepping stone in the process of capacity-building efforts.

The present study has certain limitations. We took great care for the selection of literature to be reviewed, following well-stipulated and systematic steps, securing rigor and validity in the selection process. Despite this, we may have inadvertently missed some publications. However, the number of publications reviewed is quite substantial and we reached a 'saturation point' in the analysis process, as we were repeatedly observing the trends and thinness we have identified. Obviously, as future research in this field advances and takes stock of our findings, we expect that more recent literature will address some possible unobserved aspects in our study.

A possible fruitful line for further research could be to examine various related aspects about transformative capacity from a time perspective, such as examining how public sector organizations change roles, mobilize different resources, and deploy different skills through time, according to the different implementation phases of the specific climate action they are engaged in. Such a temporal approach would help our understanding of transformative capacity through time. Similarly, another relevant line for further research could be to examine the different leadership approaches that leaders of these organizations are actively using, not only in guiding the implementation of climate initiatives, but especially when actively seeking to build transformative capacity in their organizations. Hence, the individual level of agency mentioned in the paper (Table 1) could be much more in focus in future research. Last but not least, a logical continuation of our exploratory and largely inductive work would be to develop a more deductive approach, setting up concrete hypothesis with expectations such as under what conditions, and how far can public sector organizations develop and exercise transformative capacity in the absence of extensive internal and/or external resources. This would be highly relevant, given the resource scarcity in which many public sector organizations worldwide tend to operate.

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Appendix 1: Detailed methodology

Contents Appendix 1

General about rigor, internal consistency, and relevance

As mentioned in section 2, we have paid careful attention to ensure the methodological quality of this theoretical literature review, and in this regard, we have followed the specific approach suggested by experts in literature reviews. More concretely, we have secured the rigor, the internal consistency and the relevance of our literature review in all its process.
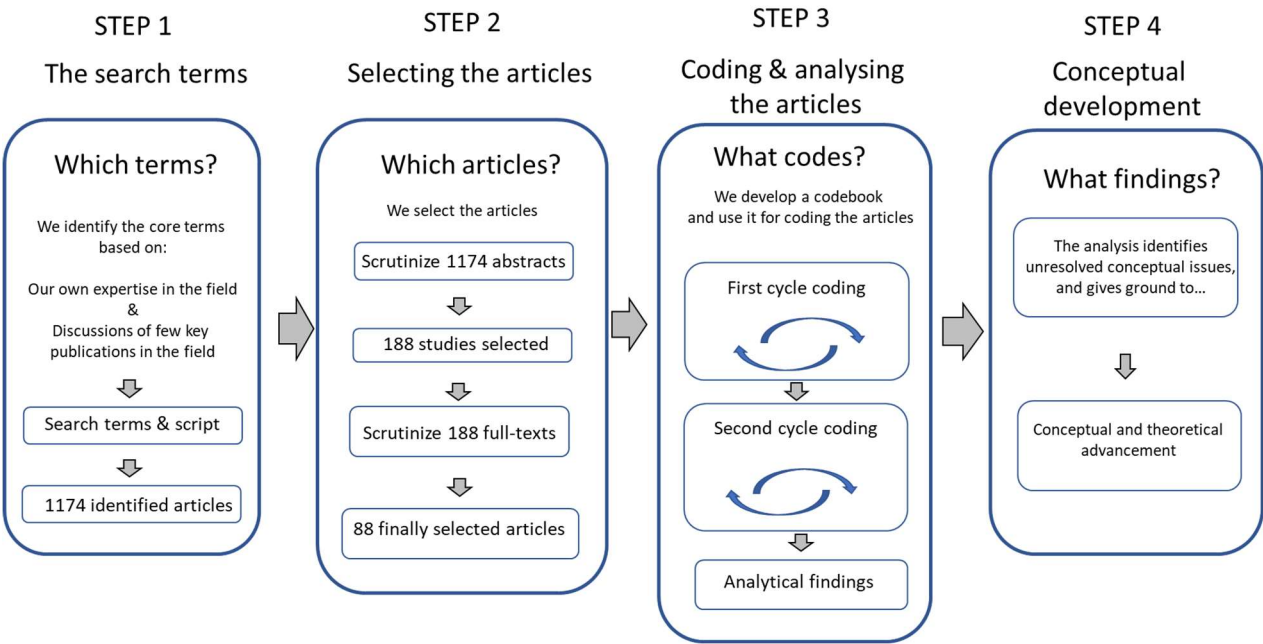
Rigor refers to the thoroughness of the documentation about the search, selection, and synthesis process of the literature review. This refers to the soundness in the choices made along the way (Paré, Trudel et al. 2015). To secure the rigor of this review, we followed specific steps, and made careful decisions about screening, selection, organization, and reporting of the reviewed articles. Below we provide a detailed account of the different steps and the criteria used in each of them, showing that the whole process has followed carefully designed criteria in a rigorous manner. **Internal consistency** is another important aspect of the methodological quality of literature reviews. It refers to the consistency of the processes undertaken in relation to the features that characterize the type of review chosen from the beginning. In this article, we follow the guidelines and features of a "theoretical review", according to the approach suggested by Paré et al (see section 2 of the paper). More concretely, these authors suggest that a theoretical literature review has the following features: it defines research questions with a broad scope, it undertakes a comprehensive search strategy, it uses conceptual and empirical primary sources, it defines an explicit study selection, and it uses content

analysis or interpretative methods for analyzing the findings. Our study is consistent with these features, as we have carefully followed each of them: our two research questions are broad and suitable for the overall aim of the review; we undertook a comprehensive search strategy (see below about Step 1); it used primary sources (scientific publications on the topic); defined explicit inclusion/exclusion criteria to guide the selection process (see below about Step 2); and underwent two cycles of coding, based on magnitude and structural coding (see below about Step 3). The third aspect that defines the methodological quality of the review has to do with the **relevance** of the literature review. This is related to the ability of the literature review article to answer convincingly its own research questions. We have defined these questions upfront (see section 1). Our literature review is relevant, as we have carried out an encompassing analysis of the findings, which has allowed us to identify trends, as well as thinness in the literature. Following from that, we have developed a conceptual framework about the transformative capacity of public sector organizations based on three core elements: their roles, resources and skills; which serves to advance research in this field.

The four Steps

As indicated in the paper, our literature review followed 4 overall Steps:

STEP 1
The search terms

Which terms?

We identify the core terms based on:

Our own expertise in the field
&
Discussions of few key publications in the field

⇩

Search terms & script

⇩

1174 identified articles

STEP 2
Selecting the articles

Which articles?

We select the articles

Scrutinize 1174 abstracts

⇩

188 studies selected

⇩

Scrutinize 188 full-texts

⇩

88 finally selected articles

STEP 3
Coding & analysing the articles

What codes?

We develop a codebook and use it for coding the articles

First cycle coding

Second cycle coding

⇩

Analytical findings

STEP 4
Conceptual development

What findings?

The analysis identifies unresolved conceptual issues, and gives ground to…

⇩

Conceptual and theoretical advancement

STEP 1: The search terms

The research team discussed the theme of the literature review from the perspective of their different backgrounds, their expertise in the field, and from the inspiration of a number of relevant background texts (see the list in Appendix 2).

In several iterative meetings, the research team generated a list of terms in order to guide the bibliographic search: the list contained terms that are synonyms to the three core topics of the search, namely, sustainability transitions, public actors/organizations, and capacity. The logic of the search was to find articles that are explicitly referring to all these three topics at once.

Interacting with two specialized librarians, the list of terms was further discussed and simplified. The terms were truncated with * to capture different word endings.

The librarians recommended to conduct the search focusing on identifying those terms in the titles, abstracts, and keywords of articles, because this will yield outputs with lower levels of noise[3].

We followed as well the librarians' recommendation to limit the search according to specific subject areas in the bibliographic databases, rather than to limit the search to specific journals. The reason is that this will allow to find relevant articles in a wider range of journals, which is relevant given the various strands of literature that deal with this research theme.

The subject areas in the bibliographical dataset Scopus were: environmental sciences, social science, business management and accounting, decision science, and multidisciplinary. We used similar subject areas in the other bibliographical dataset we used, namely, Web of Science.

Together with the librarians, we tested different versions of search scripts in order to identify which script yielded less noise. The script used:

((TITLE-ABS-KEY ((transition* OR transformation OR innovation*) W/2 (green OR sustainable)) OR TITLE-ABS-KEY (decarboni*) OR TITLE-ABS-KEY (("Socio-technic*" OR sociotechnic*) W/2 (system* OR niche*)) OR TITLE-ABS-KEY (("living lab*" OR livinglab) W/3 (sustain* OR green)) OR TITLE-ABS-KEY ((green OR sustainab* OR renew*) W/1 energy) OR TITLE-ABS-KEY (environment* W/2 (governance OR policy OR sustain*)))) AND (TITLE-ABS-KEY (((transform* OR change OR policy OR governance OR urban OR administrati* OR enforcement OR implement* OR transfer* OR regulat*) W/2 (capacit*)) OR "transformative capabili*" OR "dynamic capabili*")) AND (LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "MULT"))

We first run the script in the bibliographical database Scopus in the time period (2000-October 2021), and we re-run the same script in the database World of Science. After removing duplicates, and publications without clear author names or incomplete references, the final output for screening was 1.174 publications.

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[3] Noise refers to search outputs that have a disproportionate amount of non-focused results.

STEP 2: Selecting the articles

Overall aim guiding the selection of the publications: We want to review the literature about the capacity of public sector organizations in sustainability green transitions, with the aim at developing a consistent review, and at advancing the conceptual framework in the field.

Two sub-steps:

- **Scrutinizing titles and abstracts**: We first screened/scrutinized the titles and abstracts of the 1.174 publications. Out of those, we selected 188 publications.

- **Scrutinizing and selecting full texts**: Thereafter, we screened/scrutinized those 188 publications, reading their full text. Out of those, we finally selected 88 final publications for the review.

Inclusion and exclusion criteria

We used the following inclusion and exclusion criteria for both sub-steps above.

a) **Type of publication**:

Inclusion:

- We only include acknowledged publications: articles in journals, or chapters in books of academic nature.
- We only include articles older than 2000.
- We include publications with clear authorship.

Exclusion: Hence we exclude opening letters in special issues (those too general, not really providing in-depth conceptual approach), editorial letters (too generic), grey publications (f.ex. assessment reports, think-tank reports, etc.), or full books (we are interested in the specific chapters conceptualizing capacity); we exclude non-authored publications (with no clear author, or no specific author names); we exclude publications earlier than 2000.

b) **Thematic assessment**:

We include theoretical, conceptual and empirical articles (we will review the way in which they use the concepts 'capacity', 'capability', 'competences')

We include articles about sustainable transitions/green transformation/sustainability/green innovation, and similar; not about economic growth or transformation of industrial sectors.

We include articles dealing with 'public sector organizations', which can be understood as: governments, municipalities, public administrators, agencies, public actors, or similar.

We include articles on 'governance', 'policy', 'organizations' capacity.

Hence **we exclude** studies about economic growth/industrial transformation: we are interested in green/ecological/sustainability transformation; We exclude articles talking about capacity, capacity-building or capability-building at the very end of their analysis, and/or only in relation to 'policy advice/practical implications': f.ex.: a publication with generic remarks like "there is a need of capacity-building" in the conclusion section is to be excluded. We are interested in studies that explicitly analyze empirically or conceptually capacities/capabilities as a central part of their study and analysis, etc. , not articles mentioning 'capacity' as policy advice.

We exclude as well publications which are not truly examining capacity, but mostly oriented towards assessing success, effects, effectiveness of policies, etc.: It is not the determination of empirical 'success' that interest us: it is the concepts and conceptual framework about capacity that is the aim of our review and hence selection criteria: We are interested in publications (theoretical and/or empirical) that explicitly develop/use concepts related to the capacity/capabilities in processes of sustainability green transitions.

STEP 3: Coding the articles

We reviewed the 88 publications, reading them carefully, and coding each of them.

We coded all publications in two simultaneous manners:

Magnitude coding: Assigns a value to the publication for each dimension coded: the value can be binary (if yes/no that dimension is present in the publication), or can be ordinal (according, f.ex. to the type present in the publication). See the codes in Table A.

Structural coding: is a qualitative coding, about how/which specific aspects of that dimensions are mentioned in the publication. The researchers wrote their interpretation, occasionally also providing specific quotations from the text, to substantiate the interpretation, or/and page numbers where to identify that in the text. The structural coding output came in a large Excel file, which was actively used and discussed among the researchers for its analysis. The outcome of that analysis in in section 3 of our review paper.

The final **code book** includes 9 dimensions, which we clustered around 3 headings:

<u>Empirical field</u>: We coded the empirical field that characterizes the reviewed publication, in terms of two dimensions:

- '**Geographical location**': We coded which world region of the empirical study is about. The codes are not excluding each other, because some publications might study/refer to various; and

- '**Focal area of the empirical study'**: We coded which specific area of the empirical study analyzes, mainly in terms of whether the empirical study analyzes urban sustainability, policy processes, multi-level dynamics, sector analysis, other focus of the analysis, or whether the publication reviewed does not have any empirical analysis.

Subject of Capacity: In the dimensions 'agency' and 'public sector organization' we coded the subject to which the term 'capacity'/'capability' in the reviewed publication refers to. We did that in two dimensions:

- The level of '**Agency'** in sustainability transitions: We coded the level to which the notion capacity refers to. More specifically whether the publication reviewed is about policy capacity, governance capacity, or organizational capacity, or none. The codes are not excluding each other, because some publications might study/refer to various levels of agency.

- The '**Public Sector Organization**': When mentioned, we coded the type of public sector organization studied in the reviewed publication. We coded the following possibilities: municipality, sub-national regional, national agency or ministry, international organization, utility, other, none. The codes are not excluding each other, because some publications might study/refer to various types of public sector organizations.

Conceptualization: This literature review is particularly focused on the way in which the reviewed publications conceptualize 'capacity' and similar. Hence, we coded the reviewed publications according to 5 important dimensions:

- **'Capacity or Capability'**: We coded whether the reviewed publication uses the concept 'capacity' or 'capability', and how.

- **'Transformative Capacity'**: We coded whether the reviewed publication explicitly and actively uses the concept 'Transformative capacity' and if so, how;

- **'Roles'**: We coded the reviewed publication whether it focuses on the **roles** of public sector organisations/ agents of change, and if so, which roles were mentioned. In order to collect the information in an orderly manner we followed the typology of 13 roles by Borrás and Edler 2020, and we allowed for additional possible roles, which resulted in a 14th one, which we termed 'designer' role. Please, see the definition of these 14 roles below.

- '**Resources'**: We coded whether the reviewed publication considers the resources of public sector organisations / agent of change, and if so, which ones.

- '**Skills'**: We coded whether the reviewed publication considers the skills of public sector organisations, and if so, which ones.

Table A: Codes in the magnitude coding

	Dimension	Codes
FIELD	Geographical location	EUR, USA, Africa
	Focal Area	URB: urban sustainability POL PROC: Policy processes and policy change MULTI: Multi-level governance dynamics SECTOR: sector analysis like mobility sector, energy sector, food sector, etc. OTHER: other empirical focal areas NONE: not specified
SUBJECT	Agency level	PO: Policy capacity GOV: Governance capacity ORG: Organizational capacity (the capacity of one organization, or group of organizations) NONE: not specified agency level
	Public Sector Organization (PSO)	MUN: Municipality REG: sub-national regional authority AGE: National agency / national ministry INT: International organisations UTL: publicly controlled utilities OTHER: other type of PSOs NONE
CONCEPTUALIZATION	Capacity/Capability	CAPC: Capacity CAPB: Capability BOTH: when the text mentions both NONE: not specified
	Transformative	Code: Y/N when the text explicitly mentions 'transformative' in relation to capacity or capability
	Roles	In the 1rst cycle coding we identified publications generally mentioning roles. In the 2nd cycle coding we coded those roles following the 13 roles defined by Borrás & Edler, 2020; and finding inductively an additional role of 'designer'. During the analysis, these roles were subsequently clustered in three groups following the 'institutional work' literature, which sees change agents for sustainability green transitions, by maintaining, creating or disrupting institutions in socio-technical systems. Final codes: Roles of organizations acting as change agents by **disrupting** institutions: - **Designer role**: prepares overall aspects required for transformation - **Initiator role**: identifies early opportunities and uses own knowledge - **Facilitator role**: supporting specific dynamics - **Opportunist role**: using an opportunity for specific purpose - **Promoter role**: acts as champion, proponent of sustainability

		Roles of organizations acting as change agents by **creating** institutions: - **Gatekeeper role**: controls access for change agents - **Moderator role**: acts as arbitrator and negotiator different views - **Enabler role**: Enables actively societal engagement - **Lead-user role**: initiates market-creation Roles of organizations acting as change agents by **maintaining** institutions: - **Watchdog role**: ensures other actors comply - **Mitigator role**: actively reduce negative effects of change - **Warner role**: identifies & communicates risks - **Observer role**: monitors course of events - **Guarantor role**: directly secures operations against financial and/or security and safety risks.
	Resources	In the 1rst cycle coding we identified publications generally mentioning resources. In the 2nd cycle coding we coded those resources in an inductive manner, resulting in the following types of resources, for which we coded Y/N if found in the publication: 1. **Physical resources** (natural, energy, property, land, water, biological, Earth, renewable energy, non-renewable, artefactual/ artefacts/ infrastructure); 2. **Human resources** (personnel, staff, personal, man-power, similar) ; 3. **Financial resources** (economic, budgetary, funding); 4. **Knowledge resources** (technical, information, data, intelligence, online, learning); 5. **Legitimacy resources** (acceptance, reputation, social, authority, endorsement, trustworthiness, influence); 6. **Mandate resources** (institutional, regulatory, governing, government, political, legal, state, constitutional, structural, mission, remit); 7. **Network resources** (access, contacts, social, relational, inter-organizational, network); 8. **Cultural resources** (administrative-organizational culture, operational culture, bureaucratic culture, culture in society in general).
	Skills	In the 1rst cycle coding we identified publications generally mentioning skills (as abilities, (cap)abilities, competences, and similar, at the organizational level). In the 2nd cycle coding we coded those skills in an inductive manner, resulting in the following types of skills, for which we coded Y/N if found in the publication: Code: Y/N for each of the following: 1. **Analytical skills**: ('analytical', 'anticipatory', 'intelligence', 'exploration', and similar) 2. **Coordination skills**: ('coordination/ coordinating', 'aligning', 'collaborating', and similar) 3. **Operational skills** ('administrative', 'institutional', 'regulatory', 'exploitation' and similar) 4. **Learning & reflectivity skills** ('learning', 'reflecting', 'considering', and similar).

Appendix 2: References

Relevant background texts used in Step 1

Borrás, S. and J. Edler (2020). "The roles of the state in the governance of socio-technical systems' transformation." Research Policy 49(5).

Breznitz, D., D. Ornston and S. Samford (2018). "Mission critical: the ends, means, and design of innovation agencies." Industrial and Corporate Change 27(5): 883-896.

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The list of the 88 publications reviewed:

1. Allain, M. and A. Madariaga (2020). "Understanding policy change through bricolage: The case of Chile's renewable energy policy." Governance 33(3): 675-692.

2. Anadon, L. D., G. Chan, A. G. Harley, K. Matus, S. Moon, S. L. Murthy and W. C. Clark (2016). "Making technological innovation work for sustainable development." Proc Natl Acad Sci U S A 113(35): 9682-9690.

3. Arts, B. and P. Leroy (2006). Institutional processes in environmental governance: Lots of dynamics, not much change? Institutional Dynamics in Environmental Governance. B. Arts and P. Leroy. Dordrecht, The Netherlands, Springer: 267-282.

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