Urban Transformations

PERSPECTIVE

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Premises, practices and politics of co-creation for urban sustainability transitions

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Abstract

Co-creation is becoming a widely used mode of urban governance and research for city-making and city-transitioning being conceptually entangled with experimentation, innovation and collaboration. In this paper, we address three questions to systematize knowledge about and advancing the research and practice of co-creation: Why co-create? How to co-create? With whom to co-create? We first present three distinct premises of co-creation that respond to the question of why to co-create, and mark advantages of co-creation in comparison to participatory processes: bridging and weaving knowledge for place-based urban transitions, emancipating urban policy and planning, and advancing research to transformative and transdisciplinary approaches that are socially relevant. We then present key practices and skills required for engaging in and organizing co-creation processes (i.e., how to co-create). Next to advocacy, communication, leadership, and organizational skills, we identify that creativity, playfulness, emotional intelligence, receptivity, and collaborative learning are important, yet often overlooked, skills and capabilities for co-creation. Finally, we investigate the politics of co-creation through the lens who is included in co-creation and how (i.e., with whom to co-create). We discuss future research on co-creation and its applications centered on measuring its impact against its premises while recognizing the importance of having different metrics and reflexive measures that can evaluate its deep impact and its relation to urban transitions.

Science Highlights

- Co-creation is a key epistemological foundation for the new urban science or science of cities.
- Co-creation is a novel form of governance that supports evidence-based policy making in gearing up innovative pathways for urban transitions.
- Co-creation requires careful research design, practice and organization.

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Keywords: Co-creation, Urban governance, Transdisciplinary research, Transitions, Knowledge, Policy

Policy and practice recommendations

- Co-creation can be designed to leverage and bridge knowledge from different types of actors including business, civil society, and practitioners in support of experts/scientists.
- Co-creation has the potential to generate actionable knowledge for urban policy and planning.
- Co-creation can facilitate the empowerment of urban citizens in actively participating in urban transitions.
- Co-creation is a place-based development process to foster the vitality, viability, and ability of urban communities to participate in urban transitions.

Introduction

A broad movement in urban sustainability research and practice calls for collaborative research and governance approaches that promote epistemic and ontological pluralism to address the complexity, persistence and inequalities of contemporary urban challenges (Frantzeskaki and Rok 2018; Ansell and Torfing 2021). In cities, much knowledge about novel solutions and institutions is held by diverse actors including scientists, local policy-makers, entrepreneurs, social innovators and citizens. Setting up processes that can valorize and weave in these diverse epistemologies may support urban policy-making and planning to promote urban sustainability transitions in ways that are not only more effective but also more equitable and just (Nevens et al. 2013). Participatory methods and frameworks – such as transition management and urban living labs – have laid the ground for advancing urban governance towards co-creation (Cvitanovic et al. 2019; Frantzeskaki 2019). Co-creation is a process that equates academic and non-academic expert and tacit knowledge (for example: Kabisch 2019). In this way, co-creation is understood to hold the potential to leverage the creativity needed for transformative solutions to be formulated and put in action (Collier et al. 2013; Frantzeskaki et al. 2018a).

While co-creation is becoming a common research and governance practice in cities, for instance to advance nature-based solutions (Mahmoud et al. 2021; Hölscher et al. 2024), mobility transitions (Nunes et al. 2014; Smeds and Papa 2023) or energy transitions (Itten et al. 2021; Sillak et al. 2021), co-creation remains under-conceptualized and under-examined. Co-creation has, alongside the related term co-production, emerged across different research fields including environmental governance, public management, sustainability transitions and transdisciplinary research (Nordström et al. 2020; Miller and Wyborn 2018; Brandsen and Honingh 2018). Both terms are often used interchangeably and to refer to modes of transdisciplinary research as well as collaborative governance (Frantzeskaki 2019; Frantzeskaki and Kabisch 2016; Frantzeskaki and Rok 2018). In this perspective paper, we focus on co-creation as a more open-ended process than co-production, where diverse urban actors (e.g., policy-makers, researchers, citizens) work together to design and implement new ideas, strategies or projects.

Co-production emphasizes the joint execution or delivery of a service, product or project (Brandsen and Honingh 2018).

With this perspective paper, we aim to further conceptualize and unpack co-creation as both a research mode and a mode of collaborative urban governance with the potential to contribute to the research and practice of urban transformations. We define co-creation has a distinct mode of collaborative research and governance that brings together diverse disciplines, knowledges, and experiences of different actors (e.g., civil servants, scientists, citizens, entrepreneurs) in formal or informal, temporal or long-standing, location-specific or city-wide social learning processes (Kabisch et al. 2022; Basnou et al. 2020). The aim is to activate and generate a wider range of ideas, knowledge and partnerships for holistic and inclusive envisioning and decision-making, adaptive collaborative management, and ongoing monitoring and evaluation. This positions co-creation as a means to support urban sustainability transitions through altering or creating new social relations, place-based narratives of problems and visions, and solutions that disrupt current development pathways in cities (Frantzeskaki et al. 2018a). Co-creation goes beyond participation as merely informing or seeking input from participants, by creating 'activity spaces' for participants to collectively shape discourses, imaginaries and solutions (Jaspers and Steen 2019; Puerari et al. 2018). Thus, through co-creation, new relationships are fostered and participants can be activated and empowered to continue collaborating and learning after a – usually temporal – co-creation process is completed (Hölscher et al. 2019).

The diverse interpretations and manifestations of co-creation hinder its uptake as an approach in specific urban settings and for different urban problems. Because the premises of co-creation are not clearly defined, co-creation often takes temporary, project-based forms rather than considering how to enable lasting partnerships and continuing engagement (Basnou et al. 2020; Jaspers & Steen 2019). Similarly, co-creation is no ready-made approach but relies on participatory methods that are fit-for-purpose for a particular co-creation process, as well as different sets of skills and capabilities than conventional research, policy and planning processes (Hölscher et al. 2024). These issues raise concerns over the politics of co-creation, including who is given access to and power over co-creation processes, and the ways this influences outcomes, take up of outputs and the design or progress of co-creation itself (Turnhout et al. 2020). Thus, to further enrich the knowledge of co-creation for urban sustainability transitions, we need to examine and invigorate the premises, practices and politics of co-creation.

This perspective contributes to providing clarity about these dimensions of co-creation by bringing together the expert knowledge and experience of the co-authors. We have collectively investigated the dimensions of co-creation during a workshop at the Erasmus University Rotterdam, The Netherlands, held in November 2018. This workshop brought together 26 – mostly European – scholars and urban practitioners (policy-makers and planners) across different research fields and domains of interest, e.g., climate change, energy planning, organization research, design research, spatial planning, nature-based solutions, and circular economy. The workshop was designed as an intensive focus group structured along three questions for unravelling the premises, practices and politics of co-creation:

- *Why to co-create:* What are the premises of co-creation as distinct research and governance practice for urban transformation? (Sect."Why to co-create: premises of co-creation")
- *How to co-create:* What are the methods, skills and capabilities required for co-creation? (Sect."How to co-create: methods, skills and capabilities")
- *With whom to co-create:* What are the politics to be considered in designing, setting, facilitating and evaluating co-creation processes? (Sect."With whom to co-create: the politics of co-creation").

The collected insights were post-workshop processed by the author team and, in the course of developing this paper, positioned within recent research on co-creation in urban sustainability transitions research. The insights on the three dimensions of co-creation provide a canvas to envision and progress future co-creation research and practice for urban sustainability transitions. We discuss future co-creation research and practice centered on measuring the impact of co-creation against its promises to support urban sustainability transitions, while recognizing the importance of different metrics and reflexive measures (Sect."Future research for co-creation: from understanding the potential to measuring the impacts of co-creation"). We conclude on the future of co-creation (Sect."Conclusions").

Why to co-create: premises of co-creation

Co-creation has become recognized as a valuable approach to deal with the complexities of urban sustainability problems. As a means to support urban sustainability transitions, co-creation embodies multiple outputs in terms of 'what' is co-created, including the creation of new problem definitions and visions, social relations, and solutions. In doing so, co-creation holds the potential to contribute to broader changes of research norms and paradigms as well as urban governance, from prioritizing expert knowledge and segregating researchers, policy-makers and citizens towards collaborative definition of problems and solutions, as well as of how these solutions are implemented, monitored and adapted (Wittmayer et al. 2024; Hölscher et al. 2024). The following summarizes three, partially interrelated, premises of co-creation – i.e. the 'why' to co-create – encompassing inclusive place-making for transitions (Sect."Co-creation can bridge and weave knowledge for place-based urban transitions"), the emancipation of urban policy and planning (Sect."Co-creation can be tuned to emancipate urban policy and planning"), and support socially relevant transdisciplinary research (Sect."Co-creation moves scientific discovery towards socially relevant transdisciplinary research").

From the interdisciplinary dialogue and conceptual reflection (Leino and Puumala 2021; Lund 2018), we propose three a priori premises of co-creation:

- *Co-creation can bridge and weave knowledge for place-based urban transitions;*
- *Co-creation can be tuned to emancipate urban policy and planning;*
- *Co-creation moves scientific discovery towards socially relevant transdisciplinary research.*

The premises also provide implications for how to design and enable co-creation; they may thus be utilized by researchers, urban planners, and other actors (e.g., community leaders) to tailor co-creation to different objectives and within different arenas. Researchers can extend these premises to position co-creation as a transdisciplinary research approach in research projects and as a process that links scientific inquiry to social and policy impact. Urban planners and practitioners can utilize these premises to advocate for the advantages that co-creation brings in terms of bridging knowledge, increasing ownership, and producing actionable knowledge about transformative solutions.

Co-creation can bridge and weave knowledge for place-based urban transitions

Co-creation represents a mechanism to bridge the plurality of knowledge and experiences of diverse urban actors, and in this way generate more holistic and socially robust knowledge that is embedded in a specific place, context and time. Co-creation processes understand the joint creation of knowledge as being more than a linkage of these forms of knowledge. The result is larger than the sum of its parts: it represents a heightened expression and formulation of knowledge, which is developed further in a given co-creation process to create new knowledge and new starting points. As a form of place-making, co-creation results in new place-making narratives, understandings and meanings, and interventions that care for both people and place and thus shape and transform the relations between people and place (Basnou et al. 2020).

On the one hand, co-creation posits the imperative to *bring together a plurality of knowledge* to match the 'wickedness' of urban sustainability challenges, which are cross-sectoral, multi-level and linked to multiple complex systems (Seto et al. 2017). Communities represent a complex and deep resource in relation to genuine, legitimate (able to be defended with logic, justification, or law), actionable and creditable knowledge, but also in relation to deep-held belief and cultural experience (Tengö et al. 2014; Nowotny et al. 2001). Co-creation serves as a mechanism to bridge the knowledge and experience of different communities by making the different types and forms of knowledge accessible to all participants. In this way, co-creation also values and appreciates the knowledge base of local communities by reflecting on it as of equal value to that of expert practitioners.

On the other hand, co-creation is best designed and facilitated to be *place-informed* given that people bring knowledge that is relevant and embedded in a specific place, context, and time. By means of a specific place (e.g. a city, district of neighborhood), experiences and academic knowledge from different disciplines can be linked. Place as an inter- and transdisciplinary bridging concept also specifies the collected knowledge in the local context and thus enables local-specific interactions and place-making by the people living there (Levin-Keitel et al. 2018; Mauser et al. 2013). Beyond activating entrepreneurs and urban change agents, co-creation can thus also engage them actively in the collective process of building a systemic vision of the place or city, co-designing pathways and eliciting potential solutions that support new outcomes of place making (Frantzeskaki 2019). This highlights the strength of co-creation to complement formal or regulatory planning processes by opening-up the discussion towards the plurality

of ideas and understandings of place (von Wirth & Frantzeskaki 2019, as is shown by research on green areas (Cortinovis et al. 2018).

A critical condition for co-creation as place-making for urban transitions is *ensuring inclusivity* in process and outcomes. The challenge is to access the true potential of the knowledge embedded in a community about the value, potential, and symbolism of its place. This requires approaches that give all participants equal opportunity to participate and go beyond the usual path of representatives and 'usual suspects' in participatory planning and policy processes (Trencher et al. 2014; Schoder et al. 2019). Yet inclusivity is not merely a matter of being invited (passively), but of having the active ability to co-create in a meaningful and productive way. This means that co-creation needs to be designed and facilitated to ensure constructive exchange between diverse actors, as well as accessibility to diverse capabilities and needs (Wahl 2016; van der Jagt et al. 2019; Hölscher et al. 2024).

Another crucial condition of co-creation is its *open-endedness*, which means that problems and solutions, or outcomes of co-creation processes, are not pre-defined. Only in this way is it possible to invite creativity, new ideas, courage and reflexivity to emerge. Unexpected results need to be accounted for ad their provisional and uncertain nature acknowledged. However, this requires trust and openness between the co-creators, as well as actively linking the results to existing agendas, initiatives, practices etc., to make them usable and relevant (Frantzeskaki & Rok 2018; Ferlie et al. 2019). Otherwise, there is a risk that co-creation efforts are wasted when results remain unused, for instance, due to discrepancies between informal co-creation and formal institutional contexts and requirements for administrative and legal legitimacy (Trivellato 2017; Jaspers & Steen 2019). Thus, we note that co-creation is dynamic and adaptive by design, aloowing to respond to new insights, dmeands and needs by continuously reflecting about goals, rules, actors involved, engagement methods, meeting schedules etc. (Basnou et al. 2020; Reed et al. 2014).

Co-creation can be tuned to emancipate urban policy and planning

Co-creation marks a novel mode of collaborative urban governance and can spark or institutionalise new forms of decision-making practices and approaches for collaboration (Buijs et al. 2018; Leino and Puumala 2021; Lund 2018). Co-creation creates more opportunity for Habermasian democratic policy and planning processes that extend beyond the dichotomy of administrative actors and political representatives, on the one hand, and citizens, on the other hand, as well as different forms of participation included for instance in Arnstein's 'Ladder of Participation' (1969, 216). Co-creation gives diverse urban communities meaningful access to 'activity spaces' for joint social learning (Coenen et al. 2020), by stimulating debates about societal values and beliefs and, therefore, enabling trust-building, and developing shared sense of responsibility (Devolder and Block 2015; Van Veen et al. 2013). Along these lines, co-creation is often linked to enhanced democratic accountability and changing power relations, thereby catalyzing a shift towards an emancipatory way of co-governance that is better tailored to local contexts and needs (Bussu and Galanti 2018).

The active engagement of urban communities through co-creation helps to *progress and bridge urban agendas* at all stages of urban policy and planning processes. New

research on smart cities reports that co-creation has been a complementary planning process especially for introducing principles of open science in planning (Cappellaro et al. 2019), digital services and digital platforms for data collection in city planning. Within the smart city planning context, co-creation is also identified as a mechanism to increase constructive participation of citizens in a creative process to design and delivery new services especially with a focus to affordability and inclusivity (Gutierrez et al. 2016), and to ensure digital inclusivity in smart cities. Moreover, co-creation can encourage actors to not stay within their own narrowly defined boxes of accountability and work towards addressing problems across agency, jurisdictional and public problem domains (Bianchi et al. 2021; Ferlie et al. 2019). For example, the co-creation of nature-based solutions can end up to also include discussions on food, mobility, and air quality in the city (Hölscher et al. 2023).

By spurring *new relations and partnerships between public and private actors*, co-creation can contribute to replacing, or complementing more traditional, top-down governance structures, changing the city government's role from intervention 'delivery systems' to host organisations for sustainable change (Ferlie et al. 2019). For example, new governance approaches and collaborations can emerge between city governments and other groups of stakeholders (local citizens, businesses, researchers etc.). The (new) governance modes and partnerships can differ in quality, ranging from more loose ties to institutionalized partnerships (Hölscher et al. 2018; 2024; Battisti et al. 2024). Explicit attention is needed to develop and sustain (new) forms of collaboration and partnerships and to continuously build trust (Frantzeskaki et al. 2023; Mahmoud et al. 2021; Chatterton et al. 2018).

As a mode of collaborative governance to facilitate social learning, co-creation may represent a mechanism to *foster the empowerment of urban communities* by equipping them with skills, knowledge, relations and tools to self-govern and self-organize (Dörk & Monteyne 2011; Hölscher et al. 2019). Manktelow et al. (2023, p.8) noted that "research showed that next to effectiveness, efficiency and acceptability, co-creation can also have impact in terms of (…) knowledge generation and capacity building". Co-creation establishes a setting for participants to reflect on an (re-)define their roles in the context of the place where they live (Wittmayer et al. 2017; Guemes and Jorge 2019). At the onset of the co-creation process, the 'getting to know each other' phase is a fundamental necessity to engender a sense of community of values, and more importantly, of work. This makes possible the identification of roles and tasks in any project, depending on the skills, competences, availabilities, and interests, and is particularly needed when co-creation engages various professional profiles (Bonneau 2018). Community empowerment is crucial for increasing local, place- and community-based resilience and adaptive capacity as the impacts of already locked-in climate, social and environmental change continue to unfold (Chu et al. 2017; Archer et al. 2014).

Still, there are risks of *dis*empowerment when co-creation is used to legitimize existing urban agendas, or when the politics and power struggles underlying co-creation are not addressed, including questions of who participates, what values, perspectives and interests the participants represent, and who dominates the process (Turnhout et al. 2020; Hölscher et al. 2019; Avelino 2009). Co-creation can be instrumentally used as tokenism, to marginalize certain groups, or to legitimize retreating welfare state and social policy

reforms that shift responsibility from the state to the private sector (Lorne 2019; Bussu and Galanti 2018). In this context, scholars highlight the need to *invest in co-creation as a viable governance approach*, building on the experience of how different tools and adaptations work for specific contexts (Ferli et al. 2019). This includes supporting local communities and citizens in becoming active co-creators, by tailoring processes to their capabilities and needs, providing connections and resources (Basnou et al. 2020; Jaspers and Steen 2019). As the roles of local governments shift towards enabling co-creation, it often remains their task to coordinate co-creation, ensure legitimacy and availability of resources (Zingraff-Hamed et al. 2020).

Co-creation moves scientific discovery towards socially relevant transdisciplinary research

When employed as a research mode, co-creation is an exemplar process of transdisciplinary research since it emphasizes collaboration, inclusivity and integration of diverse knowledge by and for society to generate actionable knowledge that is contextually relevant for urban transformations (Hölscher et al. 2021; Wittmayer et al. 2024). Transdisciplinary research has been defined as a new mode of knowledge production and decision-making that involves actors from outside academia into research processes (Gibbons & Nowotny 2001; Hirsch Hadorn et al. 2008). Transdisciplinary research goes beyond the integration of multiple scientific disciplines (interdisciplinarity) in that it focuses on engaging non-academic stakeholders in the creation of a shared problem understanding and solutions (Nowotny 2001; Lang et al. 2012; Pohl et al. 2017).

Co-creation as a transdisciplinary research mode aims to *render research more socially relevant*, especially since contemporary societal challenges are too complex for any one discipline or stakeholder group to solve alone (Pohl et al. 2017; Jahn et al. 2012). This resonates a broader movement towards collaborative research approaches to support policy-making to address complex sustainability problems in ways that are not only more effective but also more equitable and just (Turnhout 2024). Next to scientific knowledge that describes, explains and/or evaluates societal phenomena and generates innovative insights, heuristics, method, the aim is to generate both actionable knowledge and transformative action that is "(social knowledge on how to take) action on social problems, enhanced capacity, and network effects" (Hölscher et al. 2021, p 4; Caniglia et al. 2020)). Transdisciplinary research defines three types of knowledge – systems, target and transformation knowledge – to guide the collaborative process of problem-solving by diagnosing and analyzing the systemic problem, establishing shared goals or targets among stakeholders, and charting transition pathways and interventions (Hirsch Hadorn et al. 2008).

Actionable knowledge and transformative action mean that the results of co-creation are useful for urban actors and inform (new) policy and community goals and agendas, solutions and practices. With co-creation as a mode of urban governance (Sect."Co-creation can be tuned to emancipate urban policy and planning"), the attempt to tackle complex societal problems in collaborative alliances of actors from science and practice follows the rationale of *increasing the ownership of and accountability* for the respective problem, as well as for the solution options (Lang et al. 2012, p.26; Lindberg et al. 2020). Taking the example of citizen science as a co-creative research approach: Research demonstrates that citizen science and support urban policy-making by tapping

into distributed knowledge domains, raising environmental awareness, enhancing social acceptance of policies or solutions, and fostering behavioural change (Criscuolo et al. 2023; Göbel et al. 2019).

A key premise of co-creation as a transdisciplinary research mode is to *democratize science* by establishing new forms of collaboration between researchers, policy-makers and citizens (Austen et al. 2024; Turnhout2024). Co-creation challenges dominant assumptions about research as taking place outside of policy and societal processes: it aims to question and change the social, governance, institutional and power dynamics reproducing unsustainable or inequitable patterns in society, with society. In this sense, when co-creation is selected as a research method in scientific projects, it can provide a process through which scientific results can be tailored, structurally integrated and translated to actionable knowledge for practitioners and communities, when it ensures and fosters trust and openness to ideas and knowledge between co-creators (Newig et al. 2019, p.417; Manktelow et al. 2023, p.9).

A challenge is that co-creation is at odds with existing science systems, which neither incentivize nor equip scientists to take up co-creation (Turnhout 2024; Newig et al. 2019). Transdisciplinary research including co-creation remain at the margins of mainstream scientific practice and research funding. Researchers engaged with such approaches highlight the high amount of time needed for activities like inducing reflexivity and trust-building (Jahn et al. 2012). Facilitating social learning transcends existing roles and skills of researchers and others involved in the research, requiring collaboration, communication, and reflexivity (Wittmayer and Schäpke 2014). Furthermore, it remains to be examined how co-creation as a transdisciplinary research approach can epistemologically match with more conventional research methods such as ethnography, participatory action research, historical analyses in progressing knowledge generation for urban transitions. Embracing co-creation – and transformative impact generated through it – requires reflecting on and redefining academic quality criteria, funding schemes and career trajectories.

How to co-create: methods, skills and capabilities

Co-creation is facilitated using particular methods to guide participation (Sect."Co-creation methods") but also requires adequate skills and capabilities of those involved in co-creation – both as facilitators and as participants (Sect."Co-creation skills and capabilities"). Importantly, the question of *how* to co-create with the aim to contribute to urban sustainability transitions initially gives rise to the substantial question of whether *any* co-creation does, by definition, does so. We answer this question with a decisive 'no'. However, making mistakes, recognizing, and learning from them are part of the open-ended learning process about urban transformation that can be facilitated by co-creation. Thus, it is important to consider some key points for the design of the common learning processes (procedural aspects of co-creation), which also emerge from the premises outlined in Sect."Why to co-create: premises of co-creation":

- Transparency and joint problem definition: All participants ought to know about the context that the co-creation process is embedded in. For a joint problem definition, consensus does not necessarily have to prevail, rather it is about transparency and

an understanding of who wants to change what in this process and to whom which goals are important (Mouffe 1999; Pløger 2004). Meanwhile, differing expectations are compared, goals for the process are defined and different values are made explicit to work with.

- Co-creation for the public good: Co-creation for urban sustainability transitions must reach beyond personal and individual scopes by definition; it is a means to create better urban places for the public good. The question of how these urban common goods should develop must always be renegotiated with society, and is in constant transition itself (Borch & Kornberger 2015; Huron 2017). The question of who decides is as complex as the question of who does not feel represented. Social inequality as a structural problem can be the basis of every decision made for common goods. Therefore, the moderating integration of different perspectives on these places is essential. The local specific *genius loci* as well as the socially constructed dimension of place play an extraordinary role in questions of justice in how to develop our living environments (Borch & Kornberger 2015; Campbell 1996).
- Embeddedness in decision-making processes: As Voorberg et al. (2015) point out, a rather less analyzed and even disregarded aspect of co-creation are the *outcomes*. A co-creation processes can be primarily considered as a virtue in of itself; one that does not need to be legitimized by external validation. A key aspect for the design of co-creation processes is the indispensable connection and embeddedness of these processes to responsible actors and decision-making processes.

Co-creation methods

Co-creation encompasses a multitude of possible methods, and method frameworks, to guide the process. As situations and projects within which co-creation happens are highly contextual, methods of co-creation are consequently contextual and situated, depending for instance on the goals of the co-creation process, and who is to be involved. It would thus be a worthwhile effort to have an overview of methods and tools used specifically aiming at co-creation and appropriate them to the context of urban transitions. There is ample evidence of user involvement in the design and diffusion of new technologies in transition projects where there was no involvement of professional (i.e. trained) designers (Heiskanen et al. 2014; Hyysalo et al. 2017). These findings bring to surface questions on actors and agency of design as well as what may count as design activity and design output in sustainability transitions with significant implications on co-creation processes.

For instance, design research puts forth a nuanced understanding of participation depending on when and how non-designers are included in a process (Gaziulusoy and Ryan 2017a; Lee 2008; Zhang and Dong 2016). There is a wide variety of classifying levels and modes of participation, including the involvement of non-designers as design partners, or their support in creating own designs. Depending on the desired output (e.g. visions, scenarios, technology, product and service concepts) and purpose of co-creation (ideation, evaluation, engagement), there are numerous approaches that can be

Table 1 Examples of methods, characteristics and cases of research projects that involved co-creation

Co-creation method	Main characteristics	Examples
Transition management	Spaces for a small group of front-runners to co-develop long-term visions, transition pathways and experiments and thus *coordinate and empower actors*	MUSIC project (Frantzeskaki et al. 2018a) Resilient Europe (Frantzeskaki 2019) IMPRESSIONS Project Mechelen Energy Transition Project via SHIFFT Project (Maktelow et al. 2023)
Urban Living Labs	Spaces of co-creation to *test transformative innovations and solutions* with different governance arrangements in a territorial context	European Living Lab Network (https://enoll.org) Edible City Network (https://www.edicitnet.com) Clever Cities (https://www.clever-cities.eu; Mahmoud et al. 2021) Resilient Europe (Frantzeskaki 2019) Bioregional Weaving Labs Collective (https://www.ashoka.org) Arctic cities research (by Lindberg et al. 2020) TANGO-W project (Dvarioniene, et al. 2023)
Participatory resilience thinking	*Capacity building* to handle change in complex systems of human-nature interactions	https://wayfinder.earth/
Gamification	Knowledge management and collaborative tool for co-creation	Serious game for participatory planning (https://geogameslab.net/portfolio/b3-design-your-marketplace/; http://superbarrio.iaac.net)
Regenerative design and development	Framework for co-creation involving the community to explore the potential of a place	

used ranging from low-tech low-cost (e.g. drama and acting out) to hi-tech high-cost (e.g. simulators and virtual reality), including methods of embodiment and immersion.

We present selected methods of co-creation that were identified during the expert workshop. Each method encompasses distinct characteristics in whom and how to bring diverse urban actors together with a focus on advancing urban sustainability transitions: transition management, urban living labs, participatory resilience thinking, gamification, and regenerative design (Table 1).

Transition management

Transition management has been introduced as a practice-oriented framework to scientifically ground and support the governance of sustainability transitions (Loorbach et al. 2015; Frantzeskaki et al. 2018a). Transition management offers a portfolio of co-creation tools to bring together and connect diverse actors and guide them in collaborative long-term thinking, learning and experimenting to enable change in strategic directions, practices and institutions (Nevens et al. 2013; Wittmayer et al. 2018; Wittmayer and Loorbach 2016). The transition arena is the most prominent instrument of transition management: it creates space for a small group of pioneers, so-called 'frontrunners', to co-develop shared directions and narratives of transformative change, experiment with alternative ideas and solutions as well as to form new coalitions, partnerships, and

movements (Loorbach et al. 2015; Frantzeskaki et al. 2014). The ambition of co-creation in transition arenas explicitly extends beyond the generation of new knowledge towards empowering the participating actors to take up concrete roles and actions in influencing the envisioned sustainability transition (Hölscher et al. 2018; 2019). Transition management has been applied to a variety of urban contexts and settings (Frantzeskaki et al. 2018a; Wittmayer et al. 2016). It has shown to support new types of governance capacities with particular emphasis on enabling novelty creation (e.g. ideas, strategies, actor relations, governance approaches) that provide seeds for systemic change. It also offers a basis for aligning diverse goals under a systemic and long-term orientation for an urban sustainability transition, and thus to coordinate and mobilise actors and actions in bringing this orientation forward (Hölscher 2018).

Urban living labs

Experimentation in urban living labs has been adopted as an urban governance approach in practice and as a transdisciplinary research approach in research (Scholl et al. 2018; Voytenko et al. 2016). The blending of research and practice that is realized in urban living labs drives an interest in better designing them and examining their impact. Urban living labs create diverse collaborative governance arrangements from more government actor led to non-government actor led models within the triangle of central/local government, private sector and civil society (Wilk et al. 2021). There has been a proliferation of urban living labs as spaces of co-creation due to their flexibility in design and scope, and to the place-based identification that complements other governance innovation methods (Puerari et al. 2018; Mahmoud et al. 2021). Recent research about co-creation in urban living labs provides evidence about the outputs and outcomes that urban living labs potentially bring about: co-designing transformative solutions that are tested and trialed (Lomba-Fernandez et al. 2019), emerging narratives and imaginaries that relate to new institutions (Amenta et al. 2019; Marana et al. 2019), new strategies and coalitions in place-making and instigating the emergence of new senses of place (von Wirth et al. 2019; Frantzeskaki et al. 2018b), as well as forging and supporting new relations between different partners (Menny et al. 2018) and in result, indirectly support social and governance innovations to flourish (Frantzeskaki 2019).

Participatory resilience thinking

Resilience thinking, characterized by principles formulated by Biggs et al. (2012), aims to enhance local communities' capacity to handle uncertainty and continuous – both desirable and detrimental – change in complex human-nature systems, including urban systems. It is an approach with a normative standpoint in strong sustainability that was developed within natural resource management and has been increasingly applied in other systems including cities (Sellberg et al. 2015). The seven principles proposed by Biggs et al. (2012) all require a combination of diverse knowledges to understand the system dynamic and decide on proper actions based on that co-created understanding among the participants. Participatory resilience thinking is characterized by the openness to capture the ever-changing character of complex systems by being adaptive, with

in-built iterations of evaluation and revision. It starts with engaging local communities in deciding on the system boundaries of the process, proceeds to shared sense-making of the problem, and reflecting on own capabilities and roles to respond to change (Sellberg et al. 2017, 2018).

Gamification and serious gaming

Gamification, a sub-discipline of game science and game design, is an approach that aims to learn about and reflect on human behavior using game elements and can provide a platform for changing human behavior using game elements (Landers et al. 2018a, b). Gamification is an approach to knowledge management that has been recently suggested as having the potential to enhance knowledge-sharing as well as boost organizational and individual motivation and reward. Due to this dual nature, gamification and gameful design can be incorporated into the co-creation process as an approach to elicit initial collaboration, trust-building and foster long-term transformative solutions. Further, as gamification approaches have the advantage of being normative and quantifiable, this can encourage co-creators to comply with a set of goals and boundaries (i.e., co-creative rules), while receiving regular feedback, appraisal and reward that can sustain a co-creation process in the longer term. A prominent example are serious games, a knowledge-based, immersive and collaborative tool, making participatory processes more enjoyable (Ampatzidou et al. 2018). Serious games for urban planning can facilitate learning, interaction and allow individuals to see direct consequences of their actions as of others' actions and decisions (Constantinescu et al. 2017). The tool can help in team building processes by providing a space for taking and reflecting solutions together in a team and for changing perspectives and experience different points of view from other stakeholders and thus support negotiation process especially when divergent interests touch conflicting grounds. However, in some aspects, serious games remain problematic as representativeness of participants is limited by the exclusion of non-digitalized people.

Regenerative design

Another advanced framework for co-creation is that of regenerative design and development (Mang and Haggard 2016). This framework understands co-creation as a developmental process for both place and people. It is very different from other approaches because it starts from potentials instead of problems. It asks: 'What is this place aspiring to become?', and, 'What is the unique essence of this place and its inhabitants that is wanting to be born?'. By involving the community into a deep exploration of the history and uniqueness of the place they invoke a deep sense of belonging and ownership. By working from potential, they create space for participants to explore meaning, essence, and interrelatedness, building the will for residents to take up new roles of value adding that benefits both community and place. Accomplished regenerative practitioners trigger an evolutionary process in the communities they serve that does not stop when the project is over. They leave the communities better equipped, with new energy, agency, and capabilities, to keep moving forward, despite difficulties and obstructions and with a stronger connection to their place.

Co-creation skills and capabilities

As indicated in the premises above (Sect."Why to co-create: premises of co-creation"), co-creation requires diverse skills and capabilities. These encompass both the co-creators (Sect."Co-creation methods"), as well as the organizers and facilitators of co-creation processes (Sect."Co-creation skills and capabilities").

Skills and capabilities of co-creators

Co-creation processes rely on the individual contribution in a process of creating a collective creativity and intelligence. This requires participants to be activated as co-creators. Without this activation, co-creation can fail to unlock the potential of the individual and risks becoming a more traditional top-down process.

Co-creation draws the context necessary for the *manifestation of creativity and imagination* by stimulating new associations between ideas, by reassembling the elements of the problem in a new perspective and by disinhibiting imagination. Co-creation requires both components of creativity: originality (i.e., the novelty of the solution) and usefulness (i.e., the potential of the solution to be implemented). Contemporary understanding of creativity suggests that it is a systemic property (Hennessey and Amabile 2010), and that a creative personality alone is not enough to produce actual creative performance (Amabile 2013). Research shows that explicit support for creativity from both work (supervisors and/or co-workers) and non-work (family and/or friends) contributes to creative performance in the workplace. Co-creation thus comes to mediate and bridge creativity of co-creators in view of or in designing solutions or pathways for urban transitions.

Additionally, *curiosity* about the process of co-creation is a skill required for remaining activated in the process and considering it as a process of discovery next to a process of delivery of actionable outcomes. Art, design, and performative methods can help in facilitating and organizing co-creation processes that bring playfulness alongside with creativity, imagination and curiosity (Edwards et al. 2016; Galafassi et al. 2018). For opening imagination, co-creators need to embrace playfulness. Playfulness is linked to approaches to co-creation based on gamification and gameful design, as these enhance knowledge sharing and collaboration via establishing creative environments (Agogué et al. 2015).

Based on practical experiences with co-creation, *collaborative learning* is a necessary skill for co-creation. In co-creation processes, participants need to switch mindsets from "*thinking for*" to "*thinking with*" others and remain open to learning. This requires being aware of the way of thinking and doing and the impact it may have in practices and decisions. In addition to this, the openness to learning needs to come with the capacity to understand conflicting and paradoxical paradigms, solutions and approaches, and to recognize the complexity of transitions. Collaborative learning as a skill and capacity required in co-creation processes catalyzes the ability to appreciate and weave in different forms of knowledge such as tacit, expert, experiential knowledge. Conscious and conscientious *receptivity* to multiple perspectives, understandings and emotions associated to knowledge, solutions and approaches is a required capability for co-creation. It implies the ability of people to reflect on own mind frames to open-up to plurality of visions and solutions that are co-created.

Argumentation and dialogue skills are also required to embark in the co-creation process as an active co-creator. Reasoning abilities, the capacity to argue an idea, and the rejection of pre-conceptions, all facilitate the understanding of how an idea is developing through the co-creation process. Ability and skill to engage in a dialogue also involves counter-argumentation which can regulate co-creation by limiting the risk of fallacies (Ribes-Giner et al. 2016).

Finally, *emotional intelligence* may have a regulating role both for the co-creation process in the sense that keeps it oriented towards the goal, but also for the dynamics of relationships during the process (Goleman 1998). While the merits of the emotional intelligence construct are not without criticism, notably focused on measurement issues (O'Connor et al., 2019), previous research has reported its relevance in a range of transformative processes integral to urban initiatives (Berman and West 2008). Thus, knowing what we are feeling (self-awareness) and being able to take the other person's perspective (social awareness), handling our emotions so that they facilitate rather than interfere with the task during the co-creation process (self-control) and handling emotions in relationships and using them for cooperation (social skills) make co-creation a (more) substantial and consistent process. Working on everyday life context may trigger a wide array of feelings, ranging from the relationship to the ownership of the place, of its identity and culture, representativeness in a project (neighborhood or city), to the personal attitude towards the co-creation process, from the issue of communication skills to self-esteem via its meaning and value for each of the participants. As such, being able to clearly identify and name each emotion enables consolidating the common work around agreed principles, and setting up the most workable, and efficient, governance model. So, emotional intelligence is likely required, not just for leaders, but for multiple actors for understanding that urban transitions inflict and trigger different emotions to people varying from excitement to anxiety about the uncertain futures and the complexity that transitions entail.

Skills and capabilities of facilitators and/or organizers of co-creation

Facilitation and organization of co-creation as multi-actor processes are essential, and require a specific set of skills and capabilities to effectively engage with participants, organize venues, analyze discussions, reach out to and facilitate constructive exchange between diverse actors.

Next to the personal skills and capabilities required for participating in co-creation processes, organizers of co-creation efforts need to have the *organizational skills* to maintain the level of involvement in co-creation. It is important in co-creation to sustain the salience and veracity in the process that requires the motivation and will of people who are engaged and those who are involved over the course of the process. Critical to this is organizing and maintaining involvement, contributions and expectations over extended periods of time.

With co-creation being an open-ended approach lacking a strictly defined outcome, not meeting expectations and stakeholder fatigue can be defining barriers. *Facilitation* of such processes needs a change into a coaching role for helping co-creators in their collaborative learning journey while ensuring inclusivity of different standpoints, ideas, and knowledge. Expert facilitation can be required to manage these issues and bridging

organizations and industrial entrepreneurs can represent a critical independent supporting mechanism for overcoming these barriers and driving forward collaboration (Rao et al. 2000; Kampelmann et al. 2016).

Relatedly, co-creation processes require diverse *communicative skills* to particularly reach out to and engage diverse urban actors. It has been found that, despite best intentions to achieve diverse and inclusive sets of participants in urban co-creation processes, reaching out to and motivating diverse stakeholders remains a major challenge (Hölscher et al. 2024). Scholars outline various strategies to actively reach out to actors and raise motivation to participate, including spending time with communities, employing tailored communication formats and providing incentives (e.g. financial support, training, social recognition) (Bussu and Galanti 2018).

With respect to organizational skills, *leadership* in the co-creation processes is more about organizing and maintaining the momentum and it ought to include the capability to keep the knowledge-generation process salient, i.e. relevant to the problem at hand (Cash et al. 2003; Bonneau and Jégou 2017). Commonly, leadership is focusing on the outcomes rather than process goals, wherefore a co-creative process deviates from other collaborative processes. Even if different leadership styles can be effective in different contexts and at different stages of the innovation process, there is a strong consensus that a participative or collaborative leadership style is more conducive to innovation (Anderson and King 1993; Manz et al. 1989).

With whom to co-create: the politics of co-creation

In questioning with whom to co-create is where the process cannot escape power struggles, the threat of instrumentalization by third parties, challenges or to the integrity or self-understanding of the co-creators. A number of scholars pinpointed the underexamination of issues of power in co-creation processes, while concerns over the power of research and expert knowledge in framing and dominating the co-creation settings and design prevail (Engels et al. 2019; Newig et al. 2019; Hölscher et al. 2018; 2019; Bartels and Wittmayer 2018). It is thus necessary to provide more critical examination of power dynamics within and of co-creation, to develop new tools and approaches to deal with of processes. This also includes how power relations are established or even reinforced, given that co-creation processes are not immune nor unaffected from pre-existing 'close' relations between actors and their networks holding power positions (Turnhout et al. 2020). We examine the politics of co-creation focusing on who has (or is given) primacy of voice, what is the role of power and power asymmetries, and what is the role of research.

Primacy of voice

One of the most critical issues concerning the politics of co-creation is who has (or is given) the primacy of voice in co-creation processes. The underlying question here are: "*what are the selection criteria for the participation?*", "*who is participating in whose process?*" and "*what is the process meant to accomplish?*". Generally, as stated above, who is included depends on the goals and selection of methods – for instance, transition management focuses on diversity but a small number of frontrunners (Sect."Co-creation methods"). However, from the perspective of co-creation for urban sustainability

transitions, several considerations can be made in terms of who is included in a co-creation process.

Co-creation represents an explicit opening up of traditionally expert-focused settings towards recognizing the importance of tacit knowledge in policy and planning. Fernandez 2016 (p.173) defines that tacit knowledge is "*encompassed by a view of expertise that includes not only technical information, but also the experience and proficiency needed to apply it under specific contexts, being aware of uncertainties, risks, and knowledge gaps*". Tacit knowledge is the result of implicit learning, which is unintentionally, without instruction, and not openly expressed. It is an experiential learning. Learning from experience and transfer the experience-based knowledge in new learning contexts is an advantage in co-creation (Sternberg and Wagner 1986). Carton and Ache (p.237) further support that co-creation through engagement of experts and citizens in urban projects enables democratization of knowledge and it can "*impact professional research and planning*". This means that expert knowledge did not get distinguished nor compartmentalized from tacit, or, experiential knowledge other actors bring in the co-creation process. We can distinguish between three types of communities to engage in co-creation for sustainability transitions: communities-of-influence (e.g. key thinkers, environmental and social scientists, the media of all formats, educators, opinion, controversy), communities-of-interest (e.g. researchers and local actors, NGOs and development institutions, innovators, thinkers), and communities-of-practice (e.g. local authorities and city governments, businesses). These communities provide a direction about the different types of actors to be involved in co-creation.

A justice lens on co-creation invites further questions on which type of knowledge and expertise is valued, and accordingly, who it is having access to participate in co-creation processes. For example, Shrestha et al. (p.5) argue that "*a genuinely inclusive process in the climate-constrained urban world requires more informed deliberation between urban development professionals and disadvantaged communities. This further implies rethinking the way in which urban expertise is organized – making it more collaborative with the people who are suffering diverse forms of social exclusion and ensuring that it is grounded in their lived reality*". In this way, it is critical for co-creation to span across the entire *private-social-public domain* (Ossola et al. 2018), by ensuring that all possible co-creators in urban systems are actually represented and heard.

Besides the issues of inclusivity for plurality of voices (Sect."Co-creation can bridge and weave knowledge for place-based urban transitions"), in urban transitions contexts it is important to explicitly consider how to include 'voiceless' actors. Besides traditionally 'under-privileged' and marginalized urban actors, this also encompasses those whose inclusion is impractical or impossible (such as non-human actors, actors from differing cultures and ethnicities, and/or actors who are not born yet). Kondo et al. (2019, p.57) argue that with careful and curated process designs it is possible to ensure "ethical equity" and attend to marginalized voices and empower communities. We thus point to this very issue to be considered when designing co-creation processes to be inclusive and open throughout aiming for diversity designs in co-creation (Musch and von Streit 2020).

Another view on inclusivity is that in order to make urban transformation happen, we need new narratives, framings and ideas that cannot come from incumbents – this view

invites to think of including voices of those silenced in current ideas about the future of cities since they provide alternatives that might be considered too radical. Co-creation for urban sustainability transitions implies that all those engaging in the co-creation do so from the normative standpoint of a desired sustainability transition and/or with the aim to have practical impacts supporting such a transformation process. For instance, inviting climate deniers into urban low-carbon transitions projects may not be desirable (Gaziulusoy and Ryan 2017b). Making decisions about primacy of voice involves establishing conceptual boundaries around urban systems, both physical and social, that are the subject of transition efforts.

Moreover, urban to regional to global linkages are core to achieving sustainable development goals across scales. If one understands complex urban systems as being embedded in larger social-ecological-infrastructure systems that extend across multiple scales (Grimm et al. 2008; Ramaswami et al. 2012; 2016; McPhearson et al. 2016) – for example as a result of expansive direct physical footprints, material flows and resource withdrawals from distant resource sheds, or social and economic effects that are generated extra-territorially – the boundary around an urban system becomes expandable to include many more potentially relevant voices. The question then becomes "*how do place-based urban transition and co-creation efforts account for and include, if at all, potentially relevant voices who may not be of that specific place?*" Here, concepts of flows and continuums, and transition processes that are structured around such flows or that are generating effects along such continuums, may help us advance an analytical understanding of how to evaluate questions of "relevance" and "primacy" of voice in the context of ostensibly "urban" co-creation.

Power asymmetries

Co-creation ought to be based on deliberative processes, and it should facilitate participation by 'weaker' actors. Often, there is a need to ensure parity in contribution and diversity of platforms to ensure all voices can be heard. This question of inclusivity, however, needs to be balanced against a process of recognizing and filtering legitimate knowledge to ensure that outcomes are relevant to situational challenges and achievable in relation to the constraints of the project objectives.

Vigar and Healey (2002) discuss how the term stakeholder has been useful for describing the various actors, human as well as non-human, participating in and affected by an environmental issue. They note that some urban actors have more power and voice than others (for example within social classes) and this can lead to asymmetries in environmental and governance policies (see also Marafa 2002). Recognizing, mitigating and mediating power asymmetries is a critical political struggle in co-creation.

Co-creation does not necessarily result in equal power relations, but rather in empowering people through the process of collaborative learning. Along these lines, empowerment can be understood as the development of actors' capacities and motivations to define and take up roles in influencing urban sustainability transitions (Hölscher et al. 2019). To support this, co-creation needs to be designed to allow room for actors to enter into collective processes, in which participants can give their voice and opinion on a desired urban future as well as reflect on their needs and roles in relation to this future vision. For example, it has been found from applications of transition management in

cities that the provision of opportunities for actors to question, develop and experiment with new social relations, roles and abilities in relation to a shared vision supports perception of legitimacy and ownership of the overall process and its results (Hölscher et al. 2018). At the co-creation level of communication, it is expected that participants move beyond telling and sharing their views, knowledge, and experiences (that would be negotiated and compromised), to a process that catalyzes and nurtures new thinking and creativity among participants. This can allow to envision the full potential of urban areas as well as new ways of being and acting (at the individual, organizations, and community levels).

Co-creation as an empowerment process requires specific skills and mindsets to ensure open, inclusive, transparent, and adaptive process settings for actors to exchange their perspectives, as well as to challenge them to move beyond their usual expectations and roles and enter into co-creative relationships (Sect."Co-creation skills and capabilities"). At the same time, when considering power asymmetries it is important to recognize the different roles of actors played in the co-creation process, with different access to power and resources, and the risk of disempowerment if processes are not well-designed (Sect."Co-creation can be tuned to emancipate urban policy and planning"). As the co-creation is often initiated by the local governments, it is important to understand the implications of their roles both in city-making and in facilitating the process. When co-creation becomes highly politicized, it runs the risk of being captured and controlled by political agendas and of diminishing participants' trust. There lies the value of involving independent, bridging organizations in co-creation processes to help with improving the social license and social value or learning from it (Ehnert et al. 2022; Kampelmann et al. 2016).

One way to empower people through co-creation is by having an active role in the different interactions that co-creation requires. Such a process setting facilitates open and respectful exchange, giving voice to everybody (also paying attention to people who find it more challenging to 'speak-up') and flexibly responding to emerging needs and dynamics in the co-creation process. Creating empowering process settings also involves being perceptive to the different power positions of people and their roles in the co-creation process. Communicative participation enables co-creation growth and stimulates the formation of value with the cooperation of all urban actors, as it includes supportive collaboration between all the people involved with a high degree of dialogue. A dialogue means interactivity, engagement, and a propensity to act from all parts involved, as it implies shared learning and communication between problem-solvers. It must be built on transparency to facilitate a collaborative dialogue (Prahalad and Ramaswamy 2004). Through collaboration a good argumentation and gathering ideas from each part can be maintained, reducing the possibility of emerging ambiguities. Thus, collaborative participation can be seen as a main co-creation driver, with the satisfaction of the people involved as an important implication (Ribes-Giner et al. 2016).

The role of researchers in co-creation

Co-creation promotes a new role of science not for cities but with cities. Active participation of citizens and other urban actors in co-creation process contributes to the democratization of the knowledge and planning process overall (van der Hel 2016,

p.166). Specifically, "*by shifting the terms of engagement from 'on' and 'in' to 'with', the 'researched' are not only given voice, but play an active role in the research process itself with the idea of enacting some form of social action to improve the current situation*". As such, co-creation aligns with a pragmatism approach to science. It implies that science is collaborative produced, remains open to reflection and evaluation and challenges "*the presumed dichotomies between (…) production and use of knowledge*". Conclusively, co-creation is an epistemological foundation for the new urban science or science of cities.

Such a change in the framing of science and research is not only a change in the role of the researcher – who sees oneself being confronted with having to fulfill numerous roles such as change agent, knowledge broker, reflective scientist, self-reflexive scientist and process facilitator (Wittmayer and Schäpke 2014). A change in the role of one actor also presupposes a change in the roles of other actors addressing a specific issue, such as urban sustainability his means that not only do other actors such as policymakers and citizens need to change their expectations towards science (not speaking truth in that sense) this also changes their relation with one another towards one that is based on the acknowledgement that different knowledge are necessary to address the persistent problems our cities are facing (Wittmayer et al. 2017). The translation of urban research into actionable knowledge starts from the "*reciprocal recognition and appraisal from both researchers and practitioners*" (Ossola et al. 2018).

Future research for co-creation: from understanding the potential to measuring the impacts of co-creation

The value(s) of co-creation in any given process are not always captured or obvious (Mauser et al. 2013), which hinders the uptake of and support for co-creation both as a mode of urban governance and transdisciplinary research. If scientists and practitioners are to understand the diverse values of co-creation in urban sustainability transitions, it may be necessary to develop metrics for co-creation that capture a measure of change in relation to its application (Topp et al. 2020), while also allowing for unexpected knowledge and results to emerge (Voorberg et al. 2015).

There is a need to define, at the outset, why co-creation processes need to be measured, and what questions are to be addressed through such evaluation. This indicates that there ought to be a clear understanding of the 'why' and the 'what' of co-creation, to be able to generate a greater understanding of the success of the process in relation to the outcomes. The generation of understanding in relation to the scalability of the co-creation process would assist the potential of this technique to underpin urban transitions. At the same time, a closer examination is needed of the contexts in which co-creation is more appropriately employed, and how different tools and adaptations work for specific types of co-creation and contexts (Kabisch 2019). Hence there is the possibility of providing opportunities for scaling co-creation as a governance model, or, for example, broader in conjunction to participatory planning one.

At a fundamental level, however, there may also be a need to consider how progress/success can be measured if, by definition, co-creation begins as an open-ended process with no specific target, and how this be considered when measuring the 'success' of a co-creation process in comparison with other participatory processes (Trencher et al. 2017). Accordingly, co-creation as a form of governance needs a monitoring and

evaluation method that fits its nature: a dynamic open-ended process of active involvement and part-taking in the making of all structural elements, with different types of knowledge and continuously changing co-creators and objectives. In this way, scientists may be challenged to change their *modus operandi* when taking part in the co-creation process and, if so, this may generate possibilities for innovative monitoring and evaluation models and methods to emerge (Wood et al. 2015).

To mitigate against negative long-term outcomes, such as 'greenwashing', it is logical to establish the efficacy, or added value, of a co-creation approach in delivering urban sustainable transitioning, and to compare this in relation to other participatory processes (Reed et al. 2014). As such, it is important to identify what the strongest characteristics of co-creation are that set them apart from other, less inclusive but participatory, processes, and how these contribute to supporting urban transition dynamics (as conceptualized, for instance, by Hölscher 2019 or Ghosh et al. 2021). This can only be achieved by establishing clarity in relation to the definition of co-creation compared to similar forms of participatory processes such as passive consultation or stakeholder 'engagement', which is often an *ex post* approach in contrast to the *ex-ante* approach of co-creation. As discussed earlier, power asymmetries within the policy arena imply that measuring and evaluating co-creation processes requires attention to the role of power and politics and the risk of disempowerment (Collier and Scott 2009). In exploring this, it may be possible to use common metrics to quantify the added/differentiated value of a co-creation approach (e.g. evaluating adaptation of urban plans and policies, employ evaluation frameworks to assess policy learning during and after co-creation, employ discursive analysis methods to capture shifts in discourses due to co-creation in policy or urban plan formulation stages).

Further investigation is needed to understand more whether (and/or how best) to configure or reconfigure co-creation processes such that they account for and are compatible with the use of urban proxies and types. A question raised here is whether learnings from urban transition co-creation processes are meant to be mobile, generalizable and/or transferable from one place-specific context to the next. If the intention is to be mobile, we need to understand which indicators are useful to judge the closeness or "level of fit" (Sarkkia et al. 2015) for transferring interface learnings across place-specific co-creation processes. Luederitz et al. (2017) have articulated assessment questions about the intended transferability of learnings from urban experimentation, an arguably closely related process to urban co-creation, but as a whole, the question of how to systematically consider indicators and proxies in evaluating the applicability of co-created learnings transferred between or among a given set of urban contexts remains unanswered.

Conclusions

This perspective paper discusses three critical questions of co-creation – related to its premises, practices, and politics – to offer a canvas for envisioning future co-creation research and practice for urban sustainability transitions. It is clear that to foster urban sustainability transitions, co-creation is not just a matter of urban planning for new developments but also an important tool for managing the urban fabric, which itself is an everchanging and modifying substance. The experiences of diverse urban actors and knowledge holders are extremely valuable sources of implicit as well as

explicit knowledge to understand and navigate change at the local scale, and to foster a sustainable pathway for all urban dwellers.

As modes of collaborative urban governance and transdisciplinary research, co-creation may be able to induce new mindsets and practices, yield new innovations in knowledge transfer and communication, and bring about a transformation towards more sustainable behaviors. However, while contributing to structuring the debate about co-creation, many research questions remain unaddressed. These include, amongst others, the politics of co-creation, as well as, as discussed in the discussion, an improved understanding about the impacts of co-creation.

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NF conceptualised the dimensions presented in the paper and led the workshop that all co-authors participated and co-produced the paper. MC, KH, IG, AO contributed substantially to the conception, design of work, analysis and revision of the manuscript. All other co-authors contributed to the analysis, argumentation strengthening and enrichment from own expertise and discipline and wrote on the paper throughout the rounds of its revision.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Competing interests
The authors declare no competing interests.

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