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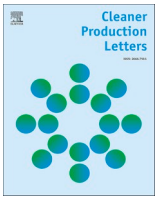

Crossovers between Sustainability Transitions Research and Social Practice Theory: A Systematic Literature Review

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A B S T R A C T

Researchers employ many different approaches to study transitions towards more sustainable futures, of which Sustainability Transitions Research and Social Practice Theory are often used. These approaches offer complementary concepts that are helpful to analyse, explain, forecast, and drive sustainability transitions, e.g. heuristics on changing institutions (Sustainability Transitions Research) or dynamics to change behaviour through practice development (Social Practice Theory). However, despite first attempts, it remains unclear how the approaches can be used together. Therefore, the aim of this paper is to expose crossover frameworks in which these approaches are used together, elaborating on conditions that make this possible, and the strengths and weaknesses of specific crossover frameworks. A systematic literature review has been conducted, investigating the potentials and the limitations for crossovers between Social Practice Theory and Sustainability Transitions Research by analysing the approaches according to the different ontologies and theories and then analysing frameworks that have been created so far. This research elaborates on six crossover frameworks that have been created that all have diverse strengths, such as the ability to conceptualize early transitional changes or finding points of resistance in transitions. All the found crossover frameworks made use of either the multilevel perspective or transition management. Other frameworks of transition research have not been found. This research shows that there has been surprisingly little research to crossover frameworks that incorporate an element of time. The exposition following from this study is interesting for researchers and policymakers working on sustainability transitions and sets an agenda for further framework development.

1. Introduction

Sustainability transitions require radical changes in the way products and services are produced and consumed in many systems and societies (Laakso et al., 2021). A change on systemic level is needed that goes beyond incremental improvements (Geels, 2020; Hargreaves et al., 2013; Keller et al., 2022b). As these transitions are complex (Mickwitz et al., 2021), many different approaches have been developed to study them (Sovacool and Hess, 2017). This development is relevant, as no approach is neutral in itself, because every approach already comprises visions regarding governance, offering both insights and 'black-boxing' of complexities (Jørgensen, 2012). Two often used approaches are Sustainability Transitions Research (STR) and Social Practice Theory (SPT) (Sovacool and Hess, 2017). These have been developed largely in separate academic communities, and provide their own research traditions and answers (Geels et al., 2015). However, these communities have a lot to learn from each other to better understand the complexities of transitions. This understanding is one of many potential specific answers to a larger mission in transition research: to combine insights from both the system level as the level of the actor, which is sometimes conceptualised as behaviour or agency, and sometimes, such as here, as practices (e.g. Dutch Research Council (NWO), n.d.; Köhler et al., 2019; Watson, 2012).

Based on a diverse set of theoretical origins, such as Science and Technology Studies, Complexity Theory, and Sociology of Innovation (Köhler et al., 2019), Sustainability Transitions Research is a set of five codeveloped heuristic frameworks that considers transitions as complex phenomena[1] (Geels, 2002; Öztekin and Gaziulusoy, 2020), perceiving

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[1] 'STR' is also often used for the wider field, wherein sometimes concepts from these heuristic frameworks are used, but these frameworks themselves not explicitly. In this paper we use the narrow term when these frameworks are explicitly used.

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change as happening at different scales (Obersteg et al., 2019), with multiple actors (Geels, 2002), concerning multiple aspects (Heurkens and Dąbrowski, 2020), in a path-dependent, non-linear way (Wittmayer and Loorbach, 2016). The five frameworks are Strategic Niche Management (SNM) (Rip and Kemp, 1998; Schot and Geels, 2008), Technological Innovation Systems (TIS) (Bergek et al., 2008), Mission-oriented Innovation Systems (MIS) (Hekkert et al., 2020), Transition Management (TM) (Loorbach, 2010), and the Multi-Level Perspective (MLP) (Geels, 2005; Köhler et al., 2019). In the last decade, there has been a huge increase in papers that use STR as an approach for sustainability transitions (Köhler et al., 2019), both in past and future transitions (Köhler et al., 2019; Vähäkari et al., 2020). Several systems have been researched with the approach, e.g. energy, food, water, housing, and transport (Geels, 2005; Hargreaves et al., 2013; Köhler et al., 2019). Yet, despite its usefulness and popularity, researchers found several limitations to the approach. First, so far this approach has mainly been applied to case studies in the Global North, especially The Netherlands and The UK (El Bilali, 2020). Further, it offers useful concepts for change, but not for normality (Hargreaves et al., 2013). And lastly, transitions research is critiqued to tend to focus too much on technology (McMeekin and Southerton, 2012; O'Neill et al., 2019) at the cost of considering agency of individuals and their collaborative actions (Grin et al., 2011; O'Neill et al., 2019). Scholars have argued that with these shortcomings transitions research is not developed (enough) to deal with all relevant transition questions (e.g. Geels, 2011, 2020), even though researchers are actively working on overcoming this (e.g. Van Welie, Cherunya, Truffer and Murphy, 2018, on the Global South).

To deal with some of these shortcomings, some authors have suggested that more attention should be given to SPT (e.g. Koretsky and van Lente, 2020; Shove and Walker, 2010), a combination of theories that use practices as their focus (Schatzki et al., 2001). Guided by sociologists Pierre Bourdieu and Anthony Giddens among others, SPT originated in the 1970s in response to the agency versus structure debate in the social sciences (Plummer and Van Poeck, 2020). This debate concerns whether individual actors or large-scale social phenomena are the primary determinants of human behaviour, and thus the appropriate focus for social analysis (Schatzki et al., 2001). SPT proposes an alternative view, i.e. that actors and social structures are dialectically shaped at the level of social practices (Giddens, 1984). Social practices can be understood as being composed of individuals carrying out both bodily activities and routinized ways or understanding things and situations (Reckwitz, 2002). As such, the approach offers theory about the normality of practices and actor agency in the individual performance of every practice (Hargreaves et al., 2013) and can therefore help overcome many of these gaps of STR. However, the gap regarding the geographical focus of STR (i.e. focus on the Global North, specifically the UK and the Netherlands) will not be overcome by just applying SPT. This requires more empirical work.

As STR is not a theory, but a set of heuristic frameworks (Geels, 2011; Köhler et al., 2019), and SPT is not a single, but a multitude of similar theories (Schatzki et al., 2001), here the term approach is used. This allows to elaborate on these two semi-coherent bodies of literature. When looking at transitions, scholars state the importance of perceiving these through multiple approaches, as multiple perspectives can compensate each other's weaknesses, while acknowledging each other's strengths (e.g. Geels, 2010; Huttunen et al., 2021; Seyfang and Gilbert-Squires, 2019). Nevertheless, for a long time, SPT and STR have been developed in mutual exclusion (Hargreaves et al., 2013), and only recently use of both approaches in an article has increased (Keller et al., 2022b). Many scholars also state that a full synthesis between the two approaches is impossible, as their ontological basis is fundamentally different (e.g. Geels, 2010; Hargreaves et al., 2013; Laakso et al., 2021). Further, they focus on different units of analysis, i.e. SPT focuses on practices and STR focuses on systems/regimes (Seyfang and Gilbert-Squires, 2019). However, in this paper Geels' (2010) more nuanced statement is followed: the approaches can be usefully linked with crossovers.

Following Geels (2010), crossovers are here defined as interplay of concepts between two different approaches. Crossovers therefore do not aim to synthesise approaches (Geels, 2010; Moore et al., 2018), but use insights from both, while still staying true to the foundations of both. Several researchers (e.g. Hargreaves et al., 2013; Van Welie et al., 2018; Watson, 2012) used crossovers into specific conceptual frameworks, which are referred here to as crossover frameworks, which are defined as conceptual frameworks that bring together concepts from different approaches, resulting in a newly defined ontology based on the approaches it stems from. Further, in this case a crossover is never between the whole of STR and SPT, but always between one heuristic framework of STR and one of the interpretations of SPT. Both approaches perceive sustainability challenges as too complex to be solved by incremental tinkering (Hargreaves et al., 2013; Shove and Walker, 2010). Instead these challenges demand fundamental systemic change (Geels, 2005; Hargreaves et al., 2013). As this research shows, crossovers so far focused on connections between MLP/TM and SPT. The other heuristic frameworks from STR have not been developed into crossovers, so they will not be the focus of the rest of this paper. So far, crossovers have proven fruitful (Keller et al., 2022b), as researchers can make use of system transition explanatory or steering concepts from MLP/TM (Geels, 2011, 2020), but also from concepts of dynamics to change behaviour through practice development, as is common in SPT (Hargreaves et al., 2013; Van Welie et al., 2018). Keller et al. (2022b) distinguished seven insights for usage of both SPT and the MLP: 1) one can zoom in on practices and zoom out on regimes/systems, 2) practices and regimes influence each other, and the intersection points between them are interesting points for analysis, 3) the regime is not a completely formal, there are degrees of formality, 4) multiple regimes influence a practice and researching both practices and regimes allows insights in how regimes interact, 5) both producers and consumers play important roles in the transition, 6) 'sticky', persistent practices are useful to study as they can hinder transitional change, and 7) some practices can play a role on the landscape level. This research partly builds on this earlier research and discusses diverse ways in which crossovers can be made, forming crossover frameworks. Crossovers frameworks can be used to answer questions about topics on systematic change, such as the practices that form regimes, or system changing in different locales. Both approaches offer a piece of the complex puzzle of how to analyse transitions. Using crossovers, more of the puzzle becomes visible. Different crossover frameworks have been developed that focus on fundamentally different aspects of the approaches, but as a clear overview of the current research is missing (Geels et al., 2015; Keller et al., 2022b), academics focusing on transitions would benefit from an exposition of the different crossovers to make better informed decisions on which frameworks to use.

This paper primarily aims to expose how these two approaches have been used together so far, elaborating on what the strengths and limitations of the different crossover frameworks are and so offer tools for researchers and policymakers, both private and public, to study and steer sustainability transitions. By distinguishing between different crossover frameworks, it becomes possible to be more precise about their ontological and theoretical contributions. By exposing this, this paper secondarily aims to set a research agenda for future researchers interested in researching transitions and practices. A systematic literature review has been conducted, resulting in 76 papers that have been included that all mention both approaches. First, these papers have been analysed on statements regarding ontology and theory resulting from making crossovers, to understand under which conditions crossover frameworks can(not) be made. For this first part therefore also papers that have not made use of crossover frameworks have been included, as they sometimes explain the conditions that hinder making crossovers. Then, analysis regarded crossover frameworks specifically, and these have been analysed on strengths and limitations. This analysis involved describing contexts they are useful for, regarding complexity of systems

and size (contextual or system), and which aspects of either approach were most commonly used. Findings show that there are fundamentally different ways in which crossovers between the approaches have been found and designed into frameworks, highlighting different elements of either approach. Some are more fundamentally rooted in SPT literature, whereas others have a more equal division between elements from SPT and MLP/TM, therefore also creating new ontologies. Different crossovers can therefore be used to answer different types of research questions (e.g. why certain practices are likely to be reproduced, or which practices influence policy making) and focus on different units of analysis (e.g. set of contextual practices or system (of practices)). With this exposition researchers will be better equipped to use and create crossover frameworks to study transitions, focusing on everyday practices, as is asked for in literature (e.g. Garduño García and Gaziulusoy, 2021; Köhler et al., 2019; Vähäkari et al., 2020).

The article is built up as follows. Section two offers a brief overview of the two approaches. Section three sets out the methodology and elaborates on how data was analysed for this systematic literature review, followed by the results in section four in which combining the approaches is discussed on the level of ontology and theory. Section five sets out the different crossover frameworks that have resulted from the combination and discusses the value and limitations of them. This is followed by a discussion and conclusion with a research agenda in section six.

2. The two approaches

This section introduces the Multi-Level Perspective (MLP), Transition Management (TM), and Social Practice Theory (SPT), including different forms in which these approaches have been used. Both approaches are considered middle-range 'theories' that give dominance to neither agency nor structure (Geels, 2011; Hargreaves et al., 2013).

2.1. Sustainability Transitions Research

2.1.1. Core notions on MLP and TM

Since this research showed only TM and MLP have explicitly been used in combination with SPT, these are the focus in this article. TM is based on complexity science and governance studies and focuses on policies that can shape transitions through strategic, tactical, operational, and reflexive activities (Loorbach, 2010). Its primary focus is on prescription and less on description, involving processes of learning, searching, and experimenting. An often used method is backcasting, identifying short-term goals based upon long-term goals and reflections of future developments with the use of scenario building (Loorbach et al., 2016; Quist, 2007). TM is a pragmatic framework without a clear ontology or predefined units of analysis (Köhler et al., 2019); the focus can for instance be on activities, experiments, learnings, or (sub-)systems. TM uses several concepts to explain, and help guide transitions, for example, transition arenas, "a small network of frontrunners with different backgrounds, within which various perceptions of a specific persistent problem and possible directions for solutions can be deliberately confronted with each other and subsequently integrated" (Loorbach, 2010, p. 173). These frontrunners, protected by regime actors and structures, help guide the transition on a strategic level. It requires actors with a high level of abstraction. The vision created from this transition arena is then translated to transition agendas on a tactical level, where structural barriers on the regime level form the focus. Overcoming these is explored through developing transition scenarios. On an operational level, experiments and other actions are used to broaden, deepen, and scale up planned initiatives (Van den Bosch and Rotmans, 2008). All levels are continuously monitored reflexively (Van Mierlo and Beers, 2020), both regarding the transition as its management (Loorbach, 2010).

More often used, also in relation with SPT, is the MLP. The MLP consists of three levels, as is shown in Fig. 1 (Geels, 2002):

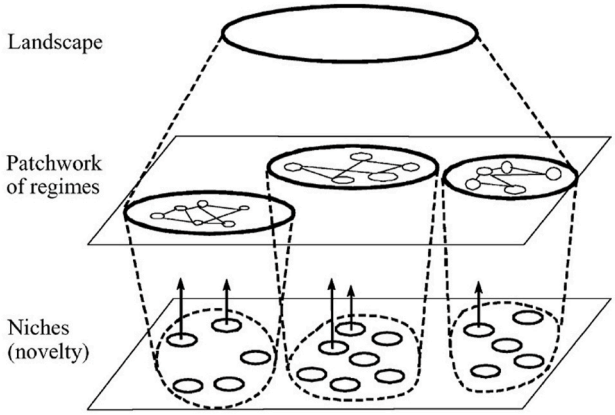

Fig. 1. Multi-level perspective (from Geels, 2002).

- The micro level, which is formed by protected niches which create radical innovations (Geels, 2002, 2020).
- The meso level or socio-technical regime, which is "the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems - all of them embedded in institutions and infrastructures" (Rip and Kemp, 1998, p. 338).
- The macro level, which is formed by the socio-technical landscape, a force beyond the direct influence of niche and regime actors, which influences both niches and regime (e.g. macro-economics, deeply embedded cultural patterns, macro-political developments) (Geels, 2002, 2020).

According to Geels (2011), based on these definitions the perspective is conceptualised as sets of rules. Depending on which level of the MLP they are part of, these rules can be highly flexible (niche) or consistent for long periods of time (landscape). However, in empirical studies the unit of analysis often tends to differ, ranging from actors to complete systems or even transitions. The MLP is often characterised as a flexible ontology based on evolution theory and interpretivism that allows growth through interaction with other, but not all ontological traditions (Geels, 2010).

MLP and TM can be interpreted as intertwined research traditions (Paredis, 2013). Concepts of the MLP (e.g. niche or regime) are therefore also often used in TM research (Loorbach, 2010), though its unclear ontology does not require usage of these concepts. Whereas theoretical papers sometimes make quite clear distinctions between the two perspectives (e.g. Köhler et al., 2019), in empirical studies notions from both traditions are often implicitly used together or TM is interpreted as a practical implementation of MLP (e.g. Lode, Te Boveldt, Macharis and Coosemans, 2021).

2.1.2. Ontological inconsistencies

In this part the ontological inconsistencies of MLP are discussed. TM is left out from this discussion as it does not have a clear ontology to start with (Köhler et al., 2019). The definition of what constitutes a regime has changed over time. Whereas Rip and Kemp (1998) speak of a set of rules, later the concept often also includes specific actors (e.g. Köhler et al., 2019), or within empirical studies it is often used as 'system', contrasting the theoretical papers that remain closer to the original definitions (Geels, 2011). This ambiguity of the concept regime therefore sometimes has the result that the different levels start to represent 'real world' levels (e.g. administrative or geographical levels including their actors, artefacts, and institutions) instead of levels of structuration, something Grin et al. (2011) explicitly warn against for sake of ontological consistency and the ability to translate theory from one context to the next. This paper sticks to the interpretation of levels as rules,

because it is closer to the theoretical foundations of the MLP and makes crossover more likely.

Also, the way in which the levels relate to each other has changed over time. Rip and Kemp (1998) distinguish between the levels by different levels of structuration. The regime is the rule set that sets the norm. This is influenced by a more stable set of rules, the landscape, and a quickly changing set of rules, the niche. Later articles on MLP (e.g. Geels and Schot, 2007; Laakso et al., 2021) explicitly mention the nested hierarchies of the levels, assuming that the quickly changing rules of a niche are embedded in the stable rules of the regime and the landscape. However, Geels (2011) later mentioned that the concept of nested hierarchies might better be abandoned, as niches can emerge without direct influence from the regime. This notion would make crossovers with SPT more likely, as this hierarchical aspect misaligns with the flat ontology of SPT (Hargreaves et al., 2013; Laakso et al., 2021).

2.1.3. Change in the MLP and TM

The core notion of MLP is that change comes about when 1) niches build up momentum, 2) the landscape pressures the regime, so 3) the destabilised regime is pushed to create windows of opportunity for niche innovations (Schot and Geels, 2008). In both MLP and TM change is also often conceptualised through transition paths (e.g. Geels and Schot, 2007; Hoekstra et al., 2017; Rotmans et al., 2003). Geels and Schot (2007) recognise that there are different transition paths that can emerge (partly) based on the timing of landscape pressure, which are: 1) transformation, 2) substitution, 3) reconfiguration, 4) de-alignment and re-alignment. Further, disruption is sometimes used as a transition path (e.g. Kivimaa et al., 2021), but in the parlance of Geels and Schot (2007) disruptive change is merely a part of any one or a combination of these transition paths. Then, Grin et al. (2011) refer to reproduction, a stable state of the regime that has to be reproduced. Lastly, phase-out can be perceived as a transition path in which no new regime takes over the old (Koretsky and van Lente, 2020).

TM is used to analyse change, but maybe more often as heuristic framework to steer change (Loorbach, 2010). Next to the conceptualisation of transition paths, change in TM is conceptualised as coming about on strategic, tactical, and operational levels that all influence each other. This then results in an X-curve (Hebinck et al., 2022): on the one hand, new regimes emerge through experimentation, which turns to acceleration, emergence, institutionalisation, and stabilisation. On the other hand, old regimes are broken down, from optimalisation, to destabilisation, chaos, breakdown, and phase out. TM is used on systemic scales (Köhler et al., 2019), but maybe more often on local scales, for instance regarding transformation of cities or local regions (e.g. Heurkens and Dąbrowski, 2020; Loorbach et al., 2016).

2.1.4. Critiques on the MLP and TM

Over time, MLP has had several critiques. Some of the critiques can be solved by development of MLP itself, while other critiques simply require or are better solved with a different approach (Geels, 2010) or in combination with another approach, such as SPT. MLP is critiqued on its inability to focus on small scales (Banos et al., 2022; Geels, 2011, 2020) and lack of concepts to explain dynamics on that level (Geels, 2011; Hargreaves et al., 2013; Shove and Walker, 2010; Vasileiadou and Safarzyńska, 2010), such as interaction between humans and technology (Davies and Doyle, 2015; El Bilali, 2020). On a more fundamental level MLP is critiqued as it does not offer a clear ontology, but merely a heuristic framework (El Bilali, 2020; Geels, 2011; Genus and Coles, 2008). Further, the landscape level can be the source of an infinite type of contextual influences, making it a residual analytical category (Geels, 2011; Shove and Walker, 2010). Also, it remains unclear why the landscape creates pressure in the first place (Labanca et al., 2020). Further, despite proposals to focus more on power relations (e.g. Avelino and Wittmayer, 2016; Geels, 2014), some claim that the difficulty stems from the ontological foundations of the MLP, given its focus on levels of structures at the cost of considering how actors relate to these structures (El Bilali, 2020; Svensson and Nikoleris, 2018). These critiques have led to 1) promoting SPT as better alternative (e.g. Shove and Walker, 2010) or 2) for promoting the coexistence of approaches (e.g. Geels, 2011). In line with the latter, some (e.g. Geels, 2011) claim that the approaches have different foci – MLP focuses on recurring patterns and mechanisms that guide transitions (see also: Papachristos, 2018), while SPT has a more descriptive focus, allowing for heterogeneity, fluidity and specifics of every single transition. Although this is how the approaches have mostly been used, one can question if the difference stems from the theory driven assumptions of the approaches or the empirical studies that have mostly been conducted with them (e.g. as exception Hoolohan and Browne (2020) use designing practices). Lastly, 3) apart from the possibilities to use SPT and both approaches next to one another, following this article the theoretical developments of the last decade are followed (e.g. Crivits and Paredis, 2013; Hargreaves et al., 2013): crossovers could also offer an answer to some of these critiques.

TM has had several other critiques. As the ontology of TM remains vague, the concepts (e.g. chaos and destabilisation) are often interpreted differently (Hebinck et al., 2022). Further, the concepts used in TM also explicitly hide others, simplifying the framework at the cost of understanding complex transitions (Voβ and Bornemann, 2011). Also, there is often an implicit normativity involved in TM research (Shove and Walker, 2010), which often benefits some groups more than others (Voβ and Bornemann, 2011). Further, similar to the MLP, TM is critiqued for its lacking concepts on agency and power (Davies and Doyle, 2015). Lastly, TM is often critiqued on not challenging, but stabilising an incumbent, capitalist economy (Nadasdy, 2007; Voβ and Bornemann, 2011). Crossovers with SPT might help overcome forgetting concepts and therefore also make the normativity more explicit, though this largely depends on the researcher and scope setting. Crossovers might not help with challenging the incumbent capitalist economy.

2.2. Social Practice Theory (SPT)

2.2.1. Core notions on SPT

Social practice theory is an approach consisting of several interrelated theoretical bodies of literature that uses practices as units of analysis (Hargreaves et al., 2013; Nicolini, 2012; Schatzki et al., 2001). Within SPT, practices take centre stage to the extent that people (and sometimes things) are merely perceived as carriers of the practice, but are not the units of analysis themselves (Reckwitz, 2002; Shove, 2010; Watson, 2012). The approach is often applied to observe and understand the balance between change and stability, i.e. why practices change or why they keep being reproduced. These notions of stability offer researchers the profound challenges that need to be overcome when trying to change practices (Hargreaves et al., 2013), such as the use of innovative technologies. As such, SPT is often applied to big societal problems, such as climate change, obesity, and inequality, while taking into account contextual scales (Labanca et al., 2020; Shove et al., 2012).

Schatzki (2002) distinguishes two types of practices: practices-as-performances and practices-as-entities. The first refers to the enactment in specific times and places and is often unique (Warde, 2005), whereas the second refers to the emergent outcome of these performances in the form of what is generally understood as the idealised type of the practice. Practices-as-entity come to exist due to the constant reproduction of practices-as-performance (Watson, 2012) and in that reproduction concepts of power get interwoven (Shove and Walker, 2010) that make practices self-reinforce (Seyfang and Gilbert-Squires, 2019). This reproduction is itself enforced by the practices linked to a practice, that together form a complex (Shove et al., 2012). Complexes can be formed by overlapping elements within a practice or the fact that practices are performed in sequence (Huttunen et al., 2021) or in any other way depend on each other (Shove et al., 2012). Sometimes the bond between practices is more loosely knit, but still existing, for instance when practices influence each other slightly because they are performed in the same space and for this the term

'bundle' is used (Shove et al., 2012). Note that the terms 'bundles' and 'complexes' are sometimes used differently or interchangeable (e.g. Cherunya et al., 2020; Spaargaren et al., 2016), but this is how the terms are used in this paper.

Many SPT scholars agree that all activity is perceived as practices that form bundles and complexes; there is no context outside practices (Huttunen et al., 2021) or hierarchy between practices (Hargreaves et al., 2013; McMeekin and Southerton, 2012). This is why it is called a 'flat' or relational ontology (Geels, 2010; Huttunen et al., 2021; Seyfang and Gilbert-Squires, 2019; Spaargaren et al., 2016). Some SPT scholars take a less flat take on practices, claiming that practices have different levels of structuration (e.g. Warde, 2005). Further, Røpke (2009) argues for a pragmatic approach that includes broader contexts, e.g. labour division, gender relations, and unequal accessibility to resources, as these contexts shape practices as well as the other way around.

2.2.2. Ontological inconsistencies

As already mentioned, there is not merely one Social Practice Theory. To illustrate, some scholars focus on elements that make up practices (e.g. Shove and Pantzar, 2005), whereas others focus on the connection between these elements (e.g. Warde, 2005), or the connection between practices and socio-technical systems (e.g. Spaargaren and Van Vliet, 2000). In empirical studies, especially in the crossover frameworks found in this study, an often recurring form seems to be the version of Shove and Pantzar (2005). As this is the only found interpretation of SPT in crossover frameworks, this is the only interpretation upon which is elaborated here. Shove and Pantzar (2005) made a simplification of the elements found by Reckwitz (2002), that breaks down practices into the elements meanings, materials, and competences (Fig. 2). They state that these elements have no use on their own; only linked together do they produce something, a practice. In the development of a practice, some elements might exist on their own, thus forming a proto-practice, an innovation-in-waiting. Although it is helpful to organize data on social change with only three elements, this is at the expense of potentially simplifying what practices are about (Shove et al., 2012; Spaargaren et al., 2016).

2.2.3. Change in SPT

Watson (2012) distinguishes three ways in which practices can be steered towards change. First, the elements that constitute a practice can change. Second, the practices linked to a single practice can change. Lastly, the carriers of the practice can change. Additionally, Shove et al. (2012) mention the relevance of networks between carriers of practices that can help to change practices and Spurling and McMeekin (2014) mention substituting practices themselves, e.g. riding a bike instead of driving a car. Similarly, these first four ways of stimulating change can also function as stabilising factors that help reproduce practices similarly. In academic practice, these four ways to stimulate change have mostly been used contextually or for single practices, but they can be applied on a transitional scale too (Spaargaren et al., 2016). Change on a transitional scale is then conceptualised as change in one or more of these four ways that encompass a complex of practices on the scale of a large system, a system-of-practices (Klitkou et al., 2022; Watson, 2012).

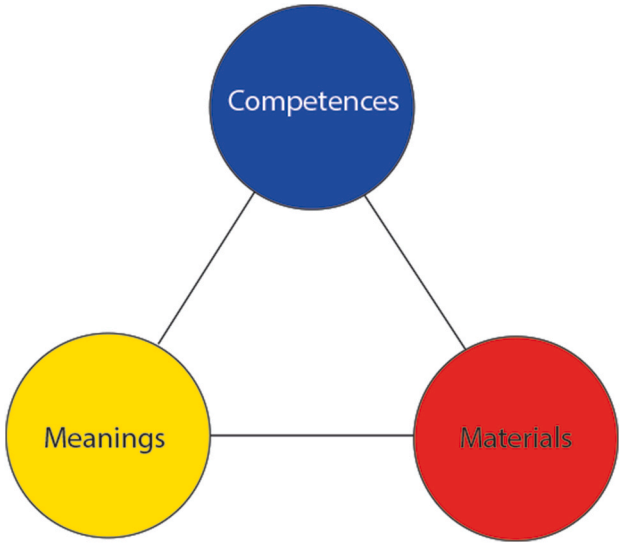

Fig. 2. Elements that constitute a practice (based on Shove and Pantzar, 2005).

2.2.4. Critiques on SPT

SPT has had some critiques as theoretical approach to study transitions. Some scholars (e.g. Geels, 2011) claim that the focus of SPT is not so useful to study transitions; –whereas STR focuses on recurring patterns and mechanisms that guide transitions (see also: Papachristos, 2018), SPT has a more contextual/descriptive focus, allowing for heterogeneity, fluidity and specifics of every single transition. However, contrastingly, several scholars (e.g. Klitkou et al., 2022; Spaargaren et al., 2016) acknowledge this, but also state that this is caused by how SPT for a long time has been used most often empirically: on a relatively small scale, making it difficult to generalize findings beyond their contexts. Some seminal works have shown for decades that SPT can focus on large systems (most famous the work of Shove (e.g. 2003)). Further, as bundles of practices can form a whole system, the unit of analysis is not necessarily small (Klitkou et al., 2022; Schatzki, 2016; Spaargaren et al., 2016). To further deal with this critique of limited explanatory value, in recent years several larger scale studies have been conducted (e.g. Koretsky and van Lente, 2020; Shove and Trentmann, 2018; Taillandier et al., 2023) and theoretical guidance on conducting such research has emerged (e.g. Schatzki, 2016). Geels' (2011) critique therefore seems to have become outdated.

2.3. Reasons for crossovers

There are various reasons why both MLP and SPT have been used together. Originally, the combination was sought because MLP alone was deemed capable of offering insights about production, but not about consumption, a gap filled by SPT (Crivits and Paredis, 2013; e.g. Grin et al., 2011; Little et al., 2019). Up to this day this seems the dominant reason to combine both approaches (Mathai et al., 2021; Morrissey et al., 2014).

However, more recently it is argued that the interpretation of using MLP for production and SPT for consumption is an oversimplification of the uses of these approaches (Heiskanen et al., 2024; Keller et al., 2022b; Laakso et al., 2021). There are other reasons why the combination is considered fruitful; MLP/TM offer many concepts on producing change, but it offers very little on the dynamics of normality (i.e. why transitions do not happen), for which SPT can be used (Davies and Doyle, 2015; Hargreaves et al., 2013). SPT can also be used to describe other elements than merely consumption, such as production or the creation of rules and norms, but it so far is seldom applied as such. More recently a few examples (e.g. Jakku et al., 2019; Seyfang and Gilbert-Squires, 2019; Svennevik et al., 2021) emerged that have used the combination, using SPT concepts (also) for production and setting rules and norms.

Further, scholars stress that the combination provides insights that go beyond individual or structuralistic models (El Bilali, 2020), that it offers a more thorough understanding of the systemic problems and sustainability innovation processes (Hargreaves et al., 2013; Seyfang and Gilbert-Squires, 2019), that SPT can offer new insights on agency and power for MLP/TM (Davies and Doyle, 2015; Grin et al., 2011), and that it offers clarification about the points that are likely to offer resistance when changing practices or regimes (Boamah and Rothfuβ, 2018; Hargreaves et al., 2013; Seyfang and Gilbert-Squires, 2019).

Combining the two approaches has resulted in many new insights (e.g. on the aspects of a system that are most likely to offer resistance when

transitioning (Hargreaves et al., 2013) or how to investigate starting system changes (O'Neill et al., 2019)) and scholars advise exploring new ways in which these approaches can be combined (Huttunen et al., 2021; Nogueira et al., 2021). However, there are some limitations when using just these approaches. Öztekin and Gaziulusoy (2020) note the limited explanatory value of the MLP and SPT during interventions and suggest the use of a design approach to fill this gap. We see this potential, as earlier research from both STR and MLP already combined with design approaches (e.g. Scott et al., 2012). Geels et al. (2015) further note that the approaches offer useful insights for system change, but no concepts to claim that this will actually benefit sustainability.

3. Methods

To elaborate on how SPT and STR have been used together and what potentials lie in the combination, a systematic literature review has been conducted.

A literature search has been conducted on Scopus on 12-11-2021 using the terms "Sustainability AND transition AND practice AND theory" and "Sustainable AND transition AND practice AND theory" in abstracts, titles, and keywords of articles, conference papers, and articles in books. Scopus is considered a decent stand-alone database (Bergman, 2012). The result of the search was 787 papers, 548 after removing duplicates. These papers have been appraised by their title, keywords, and abstracts to find the articles that use both SPT and STR. This resulted in 70 papers. These 70 articles have been read in full, and appraised again on whether they used both SPT and STR. This resulted in a body of literature comprising 50 articles. A second search on Web of Science was conducted on 23-3-2023 using the same criteria resulting in 553 extra articles, of which 362 duplicates. After appraising them similarly, 4 additional articles have been found. A third search was conducted on 24-5-2024 which led to 620 new articles, of which 178 duplicates. 7 additional articles have been found in this search. Articles that have been dropped often only used one of the approaches, and words but not concepts of the other, e.g. articles that use SPT with a concept of transition that is not directly related to STR, but to changing large bundles of practices, or articles that use STR with mentions of practices, but usually undefined and without using concepts from SPT to talk about these practices.

As the search terms are words that have been used extensively in contexts outside STR and SPT, conducting this search on full texts was not feasible. Consequently, some articles might have been missed. Snowballing has been used to compensate. References in the found body of literature that explicitly mentioned crossovers were included when they did not show up in the search results. Also, in line with Xiao and Watson (2019) two experts were consulted for additional articles. Through snowballing and expert additions, 15 articles have been added to this amount, resulting in a final amount of 76 articles, as can be found in Appendix A. The combination of systematic searches in online databases, snowballing, and expert consultation cannot be complete, as is often mentioned in literature (e.g. Xiao and Watson, 2019), but the combination of methods should drastically improve results (Shaffril et al., 2021). Next to this body of literature, several seminal papers on either STR or SPT have been used to aid in understanding either approach.

The approaches have been analysed according to their ontology and theory, as these shape the crossover frameworks. Ontology is "the match […] between entities with which the theory populates nature and what is 'really there'" (Kuhn, 1970, p. 206). These entities provide focus on what are legitimate problems to be solved by science (Greenhalgh et al., 2005; Kuhn, 1970). The element of theory further elaborates on how these entities and the relationships between them and the world are used to explain natural phenomena (Creswell, 2003; Greenhalgh et al., 2005; Kuhn, 1970). For MLP/TM and SPT specifically this means comparing and contrasting how change comes about. 'Transition paths' is the common term for this in the MLP (Geels and Schot, 2007), which is also used in TM (Loorbach, 2010), and SPT focuses on substituting practices, changing elements, re-locking practices in their complex, and changing the practice performers, or their networks. First, the meta-information was coded, focusing on the systems for which both approaches were used to study and the moment of publishing. Then, deductively the found body of literature was coded regarding ontology and theory. Then, within this subset inductively emerging themes were coded. This was needed to understand under which conditions (e.g. definitions or research context) crossovers can be made. The result is an overview of the discussion on crossovers, ontologically in 4.2 and theoretically in 4.3.

After this first analysis, the body of literature has been scanned on different crossovers that have been made specifically. First, it was coded if articles used crossover frameworks, and these were then grouped together based on similarities. This resulted in six groups of crossover frameworks. As this research primary interest is how these approaches are used together, it includes conceptual, methodological, and heuristic frameworks. These frameworks have then been compared on their strengths and limitations, in part by focusing on the added relevance of the crossovers, the different interpretations of the approaches they use and the different focal points they have. This has resulted in an analysis on the following aspects: the units of analysis, their uses for either complex or homogeneous systems, and the elements of both approaches use to explain transitions, as well as the elements they cannot use anymore due to the specific crossovers. Crossover frameworks have been grouped and visualised based on general similarities, as is common in qualitative research (Creswell, 2003). Visualisations have been created by the authors in absence of existing visualisations, and to generalize system specific elements. Lastly, it was found that most groups of crossover frameworks have been used by a multitude of sources, but there is also one that has been used in only a single article. As the aim of this research is to find potential ways in which crossovers can be created, all have been incorporated. Disregarding a crossover framework for having a single source, would defeat that purpose and weaken our understanding of crossover creation.

4. Results

In this section the paradigm of the combination of both approaches is discussed. First, in 4.1 the meta-information of the found body of literature is discussed. The rest of this section is devoted to explaining different elements of the ontology in 4.2 and theory in 4.3.

4.1. Meta-information

SPT and STR are mentioned together in papers from 2008 onwards. Over time a slight, irregular increase of papers that use both approaches is visible. At first, this mainly meant mention or discussion of both approaches, where later – slowly starting in 2011 – also frameworks with crossovers were applied, as is shown in Fig. 3. Still most articles that mention both approaches do not make explicit crossovers. Relatively often STR is used for purpose of context, where SPT is used as primary approach. Also, quite often one of the approaches is merely mentioned as suggestions for further research, which illustrates that both approaches have mostly been developed in mutual exclusion.

Of these articles 30 were purely theoretical and 44 had at least some empirical elements. Most theoretical papers did not focus on specific systems, but five did. The relative large amount of theoretical papers indicates a perceived theoretical gap that researchers still find difficult to meet with empirical studies; it still requires theoretical understanding of what it would entail to combine the approaches, before they can be used for empirical research on a larger scale, as has for instance been asked by Hargreaves et al. (2013). Some of the empirical papers covered several systems, and one nearly covered all and is therefore not included in Fig. 4 below. The figure shows the systems in which both approaches have been applied and to which crossovers have been applied.

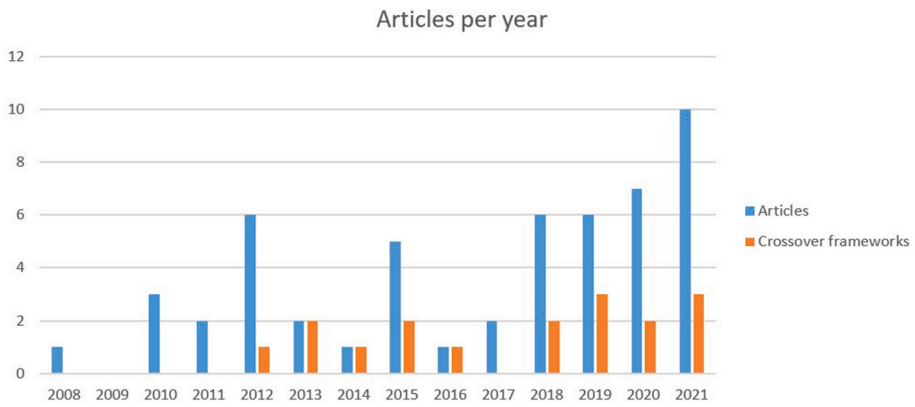

Fig. 3. Articles that use SPT and STR per year.

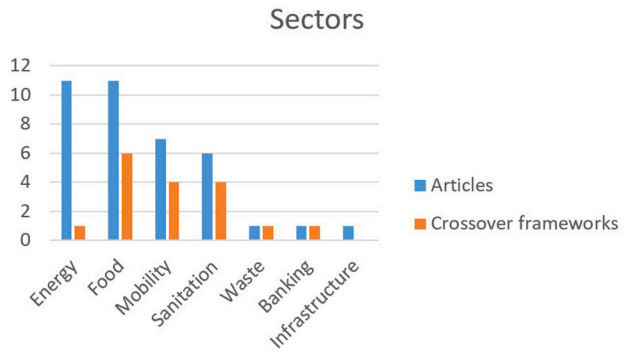

Fig. 4. Systems for which both SPT and STR are used.

Noteworthy, many articles have been published on the energy system using both approaches, but only two apply a crossover framework. Of these articles, most (14/19) focus on consumption or local production (e.g. PV cells) (of which 4 also consider the rest of the system), and regard themes such as lifestyle, energy justice, and bottom-up approaches. Transitions research is then used as a context (e.g. Sovacool et al., 2021). Contrastingly, more than half of the articles published on the food system use crossover frameworks. In food systems research, the topic of interest was diverse, focusing on both the consumer side, the producer side, or both. The use of crossover frameworks in specific systems heavily change their usefulness, as it was found that some frameworks for instance add more value in contexts of either more heterogeneous or more homogeneous practices, as will be further discussed in section 5.

Generally, the small number of articles on crossovers, and specifically of empirical studies shows that crossovers are still in the early stages of their developments, and that even though there is a clear sign of increased interest among scholars, most authors do not undertake the challenge of creating crossover frameworks. A reason for this could be that some influential articles have warned against it because of the assumed ontological incompatibility (e.g. Geels, 2010; Schatzki, 2011), which shows the importance of making an exposition under which assumptions this incompatibility is perceived and under which it is not.

4.2. Ontological comparison between SPT and MLP

The most common notion scholars make when writing about the combination of MLP and SPT is the ontological incompatibility (e.g. Geels, 2010; Huttunen et al., 2021; Laakso et al., 2021; Schatzki, 2011; Seyfang and Gilbert-Squires, 2019; Svennevik, 2021; Welch and Yates, 2018). On the one hand this is strange; Geels (2011) agrees with the critiques on the MLP that claim that it does not have a clear ontological background, and that it should more be perceived as a heuristic framework, rather than a theory, in line with interpretive traditions, but not positivist traditions of doing research. As heuristic framework, it offers researchers guidance on which questions to ask, but since the unit of analysis and the ontological foundations often remain highly ambiguous, researchers can use the framework as they consider appropriate, on different scales, privileging the worldview of the analyst (Genus and Coles, 2008). Nevertheless, the MLP does have ontological origins and assumptions (Geels, 2010) that some authors see conflicting with SPT. That is, where the MLP on the one hand takes on a nested, and therefore hierarchical/'vertical' ontology, the ontology of SPT is explicitly flat (Huttunen et al., 2021; Spaargaren et al., 2016). A flat ontology here means that reality is not perceived as existing within multiple layers, but as a series of practices that influence each other. Apart from this dimension, an obvious difference is the scale on which SPT and MLP focus. Where SPT focuses on practices that are performed in their own contexts (that can be part of larger structures/phenomena), MLP focuses on systems or regimes (Watson, 2012). Partly because of this perceived incompatibility, many scholars (e.g. Geels et al., 2015; Hargreaves et al., 2013) do not plead for integrating the approaches, but they see a useful combination in finding crossovers.

Closer examination offers more nuance to these incompatibilities. Some scholars (e.g. Spaargaren et al., 2016; Watson, 2012) for instance argue that systems are built up from practices, meaning that if a system change occurs, this is visible in its practices, and vice versa, if practices change, something must have changed within the system. In other words: "any socio-technical transition has to be a transition in *practices*" (Watson, 2012, p. 489). This notion has resulted in several new concepts to explicitly bridge the scale distance between SPT and MLP. An example is the concept of 'system of practices', the explicit notion that a system is built up of practices (Kokko and Fischer, 2021; Svennevik, 2021; Watson, 2012). This means that the perceived incompatibility of scale has little to do with the approaches *in* se, but mostly with how scholars have used the theories (Spaargaren et al., 2016). Another emerged concept is 'regime-practice' (contrasting 'niche-practice'), the notion that some practices make up or are influenced by the regime (Crivits and Paredis, 2013; O'Neill et al., 2019; Plummer and Van Poeck, 2020). Used as such, the regime can be studied on a small scale, instead of on a system scale (e.g. Crivits and Paredis, 2013).

Further, the explicit dichotomy of the horizontal and vertical ontologies of SPT and MLP is not always as strict as it is often portrayed. Early MLP literature tended to focus less on the vertical relations of systems, and more on the different types of rules that guide human behaviour (Hargreaves et al., 2013; Rip and Kemp, 1998; Seyfang et al., 2010); niches were not considered as nested within regimes, but merely more loosely structured than regimes (Geels, 2011). Seyfang et al. (2010) therefore plead for researching more complementarities between SPT and early versions of MLP. Apart from this concept of different

levels of structuration in MLP, some scholars note the more vertical interpretation of practices in the work of Shove (2003) and Warde (2005) that is, just as early MLP research, also based on different levels of structuration, based on the work of Giddens (1984). Warde (2005, p. 143) for instance states: "[…] dominant groups exclude others from involvement in activities which they represent as especially worthwhile and where expertise is, hence, socially and personally prestigious." Ontological (in)compatibility largely depends on these exact definitions and interpretations; if on the one hand the regime is defined as a system with actors and infrastructures, this leads to ontological incompatibility (see e.g. Schatzki, 2011), whereas on the other hand the regime is defined primarily as a set of semi-stable rules (Geels, 2011), some authors have found potential for crossovers (e.g. Watson, 2012). When regime is defined as set of rules, these rules can be used to understand how they influence practices. However, when actors and infrastructures are added to the concept of the regime, what constitutes as a practice partly overlaps with what constitutes a regime, e.g. the materials of a practice with infrastructures or the carriers of a practice with actors. This overlap creates an ontological mismatch, as suddenly it differs per aspect how the two approaches relate to each other. It is therefore not merely a terminological mismatch. It could be argued that this inconsistency in compatibility primarily stems from the fact that the MLP functions as a heuristic framework instead of a theory.

Despite these notions to overcome or evade the ontological incompatibilities of the two bodies of literature, some authors state the two approaches are best used apart from each other, as they both have strengths that will generate specific results, which will be diminished by integration (e.g. Geels, 2010; Moore et al., 2018). It is argued that due to the ontological differences, using them independently means that in fact different worlds are perceived that are hard if not impossible to compare.

4.3. Theoretical comparisons

Both SPT and MLP/TM are concerned with stimulating sustainability transitions (Hargreaves et al., 2013). To analyse this, similar terms have popped up in both fields, each with slightly different meanings, caused by the specific theoretical background in which they have been developed. A dominant theme for MLP/TM is the concept of transition paths; phase out, disruption, and reconfiguration are concepts that have been developed in MLP/TM and they have been compared and contrasted in the literature with similar elements in SPT that uses its own vocabulary for this that indicates its different ontological foundations. With this structure, this section goes deeper into the notions of how change is conceptualised in both approaches. In the found articles, MLP was mostly used for technological change, and SPT for consumption or social innovation, as these topics seem to be less developed in MLP (Hargreaves et al., 2013).

4.3.1. Phase-out, destabilisation and disappearing practices

Phase-out of unsustainable technology has increasingly been accepted as a necessary and viable measure to stimulate sustainability (Koretsky and van Lente, 2020). It was found that both within MLP and SPT similar concepts are used that refer to the evolutionary process of emerging and disappearing elements. Within MLP/TM, the concept of phase-out usually relates to the destabilisation of regimes and the role industries play therein (e.g. Cherunya et al., 2020; Koretsky and van Lente, 2020; Rolffs et al., 2015; Welch and Yates, 2018). It might be part of other transition paths, e.g. substitution or obsolescence, or happen on its own (Cherunya et al., 2020; Koretsky and van Lente, 2020). Because of the focus on actors and regimes, the focus of phase-outs in empirical research seems to be less on technology Laakso et al. (2021b)), e.g. Mickwitz et al. (2021) speak about destabilisation of path-dependencies and lock-ins of regimes and Koretsky and van Lente (2020) highlight the importance of the changing practice element of meanings in their work on cloud seeding. The focus on phase-outs stimulates research in 'forgotten' themes in MLP such as multiplicity of regimes and dynamics of everyday life (Huttunen et al., 2021), countering common sources of critique on MLP (Geels, 2011). Note that in theory these themes can be researched anyway, but the focus on phase-out seems to stimulate it. Within SPT, the concept of destabilisation of elements or practices is also a common theme (e.g. Koretsky and van Lente, 2020; Shove et al., 2012). Elements already differ slightly in every performance of a practice (Shove et al., 2012). Further, elements might disappear, become dormant, or become part of other practices (Shove et al., 2012). Conceptually, SPT therefore has additional relevance to MLP/TM, as destabilising regimes do not necessarily lead to destabilised practices (Cherunya et al., 2020). For this, other interventions might be needed, e.g. articulation of system components that can destabilise practices (Laakso et al., 2021b). Further, a phase-out of a technology might be the end of a practice, a niche, or a regime, but SPT shows how elements of such a practice might still live on.

4.3.2. Disruption and breaking practices

Disruption is (part of) a transition path where a high-intensity effect stimulates a long-term change (Kivimaa et al., 2021), such as for example a new technology such as autonomous vehicles that disrupt the (regime of the) mobility system (Laakso et al. (2021b)). Both MLP/TM and SPT make use of this concept of disruption. Within SPT disruption is a recurring theme in multiple dimensions, but the discoursal differences expose the ontological and theoretical differences with MLP/TM. Disruption might relate to disruptive technologies, breaking of links between elements that might weaken the reproduction of practices, practices (or the lack thereof) that disrupt the reproduction of other practices, and practitioners that might cross thresholds to either continue as practitioners or defect (Kivimaa et al., 2021; Shove et al., 2012). For MLP/TM, Geels and Schot (2007) define disruption as a gradually and infrequently occurring high-intensity effect from either the landscape or the niche on the regime, that for instance brings forth a substitution in regime technology. SPT can perceive disruption in multiple dimensions, yet Kivimaa et al. (2021) stress that not all dimensions of disruption necessarily influence each other, e.g. the disruptive technology of electric vehicles (dimension of practice element of materials) does not necessarily largely disrupt transport practices (dimension of practice). However, naturally it is possible for these different dimensions to influence each other, e.g. when consumers actively invest in renewable energy (dimension of practice element of materials), this does change the energy production process (dimension of practice). Aligning disruptive technology with disruptive practices can sometimes be considered a positive thing, as in this last example, but sometimes disruption is actively sought after by explicitly changing one and not the other. For instance, replacing meat with vegan burgers has proven successful because of the explicit similarities between the two products, in terms of cooking, consuming, sensory aspects, and nutritional values (Laakso et al. (2021b)). This way a disruptive technology (practice element of materials) can largely strengthen the reperformance of its practices, be it in a small variation.

4.3.3. Reconfiguration

A more subtle transition path is reconfiguration, that focuses on changing institutions, actors, practices, and constituent elements of practices in such a way that the new combination also entails elements of the old combination (Geels et al., 2015). Mazur et al. (2015) for instance illustrate this by elaborating on the development of new practices in the German car industry where actors purposefully remain stable. Change in reconfiguration is perceived as a processual phenomenon, involving constant adaptation and reflections (Keller et al., 2022). The agenda for the use of the concept of reconfiguration is different in both bodies of literature. In SPT it is used to describe the inner dynamics within and between practices, taking the impact of practices beyond the context of their performances. Change is considered to happen when one element of practice is changed, stimulating change in other elements, or

when connected practices change each other (Shove and Walker, 2010). An example of this is the building of trust (practice element of meaning) that grew stronger as tenants of a Brazilian ecovillage started participating in community chores, which in turn led to car-sharing (Laakso et al., 2021b). In the MLP the concept of reconfiguration is often used to blur the hierarchies of the nested levels (niche, regime, and landscape) (Laakso et al., 2021). Laakso et al. (2021a) go further and state that reconfiguration should not just blur the hierarchies of a nested system, but also blur the distinction between different regimes, where certain elements may circulate between different systems, because practices are influenced by so many different factors (e.g. producing, promoting, adopting, or aligning technologies; enlisting users; protecting novel technologies; adding practice elements to the repertoire of practice complexes).

5. Frameworks with crossovers

In the found body of literature, 21 articles developed or made use of crossover frameworks. Crossovers have been made in several ways, here divided into six groups. Apart from these frameworks STR has also been used as a context for SPT. Such research focuses on social practices, but does this in the context of socio-technical transitions (e.g. Cherunya et al., 2020; Heiskanen et al., 2024) or specific socio-technical designs (e.g. Ulsrud et al., 2018). It therefore does not use MLP labels such as niche and regime on practices, as many crossover frameworks below do, but focuses on concepts such as the introduction of innovations, the complexity of change in transitions and the many aspects that need to be altered for transitions to take place, or the institutions and (infra) structures in which practices are embedded. Such a way to deal with both approaches functions well, but has very little to offer in terms of crossovers. Similarly studies that use both approaches next to each other (e.g. Banos et al., 2022; Laakso et al., 2021) offer insights from both approaches, but it remains implicit how these insights ontologically relate.

The six groups of crossover frameworks summarised in Table 1 must all deal with the perceived ontological incompatibility of the two approaches. Table 1 shows the different concepts of the approaches that interplay with one another, the different focal points they have, and in which context they will prove most useful (i.e. contextual scale or system scale and the number of regimes and practices that can be studied fruitfully with the framework). All frameworks can be used on both scales, but sometimes a systemic scale requires combining many practices, which can heavily increase the complexity of the study. These frameworks have been compared on their strengths and limitations, by focusing on the added relevance of the crossovers, as is shown in Table 2. This has resulted in an analysis on aspects as the units of analysis, their uses for either complex or homogeneous systems, and the elements of both approaches use to explain transitions, as well as the elements they cannot use anymore due to the specific crossovers. Lastly, the crossover frameworks are evaluated on their use of change, as described in section 4.

So far, most of the interpretation of what can be achieved with crossovers between the approaches stem from just a few sources, to which most articles in this review refer. These are Watson (2012), Crivits and Paredis (2013), and Hargreaves et al. (2013), the last of which base their crossover again on the work of Elizabeth Shove (2003). The popularity of these articles might stem from the relative simplicity of crossover frameworks (containing few components), while having a broad application (for many contexts). This makes them easy to understand and transferable to different contexts. Sovacool and Hess (2017) plead for creating crossovers with care. They state researchers need more understanding of the epistemological underpinnings of the approaches, to get more nuanced ways of comparing, contrasting, and combining them. This is important, as theoretical frameworks not only

Table 1
Six groups of crossover frameworks.

No	Crossover framework	Key-authors	Concepts in interplay	Key concepts	Base approach	Number of practices and regimes	Scale (context/ system)
	Crossover frameworks for specific moments in the transition						
1	Multi-level Practices	Bachus and Vanswijgenhoven (2018); Crivits and Paredis (2013); Keller et al. (2022); Langendahl et al. (2016); Little et al. (2019); Svennevik (2021); Svennevik et al. (2020); Watson (2012); Muylaert and Maréchal (2022); Svennevik (2022)	Niche and practice, regime and practice, system and practice complex	Niche-practice vs. regime-practice; complex of practices as a system	SPT	Best used for complexity of practices, with a limited number of regimes	Context to system
2	System of Practices and Shared Elements	Svennevik et al. (2021)	Practice complex and system, shared elements and regime and system	Complex of practices as a system; shared elements throughout the system	SPT	Best used for complexity of practices, with a limited number of regimes	Context and system
3	Spatial Practices	Cherunya et al. (2020); Kokko and Fischer (2021); Van Welie, Cherunya, Truffer, and Murphy (2018)	Practice and space and regime, space and service regime, service regime and system regime	Practice vs. competing regimes, based on space.	SPT	Best used for complexity of practices, with a limited number of regimes	Context to system
4	Practice-Regime intersection	Cass et al. (2018); Hargreaves et al. (2011); Hargreaves et al. (2013); Morrissey et al. (2014); Seyfang and Gilbert-Squires (2019); Gazull et al. (2019)	Practices and regimes,	Practices that influence regimes; regimes that influence practices	SPT & STR	Best used for systems with several (but not many) practices and regimes	Context and system
	Crossover frameworks with time element						
5	System Fractures	O'Neill et al. (2019); Rauschmayer et al. (2015)	Niche and practice, regime and practice, practice elements and reconfiguration	Niche-practice vs. regime practice; Reconfiguration of practice elements in niche- and regime-practices	SPT & STR	Best used for one or few practices and single regime	Context and system
6	Practices in Backcasting	Camilleri et al. (2022); Davies and Doyle (2015)	Practice elements and regime, practice elements and reconfiguration	Regime-practice vs. backcasting; backcasting vs. reconfiguration	SPT & STR	Best used for single practice with one or several (but not many) regimes	Context and system

Table 2
Strengths and limitations of the crossover frameworks.

		Strengths	Limitations
1	Multi-level Practices	Insight in the stability of the rules that guide a practice; insight on niche-regime interaction on a contextual scale; insight in change as conceptualised in SPT.	Limited input from STR; limited grip on blurred distinction between levels of MLP; limited insights in influence of multiple regimes; no element of time that would give insight in the transitioning; mostly useful for reconfiguration and less for other transition paths.
2	System of Practices and Shared Elements	Minimised gap between units of analysis of MLP and SPT; insight in system coherencies.	Limited input from STR; limited grip on blurred distinction between levels of MLP; limited insights in influence of multiple regimes; no element of time that would give insight in the transitioning; mostly useful for reconfiguration and less for other transition paths.
3	Spatial Practices	Insight in complex, heterogeneous contexts; insight in differences and similarities of different service regimes; insight the influence of space on regimes; insight in regime plurality; insight in blurred distinction of niches and regimes.	Limited insight from dynamics between MLP levels; no element of time that would give insight in the transitioning; mostly useful reconfiguration and less for other transition paths.
4	Practice-Regime intersection	Insight from both SPT and STR; stimulation to research new points of interest.	Limited usefulness in complex systems; limited understanding of practices that inform niches and landscapes and vice versa; no element of time that would give insight in the transitioning; limited ability to describe any transition path.
5	System Fractures	Insight in system change early on; insight in the transitioning; insight in all kinds of transition paths.	Limited insights in influence of multiple regimes; limited insights from practice bundles and complexes; limited use of landscape concept.
6	Practices in Backcasting	Insight in strategizing of futures for governance and policies; insight in regime plurality.	Limited input from STR; limited insights from practice bundles and complexes; limited insight in how change can come about; mostly useful reconfiguration and less for other transition paths.

open our minds, but also close them (Sovacool and Hess, 2017) and stimulate different ethical stances when it comes down to intervening (Jørgensen, 2012). Table 1 shows these crossover frameworks, the authors that use these and the concepts that are in interplay with each other in these frameworks. Many groups have several similar ways in which the crossover frameworks have been created. Group differentiation has taken place when crossover frameworks connect different types of concepts between the two approaches. The first four groups discuss crossover frameworks for specific moments in time, whereas the last two describe crossover frameworks that to a certain extent incorporate an element of process. The first three crossover frameworks have a clear basis in SPT and mainly add elements of MLP to create crossover frameworks, whereas the last three crossover frameworks borrow more evenly from both approaches. All these crossover frameworks can be regarded analytical frameworks, with the exception of crossover framework five, which is more a heuristic framework, and crossover framework six, which is more a methodological framework. The frameworks have different cases in which they function optimally, e.g. being able to capture either few or many practices and regimes, as is explicated in the table. For empirical researchers this is a vital distinction to work pragmatically. As part of the advantages and limitations, Table 2 offers an overview of the transition paths that can be researched with the crossover frameworks. Reconfiguration is the dominant transition path that can be researched with these crossover frameworks. Lastly, the crossover frameworks have different interpretations of the relation between the researched context and the system, i.e. either the system is built up from contexts, or the system is analysed parallel to the contextual influences thereof.

5.1. Multi-level practices

This framework group, as visualised in Fig. 5, perceives the system as a set of interlinked practices. It offers insights in the interaction between niche-practices and regime-practices, whilst staying true to the dominant horizontal ontology of SPT. The distinction between niches and regime here offers insight in the stability of the rules that guide a practice, i.e. niches have fast changing rules, whereas regimes are more stable. This is the most widely used group for crossovers and encompasses several variations. Some (e.g. Langendahl et al., 2016; Muylaert and Maréchal, 2022) for instance add the concept of landscape practices or practice elements, e.g. practices that lead to peak oil that will then influence other practices, such as cycling. Watson (2012) uses this framework with the elements of Shove and Pantzar (2005) (meanings, materials, and competences) as basis of a practice, allowing to observe overlap in these as practices form bundles. Crivits and Paredis (2013) on the other hand divide a practice in the elements agency, social-cultural structure, and material-functional structure, allowing for differentiation of (temporary) dominance of agency over structure (niche) or structure over agency (regime) depending on the specific practice in a bundle. Bachus and Vanswijgenhoven (2018) also use this interpretation of a practice and, contrasting Langendahl et al. (2016), perceive the landscape as the set of rules that influences the structure elements in both niche- and regime-practices. This group of frameworks therefore allows for multiple interpretations of what a practice is and can answer different types of research questions, based on this distinction, even though the crossover is still designed similarly. Note here the division of niche-regime-landscape as different sets of system rules (Geels, 2011), instead of different sets of a system (as e.g. Moore et al., 2018), or just very ambiguous (Jørgensen, 2012), as it is often used. A different interpretation of regime is likely to encounter ontological frictions between the two theories. The conceptualisation of niche-regime-landscape as different sets of system rules is somewhat similar to the 'vertical axis' of SPT that was already present in the work of Warde (2005), who mentions different levels of structuration. With this verticality incorporated in a practice, it becomes clear where change is happening in a complex. Further, it can be researched how different levels of stability have an influence on the composition of a complex, of practices, and its elements.

The strength of this framework is the focus on common notions of systemic change in both MLP and SPT. For STR, it focuses on the dynamics of niche-regime interaction (Pekkarinen et al., 2020), which through this framework can be observed very well. This framework group also allows insights in the elements that make up practices, as well as the bundles and complexes of practices around a practice that all influence changing practices (Shove et al., 2012). The framework can give answers on research questions regarding several topics, e.g. contextual interaction of new (i.e. niche-) practices with established (i.e. regime-) practices within a transition, or overlap and differences between elements between regime-practices and niche-practices, which can give a better understanding of reconfiguration.

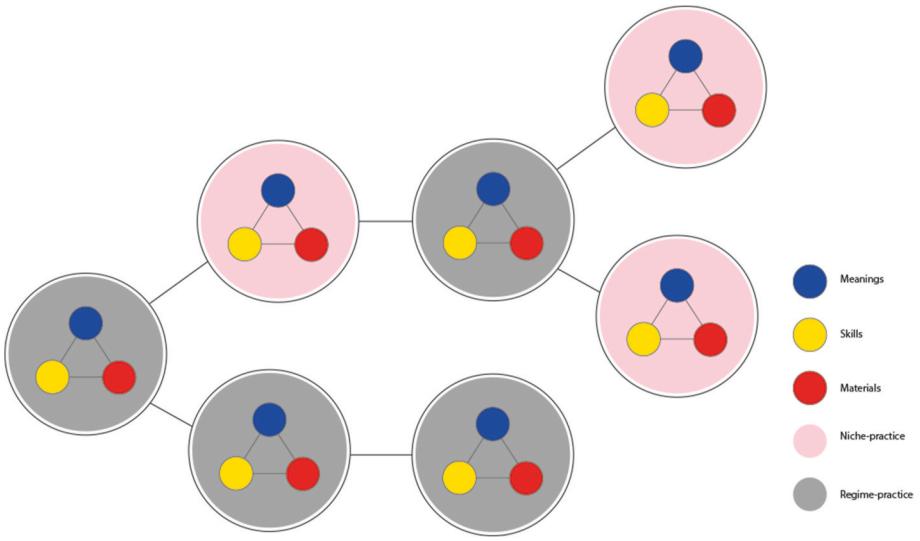

Fig. 5. System of regime- and niche-practices, based on Watson (2012) and Crivits and Paredis (2013).

Apart from these strengths, there are also some limitations, depending on the specific interpretation of what constitutes a practice. First, in general, the framework is primarily focused on practices, and therefore lacks several concepts from MLP that could have additional value. If, more specifically, several regimes influence a practice, this is more difficult to capture when a practice is conceptualised through the elements meanings, materials, and competences. In the description of the structuring elements of Crivits and Paredis (2013), however, this can be captured. For instance, material-functional structure can be further divided into different influencing regimes. How different practices are influenced by different regimes can therefore be an explicit research topic. Other MLP elements, such as transitions paths or the protection of niches are not explicitly mentioned and difficult, if not impossible, to capture. Further, as is often mentioned (e.g. Laakso et al., 2021), the hierarchies between niches and regimes are often more blurred than they are usually portrayed within the MLP. Whereas SPT can capture some of the complexities of different levels of structuration and different regimes influencing practices, this framework makes it more difficult to grasp that. And as such, it runs the risk of underplaying the distinctive contributions in either field, caused by the different units of analysis (Hargreaves et al., 2013). Lastly, the framework group is well equipped to capture change at a specific moment, but it is less equipped to deal with system transformative change, as it does not capture an element of time. Transition paths are therefore difficult to distinguish using this framework. Keller et al. (2022b) come close by focusing on intervention points in a transition such as niche stimulation or regime destabilisation, but also they do not really offer concepts for the process of transitioning. To deal with transformative change anyway, this framework can be used twice, either on different moments or for both new (i.e. niche) and established (i.e. regime) practices, of which the comparison can be used to better understand the transitioning in a single moment in time. Used as such, it is possible to understand reconfiguration, by comparing overlapping practices and practice elements, but other transition paths might be more difficult to capture. Also, research on the moment when practices are breaking/disrupting can be used to understand their changing (Svennevik, 2022).

5.2. System of Practices and Shared Elements

The second framework, as visualised in Fig. 6, is based on the work of Svennevik et al. (2021). The framework uses additional practice elements next to the original elements from Shove and Pantzar (2005). The premise is that several elements are shared by all practices and together form a system (Svennevik et al., 2021). These shared elements can be formed for instance by 1) infrastructures, 2) laws and policies, 3) business models, and 4) social norms, all of which in turn can be divided under the headings of the original elements of Shove and Pantzar (2005), i.e. the first three can be regarded as shared materials, and the

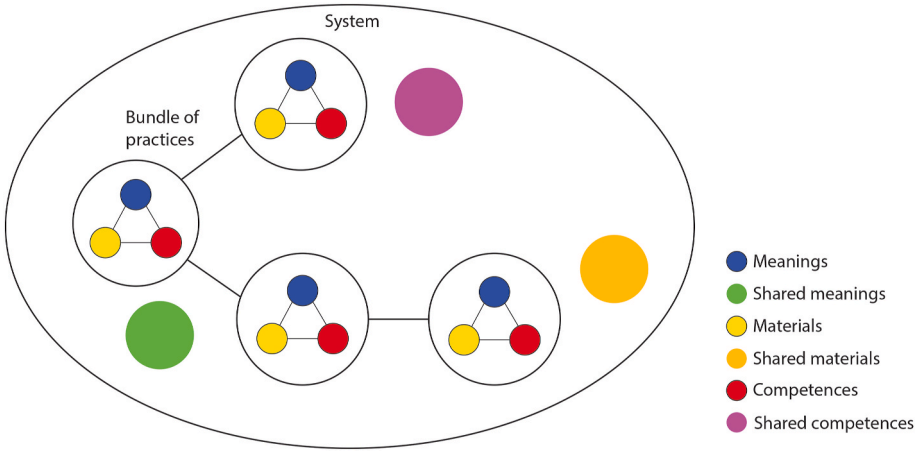

Fig. 6. System of Practices and Shared Elements, based on Svennevik et al. (2021).

fourth as shared meanings (Svennevik et al., 2021). Practices are therefore not divided into niche-, regime-, and landscape-practices as in the previous framework, but a similar concept of the regime is formed by the different rules of these shared elements that together influence practices.

There are some strengths to this framework. First, it minimises the gap between the units of analysis in SPT and STR, which is sometimes (e.g. Cohen and Ilieva, 2015), but less and less (e.g. Spaargaren et al., 2016) perceived as a problem. Further, adding new, shared elements to the complexes of practices highlights the coherency of a system and illustrates how all practices are linked. This crossover framework can answer research questions on topics such as the reasons for reproduction of practices, given a certain explicit regime.

There are several limitations to this framework. First, as these shared elements are conceptualised as elements that are shared between practices (Svennevik, 2021; Svennevik et al., 2021), it becomes impossible to elaborate on different regimes that influence different practices differently, or the influence of niches that do not follow the same rules; practices cannot be contested using this framework. This makes the framework mainly applicable in very coherent systems. Further, as this framework is mainly based on practices, very few heuristics of MLP have any relevance, e.g. niche-regime interaction. Lastly, similar to the previous framework, this framework offers no element of time, making it more useful for describing or explaining a moment in time than describing or explaining the process of transitioning. Also here, comparing new practices (i.e. niche) with established practices (i.e. regime), the system in two moments in time, or on a moment of practice breaking might still provide insights in the transitioning (e.g. see Svennevik et al., 2021), especially perceived through the notion of reconfiguration, as this provides understanding of remaining practices and practice elements. Other transition paths, such as disruption or phase-out, will be difficult to understand with this element of time. Nevertheless, due to these fundamental limitations, one can wonder to what extent this can still be considered a crossover framework or merely a practice framework with a less horizontal ontology.

5.3. Spatial Practices

This framework group (see Fig. 7) is formed by a spatially layered interpretation of reality and useful in settings with a multitude of urban services, such as solid waste, sanitation, or drinking water (Van Welie et al., 2018). When multiple regimes are present to deliver a single service, such as the electric power market in the United States of America, it makes no sense to speak of a coherent system regime, as it is first divided into multiple service regimes. A service regime is a regime formed around a specific set of technologies, user routines, and organizational forms (Van Welie et al., 2018). This distinction between system regime and service regime creates a layering based on space, wherein specific service regimes take hold. As practices compete with each other for space, different service regimes influence the victors of every location (Kokko and Fischer, 2021). In such a space, a bundle of practices together forms a service regime. Several service regimes further form a system regime. This framework does not explicitly distinguish between niches and regimes, but can elaborate on the different types of structuration of the different service regimes (Van Welie et al., 2018). The interpretation of what constitutes practices differs per author, e.g. Van Welie et al. (2018) uses five dimensions that make up practices in a service regime (infrastructure and artefacts, organizational mode, time and space, rationale/meaning, and social interaction), whereas Kokko and Fischer (2021) use the traditional elements of Shove et al. (2012) with the addition of the element activity, that is used to describe the time and space in which activities are performed.

The advantage of this layered approach, is the applicability in complex, heterogeneous contexts, where system regimes are built up by sometimes competing service regimes, for instance as is common in the Global South (see e.g. Kokko and Fischer, 2021; Oates, 2021; Van Welie et al., 2018) or in systems with multiple competing infrastructures and technologies, such as the waste system in The Netherlands that functions differently per municipality; waste is for instance separated by consumers and/or waste companies, and gathered using for instance private containers and/or public underground storage systems. The framework can be used to analyse the differences and similarities of practices in different service regimes, which seems essential to understand change on the level of the system. The added element of activity (Kokko and Fischer, 2021) or the similar dimension of time and space (Van Welie et al., 2018) is useful in understanding practices for which the different system regimes compete. This is one of the few frameworks that explicitly allow for analysing the influence of a multiplicity of regimes on practices. Similarly, the framework has worked itself around the fact that the dichotomy between niches and regime is not as strict as is often portrayed, by naming all sets of rules ‘regimes’, while acknowledging

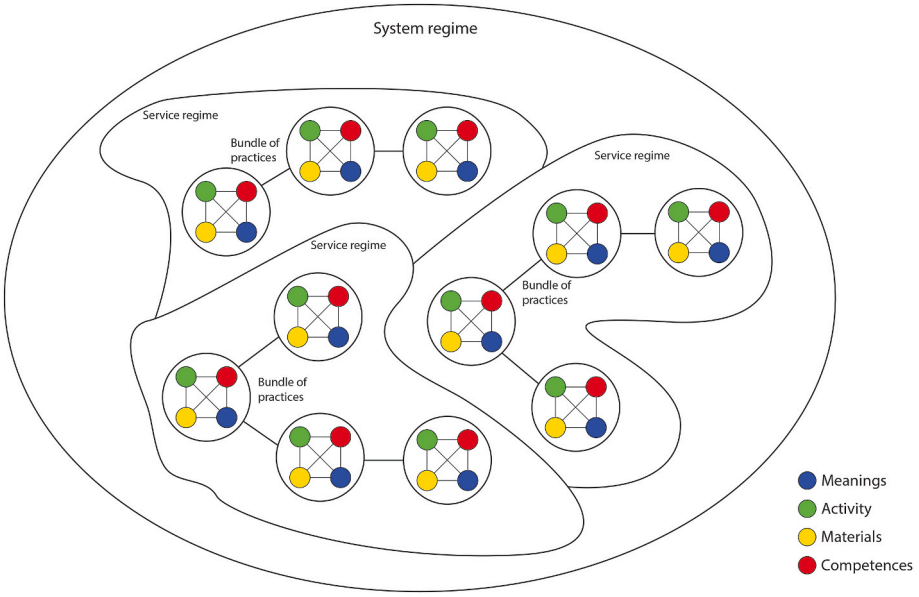

Fig. 7. Spatial practices as service regime, based on Kokko and Fischer (2021).

that every regime is different and can be more or less structuring. This framework could potentially also be useful to describe a system with practices that are not spatially divided, but are divided differently, e.g. culturally.

Although this approach offers useful concepts, there are several limitations of the framework. The nuance of interpreting the service regimes as different sets of rules, makes it possible to describe these contexts. However, it also makes more difficult to theoretically explain them, as for instance it becomes unclear how to translate the notions of niche-regime interaction. Also, again, the framework does not offer any notions on process, but merely elaborates on a stabilised moment in time. Therefore, similar to the previous two frameworks, it can be used to compare new (i.e. niche) and established (i.e. regime) practices, practices in two moments in time, or practices in the moment of breaking. By comparing practices and practice elements, a reconfiguration path can be better understood, but other transition paths might be difficult to capture.

5.4. Practice-regime intersection points

The fourth framework (see Fig. 8) is a constellation of different intersections between practices and regimes, based on the work of Hargreaves et al. (2013) and further used for instance by Seyfang and Gilbert-Squires (2019) and Morrissey et al. (2014). The intersection points show which practices influence which regimes, and vice versa. These intersection points show where the combination might help or hinder the transition (Hargreaves et al., 2013; Morrissey et al., 2014). In addition to the System-of-Practices Framework (e.g. Watson, 2012), regimes here can be defined as rules, but also as (infra)structures that influence practices (e.g. Cass et al., 2018).

Even though it is often mentioned that the three elements that constitute a practice (Shove and Pantzar, 2005) are reconfigured together (Shove et al., 2012), quite often the element of meaning is used to focus on change in practices (e.g. Kokko and Fischer, 2021; Seyfang and Gilbert-Squires, 2019). This framework is more open than that, as it focuses on any practice that manages to influence regimes and vice versa, and therefore can offer understanding on a wider variety of change instigators; compared to the Multi-Level Practices framework, this framework is open to a wider set of heuristics from STR, as it is not built up from SPT with additional elements from STR, but instead offers equal viewpoints from both approaches. Another strength of the focus on the intersection points between practices and regimes, is that it potentially broadens the scope of practices and regimes that are considered relevant, e.g. researchers that normally focus on MLP will be less likely to have a technology bias or a focus on state actors and dominant market actors to the neglect of actors within civil society (Hargreaves et al., 2013). Compared to the frameworks above, the object of study is therefore broader and could answer research questions on topics, such as the practices that form policies, or the critical point of systems in which to intervene with the most impact.

The framework offers a rich understanding of a system, which can naturally be considered a strength, but at the same time this is can also be considered a limitation for systems that are more complex and have many different regimes and practices that all influence each other; it becomes more difficult to grasp which specific practices and/or regimes are the key for systemic change. Further, as the framework only makes use of the relation between regimes and practices, it lacks concepts for explaining the relation between practices and niches and/or the macro landscape. These could easily be added, but the added realism of the framework is at the cost of explaining power on greater complexes of practices. Lastly, similar to previous frameworks, the element of time is not incorporated, making the framework more useful for describing and explaining specific situations in the transition than a transition as a whole. It can be used to describe how new regimes have disruptive influences on practices and vice versa. Also, to some extent it can be used to describe reconfiguration, but the framework offers less grip to do this to the same level of detail as previous frameworks.

5.5. System fractures

The fifth framework (see Fig. 9) elaborates on how change comes about through fractures in practices that offer the possibility for systems to transition. As it explains how this change takes place instead of offering a lens through which one could study this, it can be considered a heuristic framework instead of an analytical framework.

This framework offers some similarities with the Multi-level Practices framework based on the division of niche- and regime-practices, with the addition of several progress stages (O'Neill et al., 2019). As such, the framework is designed to witness fractures in system practices that might later become windows of opportunity for system change. The development of proto-practices, as introduced by Shove et al. (2012) is used to explain initial change that further transforms in the interaction between niche- and regime-practices (Köhler et al., 2019). Interaction might lead to conformation of the niche-practices to the regimes or transformational change that fundamentally change regime-practices. Rauschmayer et al. (2015) designed an alternative with some similarities. Instead of focusing on fractures, they focus on how these can be achieved. They therefore add elements from TM, noting that practices can change when subject to transition arenas, a network of diverse frontrunners that tackle and discuss societal problems and solutions (Loorbach, 2010). This group of frameworks can help explain why some minor changes eventually lead to larger changes.

The strength of the framework is that it can distinguish fractures, small scale changes, which might stimulate system change. As institutional change is often too grand to witness as it happens (Little et al., 2019), this addition of SPT to MLP offers a richer and empirically more practical way to perceive change, based on important contributions of both fields. As this framework offers an element of time, contrary to earlier frameworks, it becomes possible to describe and explain elements of the progress within the transition, regarding all described transition

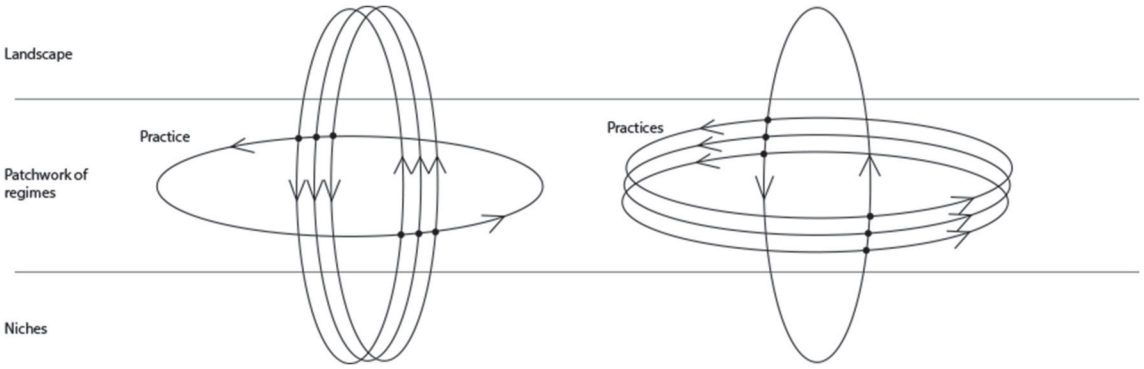

Fig. 8. Intersections between niches and regimes, based on Hargreaves et al. (2013).

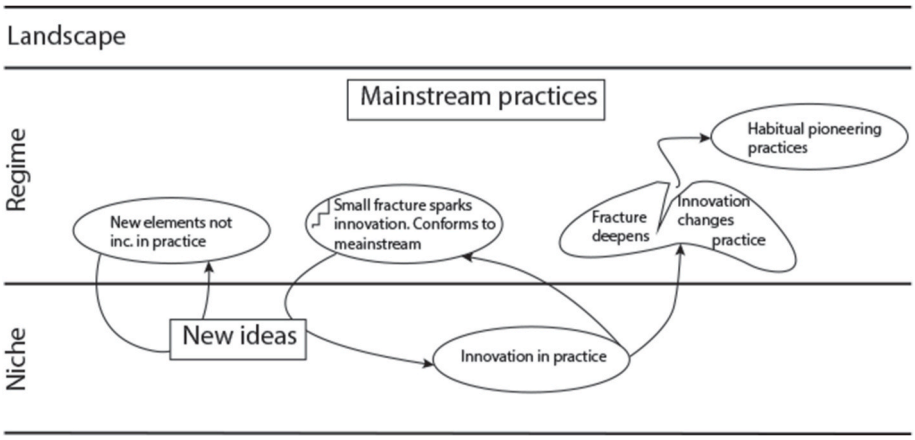

Fig. 9. System fractures, based on O'Neill et al. (2019).

paths phase-out, disruption, and reconfiguration, also depending on how many of the steps are taken into account.

However, similar to the Multi-level Practices framework, the limitation is that it is difficult to differentiate between multiple regimes. But next to that, one major disadvantage of the framework is that much of the horizontal ontology is let go, making it difficult to explain change, or the lack thereof, through the bundles and complexes of practices. However, the use of practices make it difficult to invoke concepts as landscape pressure, as very few - if any - practices can be considered landscape practices (Labanca et al., 2020). As such, the framework misses some essential features of both approaches, a known risk of combining them (Hargreaves et al., 2013).

5.6. *Practices in Backcasting*

This framework group (see Fig. 10) is more a methodological framework than an analytical framework. It interprets practices as a combination of the elements meanings, skills, and materials, similar to Shove et al. (2012), sometimes with the added element of rules, which can be interpreted as laws, regulations, norms, or (infra)structure, and access (Davies and Doyle, 2015). The framework is also used with only the three elements (Camilleri et al., 2022). This element of rules thus links to the concept of regimes (Geels, 2011). Then, the framework is used as envisioning tool to stimulate thinking of practices in far futures and backcasting these to medium-far and near futures (Camilleri et al., 2022; Davies and Doyle, 2015). This method of backcasting is a common tool in Transition Management (Laakso et al. (2021b)). Contrary to the double use of for instance the multi-level practices framework, practices are not compared to other practices, but to ideas of future practices. In this framework, rules are perceived as part of the practices and therefore backcasting makes users of the tool not only envision practices, but also regimes that are needed to support these practices. This allows for a vertical element in practices, as is common in the work of Warde (2005). The framework can help answer research questions on topics, such as the desired futures of different practitioners in the field, and help stimulate making roadmaps.

The strength of this framework is its use for strategizing about futures, and is therefore useful as a practice-based governance tool to help stimulate policies that will make a transitional difference, as they are based on practices (Shove, 2010). Whereas backcasting traditionally is focused on technology or social acceptance thereof, taking practices as unit of analysis allows for a greater social dimension (Camilleri et al., 2022; Davies and Doyle, 2015). The interpretation of rules as a practice element, makes it possible to elaborate on multiple regimes that influence a practice, or should influence it in the future. Used as such, the framework can be used to further elaborate on reconfiguration, and less so on other transition paths.

There are several limitations of the framework. First, the framework is mainly useful for single practices or small bundles of practices, as the transitional consequences of bigger envisioned bundles will be significantly harder to grasp. This also shows that the strength of the horizontal ontology gets lost, as it is not useful anymore to interpret reality as a combination of practice bundles. Further, at the same time, the framework offers very few explanatory concepts from TM to understand if certain envisioned practices are likely achievable. The different stages of practices offer a sense of the needed progress for the envisioned futures, but it remains unclear how these changes can be rolled out (Davies and Doyle, 2015). As there is no distinction between niche-, regime-, and landscape-practices, niche-regime interaction or landscape pressure is of little explanatory value for this framework. Nor does the distinction between strategic, tactical, operational, and reflexive levels, as is common in TM (Loorbach, 2010), offer any further explanatory value. The

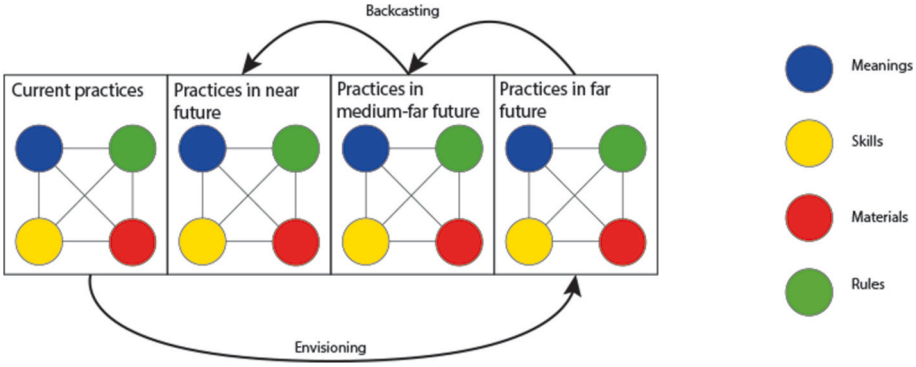

Fig. 10. Practices in Backcasting, based on Davies and Doyle (2015).

framework is therefore very similar to design, visioning, and intervention based approaches in SPT (e.g. Sahakian et al., 2023; Scott et al., 2012).

5.7. On adaptations of the approaches

It can be noted that in these different crossover frameworks, scholars take more freedom with SPT than with the MLP. Additional elements to the model of Shove and Pantzar (2005) are sometimes freely added to practices. For instance shared elements (Svennevik et al., 2021), activity (Kokko and Fischer, 2021), rules (Davies and Doyle, 2015), or time and place, and social interaction (Van Welie et al., 2018). Freedom with MLP is seldom explicitly taken, with exceptions such as explicit use of older MLP literature (Hargreaves et al., 2013), or the distinction between service regime and system regime (Van Welie et al., 2018). Because of the ambiguity of certain concepts, e.g. regimes (Sovacool and Hess, 2017), there is nevertheless further differentiation between the uses of MLP that is often not explicitly mentioned when using these approaches together. As TM has an unclear ontology, freedom with the approach is already common practice, but due to its limited use for crossovers it does not show in these frameworks specifically.

6. Discussion

This research gave an exposition of the loaded debate and assumptions that lie beneath the argumentation that MLP and TM are ontologically incompatible with SPT. Whereas many scholar claim that SPT and MLP cannot be used together due to ontological differences (e.g. Geels, 2010; Laakso et al., 2021; Schatzki, 2011), this research shows that crossovers can in fact be made ontologically, as long as the right definitions are used. The discussion regarding ontological compatibility is delicate, as these definitions, especially in STR, are often used rather loosely (Geels, 2011). With an exposition of the ontological discussion, this research further builds on a growing body on crossovers (e.g. Hargreaves et al., 2013; Keller et al., 2022b; Watson, 2012). The remainder of this discussion tackles three topics. First, it relates findings of this research to earlier overviews of crossover research. Then it discusses to what extent crossover frameworks help overcome critiques on MLP, TM, and SPT. And lastly, this discussion questions the extent to which crossovers fulfil their promises.

6.1. Crossover research

Most articles referring to crossovers make use of one specific crossover (e.g. Crivits and Paredis, 2013). Only one overview was found that connects SPT with MLP, which is the work of Keller et al. (2022b). They focused on overall insights of connecting these approaches. Keller et al. (2022b) state that 1) one can zoom in on practices and zoom out on regimes/systems, 2) practices and regimes influence each other, and the intersection points between them are interesting points for analysis, 3) the regime is not a completely formal, there are degrees of formality, 4) multiple regimes influence a practice and researching both practices and regimes allows insights in how regimes interact, 5) both producers and consumers play important roles in the transition, 6) 'sticky', persistent practices are useful to study as they can hinder transitional change, and 7) some practices can play a role on the landscape level. This research largely confirms these seven insights. However, regarding the seventh, this research showed that although some authors consider practices at a landscape level (e.g. Langendahl et al., 2016), this is also contested by others (e.g. Bachus and Vanswijgenhoven, 2018). Some authors might consider practice elements at the landscape level (Keller et al., 2022b), but regarding the ontological discussion, this would also have to relate to individual practices (Shove et al., 2012) and it remains the question what the concept of landscape can really offer to crossovers. For now it remains ambiguous if these elements are simply shared by more practices (e.g. in the System of Practices and Shared Elements framework) or if they are more structured/'sticky' than others (e.g. in the Multi-Level Practices framework). Further, the result section shows that different crossover frameworks, relating to different insights, have different ontological assumptions. This means that not all insights are necessarily true at the same time. For example, Hargreaves et al. (2013) might refer to regimes as (infra)structures in the Practice-Regime intersection points framework (regarding insight 2), whereas in the Multi-Level Practices framework (regarding insight 6) regimes can only be levels of structuration. Researchers should therefore be reminded of the ontological implications of their crossover frameworks and not take these insights for granted.

6.2. Overcoming critiques of MLP, TM, and SPT

This research shows that so far there is no ultimate way to make crossovers, but different crossovers show different potentials to understand, explain, and forecast transitions, for instance with practices that shape regimes and vice versa, or the interaction of regimes and niches in different locales. In doing so, crossovers can help to overcome several of the critiques on SPT, MLP, and TM. SPT can largely aid in overcoming critiques on MLP and TM, as discussed here though five critiques from section 2. First, the MLP is critiqued to be unusable on small scales and their dynamics (e.g. Banos et al., 2022; Geels, 2020). Several crossover frameworks can help overcome this, such as the Multi-Level Practices and Spatial Practices framework, both of which can also be upscaled so as to be applicable for larger scales. Second, the MLP and TM are critiqued as not being able to deal with power relations, regarding how actors relate to structures (e.g. El Bilali, 2020; Svensson and Nikoleris, 2018). Crossovers do not help with this interpretation of power, though they can help with other interpretations of power, as SPT understands power to occur in practices and as an aspect thereof (Schatzki et al., 2001), this can for instance be studied using the Practice-Regime intersection point framework. Other approaches are needed to further discuss power relations of actors to structures in transitions. Third, TM is critiqued for simplifying transitions too far, as not all its concepts can be operationalised at the same time (e.g. Voβ and Bornemann, 2011). The crossover framework of Practice in Backcasting might help with this, as it studies practices, and there is nothing outside of practices. If the right and enough practices are studied depends on the application of the framework. Fourth, TM is also critiqued on being normative (Shove and Walker, 2010), which remains the case with this crossover framework, but it might become more explicit. Fifth, TM is critiqued on stabilising an incumbent, capitalist economy. Though this might be the case in some applications of TM, this is not presupposed in backcasting, and therefore also not in the Practices in Backcasting framework, though this depends on its application.

SPT has had several critiques for which crossover frameworks can help to overcome them. We discuss two, based on section 2. First, SPT is critiqued for being too descriptive to help steer transitions (e.g. Geels, 2011). The Practices in Backcasting framework can be used to also become prescriptive. Second, SPT is critiqued on being unable to offer explanatory concepts (Laakso et al., 2021a). Some scholars state this is mostly an empirical, and not a theoretical problem, caused by the small scale in which many studies have been conducted (e.g. Klitkou et al., 2022; Spaargaren et al., 2016). This small scale can refer to either contextual research, or research of singular practices without taking into account other related practices in the system. This critique is already somewhat overcome by SPT studies (e.g. Koretsky and van Lente, 2020; Shove and Trentmann, 2018). Yet, some of the crossover frameworks might further help in researching large scale phenomena. For instance, the System of Practices and Shared Elements framework, the practice-regime intersection points framework, and the system fractures framework might help make it easier for researchers to analyse large phenomena. Other crossover frameworks, such as the System Fractures framework, do not offer additional help in researching large phenomena.

6.3. Promises and deliverables of crossovers

Lastly, this exposition of frameworks shows that it is difficult to create crossovers without letting go of core notions of either SPT or STR, as is for instance shown in the diminished horizontal ontology in the Multi-Level Practices and the System of Practices and Shared Elements framework or the less useable concepts of niches and landscape in the Practice-Regime intersection points framework. As might have been expected due to earlier warnings (e.g. Geels, 2010) and rising framework complexity, crossovers so far are modest in how they couple concepts. A true coupling between SPT and STR has not been created. Therefore, although ontological connections can be made, the crossovers frameworks do not do what they promise, i.e. using insights from both theories while staying true to the foundations of either approach. Some of the foundations are kept, whereas others are implicitly let go. For instance, the System of Practices and Shared Elements framework places practice elements outside of practices to help describe larger systems, which contrasts basic notions of SPT that there is nothing outside of practices (Shove et al., 2012). This makes it also difficult to combine frameworks, as each of them is built on (slightly) different ontological foundations. However, as has already been shown in the Multi-Level Practices framework and the Spatial Practices framework, the elements that constitute a practice can often be altered relatively easily. The remaining danger herein is always to oversimplify the concept of what a practice constitutes for the sake of creating pragmatic tools (Spaargaren et al., 2016).

7. Conclusion

7.1. Found crossovers

This paper primarily aimed to elaborate on how SPT and STR have been used together so far, exposing what the strengths and limitations of the different crossovers are, offering researchers and policy makers tools to study and steer transitions, for instance by using the Practice-Regime intersection points framework to find where to intervene. By doing so, the secondary aim was to set a research agenda for future researchers interested in researching sustainability transitions and changing practices for sustainability. It tried to fulfil these aims by covering an exposition of the paradigm of the combined approaches, focusing on ontology and theory, and by doing this, elaborated on the debate of possible crossovers between SPT and STR. Considering the first aim, the article covered six groups of crossover frameworks that each in their own way make use of the combined approaches. As the frameworks make use of both approaches, they can be interpreted as more complex than either. The frameworks each make their own specific crossovers and by doing so, have their specific strengths and limitations, as explicated in the result section.

Using different elements from either approaches, the crossover frameworks function best in different settings, for instance complex settings (e.g. the Multi-Level Practices or Spatial Practices framework), prescriptive settings (e.g. Practices in Backcasting framework), or in search of intervention points (e.g. Practice-Regime intersection points framework). Only two less applied framework groups offer an explicit element of time, namely the System Fractures framework and the Practices in Backcasting framework, which is surprising as transitions have different speeds and aspects of non-linear change, both of which cannot be captured without an element of time. Also how practices can change (i.e. by changing practice elements, by changing practice connections, or by changing practice carriers or their networks) is impossible to study without an element of time; only that the change is measurable. The other four frameworks have to be used more creatively (e.g. twice in different moments in time or specifically when practices are breaking) to account for change. As such, all of these frameworks can be used to understand how situations have changed, but they offer less help in understanding how the changing specifically took place.

7.2. Research agenda

Further for the research agenda, on a theoretical level there are still many questions and untouched concepts in the combined approaches of which seven important items are listed. First, the transition paths not covered in section 4.4, e.g. substitution or de-alignment and re-alignment (Geels and Schot, 2007) currently lack understanding through crossovers. Five of the current framework groups (i.e. all except the System Fractures framework that is applicable more broadly) are particularly useful for reconfiguration. Future researchers might develop frameworks that take focus on other transition paths. Second, specifically for combinations with the MLP, in many crossovers the role of the black-boxed macro-landscape gets lost. Future research that focuses on the combination of the approaches might take a further look at the relevance of the concept, which is already a returning critique on the MLP (Geels, 2011; Labanca et al., 2020; Shove and Walker, 2010). Third, more research should be conducted regarding interventions to further steer practices in transitions (Öztekin and Gaziulusoy, 2020). There is already research regarding interventions and practices and interventions for transitions, but only very limited in crossovers. Especially crossovers with TM, which is already very normative, might prove useful for that. Fourth, these approaches together offer useful concepts on change, but no concepts on if this change is actually more sustainable (Geels et al., 2015). Future researchers could look further into combining these approaches with indicators for sustainability. Fifth, although there are studies on power dynamics in STR (e.g. Avelino and Wittmayer, 2016), this remains under-researched in STR (El Bilali, 2020), and although SPT might offer concepts to study this (Schatzki et al., 2001), crossover research has not explicitly delved deeply into this topic so far. The Spatial Practices framework might have gone the furthest and might offer a starting point for future researchers. Lastly and perhaps most importantly, as most framework groups do not use an element of time, future research might look further into this. Researchers might try to tackle this research agenda with unused combinations of the approaches (e.g. with TIS or other interpretations of SPT), and on systems that remain largely under-researched with crossovers, e.g. the architecture, engineering and construction system that is known for its routinized practices (Wamelink and Heintz, 2015) and high impact on the environment (WEF, 2016), have not, to the knowledge following from this research, been explored with a combination of both SPT and STR.

7.3. Limitations

There are several limitations to this study, of which we mention three. First, regarding methodology, the found body of literature cannot be considered complete. Some works have probably been missed due to the specific search terms used and the specific databases used for this research. However, as both Scopus and Web of Science have been used, and the analysis of the found body of literature did not result in other crossover frameworks, it is not expected that many crossovers have been missed. Relating to results, this study solely aimed to find crossover frameworks between STR and SPT. We expect that many related articles have not emerged from the literature review, as they did not do this explicitly. This relates for instance to interventions, designing, or visioning based on SPT (e.g. Hoolohan and Browne, 2020; Scott et al., 2012), which is very close to the found Practices in Backcasting framework, but not a crossover framework itself. Lastly, the found crossover frameworks all contain many different aspects, which adds difficulty in their application. Although transitions are complex, and it makes sense to use frameworks that can capture that complexity, application of other, often simpler frameworks might also prove useful.

Researchers have to acknowledge that every used framework in the end opens our eyes for specific aspects, but also closes them for others. Especially for sustainability transitions that prove to be very complex, involving many actors differently, the choice of framework needs to be

made openly and consciously. This research might help in making that choice.

CRediT authorship contribution statement

Martinus Franciscus Mohandas van Uden: Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Johannes Wilhelmus Franciscus Wamelink:** Writing – review & editing, Supervision, Funding acquisition. **Ellen Maria van Bueren:** Writing – review & editing, Supervision, Funding acquisition. **Erwin Wilhelmus Theodurus Martinus Heurkens:** Writing – review & editing, Supervision.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Mart van Uden reports financial support was provided by Dutch Research Council.

Appendix A. Overview of articles

Articles from search in Scopus and Web of Science			
1	Svennevik E.M.C., Dijk M., Arnfalk P.	How do new mobility practices emerge? A comparative analysis of car-sharing in cities in Norway, Sweden and the Netherlands	2021
2	Mickwitz P., Neij L., Johansson M., Benner M., Sandin S.	A theory-based approach to evaluations intended to inform transitions toward sustainability	2021
3	Huttunen S., Kaljonen M., Lonkila A., Rantala S., Rekola A., Paloniemi R.	Pluralising agency to understand behaviour change in sustainability transitions	2021
4	Pérez-Sindín X.S., Van Assche K.	"Coal [from Colombia] is our life". Bourdieu, the miners (after they are miners) and resistance in As Pontes	2021
5	Sovacool B.K., Hess D.J., Cantoni R.	Energy transitions from the cradle to the grave: A meta-theoretical framework integrating responsible innovation, social practices, and energy justice	2021
6	Mathai M.V., Isenhour C., Stevis D., Vergragt P., Bengtsson M., Lorek S., Mortensen L. F., Coscieme L., Scott D., Waheed A., Alfredsson E.	The Political Economy of (Un)Sustainable Production and Consumption: A Multidisciplinary Synthesis for Research and Action	2021
7	Kivimaa P., Laakso S., Lonkila A., Kaljonen M.	Moving beyond disruptive innovation: A review of disruption in sustainability transitions	2021
8	Svennevik E.M.C.	Providers and practices: How suppliers shape car-sharing practices	2021
9	Kokko S., Fischer K.	A practice approach to understanding the multilevel dynamics of sanitation innovation	2021
10	Nogueira L.A., Wigger K.A., Jolly S.	Common-pool resources and governance in sustainability transitions	2021
11	Laakso S., Aro R., Heiskanen E., Kaljonen M.	Reconfigurations in sustainability transitions: a systematic and critical review	2021
12	Svennevik E.M.C., Julsrud T.E., Farstad E.	From novelty to normality: reproducing car-sharing practices in transitions to sustainable mobility	2020
13	Koretsky Z., van Lente H.	Technology phase-out as unravelling of socio-technical configurations: Cloud seeding case	2020
14	Labanca N., Pereira Â.G., Watson M., Krieger K., Padovan D., Watts L., Moezzi M., Wallenborn G., Wright R., Laes E., Fath B.D., Ruzzenenti F., De Moor T., Bauwens T., Mehta L.	Transforming innovation for decarbonisation? Insights from combining complex systems and social practice perspectives	2020
15	El Bilali H.	Transition heuristic frameworks in research on agro-food sustainability transitions	2020
16	Cherunya P.C., Ahlborg H., Truffer B.	Anchoring innovations in oscillating domestic spaces: Why sanitation service offerings fail in informal settlements	2020
17	Öztekin E.E., Gaziulusoy İ.	Co-positioning design for sustainability transitions, practice theory and transitions theories: Towards dialogue and collaboration	2020
18	Plummer P., Van Poeck K.	Exploring the role of learning in sustainability transitions: a case study using a novel analytical approach	2020
19	Jakku E., Taylor B., Fleming A., Mason C., Fielke S., Sounness C., Thorburn P.	"If they don't tell us what they do with it, why would we trust them?" Trust, transparency and benefit-sharing in Smart Farming	2019
20	Little V.J., Lee C.K.C., Nair S.	Macro-demarketing: The Key to Unlocking Unsustainable Production and Consumption Systems?	2019
21	Köhler J., Geels F.W., Kern F., Markard J., Onsongo E., Wieczorek A., Alkemade F., Avelino F., Bergek A., Boons F., Fünfschilling L., Hess D., Holtz G., Hyysalo S., Jenkins K., Kivimaa P., Martiskainen M., McMeekin A., Mühlemeier M.S., Nykvist B., Pel B., Raven R., Rohracher H., Sandén B., Schot J., Sovacool B., Turnheim B., Welch D., Wells P.	An agenda for sustainability transitions research: State of the art and future directions	2019
22	O'Neill K.J., Clear A.K., Friday A., Hazas M.	'Fractures' in food practices: exploring transitions towards sustainable food	2019
23	Poland B., Buse C., Antze P., Haluza-DeLay R., Ling C., Newman L., Parent A.-A., Teelucksingh C., Cohen R., Hasdell R., Hayes K., Massot S., Zook M.	The emergence of the transition movement in Canada: success and impact through the eyes of initiative leaders	2019
24	Seyfang G., Gilbert-Squires A.	Move your money? Sustainability Transitions in Regimes and Practices in the UK Retail Banking Sector	2019
25	Boodoo Z., Mersmann F., Olsen K.H.	The implications of how climate funds conceptualize transformational change in developing countries	2018
26	McLaren A.T.	Parent–child mobility practices: revealing 'cracks' in the automobility system	2018
27	Welch D., Yates L.	The practices of collective action: Practice theory, sustainability transitions and social change	2018

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Articles from search in Scopus and Web of Science			
28	Bachus K., Vanswijgenhoven F.	The use of regulatory taxation as a policy instrument for sustainability transitions: old wine in new bottles or unexplored potential?	2018
29	Moore A.W., King L., Dale A., Newell R.	Toward an integrative framework for local development path analysis	2018
30	Novalia W., Brown R.R., Rogers B.C., Bos J.J.	A diagnostic framework of strategic agency: Operationalising complex interrelationships of agency and institutions in the urban infrastructure sector	2018
31	Jalas M., Hyysalo S., Heiskanen E., Lovio R., Nissinen A., Mattinen M., Rinkinen J., Juntunen J.K., Tainio P., Nissilä H.	Everyday experimentation in energy transition: A practice-theoretical view	2017
32	Boyer R.H.W.	Achieving one-planet living through transitions in social practice: A case study of dancing rabbit ecovillage	2016
33	Cohen N., Ilieva R.T.	Transitioning the food system: A strategic practice management approach for cities	2015
34	Rolffs P., Ockwell D., Byrne R.	Beyond technology and finance: pay-as-you-go sustainable energy access and theories of social change	2015
35	Rauschmayer F., Bauler T., Schäpke N.	Towards a thick understanding of sustainability transitions - Linking transition management, capabilities and social practices	2015
36	Crivits M., Paredis E.	Designing an explanatory practice framework: Local food systems as a case	2013
37	Hargreaves T., Longhurst N., Seyfang G.	Up, down, round and round: Connecting regimes and practices in innovation for sustainability	2013
38	Watson M.	How theories of practice can inform transition to a decarbonised transport system	2012
39	Seyfang G., Haxeltine A.	Growing grassroots innovations: Exploring the role of community-based initiatives in governing sustainable energy transitions	2012
40	McMeekin A., Southerton D.	Sustainability transitions and final consumption: Practices and socio-technical systems	2012
41	Hargreaves T., Haxeltine A., Longhurst N., Seyfang G.	Sustainability transitions from the bottom-up: Civil society, the multi-level perspective and practice theory	2011
42	Seyfang G., Haxeltine A., Hargreaves T., Longhurst N.	Energy and communities in transition - Towards a new research agenda on agency and civil society in sustainability transitions	2010
43	Seyfang G., Haxeltine A.	Growing grassroots innovations: Exploring the role of communitybased social movements for sustainable energy transitions	2010
44	Shove E., Walker G.	Governing transitions in the sustainability of everyday life	2010
45	Chappells H.	Systematically sustainable provision? The premises and promises of 'joined-up' energy demand management	2008
46	Sovacool B.K., Hess D.J.	Ordering theories: Typologies and conceptual frameworks for sociotechnical change	2017
47	Axsen J., TyreeHageman J., Lentz A.	Lifestyle practices and pro-environmental technology	2012
48	Jørgensen U.	Mapping and navigating transitions - The multi-level perspective compared with arenas of development	2012
49	Lopes A.M., Fam D., Williams J.	Designing sustainable sanitation: Involving design in innovative, transdisciplinary research	2012
50	Grin J., Rotmans J., Schot J.	On patterns and agency in transition dynamics: Some key insights from the KSI programme	2011
51	Keller, M; Noorko, M; Vihalemm, T	Systems and practices: Reviewing intervention points for transformative socio-technical change	2022
52	Banos, V; Deuffic, P; Brahic, E	Engaging or resisting? How forest-based industry and private forest owners respond to bioenergy policies in Aquitaine (Southwestern France)	2022
53	Camilleri, R; Attard, M; Hickman, R	Future Low-Carbon Transport Scenarios: Practice Theory-Based Visioning for Backcasting Studies	2022
54	Oztekin, EE; Gaziulusoy, AI	Designing Transitions Bottom-up: The agency of design in formation and proliferation of niche practices	2019
55	Magnusson T.; Karabag S.F.; Wigger K.; Andersson G.	Sustainability transitions in tourism: on the transformation of a fragmented sector	2024
56	De Roeck F.; Van Poeck K.	Agency in action: Towards a transactional approach for analyzing agency in sustainability transitions	2023
57	Klitkou A.; Bolwig S.; Huber A.; Ingeborgrud L.; Pluciński P.; Rohracher H.; Schartinger D.; Thiene M.; Żuk P.	The interconnected dynamics of social practices and their implications for transformative change: A review	2022
58	Svennevik E.M.C.	Practices in transitions: Review, reflections, and research directions for a Practice Innovation System PIS approach	2022
59	Muylaert C.; Maréchal K.	Understanding consumer lock-in mechanisms towards clothing libraries: A practice-based analysis coupled with the multi-level perspective	2022
60	Tavory S.S.; Trop T.; Shiftan Y.	Sustainable self-organized ridesharing initiatives as learning opportunities	2023
61	Heiskanen E.; Reindl K.; Ruggiero S.	From shadows to light: The role of latent networks in mainstreaming solar PV practices	2024
Snowballed articles			
62	Boamah, F., Rothfuss, E.	From technical innovations towards social practices and socio-technical transition? Re-thinking the transition to decentralised solar PV electrification in Africa	2018
63	Davies, A.R., Doyle, R.	Transforming Household Consumption: From Backcasting to HomeLabs Experiments	2015
64	Geels, F.W.	Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective	2010
65	Geels, F.W.	The multi-level perspective on sustainability transitions: Responses to seven criticisms	2011
66	Geels, F.W., McMeeking, A., Mylan, J., Southerton, D.	A critical appraisal of Sustainable Consumption and Production research: The reformist, revolutionary and reconfiguration positions	2015

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	Articles from search in Scopus and Web of Science		
67	Langendahl, P.A., Cook, M., Potter, S.	Sustainable innovation journeys: exploring the dynamics of firm practices as part of transitions to more sustainable food and farming	2016
68	Morrissey, J.E., Mirosa, M., Abbott, M.	Identifying Transition Capacity for Agri-food Regimes: Application of the Multi-level Perspective for Strategic Mapping	2014
69	Ulsrud, K., Rohracher, H., Winther, H., Muchunku, C., Palit, D.	Pathways to electricity for all: What makes village-scale solar power successful?	2018
70	Van Welie, M.J., Cherunya, P.C., Truffer, B., Murphy, J.T.	Analysing transition pathways in developing cities: The case of Nairobi's splintered sanitation regime	2018
71	Schatzki, T.	Where the Action is (On Large Social Phenomena Such as Sociotechnical Regimes)	2011
72	Keller, M., Sahakian, M., Hirt, L.F.	Connecting the multi-level-perspective and social practice approach for sustainable transitions	2022
73	Cass, N., Schwanen, T., & Shove, E	Infrastructures, intersections and societal transformations.	2018
74	Gazull, L.; Gautier, D.; Montagne, P.	Household energy transition in Sahelian cities: An analysis of the failure of 30 years of energy policies in Bamako, Mali	2019
75	Busse, M.; Kernecker, M.J.; Zscheischler, J.; Zoll, F.; Siebert, R.	Ethical concerns in poultry production: A German consumer survey about dual purpose chickens	2019
76	Laakso, S.; Heiskanen, E.; Matschoss, K.; Apajalahti E.-L.; Fahy F.	The role of practice-based interventions in energy transitions: A framework for identifying types of work to scale up alternative practices	2021

Data availability

The data used in the article is made explicit in the article, i.e. the used papers are mentioned. No additional data has been gathered.

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