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## AN ACTOR-NETWORK THEORY CONCEPTUALIZATION FOR SMART SPECIALIZATION STRATEGIES (S3): CREATIVE BROKERAGE TOWARDS SUSTAINABILITY TRANSITION

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**Abstract.** Smart Specialisation Strategies, their planning and implementation are becoming more important in Europe's transition but also bring up several challenges, especially when it comes to complex innovation processes and requirements arising from the call for sustainable development on several levels. Even though the concept of Smart Specialisation has been elaborated on in a lot of research, the literature still lacks sufficient theoretical justification for the policy concept, resulting in a gap between theory and practice in terms of Smart Specialisation Strategy design and implementation. In this context, this paper provides cross-linkages to evidentially drivers of sustainability transition such as social innovation, cross-border cooperation, Entrepreneurial Discovery Processes and creative innovation. The exploration of synergies towards these concepts under S3 is still scant. The conducted research is based on an extensive literature review and uses a comparative analysis of Smart Specialisation and Actor-Network Theory. By applying Actor-Network Theory within Smart Specialisation Strategy research discourse, known problems of the concept might be overcome, Entrepreneurial Discovery Processes can be improved, and critical concepts for sustainability transition can be well incorporated into S3 understanding. In this, conducted research is also breaking new ground in theoretical conceptualization by providing the analysis and crosslinks of Actor-Network Theory with Smart Specialisation Strategies. Moreover, the integration of essential aspects towards sustainability transition under S3 can be enabled through the Actor-Network Theory application as it opens further research streams to be integrated into Smart Specialisation, such as social innovation and creative industries.

**Keywords:** Economic Theory; Regional Innovation; Research and Innovation Strategies; Entrepreneurial Discovery Process; Creative Brokerage; Cultural and Creative Industries; Cross-Border Cooperation; Social Innovation; Quadruple-Helix

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**JEL Classifications:** O3, O43, P25

### 1. Introduction

Smart Specialisation Strategies (S3) are important regional innovation and development policies for European regions in the upcoming years, planted in the context of the current transition from the lasting funding period of the European Union 2014 – 2020 (n+3 rule) towards its implementation in the current period as of 2021 – 2027. Here, European regions also aim to comply with the ambitious targets the European Green Deal set to accelerate Europe's transition to become a more sustainable society. Hence, contributions to the global UN Sustainable Development Goals (SDG) can also be identified. Initially, the S3 concept was implemented by the European Commission as an innovation governance concept on a regional level to support economic development and exploit growth potentials alongside the Europe 2020 Strategy (European Commission, 2010abc). The roots of the concepts can even be traced back as an answer to the increasing economic gap between Europe and other macro-regions in the 1990s (Foray et al., 2009). Considering that Europe is still

facing a productivity gap between its own countries (Borovic and Radicic, 2023), the origins of Smart Specialisation still exist, pinpointing the importance and relevance of this innovation policy.

One of the main objectives of S3 concept is to increase the efficiency and targeted distribution of European funds (Forey, 2014; Prause, 2014) through individual identification of specific S3 priority areas in the strategy documents of each European region (McCann and Ortega-Argiles, 2015). As of now, the S3 implementation between 2014 and 2020 is still under evaluation by responsible regional S3 institutions and boards to update their strategies according to the experiences made so far (Boschma, 2015) but also to set a roadmap to accelerate the region's sustainable transition and increase economic competitiveness (Gianelle et al., 2020, Meyer, 2021).

At the beginning of the first S3 implementation period, 2014 - 2020, researchers have criticized the poor design of regional strategies (Morgan, 2015). However, a gap between theory and practice (Komninos et al., 2021), lack of comprehensive micro and macro-level frameworks for S3 implementation (Andersons and Bushati, 2019) as well as missing scientific theoretical conceptualization (Boschma, 2014; Fellhofer, 2017; Gerlitz et al., 2020) is still valid and calls for such new research approaches for strategy design (Tödting et al., 2021). Even more, the selection of S3 priority areas as the main part of strategy design remains poor regarding regional strength and capabilities (Meyer, 2021), confirmed empirically in recent research (Marrocu et al., 2022).

On top of that, S3 design and implementation as a European approach also lacks sufficient cross-border cooperation concepts on policy and entrepreneurial levels among regions (Tiits et al., 2015), even though the EU mindset facilitates cooperation, and, from a theoretical perspective, cross-border cooperation is well known as a success factor for regional competitiveness and innovation (Lorenz and Oleaga, 2020). The reason might be low understanding, interest, and policy capacity for potential cross-border initiatives alongside S3 (Radosevic and Stancova, 2018). Furthermore, absent willingness for political commitment and an existing obstacle to developing common policy tools hamper approaches to overcome this lack (Uyarra et al., 2018), resulting in a still-existing research problem on how to utilize, incorporate and implement cross-border cooperation in the development and design of future S3 towards the period as of 2021-2027 (Masana, 2022). Policy learning mechanisms are key pillars of S3-driven governance (Gianelle et al., 2019), described as the political capabilities to transform theoretical concepts into sufficient innovation policies and implement policy changes to foster regional (innovative and sustainable) development. Hence, efficient innovation policy governance is also bound to path dependency paradigms. Consequently, networking, (policy) learning, open innovation and knowledge drive are key enhancers and social aspects for smart development (Dagiliene et al., 2019) and critical pillars of S3 design and implementation.

The conducted research is stepping into such new research approaches by offering a theoretical conceptualization to include four aspects into the S3 discourse on sustainability transition: Entrepreneurial Discovery Processes, Social Innovation, Cross-Border Cooperation and Cultural & Creative Industries. All four aspects have been put into discussion on S3 improvements individually as well as effects for sustainability already in previous studies of the researcher (Meyer, 2022; Meyer et al., 2021, 2022; Grigariene and Jureniene, 2023). Consequently, this research is building up on that and steps into the theoretical justification and framework exploitation to incorporate all four aspects into S3 design towards sustainability transition.

However, concepts and theories of Smart Specialisation as a regional innovation policy have been analyzed and exploited in several existing research items (Hassink and Gong, 2019; Landabaso, 2014; Lopes et al., 2021), including different literature reviews (Fellnhöfer, 2017; Janik et al., 2020; Komninos et al., 2014; Lopes et al., 2019; Meyer, 2022). In this, place-based approaches have been mainly utilized regarding S3 design, implementation, and monitoring. Thus, place-based approaches have been identified as one of the main theoretical concepts when it comes to S3 elaboration in literature in general, but also specifically towards sustainable development (Meyer, 2022) and especially when it comes to the involvement of regional actors in Entrepreneurial Discovery Processes (EDPs) (Aranguren et al., 2019). However, the Smart Specialisation and EDP concept is originally based on a quadruple-helix actor approach in its nature as it enables a large variety of innovations (Nordberg, 2017) and is an enabler for sustainability transition (Roman et al., 2020; Veldhuizen, 2020). While most research approaches consider the triple-helix approach only, quadruple-helix (and other higher-order helix models) need to be better elaborated in the context of S3 and EDPs on the micro-level when

it comes to aspects such as actor relationships, synergies, cooperation, and value creation (Cunningham et al., 2018; Höglund and Linton, 2018). Moreover, S3 must adopt outward-looking concepts in its understanding and design (Giustolisi et al., 2023). Since the regional institutionalization setup strongly determines the EDP's potential (Papamichail et al., 2022), design and monitoring concepts of European regions with a focus on their theoretical justification are required. Existing place-based theories do not explain and justify S3 design and implementation towards more sustainable perspectives and quadruple-helix applications. In this nexus, this paper argues to initiate a research discussion on applying the Actor-Network Theory (ANT) for S3 to exploit its potential. Consequently, the conceptual paper deploys the following research questions:

*How can the actor-network theory be applied in S3 design and implementation? How does an actors-network theory application in S3 enable sustainability transition through Entrepreneurial Discovery Processes, Social Innovation, Cross-Border Cooperation, and Cultural & Creative Industries?*

By answering these questions, the conceptual paper in hands does not only elaborate and utilizes ANT but also contributes to the elaboration of potential insights and add-values for S3 implementation, of benefits for new understanding of S3 design, of approaches to enable more efficient stakeholder involvement and interaction as well as of theoretical contribution to the on-going scientific discourse in the particular research field.

The paper is structured as follows: after this section, main literature findings within the research scope compiles the theoretical background and the implemented research methodology provides an overview of the research path, followed by the conceptual interlinkage between S3 and ANT. Afterwards, the results of ANT application in S3 to answer the research questions are presented. The paper concludes with a discussion of the results of the overall research discourse and concluding remarks summarising the paper, providing limitations and an outlook for future research.

## 2. Theoretical Background

One of the core elements of S3 implementation is the Entrepreneurial Discovery Processes concept, which aims to optimize the usage of limited resources and innovation exploration on the entrepreneurial level (micro-level) for certain domains of specialization (S3 priority areas of the regions) (Mieszkowski and Kardas, 2015). EDPs are groups of processes and activities implemented by involved stakeholders in an ecosystem, including formal and informal bodies and networks (Foray, 2014; Asheim, 2019). Hence, an EDP strongly relies on regionally involved actors in innovation processes and tries to establish multilevel combinations of stakeholders to transform the innovation strategy into reality (Grillitsch, 2016). In other words, the EDP is the operational instrument on a micro-level designed by the strategic approach of Smart Specialisation on the macro-level. The development and implementation of such EDPs are creating highly individual challenges on regional and local levels (Deegan et al., 2021). However, S3 promotes the bottom-up approach and is at the heart of EDPs. As noted by literature (McAdam et al., 2018; Gianelle et al., 2019), S3 policy design and implementation have yet to include the exploration of potential and effects on the micro-level (actors, partnerships, firm-based). Here, the literature also calls for more research on the impact and potentials of quadruple-helix (business, academic, policy and social capital) approaches on this micro-level (Hasche et al., 2020). In addition, the selected S3 priority areas shall support the application of EDPs in a particular region. At the same time, vice-versa, EDPs have the potential to identify utterly new specialization domains being turned into priority areas for S3 in the future (Deegan et al., 2021).

Social capital is strongly linked to social innovation in terms of S3 and regional development (Estensoro and Larrea, 2016). Moreover, social capital is also connected to social engagement (Secundo et al., 2017). Thus, it is a key success factor in ensuring the application of the quadruple-helix approach in policy-making towards S3, which includes ongoing knowledge competence exchange among the actors (Trillo, 2016). Thus far, social innovators and actors tend to be incorporated into such processes as outsiders or external experts rather than as direct actors for sustainable development, e.g., universities as knowledge drivers for society and policy learning (Secundo et al., 2017). Here, innovation policies such as S3 need to pay more attention to social and environmental challenges towards sustainability. Hence, explicit social needs and their contribution to sustainability transition should be at the centre of policymaking (Hassink and Gong, 2019). To achieve this commitment on the policy level, it is necessary to encourage social contribution in innovation processes,

utilizing public and regional resources towards sustainable development in S3 (Panagiotopoulou et al., 2019; Regueiro-Picallo et al., 2020).

To contribute to those policy issues, this paper introduces the actor-network theory into the discourse of S3 and sustainability transition. Originally, the actor-network theory was born in social sciences to analyze how growth and knowledge creation can be explained through interactions of actors and networks (Muniesa, 2015), which, in turn, corresponds with the aim of innovation policies such as S3 to create informal networks, support knowledge exchange and cooperation among actors (Szakálné et al., 2022). Nevertheless, besides social sciences, the theory also receives growing attention in other research areas as an analytical tool, such as social innovation (Degelsegger and Kesselring, 2012), politics (Alcadipani and Hassard, 2010), sustainability (Irish and Romkey, 2021), urban studies (Farias and Bender, 2010), making it worth to examine the potential theoretical implications born from the theory for S3. Moreover, actor-network theory is seen as a potential performativity research steam on politics to close the gap between theory and practice (Passoth and Rowland, 2010), which is, as aforementioned, one of the existing research problems in S3 design and implementation.

Against this background, creativity can be an approach to overcome this “hesitation” for transformative changes in policymaking (Schot and Steinmueller, 2018; Prause, 2021). The paper also aims to integrate Cultural and Creative Industries (CCIs) into policy design and theory development. It is well known that CCIs play an essential role in urban economies (Mazilu et al., 2020), regional or local development (Lazzaretti et al., 2017) as well as facilitation of economies at all scales (Boix Domenech et al., 2021; Hassink and Yang, 2021). Moreover, CCI intervention is associated with positive effects on innovation through networks of relationships and alliances (Santoro et al., 2021), promoting its integration into new S3 concepts. However, exploration and integration of CCIs into the S3 context stay scant on theoretical and practical levels, e.g., only 10 per cent of the 243 S3 strategies considered culture as part of CCI as a priority area (Stanojev and Gustafsson, 2021).

Previous explanations showcase the complexity of S3 conceptualization and design. This is even accelerated as different research streams exploited spillovers to other areas. Therefore, the theoretical justification or application of economic theories must be revised and newly discussed. This paper promotes the actor-network theory as a concept that better explains S3 and its potential for a sustainability transition. This theory allows us to understand involved actor interactions better and enables cross-linkage to other concepts as introduced: creativity for innovation, social capital, EDPs and cross-border cooperation. All these concepts have an evidentially supportive impact on sustainability transition as well.

In general, Smart Specialisation Strategy concepts and approaches are often still seen as technology innovation policy in regional planning in literature and practical implementation. In contrast, new research trends shift to the quadruple-helix approach covering regional social capital towards sustainable development (Benner, 2020). Consequently, social entrepreneurship and social innovation are becoming more important in the S3 discourse as well, as they allow the discovery of new combinations of products, services, organizations, or processes (Defourney and Nyssens, 2010), which is at the core of an EDP and can also result into local innovation approaches (Noruzi et al., 2010). EDP's success and application strongly rely on the regional innovation capabilities of the involved actors.

However, the knowledge, technology and innovation capabilities of a region are key factors in pushing sustainable development (Ferreira and Seixas, 2019), which, as studies have exploited, calls for the active involvement of all innovation actors in the region: social innovators, academics, entrepreneurs and politicians as their interplay is a driver for knowledge creation, learning facilitation and spillover identification. In this, institutional perspectives are crucial (Tiits et al., 2015) as established regional (research) institutions are the main actors to support precisely this - learning, knowledge creation and spillovers – but also the specialization process itself, which again draws back to the application of the quadruple-helix approach. More precisely, regional stakeholders and institutions on vertical and horizontal network perspectives must be involved in S3 design and implementation (Grillitsch, 2016; Mishchuk et al., 2023).

Even though institutional perceptions are important in S3 discourses (Benner, 2022), only a few research items are based on institutional theories (Lehmann et al., 2022). This is partly because of complexities and difficulties

in defining institutions and policy recommendations on a regional level (Grillitsch, 2016) since the abstract thinking in institutional theory results in problems in measuring institutional bodies, their proximity, and dynamics on a regional level (Rodríguez-Pose, 2013). In addition, regarding EDPs as a crucial concept for S3, (innovative) entrepreneurs as individuals exploring and creating knowledge are either not incorporated at all or seen as outsiders in the theoretical framework (Suddaby, 2010). This fact clearly makes institutional theories inapplicable towards S3 design and innovation governance.

Considering the call for increasing cross-border cooperation, new and unknown challenges may arise when targeting cooperation of the multilevel networks in different regions as it is still lacking theories, knowledge, and sufficient application for S3 (Korhonen et al., 2021; Tiits et al., 2015). Such challenges increase from the institutional perspective since smooth S3 implementation relies on intra-institutional coordination and cooperation at regional, national, supra-, and sub-national levels (Gianelle et al., 2016). Here, recent research has put CCIs into the context of actor mediation (Meyer et al. 2022). CCIs are crucial intermediaries, enablers, and development drivers (D'Orville, 2019). As sustainability transition demands efficient and cross-sectoral partnerships and collaboration among multilevel actors (Köhler et al., 2019), this is the logical link to CCIs' role in such settings since they endorse activities being linked to social and cultural development (Purg et al., 2009) in this context. Though CCI intervention in sustainable development is evident (Rayman-Bacchus and Radavoi, 2020; Wiktor-Mach, 2020), also increasing the level of resilience and socioecological system not only on the organizational level (Dentoni et al., 2021) fostering the quadruple-helix perspective (Dubina et al., 2012). Thus, integrating CCIs into S3 design can be a promising approach to improving the innovation capacity of a particular policy in general.

Within innovation policy governances covering multilevel actors, policy learning mechanisms are key pillars of S3-driven governance (Aranguren et al., 2019; Gianelle et al., 2019), described as the political capabilities to transform theoretical concepts into sufficient innovation policies and implement policy changes to foster regional (innovative and sustainable) development. Hence, efficient innovation policy governance is also bound to path dependency paradigms. Consequently, networking, (policy) learning, co-creation, open innovation, and knowledge drive are well-known concepts in CCIs, key enhancers for sustainability transition (Dagiliene et al., 2019; Huttunen, 2022; Van Mierlo and Beers, 2020) and in such, should be critical pillars of S3 design and implementation.

Taking up open innovation from a regional perspective, S3 strongly favours this concept (Oliviera et al., 2021; Surya et al., 2021). In this context, Open Innovation addresses the entrepreneurial level (Lopes et al., 2021) and, thus, it is connected to the concept of EDP as well by highlighting different aspects that might turn the EDP into a more sustainable one, with economic, environmental, social and institutional contributions made. This highlights the importance of EDPs, which stand as a key S3 enabler and constitute a central piece within the S3 policy puzzle (Laranja, 2021; Müür, 2022). However, EDPs find themselves caught in a dilemma. On the one hand, they enable discovery, e.g. through learning, open innovation and co-creation processes, and thus appear to be very promising S3 accelerators. On the other hand, by implying huge potential for co-creation and change, they remain under the radar among policy-makers, who, due to prevailing traditional thinking and planning of regional policies, remain somewhat reluctant in EDPs' deployment (Capello and Kroll, 2016). This is also exaggerated by the bottom-up/top-down discourses (Valdmaa et al., 2020).

In this background, various theories have been applied in research to explain, describe and elaborate S3. An extensive overview has been, for example, subsumed for S3 monitoring (Gerlitz et al., 2020). Theoretical conceptualization was linked to the affected actors being analyzed in the respective research items. Synthesizing given information, research items already covering triple-helix actors (Academics, Policy makers and Businesses) are already driven by the application of network theories (Kleibrink et al., 2016; Magro et al., 2014; McCann and Ortega-Argilés, 2016). This clearly indicates the shift from place-based towards network approaches within higher helix approaches in S3. However, the actor-network theory has not yet been a theoretical foundation in S3 literature. As the actor-network theory is an approach to critically reflect on past development while at the same time retrieving knowledge and insights towards future development (Durepos and Millis, 2012) and enabling the exploration of dynamic and socially constructed phenomena and their

interactions (Burga and Rezania, 2017), the theory can also be utilized on to explain S3 processes and regional innovation ecosystems.

### 3. Materials and Methods

The conducted research places itself in the context of interdisciplinary research, aiming for transdisciplinary solutions and new paths by linking different concepts in a sustainability context. Moreover, applying actor-network theory within the S3 research and sustainability transition nexus offers a novelty in its conceptualization. As the actor-network theory provides a framework allowing the researcher to explore dynamic and socially constructed phenomena and their interactions (Er et al., 2013), it can serve as theoretical justification to elaborate regional innovation ecosystems and networks as covered in S3 research. Though, due to the complexity and intertwining of different constructs - such as multilevel actors, EDPs, and thematic priority areas – the actor-network theory seems to be a feasible and sufficient research framework as it covers not only organizational level but also humans (actors), objects and processes at all levels (Sage et al., 2011; Floricel et al., 2014).

The paper aims to contribute to future-oriented problem-solving and exploration. Research should be based on interdisciplinary approaches (Grimshaw & Miozzo, 2021; Taebi et al., 2014), collecting different insights and new findings from various research fields to elaborate on a specific topic holistically. This can even be traced back to Schumpeter's idea of creative destruction towards innovation exploration (Schumpeter, 1942; Simmie, 2014). Consequently, different aspects of the S3 discourse are taken for the conducted research and put into a new context with other concepts and ideas to explore new ways of thinking and understanding, produce knowledge, and set a path for future research. The research that was conducted claims to be highly exploratory.

Picking this up, S3-related research requires the utilisation of qualitative studies from different innovation contexts to set those new paths (Tripl et al., 2020). Consequently, the research is capitalizing on an exploratory qualitative approach (Silverman, 2020; Shields & Rangarajan, 2013). Considering the introduced research problems and gaps, a conceptualization must be explored and comprehended. Only a little research in this field has been conducted, making a qualitative approach feasible for research methodology (Creswell, 2014). Moreover, qualitative approaches shall be preferred when the researcher still needs to know which variable should be examined (Creswell, 2014). Following this argumentation, the exploratory qualitative approach is emphasized as the methodological approach of this paper.

Furthermore, the implemented research approach is hybrid (Fereday & Muir-Cochrane, 2006), combining inductive and deductive perspectives. Deductive streams are exploited by applying the actor-network theory in a new scenario as of S3 design and implementation, including elaborating whether the theory can be sufficiently used towards identified research problems and gaps. Inductive perspectives result from observations and knowledge gathered from literature and research being examined and put together in a new context to develop general statements and recommendations. Consequently, hybrid research is based on the researcher's constructivist and interpretivist assumptions (Creswell, 2013; Mertens, 2010). Constructivism is postulating theoretical constructions' utilization and practical function (Crotty, 1998), and multiple realities are being investigated.

In contrast, the researcher is integrated into the objects of interest (Lincoln et al., 2011). As the interactions and relations of involved interdisciplinary actors and stakeholders are key to explaining S3 paradigms, interpretivism allows the researcher to give specific meaning and foundation to actions, relations, and processes (King & Horrocks, 2011). However, as the philosophical research discourse is scaling off from the boundaries of strict philosophical categories, the paper can also be placed in the emerging categories, namely interactive approaches (Svensson et al., 2008). Nevertheless, it should be mentioned that actor-network theory itself is categorized as a constructivist approach (Muniesa, 2015), pinpointing its sufficiency as the theoretical background of the paper as well.

In sum, the paper is based on a conceptual research approach using an extensive literature review in a particular field to examine relevant academic literature and premises for conceptualization development. Hence, it is also

secondary research based on previous observations and research done by the researcher and identified literature. Consequently, desk-based research has been performed to gather the most relevant research items on S3 in the sustainability nexus and actor-network theory setup. In this, the paper followed a comprehensive research journey to address the introduced research questions and set up a conceptualization to develop contributing answers to them and set the path for future research in the field.

## 4. Results

### 4.1 Linking up actor-network theory and S3 aspects

Whereas other network theories focus on the relations and boundaries of covered entities and place-based approaches examine the locally or regionally available assets, actor-network theory expands the understanding of involved actors, who can only be described as the network, which is vice-versa not non-existent without its actors (Wihlborg, 2018). The actor-network theory also disrupts the conceptual boundaries of place-based approaches, opening new thinking and new concepts being applied for S3, such as cross-border cooperation in its design.

In theory, actors can be human or non-human entities, or in other words, any entity going into some network relation (Latour, 1996; Whittle & Spicer, 2008). However, the theory calls for one crucial and binding assumption of so-called symmetry, which declares all involved actors – human and/or non-human – in the network are equally powered (Whittle & Spicer, 2008; Jackson, 2015). Though it is a bounding assumption, it can solve two issues in the context of S3 implementation. First, the idea of S3 is a practice-oriented forward-up approach, primarily through EDPs, but it is often implemented as a top-down concept set by regional politicians (Foray, 2016; Valdmaa et al., 2020). This paradox can be erased in the analyses by considering the mentioned assumption of equality between all involved actors. Second, S3 design and implementation calls for interdisciplinary cooperation according to the quadruple-helix view (Carayannis & Rakhmatullin, 2014; Fellnhofner, 2017). The theoretical assumption supports these concepts by allocating the same power to all involved actors.

In addition, according to the theory, all actors are historically driven (Durepos & Mills, 2012), and the concept of path dependency is equivalent to S3 and regional policy-making (Bellini et al., 2020).

The relations and interactions between actors are grounded in the so-called translations, which set up the actual network (Miettinen, 1999; Durepos & Mills, 2012). In addition, translations describe how involved actors create effects through negotiation or affect other actors' interests towards their own to mobilize support (Jackson, 2015). However, translations are generally aligned to four main steps in the actor-network theory: problematization, interessement, enrolment and mobilization (Callon, 1984). Putting these four stages of the theory into the policy innovation context, the actor-network theory is creating an innovation ecosystem through the establishment of a problem, development of possible solutions, iteration of potential solutions, as well as institutionalising and refining preferred solutions, which is, in fact, a key advantage compared to other theories in policy innovation discourse (Young et al., 2010).

As translations between actors can be very heterogeneous, uncertain, and ambiguous between the actors, the theory introduced so-called translation zones. Such zones subsume all actors' translations towards a common aim or field of interest (Barry, 2013) through knowledge exchange and innovation application (Rantisi and Leslie, 2015). This, in turn, is connected to the EDPs as a core concept of S3 implementation (Dubois et al., 2017), understanding translation zones as entrepreneurial discovery spaces (Morgan, 2016) to support multi-actor and cross-sectoral exchanges (Asheim et al., 2011). In addition, the translation zones can also be interpreted as priority areas fixed in the regional S3, allowing the existence of different translation zones with different actors involved for a region under S3 design and implementation.

Lastly, regarding sustainable innovation enhancement, the actor-network theory calls for translators who actively define and establish the relations between actors towards sustainable development (Aka, 2019). This position could efficiently be covered by innovators from CCIs, as they can support entrepreneurship and open

innovation among quadruple-helix actors, being a critical capability for sustainable environmental, economic, social, and institutional thinking and acting (Gerlitz, 2017; d’Orville, 2019; Meyer et al., 2022).

However, the interrelations of S3 and actor-network theory have yet to be elaborated in scientific discourses; this paper has exposed clear linkages which can be supplemented by further discussion on key concepts of the theory and their meaning in S3 as Table 1 illustrates.

**Table 1.** Further key actor-network theory aspects and their implication for S3 application

Further Key Concepts in Actor-Network Theory (Jackson, 2015, p.30)	Implications for S3
Inscription – Embodied translations into a medium or material	Translations, as the aim of early actor mobilization, lead to a specific development aim through EDPs, innovation applications, Key Enabling Technologies, etc., with a focus on the entrepreneurial level.
Enrolment – Mobilise support by creating a body of allies through translation	The joint aim of actors in EDPs is to consortia and network creation for a specific thematic innovation application and sustainable transition.
Black box and punctualisation – A temporary simplification in a network that acts as a single unit so that the network effaces into one actor.	S3 rationale is sufficient to allocate funds through different territorial programmes. In this, building up consortia of different actors from different regions alongside a common thematic goal is a usual and successful procedure to acquire these funds.
Quasi-object – A nonhuman that is necessary for the collective to exist; an object that passes through a social group and forms relations between members.	The thematic priority is bringing affected actors together, including potential sub-categories and objectives.
Hybridity – The idea that neither a human nor nonhuman is pure, that is, human or nonhuman in an absolute sense, but rather entities produced in associations between the former and the latter. Thus, humans are considered quasi-subjects and nonhuman quasi-objects.	Boundaries of human and non-human actors are vanishing, and social innovators and creative brokers are co-creating innovation and sustainable transformation with academic, policy, business and social nonhuman entities.

Source: Compiled by author.

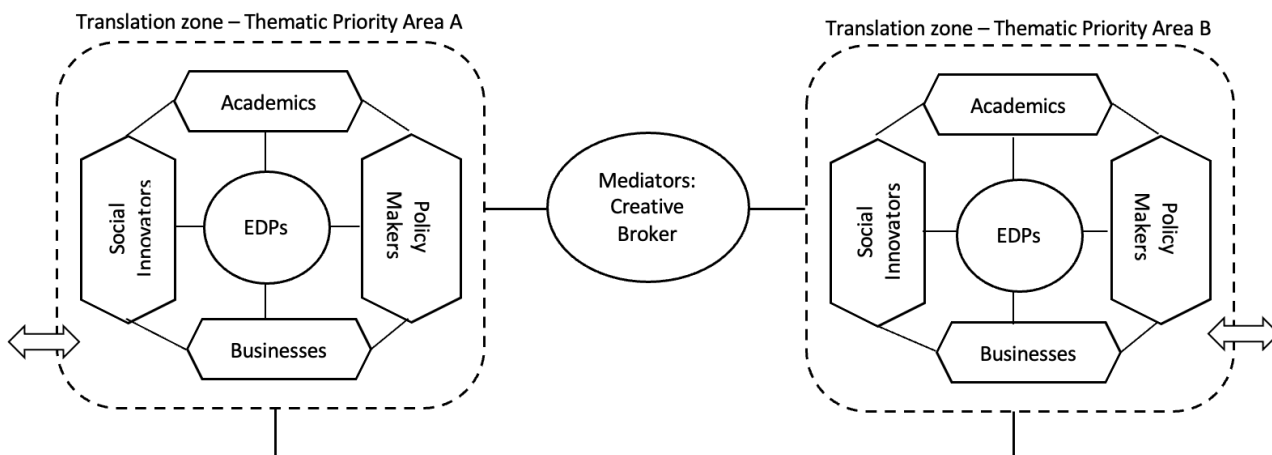
In this, the actor-network theory has more potential to increase the understanding of European regions in S3 and their sustainability transformation. However, this is the first attempt to apply actor-network theory in the context of S3 to rethink a sufficient future-oriented constitution, understanding, and mindset for S3 design and implementation.

#### 4.2 S3 Designing Framework for European Regions

Using the actor-network theory in the discourse of S3 implicitly determines how this innovation policy is ebbed in European regions. Hence, the theory also shapes the understanding and mindset towards placing relevant actors within a certain framework / European region. Here, applying actor-network theory for regions in the S3 discourse as a new approach also bears the potential to enable new or different understandings and mindsets for regional design, including multilevel actor positioning.

After introducing and applying actor-network theory and referring to the quadruple-helix approach, a framework for designing European regions under S3 planning and implementation can be derived. As such, essential parts and relations (translations) between relevant actors are showcased in Figure 1 below. This illustrated framework is based on the core concepts of actor-network theory, which, as aforementioned, offers several overlaps in S3 understanding and expands the research discourse in S3, which is theoretically justified only through place-based and network theories. However, selecting sufficient priority towards EDPs' development and implementation is crucial for the illustrated framework. However, within the chosen priorities, illustrated as translation zones in theory, are the key enablers for EDPs and quadruple-helix actors' involvement. As mentioned, the theory assumes the same power to each actor, human or non-human, facilitating interdisciplinary discovery and innovation application.





**Figure 1.** S3 Design Framework for Thematic Priority Areas.

Source: Compiled by author

One key aspect of sufficient actor-network theory application is the so-called mediators (Latour 2007). These actors connect other actors alongside translation measurements, whereas inputs can't predict their outputs. This is the role of CCIs and Creative Broker, notifying the unknown innovation output from creative method application (Klein and Spsychalska-Wojtkiewicz, 2020). Especially when it comes to cross-border cooperation approaches in S3, the literature highlights the still-existing challenge of identifying and integrating cross-border agents (Mikko et al., 2021), which can be overcome with a Creative Broker approach.

Within the translation zones, the quadruple-helix actors are illustrated for the selected thematic priority area. In this, the EDPs are incorporated in the framework placed in a quadruple-helix perspective to contribute to the sustainability transition of the whole region.

However, this is the first attempt ever applying actor-network theory in explaining a sufficient future-oriented constitution of a European region in a particular field. Thus, this paper contributes theoretically to the research discourse and minimizes the gap in the theoretical justification for this innovation policy. Nevertheless, S3 has no one-size-fits-all solution (Ortega-Argiles, 2022). Thus, it is necessary to further investigate this framework's interpretation and explain its meaning and context.

### 4.3 What's in there for the S3 sustainability transition nexus?

Successful S3 implementation strongly relies on its planning and setup. As aforementioned, the current strategies are set for the full funding period as of 2021 – 2027, focusing on planning and supporting EDPs alongside the chosen priority areas. The problems between this theoretical planning and practical implementation, especially for EDPs, have been mentioned already. Due to the implemented research and actor-network theory framework, S3 developers need to change their mindset from Planning towards Designing EDPs in a region. Whereas planning pre-determines the setup and aspired outcomes, designing processes include iteration measurements, open innovation actions, and creative mindsets. Therefore, integrating CCIs as innovation brokers is important in the framework, supported by the actor-network theory.

Moreover, Designing S3 needs to shift to a more thematic priority area orientation rather than focusing on the region, which is illustrated through the translation zones being the core of interaction within the actor-network theory. The poor priority area selection in European regions is evident. It must be overcome, as the thematic priority areas are enablers for quadruple-helix application and sufficient actor identification for EDPs and S3 implementation. Furthermore, shifting to a more thematic focus also enables sufficient and comprehensive S3 monitoring across regions, which is still an evident problem on the European level (Meyer, 2020).

In addition, as a result of the conducted research, this paper calls for renouncing place-based and institutional theories as the backbone for S3 research. Even though both concepts can theoretically contribute to innovation

research, they need more crucial approaches to explain actor involvement, open innovation, and cross-border EDPs. Cross-border cooperation as a concept for innovation development and sustainability transition under S3 design is still an underexamined field of research. Only a few attempts were made to include it in the S3 discourse, even though cross-border cooperation is an innovation driver on the entrepreneurial level and a facilitator of sustainability transition (Tripl, 2010; Meyer et al., 2021).

Linking S3 design and thematic priority areas or translation zones requires mediators according to the actor-network theory framework, calling for the integration of CCIs. One core strength of CCIs is their ability to broker and share knowledge, craft innovative policies, and mobilize EDPs. In addition, CCIs are contributing to co-designing and co-creating S3 quadruple-helix networks and partnerships in diverse collaboration models towards governance to shape innovation processes and successful EDPs. CCIs should play a crucial role in regional policy settings. Moreover, CCIs bear innovation potential and are vital actors in terms of sustainability transition in general (Gerlitz and Prause 2021). The present research calls to benefit CCIs' potential going beyond brokerage and actor incorporation. Moreover, aspects such as policy learning, social innovation, thematic priority area spillovers, and experimentation are important approaches to consider when it comes to S3 design and implementation.

## 5. Discussion and concluding remarks

Smart Specialisation Strategies is one of the main innovation policies on a regional level and remains in an essential position in scientific discourses. In this, synergies, spillovers and correlations to other future-driven initiatives are apparent. Hence, the research on Smart Specialisation is manifold. Nevertheless, even at the end of the first implementation period, 2014 – 2020 and towards the design of upcoming strategies, the research emphasizes several existing problems in S3 application from theoretical, scientific, and practical perspectives (Masana 2022).

However, as the research has emphasized, research discourse partly lacks on re-shaping S3 understanding towards future-driven needs – sustainability transition. Only a few research articles can be put in this specific research area, though they are elaborate S3 and European Green Deal implications (Larosse et al., 2020), the new idea of Smart Specialisation 2.0 (Kakderi 2020; Panori et al. 2021; Masana 2022) but also introducing a Sustainable Smart Specialisation Strategy (S4) discourse, which is currently only based on improvements in EDP application (Laranja, 2021; Kangas and Ryyänen, 2022). In this, the paper in hands can be supplemented to the research discourse of EDPs as well but goes beyond the sole elaboration and improvement of EDPs by introducing the actor-network theory as a novelty and theoretical contribution to S3 discourse, placing the EDP in quadruple-helix approaches to enable further aspects for S3 design. Moreover, it supports the current research perspective on the S3 concept to adopt external or outward-looking aspects into regional strategies (Giustolisi et al., 2023), preferably through cross-border cooperation.

From a theoretical perspective, this paper has pinpointed that common theories applied in S3 are insufficient to comply with the increasing complexity and requirements of regional innovation governance and its design towards sustainability transition, nor can they include significant trends and aspects from recent literature. This, in turn, also applies to one of the main concepts in S3 implementation and innovation development – the EDP. By introducing the actor-network theory into the S3 discourse in this paper, EDPs as key concept for S3 innovation application have been elaborated and enriched in their design and application through new perspectives and approaches by linking quadruple-helix approach, CCIs brokerage and sustainability transition. As this paper's theory application and proposed framework clearly show, CCI brokerage is a crucial aspect for innovation development under S3. On the one hand, CCI brokerage is demanded from the theoretical perspective of the actor-network theory, which calls for mediators between actors and translation zones. The potential and competencies of CCIs for this role are evident (Jones et al., 2015; Virani et al., 2016). On the other hand, CCIs are the linking aspect of the developed framework and sustainability transition (Gerlitz and Prause, 2021; Meyer et al., 2022) as they can enable and facilitate different processes which are directly linked to sustainability transition, such as policy learning (van Mierlo and Beers, 2020), social innovation (Sauermann et al., 2020) or synergies between systems (Markard et al., 2011). On top of that, policy experimentation is becoming more critical in S3 literature as part of policy transfer and policy frameworks (Veldhuizen and

Coenen, 2022), which, again, is already covered by CCIs being innovators through methods such as co-creation, design thinking and open innovation.

Regarding the proposed research questions, integrating CCIs into S3 design is the second part of the research questions proposed in this paper. However, conceptual research initially developed a framework for applying the actor-network theory in S3. Conceptual linkages between the theory and the idea of S3 have been clearly shown in the literature review and put together to develop a design framework based on actor-network theory. In this discussion, S3 is still seen as a place-based concept (Kristensen and Pugh, 2022; Santos et al., 2022), but this paper clearly claims that usually applied theories such as place-based approaches need to be overcome in S3 research as they are either limited in their explanations or not applicable for S3 design in a sustainability transition matter, e.g. the mismatch of place-based approach and cross-border cooperation in EDPs.

As mentioned, integrating CCIs into S3 design is crucial to link the quadruple-helix approach as an actor involvement concept towards sustainability transition supported by the mediator position underlined by actor-network theory. Even though, CCI potential for innovation design and processes on different levels (Gerlitz and Prause, 2021), only few research items have so far elaborated CCIs in S3 design context (Cooke and De Propriis, 2011; Meyer et al., 2022), mainly considering cultural heritage of CCIs as one of the thematic priority areas (Farinós, 2021; Gustafsson and Lazzaro, 2021). As illustrated in Figure 1, the actor-network theory framework showcases this positioning of CCIs as mediators within a S3 region and among the quadruple actor helices.

This conceptual paper contributes to the ongoing research discourse on the theoretical justification for S3 design and implementation. Here, introducing the actor-network theory as the backbone of S3 design is a novelty and theoretical contribution to existing literature. The overlaps of the theory and S3 concepts have been identified and exposed in the second chapter, leading to the finding that actor-network theory is a valid theoretical backbone for S3 analysis and future design. However, the discussion is initiated from the results and insights gained from the articles, which are the basis of this thesis. Hence, it is necessary to elaborate further on the theory and its applicability for S3.

Due to its conceptual nature, the research needs to be revised. The developed conclusions and framework need empirical evidence as they are only driven by an extensive literature review and synthesis of existing knowledge towards new insights. However, the research papers' objective is not to fully explain the status quo but to enable new thinking and changing mindsets to explain and understand innovation policy and governance approaches under S3. This paper is a starting point for more conceptual and philosophical research and ideas on potential theory applications and enhancements to minimize the still-existing gap between theory and practice regarding S3 design and implementation on all affected levels.

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