

Challenge-oriented Development in a Regional Innovation Network: A Case Study from the State of Hesse in Germany

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How to cite this paper: Stefan Campos Mühlhoff, Christian Herzig. (2024). Challenge-oriented Development in a Regional Innovation Network: A Case Study from the State of Hesse in Germany. *Advance in Sustainability*, 4(1), 1-11.

DOI: 10.26855/as.2024.03.001

Received: February 8, 2024

Accepted: March 6, 2024

Published: April 3, 2024

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Abstract

The role of knowledge and innovation is undergoing a transformation. Rather than only fostering economic growth, new approaches to innovation policy underline its role in tackling grand societal challenges. However, existing concepts for researching regional innovation such as the regional-innovation systems (RIS) approach have not sufficiently addressed this shift towards sustainability. Applying the challenge-oriented regional innovation system (CoRIS) approach, this case study examines the opportunities and challenges of innovation systems to foster sustainable transformation at the regional level. Using the construction sector as the largest waste-producing sector in the economy, the case study looks at an innovation network in the North Hesse region. It highlights how the connection between private and public actors contributes to technical, procedural, and institutional innovation. At the same time, the case study shows limitations of regional innovation through limited policy coherence across scales.

Keywords

Regional innovation, challenge-oriented regional innovation systems, innovation policy, social-network analysis, construction sector

1. Introduction

The perception of the role of knowledge and innovation in modern economies and societies is undergoing a transformation. Traditionally, knowledge has been regarded as an important factor for economic growth and industry competitiveness [1, 2]. Innovation has been seen as generally desirable, without consideration for its societal effects [3, 4]. However, there are growing demands for a broader understanding of knowledge and innovation which are used to tackle broad societal problems such as climate change or resource depletion [3-5]. On a policy level, this has led to innovation policies that aim to foster transformative innovation that solves broad societal [6, 7]. However, there are limited empirical studies that demonstrate under which conditions and in which sectors the implementation of transformative innovation policy can be successful in addressing societal challenges [8].

Innovation systems, i.e., networks of actors and the institutional setup in which they operate, can support the implementation of transformative innovation policy through the development and diffusion of innovation [9]. The widely used regional innovation system (RIS) approach applies a traditional view of innovation [10]. Therefore, new approaches for the analysis of regional innovation systems are required that take a broader perspective on innovation. Reference [10] suggests to transform the RIS approach into a Challenge-oriented RIS (CORIS) approach. The proposed CORIS approach extends the traditional RIS approach towards acknowledging the directionality of innovation towards sustainable transformation, making it a framework to analyse the implementation of transformational innovation policy through innovation systems on a regional scale.

This paper analyses a regional innovation network in the German state of Hesse using the CORIS approach. The network connects private, public, and civil society actors to improve the sustainability of the construction sector, one of the largest waste producers in the economy. Using social network analysis (SNA), the paper analyses how the network facilitates knowledge sharing and knowledge creation for transformative innovation. Taking a multi-scalar perspective on innovation [11], it illustrates how actors from the private and public spheres contribute to innovation and how institutions from the federal to the regional level support and constrain the network's activities. On the empirical level, this adds to the discussion on the implementation of transformative innovation policy through innovation systems by analysing a regionally and sector-specific case study. On a policy level, it demonstrates the possibilities and limits of regional innovation to implement transformative innovation policy and the need for a coherent approach to sustainability transformations across multiple scales [12]. Using the construction sector as an example, the paper argues that challenge-oriented regional innovation systems can contribute to a "small wins" strategy [13] that leads to less radical change and more incremental innovation.

The next section of this paper will introduce the RIS approach and its adaptation towards a challenge-oriented system as the theoretical framework of the study. The following part introduces the concept of SNA and the study's methodology. The rest of the paper presents the findings and a discussion of the possibilities and limits of challenge-oriented regional innovation systems to implement transformative innovation policy. The final part offers a conclusion and implications of the case for future research and policy implementation.

2. Theory

2.1 Regional Innovation Systems

Innovation systems describe a form of economic integration with the goal of fostering innovation that goes beyond market-based forms of integration [14]. One of the most widely used frameworks in the innovation systems literature is the RIS [15]. The goal of RIS theory is to analyse how innovation systems can become a source of regional competitive advantage [16]. According to Reference [17], an RIS connects research and educational institutions, private companies, financial institutions, policymakers, and regulatory authorities. Successful systems create an environment that is conducive to innovation and economic growth [18]. As pointed out by Reference [19], knowledge is created through the combination of existing knowledge from different actors. Sharing of bits and pieces of information from different sides leads to new insights. The efficiency of the knowledge creation process thus depends on actors' abilities to find, exchange, process, and apply knowledge [20]. Regional networks are seen to be a good instrument to increase the efficiency of this process because they create an institutionalized setting in which information exchange can happen and thus reduce knowledge-related transaction costs [21]. In contrast to market-based forms of integration such as supply chains, networks require a higher level of cooperation, trust, and social capital between firms. Firms need a high degree of engagement with other network members in order to create and sustain the relations required for effective knowledge creation [22].

Networks facilitate intended knowledge transfer with knowledge being shared outside of the firm but inside the network. Therefore, knowledge networks can be a good way for small and medium-sized enterprises (SMEs) to improve their innovation capacities, especially those with limited capacity for internal research and development. As a non-market form of integration, networks are also open to non-business actors such as public research organizations and universities [22]. For universities, participation in knowledge transfer activities as part of regional networks has become more important as part of their "third mission", i.e., to contribute to society beyond research and teaching [23]. The network can therefore be seen as a suitable form of organization for knowledge creation and dissemination processes [24].

2.2 Regional Innovation Systems and Sustainable Development

Sustainable development has become a key goal of societies, at least since the publication of the Brundtland Report in 1987 [25]. The literature on sustainable development agrees that this goal cannot be achieved without innovation [26]. However, much of the regional innovation systems literature has not taken up the notion of sustainable development. It follows the assumption that innovation per se is socially beneficial as long as it serves to improve economic performance [3]. The underlying idea behind conventional innovation systems is to fix market and system failures [27]. Market failures refer to a condition where private actors do not invest in innovation because the outcomes of innovation can be profitable for other actors, thus diminishing the gains for the individual actor [28]. The system failures approach is based on the idea that innovation happens within a complex system of interaction between actors and institutions. System failures can happen when there are limited innovation capacities in the region or when innovation networks are too broad or too narrow for the circulation of new ideas [27]. Systems failures may also arise from a lack of coordination and trust between actors [29].

However, this perspective appears to be too narrow when considering the need for innovation to deliver solutions for broader societal challenges such as climate change and natural resource depletion. Innovations need to be geared towards specific

outcomes that go beyond economic considerations [3]. This requires a more complex understanding of innovation. Societal challenges are complex problems that cannot be translated into clear-cut problems with technological solutions and also require societal and behavioural change [30]. Therefore, there is a need to conceptualize innovation as socio-technical transitions that include changes in consumer practices, culture, and the disruption of existing socio-technical systems [31].

Innovation policies have started to acknowledge the need to incorporate directionality and increased complexity into thinking about innovation, as the introduction of mission-oriented innovation policies [7] or challenge-oriented innovation policies [6] demonstrate. However, there is a need to integrate this new perspective into the study of innovation systems. The traditional RIS approach remains largely focused on the idea of innovation systems as drivers of economic efficiency and growth [10]. The analysis of sustainability-oriented innovation needs a novel approach to innovation systems because it requires new actors and needs to account for the directionality of innovation [32]. New technology is not the only way to solve complex societal problems. Instead, innovation can also happen through novel applications of existing technologies or social innovation [30]. In order to adapt the RIS approach to the requirements of innovation systems to tackle societal challenges, Reference [10] suggests extending the RIS approach to a challenge-oriented regional innovation systems (CORIS) approach.

According to Reference [10], CORIS includes the normative dimension of innovation because they are directed at solving societal challenges that affect a region. At the same time, they are open to a broad range of actors beyond research institutions and companies such as public bodies or civil society organizations to reflect the complexity of societal challenges. CORIS can also build on existing innovation systems in the region that re-orient towards challenge-orientation innovation [32]. Stakeholder's expectations and motivations for participating in the network go beyond increasing economic competitiveness. Depending on the actor, motivations can be economic, social, or personal in nature [10]. Another important aspect is the demand for innovation. Conventional innovation systems theory focuses on the generation of innovation and pays no attention to the demand side. This potentially leads to a "demand articulation failure" [12] in sustainable transformation. Demand for innovation is key for scaling up sustainable solutions and thus needs to be included in theorizing challenge-oriented innovation. This does not only include market demand but a wider definition of the concept, including societal acceptance of new techniques and practices [33]. Regional innovation systems do not operate in a vacuum but are integrated into national and international innovation networks and are affected by policies at multiple scales [11]. Furthermore, regional innovation systems operate in dynamic policy environments [34]. This requires consideration of scales beyond regional boundaries and changing institutional arrangements.

The differences between RIS and CORIS are summarized in Table 1.

Table 1. Differences between RIS and CORIS [10]

	Conventional RIS	Challenge-oriented RIS
Type of innovation	Innovation in the regional corporate sector: technological, organisational, marketing innovation	Innovation in the regional corporate sector and in other realms (public sector, civil society, regional and urban communities: technological, user, social, institutional innovation)
Purpose of innovation	Economic growth & competitiveness of the regional economy	Grand societal challenges and problems faced by the region
Effects of innovation	Focus on positive effects (strong pro-innovation bias)	Focus on multi-dimensional effects of innovation: bright and dark sides
Actors, networks, institutions	Firms, universities, state, intermediaries knit together in stable (local and non-local) networks and embedded in a static multiscalar institutional landscape	Conventional RIS actors and 'new' innovation agents (civil society, public sector actors, users, etc.) knit together in / influenced by dynamically developing networks and evolving institutional configurations at multiple scales
Production and application sides	Supply-side (generation/production of innovation in the region)	Supply-side and demand/application side (diffusion/upscaling of innovation in the region)

3. Methodology

3.1 Social Networks and Social Network Analysis

This research conceptualizes the innovation system under study as a social network that is embedded in a regional and national

institutional setup. Social networks consist of a set of actors and a set of relations (also called ties) between those actors [35]. While actors and ties can take many different forms, in this research, actors are organizations (research institutions, public bodies, companies, and start-ups) as members of the innovation system and ties are the relations of knowledge exchange between them. In SNA, networks can be visualized with knots representing the actors and lines representing the ties between them [36]. As Reference [35] underlines, social network analysis (SNA) takes a relational approach to research, which means that the focus is on relations and flows of resources between actors rather than on individual actors.

The research uses a mixed-methods social network analysis approach, which combines the complementary strengths of quantitative and qualitative approaches. Quantitative social network analysis facilitates the analysis of the structure and form of networks and helps to visualize them. This facilitates the analysis of network structure by showing where connections exist and where they are absent. Qualitative social network analysis adds to this analysis by focusing on the subjective meaning that actors attribute to their social relations. In this way, a reduction of the analysis to structure alone can be avoided and individual agency be included in the analysis [37, 38].

3.2 Data Collection

The data has been collected through 20 semi-structured interviews with members of the network between March 2021 and December 2022. Initial network members were interviewed twice during that period; newcomers to the network were interviewed only once. To set a network boundary, only network members were interviewed but no contacts outside the network. Network members are considered actors who self-identify as members of the network. Interview partners came from the private and public sectors and included start-ups as well as SMEs. Table 2 gives an overview of interview partners by category. The initial interviews covered questions concerning an actor's motivation for participating in the network, knowledge exchange processes facilitated by the network, types of innovation and projects pursued, and a name-generator for the participant's most important contacts for knowledge sharing in the network. Interviews lasted between 20 and 45 minutes. In the initial interview phase, the same interview guideline was used for all interviews. The follow-up interviews were conducted by using interview guides that were created based on the results of the initial interviews. Newcomers to the network were also first interviewed using the initial interview guideline. The interviews were conducted and analysed in German. The authors translated quotes presented in the article for publication.

Table 2. List of interviews

Category of interview partner	Number of interviews	Code
Start-up	2	SU-1
Start-up	2	SU-2
Municipality	2	MU-1
Municipality	1	MU-2
Research Institute	2	RI-1
Research Institute	1	RI-2
Research Institute	1	RI-3
Research Institute	1	RI-4
SME	2	SME-1
SME	1	SME-2
Public enterprise	1	PE-1
Public enterprise	1	PE-2
Public enterprise	1	PE-3
Civil society organization	1	CSO-1
Civil society organization	1	CSO-2
Interviews total	20	

3.3 Data Analysis

The interview data was analysed quantitatively and qualitatively, thus putting the “point of integration” [39] at which qualitative

and quantitative data are combined at the stage of data analysis. All interviews were recorded and transcribed for qualitative content analysis, using categories based on the CORIS framework. Categories were type and purpose of innovations, actor motivation for membership, network characteristics, and institutional embedding. The data from the name-generators were used for a graphical illustration of the network, thus deriving the data for the quantitative analysis from the qualitative interviews, as suggested by Reference [40].

4. Findings

4.1 The InRes Bau network

The InRes Bau network was initiated as a knowledge transfer project of the University of Kassel in the northern Hesse region in Germany funded by the European Fund for Regional Development. After a kick-off event in March 2020, regular follow-up meetings and workshops were organized to facilitate networking and knowledge exchange between network members. The project builds upon previous loosely connected initiatives from actors in the regional construction industry to improve resource efficiency and sustainability. It aims to connect various actors in the construction and recycling industries such as small and medium-sized enterprises, start-ups, research institutions, and public bodies (e. g. municipalities). Concretely, resource efficiency in the network's context refers to the lowering of the carbon, water, and material footprints of the construction sector. Next to its environmental impact, construction activities are related to other societal issues such as affordability of housing, urban planning, and competition for limited (urban) space. Due to a growing population and limited construction activities in Germany, there is a shortage of housing space in many regions in Germany, including the northern Hesse region [41]. This creates demand for affordable and readily available housing, putting aside notions of sustainability. Thus, transforming the construction industry is a "wicked" problem with no simple solutions. Therefore, reaching this goal does not only involve the development of new technologies. Instead, a broader notion of innovation is necessary that involves technological, economic, cultural, and institutional aspects [30].

The challenge-orientation of the network aligns with the goals defined by the innovation strategy of Hesse which include fostering innovation to tackle climate change and resource depletion [42, 43]. It also aligns with the aim of the European Fund for Regional Development for the 2014-2020 funding period to strengthen research and innovation, reduce greenhouse gas emissions, and foster sustainable urban development [44].

4.2 Purpose of innovation

The construction industry is an important sector for sustainability transformations because it is one of the largest emitters of greenhouse gases and non-organic waste. In 2018, the German construction sector produced almost 219 million tons of mineral waste, making it the largest producer of waste in Germany. From this waste flow, only around 73 million tons were recycled, mostly as underground material for streets [45]. To improve its sustainability, improvements in resource flows and the use of recycled materials through approaches such as urban mining are considered necessary [46]. The increased use of recycled materials has the potential to reduce the carbon, energy, and water footprints of the construction sector and thus tackle the societal challenges of climate change and resource depletion [47]. The increased use of recycled materials in the construction sector is a societal goal that is also manifested in German federal policies such as the so-called Mantelverordnung (Framework convention), a collection of laws that regulate the collection, classification, recycling, and disposal of waste flows from the construction industry [48].

Urban mining can be defined as "securing raw material supply by exploration, extraction, and refining of anthropogenic resources" [49]. This means it aims to reduce the extraction of primary resources from the environment by re-using materials from existing infrastructure. This requires coordination of actors: At a first step, a proper collection and classification of the resources is necessary during the demolition of a building because separation of materials at a later stage is not feasible [47]. In the next step, producers of waste flows need to be connected to actors that can use the collected materials through the production of new building materials or usage as filling material, for example for roadworks. This requires not only technical innovation for the processing of recycled materials but also institutional and cultural innovation because the use of recycled building materials depends on the acceptance of constructors. At the same time, there are disincentives on the economic side because a higher amount of recycled material increases the costs and technical barriers [45].

4.3 Types of innovation

The types of innovation discussed in the network are threefold: Technical innovation, procedural innovation, and institutional innovation. An example of technical innovation in the network concerns the joint development of a digital application that helps to categorize and track waste flows once a building is demolished. One network member described this as creating a "digital brother or sister of each waste flow" (RI-2) that could be tracked and managed through the application. The goal of the application

is to overcome a coordination problem where potential users of the materials and those who demolish buildings do not know about each other and the kinds of materials set free through urban mining. The development of the application aims to bring the two sides together and to create a catalogue of urban mining products available in the region. In that way, it can also be regarded as a procedural innovation because it allows the creation of value chains from materials that would otherwise end up in landfills.

Other technical innovations developed within the network are a digital planning app and the invention of tiles made from construction waste. The digital application allows planners to calculate the carbon, water, and material footprints of new buildings at the planning stage. The application has been developed by one of the start-ups with support from some of the SMEs in the network. The tiles were also developed from a start-up in the network that received support from other network members.

The institutional innovation concerned the development of guidelines for sustainable construction for the federal state of Hesse through network members. The guidelines aim to clarify the kinds of procedures and steps necessary to implement sustainability in the construction sector. They are meant to be used to steer future construction projects towards a common understanding of the contested notion of sustainability. The focus of the project is on establishing resource-efficient practices and the use of recycling materials in public works projects to demonstrate the use of recycling materials and to increase social acceptance of those materials.

4.4 Actors and network constellations

The network links a wide range of actors from the public and private spheres. A key actor is the University of Kassel as research institution that has organized the initial networking event and serves as coordinator of the network activities. As Figure 1 illustrates, the university is a central actor in the network. However, it does not coordinate all network activities and there are knowledge flows between various actors independent from the university. The arrows signify a flow of knowledge from one actor to another. A knowledge flow is recorded if actors have named other actors as important sources of know-how or information that have influenced their activities with regard to the goals of the network. Figure 1 demonstrates that knowledge exchange happens between actors from the public and private sphere with both being senders and receivers of knowledge. An exception to this is the civil society organizations that are not integrated into the network and interact only with each other. The most central actors of the network are the start-ups (degree-centrality: 0.41) and the university (degree-centrality: 0.34). These three actors together with the SMEs form the core of the network. The density of the network lies at 0.06, which means that 6 percent of all possible connections between network members exist. In that way, the network can be characterized as a random network [50].

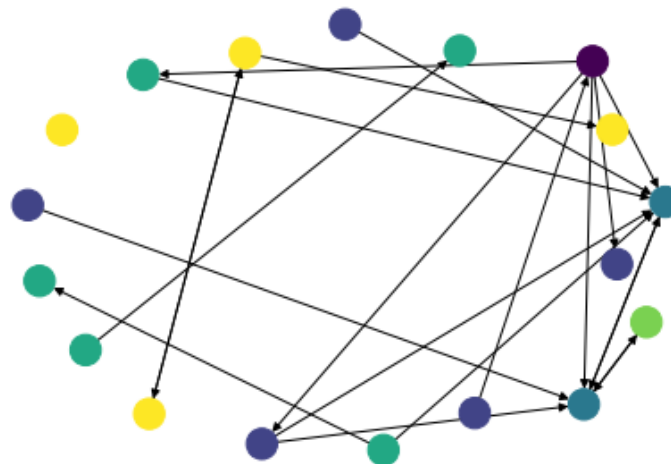


Figure 1. Knowledge flows in the network (Purple = Research institution, Yellow = Civil society organization, Turquoise = Start-up, Green = Public body, Blue = SME).

Network members reported that membership had given them valuable insights into the industry that would have been more difficult or even impossible to gain by other forms of interaction. This is attributed to the trust-creating effect of the network (SU-1, SU-2). One start-up founder compared network membership with “admission to a club” (SU-2) which allowed them to approach established members of the sector in a way that would not have been possible without the network. For other network members, knowledge increase was more nuanced with some reporting to have gained new insights and others seeing themselves more as providers of knowledge and experience. A representative from one of the municipalities in the network (MU-1) described his role as offering his point of view as a potential customer interested in sustainable construction techniques and materials. Yet, overall Figure 1 demonstrates that both, public and private actors are involved in knowledge exchange processes as senders and

receivers of knowledge.

All members described an interest in the sustainable transformation of the construction industry as a key motivation for their participation in the network. Apart from that, motivation for membership differed significantly between groups of members. For the city councils (MU-1, MU-2), membership was motivated by a drive to foster the sustainable development of their communities and to set an example for others. One interviewee (MU-1) described this as a “role model function” in which the use of recycling materials for the construction of public buildings could serve as an inspiration for other public bodies and the private sector. For the start-ups in the network (SU-1, SU-2), motivation came from the possibility of getting feedback on their products from established actors in the construction sector to improve their technological expertise. Further motivation was to get in touch with potential clients and to understand the market for their products.

4.5 Innovation applicability and upscaling

There was a consensus among interviewees that the broad range of actors in the network was beneficial for scaling up innovations by bridging the gap between innovators (in this case the start-ups and the research institution) and practitioners (recyclers, public-sector actors, SMEs). The network membership reduced the restraints of members to contact each other over questions about the applicability of innovations. One example is the development of the previously mentioned digital planning application. The network facilitated constant communication between the app developers and users by establishing connections and trust, allowing the developers to receive feedback from users and to improve their application based on the received feedback on a rolling basis. Similar feedback came from the start-up (SU-2) that produced tiles made from construction waste.

Yet, there are also obstacles to the application and upscaling of innovations. On the demand side, SMEs noticed doubts about the quality of recycled materials by clients. Constructions usually include large investments, which means that many builders prefer to stick with established materials and procedures. A further constraining factor that was noticed by interviewees was the contested notion of sustainability with regard to construction where sustainability might relate to different measures such as the carbon, water, or material footprint of materials. Furthermore, limited awareness of sustainability in the industry was pointed out by both interviewed SMEs. Here, it was argued that producers of construction materials pay only limited attention to the recyclability of their materials. This means that in some cases recycling of materials becomes economically unviable because waste flows cannot be organized in a way that the materials can easily be re-used. This makes the production of recycled materials costly and economically non-competitive with new materials.

4.6 Factors fostering and limiting regional innovation in the construction sector

One topic brought up during the interviews that limit the increased use of recycled materials in the construction sector was missing or unclear regulations and standards. An interviewee from one of the municipalities (MU-1) in the network gave the example of missing certification of recycled concrete that had been used in the construction of the new town hall. This led to the need for an individual certification process, which slowed down the progress of the building project. This point was also brought up by one of the start-up founders (SU-1) who described unclear standards on sustainability in construction as a problem. As the notion of sustainability is contested, there is no general agreement on what constitutes sustainability and how the notion of sustainability can be measured and integrated into agreed standards in the industry. However, without standards and a common notion of what constitutes sustainability, it is difficult to foster social acceptability and application of recycling materials in construction. Various interviewees also mentioned the often unclear legal situation of recycled materials. Materials gained during deconstruction are often legally classified as waste, which means that they fall under a different legal regime than new building materials. However, most builders are hesitant to use materials with an unclear legal status. This adds to the limited social acceptance of recycled materials and presents a considerable obstacle to their use.

Another issue that was brought up in many interviews (SME-2, FM-3) is the issue of limited knowledge of integrating sustainability into planning processes. As the notion of sustainability has only recently been introduced into the construction industry, many architects and engineers have not been trained in including dimensions of sustainability during their studies or during further education. However, the link between practitioners and the university has been judged as a crucial way to ensure better inclusion of the notion of sustainability into the training of future architects and planners.

5. Discussion

The InRes network was initiated with the goal of improving resource efficiency in the construction sector in the region of northern Hesse in Germany. Funded by the European Fund for Regional Development, it is an example of the implementation of a research and innovation policy that aims to direct research towards solving a societal challenge [6]. However, the directionality of innovation towards sustainability also creates challenges. One challenge is to align the sustainability of construction with competing demands for cheap and quickly available housing. Another challenge is to increase the acceptance of recycling

materials among constructors and to reduce uncertainty regarding its use. This demonstrates the “wickedness” [30] of the problem because innovation does not refer to technological innovation alone. The network addresses this “wickedness” by addressing multiple forms of innovation, including technical, procedural, and institutional innovation. However, the network also faces obstacles in the form of limited acceptance of recycling materials and limited knowledge of integrating aspects of sustainability into planning processes. The execution of pilot projects such as the use of recycled concrete for the construction of a new town hall as one project within the network can help to overcome these problems by setting positive examples. However, gaining social acceptance is a long-term process. Therefore, the kind of innovation fostered by the network can be described as a “small wins strategy” [13] rather than a radical transformation. In that way, one could argue that the network presents a case of innovation system reorientation rather than transformation [51].

The network facilitates knowledge sharing and knowledge creation between a wide range of actors, not limited to the private sector and research institutions, but including municipalities and start-ups. The inclusion of civil society organizations has so far been neglected. Even though some groups in the region are working in the field of improving sustainability in the field, these are not well connected to other actor types. Nevertheless, the network is an important facilitator of knowledge exchange processes across sectors as it facilitates knowledge exchange between actors that would otherwise remain disconnected (e. g. start-ups with SMEs).

The network structure of the innovation system increases trust among its members and facilitates knowledge-sharing processes by establishing a platform for the exchange of ideas and experiences. Thereby it creates a “niche” understood as a protective space for learning processes [51]. This is most apparent in the case of the two start-ups that profit from their membership in the network through receiving valuable information on customer needs which allows them to adapt their products before bringing them to the market. They receive further technical input from established industry members, which they can use to improve their products. In that way, the network takes on a “nurturing” function of a niche [52].

The lack of standardization and indicators for sustainability in the construction sector is a further obstacle to upscaling and distribution of innovation. This refers to general indicators for sustainability in construction as well as specific indicators for individual materials. However, it does not appear to be feasible to establish these standards on a regional level. Standardization and definitions need to be set at the national or supra-national level to be widely applicable and accepted. The same applies to the legal regulations concerning materials gained from deconstruction. The often unclear legal status adds to the limited social acceptance of materials and hinders an upscaling of their use. Following Reference [12] this can be described as a “policy coordination failure” where a lack of coordination of policies in different areas and levels hinders sustainable transformations. Innovation policy aims to increase the use of recycled materials but policies regarding standardization and usage of recycled materials are not aligned to this goal. However, the regional level is not equipped to deal with these problems as legal standards are set at the federal or even European level. This highlights the necessity for the implementation of challenge-oriented innovation policies at various levels [27]. A CORIS can help to bring together actors at the regional level to work on regionally specific solutions to grand societal challenges. Still, it needs to be supported by policies made on higher levels.

6. Conclusion

Sustainability transformations require a new understanding of the role of knowledge and innovation in economies and societies. A focus on technical innovation that fosters economic growth is no longer sufficient to deal with grand societal challenges like climate change or resource depletion. The concept of challenge-oriented regional innovation systems offers a framework to study the implications of this transformation on a regional level. This research has demonstrated the potential and limits of such a system in the context of the construction industry. The connection of actors across sectors facilitates the exchange of ideas and information that contributes to technical, procedural, and institutional innovation. The non-market type of integration allows new actors to bring their innovations to maturity while being protected by a “niche” in the innovation system [53]. However, obstacles faced by the network such as limited acceptance of recycled building materials can only be overcome slowly, thus the network can contribute to a “small wins” innovation strategy rather than bringing about radical change [13]. Moreover, the case study demonstrates the need for coherent policies to foster sustainability transformations as demonstrated by the unclear legal requirements and standards for recycled building materials. This indicates a need for further harmonization of policy goals across various scales.

Acknowledgements

Funding for this research came from a grant from the European Regional Development Fund.

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