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DRIVING THE INNOVATION PROCESS BY CONNECTING REGIONAL KNOWLEDGE BASES TO LOCAL NEEDS

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ABSTRACT

Novel approaches are needed to support the creation of more open, inclusive, and self-sustaining R&I ecosystems in healthcare. This study analysed 3 European regions (Murcia ES), (Örebro SE), and (Republic of Cyprus CY), incorporating complementary approaches from Responsible Research and Innovation (RRI) and Research and Innovation Smart Specialisation Strategy (RIS3). The exercise entailed the identification of healthcare and innovation stakeholders and the characterisation of the policy landscape in each territory. Moreover, the strengths of the regional knowledge base was analysed by measuring the Revealed Comparative Advantage (RCA) indicator based on relatedness measurement, and by using micro-level fields analyses of scientific publications. This methodology allowed us to identify the fields and topics (strengths) that provide opportunities for innovation processes. Additional identification of social needs in the three territories showed profound differences regarding the alignment of the selected needs with respect to the regions' capabilities. The results suggest that a timely direct interaction with territorial stakeholders can help in selecting the most promising innovation priorities that are based on local needs and knowledge. The process of interaction requires early engagement to support territorial ownership and is further reinforced by RRI policies in place.

THEORETICAL BACKGROUND

In this paper we address the question whether we can articulate an approach to regional science and innovation strategies that not only promote smart (i.e., competitive) but also inclusive and sustainable regional economic development (i.e., responsible research and innovation). The approach we present emphasises co-creation processes in the regions where the entrepreneurial discovery process is taking place by encouraging the participation of a diverse set of actors. It encourages a bottom-up process towards the definition of societal expectation and local needs in the regional context. This process is performed jointly with the identification of the regional capabilities and skills (strengths) founded in the regional knowledge base; the analysis of specialised knowledge aligned to the identified needs can assist a successful innovation process.

Our objective is to develop an approach to assist policymakers and other stakeholders in designing and implementing Research and Innovation Strategies for Smart Specialisation (RIS3). By combining information on the relative strength of regional knowledge production activities with information about regional stakeholders, local needs, and policies, we can specify priorities that can help to maximise the regional development potentials.

How can smart specialisation be an effective tool to help regions discover new opportunities for more sustainable and inclusive societies? This paper shares outcomes of the analysis framed under the ongoing EU-funded project CHERRIES (*Constructing Healthcare Environments through Responsible Research Innovation and Entrepreneurship Strategies*), which strives to create more open, inclusive, and self-sustaining R&I ecosystems by enabling RRI policy experiments in the healthcare sector in three European territories – in Murcia (ES), Örebro (SE), and the Republic of Cyprus (CY). The project activities encompass 1) an initial stakeholder and policy mapping exercise, 2) the definition of regional R&I capabilities or strengths, 3) the identification of local demands through a call for needs-process, 4) the definition and implementation of local innovation pilots based on delineated needs and capabilities, and 5) the formulation of policy recommendations in the territorial context of each regional healthcare and innovation system. In this article we address activities 1, 2 and 3.

The underlying rationale behind the smart specialisation approach is that by concentrating knowledge resources and linking them to a limited number of priority economic activities, regions can become — and remain — competitive in the global economy (European Commission, 2012). The priority fields for each EU region are set in an entrepreneurial discovery process (EDP) by regional actors (Foray *et al.*, 2011; OECD, 2013). The RIS3 approaches the EDP with the idea of societal engagement in the form of participatory public-private dialogue. This collaborative model tries to create alignment between regional capabilities and regional policy by enabling regions to prioritize domains seen as important (Foray, 2016). The Responsible Research, Innovation, and Entrepreneurship Strategies need to build on existing strengths of a region ('smart specialisation') and should involve reflection on local values and needs (European Commission, 2014). This principle presents a knowledge gap for policymakers and other regional stakeholders.

Shaping the territorial dimension of science and innovation policies for inclusive and sustainable growth requires the understanding of the territorial diversity, opportunities, and constraints in knowledge developments of different places to maximise their potentials. The current scientific portfolio of a region influences the capacity to innovate (Heimeriks

et al., 2019). Just as regions differ in size and wealth, they also vary in the diversity and complexity of their knowledge base. Especially large, metropolitan regions are capable of contributing to a wide range of fields (Nomaler et al., 2014). In contrast, the ability of regions to diversify into new fields of knowledge and to develop new sustainable growth paths remains very unevenly distributed (Heimeriks et al., 2019). Regarding European policy instruments and regional inequalities, the main target of the cohesion policy is to support economic and social cohesion by reducing disparities between regions and focusing on less developed territories, which receive the largest share of funding. Remarkably, there is an inconsistency between the relatively higher need to promote innovation in these less developed regions and their lower capacity to absorb available funds and successfully invest in innovation activities compared with more advanced regions, or what has been described as the 'innovation paradox' (Gianelle, Guzzo & Mieszkowski, 2020; Oughton, et al., 2002).

Knowledge production is also path and place dependent, where new activities tend to emerge and develop in a region in fields closely related to existing local activities. It is differentiated among locations and every region has its own, unique knowledge base (Heimeriks & Boschma, 2014). There is clear evidence that countries and regions are more likely to diversify into related activities. Heimeriks et al., (2019) showed that the existing scientific portfolio of regions offers opportunities for related diversification and discourages the creation of knowledge on topics unrelated to the local knowledge base. Asheim, Boschma & Cooke (2011) use the term *related variety*, referring to shared and complementary knowledge bases and competences. This concept most probably occurs through knowledge transfer mechanisms such as firm diversification, spinoff activity, labour mobility and social networking. It links knowledge spillovers to economic renewal, new growth paths and regional growth and, if pervasive, it implies that the long-term development of regions depends on their ability to diversify into new applications and new sectors while building on their current knowledge base and competences.

The Quadruple Helix model (QH) constitutes a central element in the design of smart specialization strategies. It promotes the exchange of knowledge creation by bringing together companies, universities or research centres, civil society, independent inventors, and lead users to strengthen the regional innovation system (Carayannis and Grigoroudis 2016). The model forms an integral part of European innovation policy, which aims to create sustainable and inclusive growth in Europe. It situates the role of civil society and citizens as especially valuable for the establishment of social innovations in regions (Carayannis and Campbell 2009). Despite the strong emphasis on the QH model, it is still far from a well-established concept in innovation research and policy, and civil society participation in RIS3 has remained low (Roman et al., 2020).

The major mechanism for bringing actors together in RRI policy is public engagement, one of the European Commission's (EC) six RRI 'keys' along with ethics, gender equality, governance, open science, and science education. The EC describes its RRI policy as a diverse set of societal actors that "*work together during the whole research and innovation process to better align both the process and its outcomes with the values, needs, and expectations of society*" (European Commission, 2018).

Previous initiatives establishing the RRI concept into RIS3 policy making including the MARIE[1] project (Mainstreaming Responsible Innovation in European, S3) pursued the creation of greater awareness among regional stakeholders and the wider public on the potential of S3 policies to promote responsible growth. Additional attempts to integrate regional RRI and RIS3 approaches into a responsible and regionally embedded innovation policy has been done by Fitjar, Benneworth, & Asheim (2019). The authors emphasize the complementarities between both approaches, but RIS3 policy is primarily oriented towards regional competitiveness and therefore does not fully incorporate local institutions and notions of social value, needs or choice – the main concerns of RRI. Conversely, RRI theory, policy and practice does not pay attention to the spatial dimension of innovation processes, which is central in RIS3 approaches. In that sense, RRI ignores the various ways in which the regional context affects not only the development of innovation but also the perception of what is responsible and socially desirable, understanding that knowledge and resources which are necessary for innovation – labour, mobility, R&D collaboration – are to a large extent regional. The lack of social focus in the RIS3 has been also addressed from the social innovation (SI) perspective (Nogueira, Pinto & Sampaio, 2018; Spiesberger, Seigneur & Gómez Prieto, 2018). RIS3 and SI are both largely policy-directed and practice-directed concepts which are instrumentally constructed, in which also actors not traditionally associated with innovation (public service organisations, users, citizens, individuals and social enterprises) can contribute (Richardson, Healy, & Morgan, 2014). There is a social side in smart specialisation that seeks the engagement, inclusion, and empowerment of individuals, while it promotes regional specialisation and development. Citizens and user groups should be considered as important players, both for the identification of social needs and for development and testing of new solutions (European Commission, 2014).

In the following sections, we introduce a novel approach to support the creation of more open, inclusive, and self-sustaining R&I ecosystems in the healthcare and innovation sector. The approach combines insights from RRI with research and innovation smart specialisation strategies. The exercise entails identification of healthcare and innovation stakeholders, the characterisation of the policy landscape in each territory, and the analysis of regional capabilities (strengths) that provide opportunities for innovation processes. Additional recognition of regional needs allows us to assess the alignment of the selected needs with respect to the regions' capabilities and current policy mix.

METHODOLOGY

By using a mixed method strategy that combines qualitative and quantitative analyses, our approach examines three different dimensions: *stakeholders, policies, and R&I strengths*. Through the identification of **local stakeholders** by local partners involved in the CHERRIES project a network of actors was built acknowledging the 4P model of interest conformed by providers, practitioners, payors, and policymakers (Ritz et al., 2014), and further enriched using the quadruple helix of innovation. The regional consortium employed local criteria to select key stakeholders and defined their roles in the project. In parallel, they further specified the principal national and regional **policy frameworks** on RRI, healthcare, and science and innovation. Afterwards, the analysis of the **knowledge and innovation base** used the RIS3 as a reference for the identification of regional priorities by showing the scientific fields or areas where each region has a higher level of specialisation and could therefore be used as a driver for the innovation process. The knowledge

1 https://www.interregeurope.eu/marie/

base covered scientific articles, registered patents, and European projects across all disciplines, but particularly in the biomedical and health science field as a representation of the healthcare sector. The present paper only refers to the analysis of scientific articles, and uses bibliometric indicators based on CWTS internal database (Web of Science's (WoS) produced by Clarivate Analytics). We calculated the Revealed Comparative Advantage (RCA) based on relatedness by analysing regional publications (2014-2018) as an indicator of the scientific fields or areas in which the region has an above-average concentration of publications compared to other European regions (Hidalgo et al. 2007). Furthermore, we identified which scientific fields are often found together in the same region, as a representation of the ability of the territory to diversify into related areas of expertise. Complementarily, the employment of the micro-fields level analysis provided a more detailed characterization of each prioritised field by providing information about scientific disciplines, relevant topics, and even specific diseases or disorders. The micro-level analysis method uses an algorithm, where each publication is assigned to one of the 4,013 fields based on a large-scale analysis of hundreds of millions of citation relations between publications. These micro-level fields are embedded into the five main fields of science, namely: social science and humanities, mathematics and computer science, biomedical and health science, physical science and engineering. For further methodological details please refer to Waltman and Van Eck (2012). The characterisation of the selected fields also considered the most representative journals in which the region publishes, together with the publication content by using the titles of articles contained in each micro-level field. For those with a larger set of publications we used text mining techniques or term maps (Vosviewer[2]) to detect the core topics in the abstracts.

RESULTS AND DISCUSSION

STAKEHOLDER NETWORK AND POLICY MAPPING

In the context of CHERRIES project implementation and as a result of the regional analyses, the identification of stakeholders for the Murcia region found 84 institutions. These actors are mostly represented by civil society organisations (CSO) linked to patients' associations and hospitals. Cyprus identified 50 actors with hospitals and health centres (providers) and higher education institutions. For Örebro, 58 actors were reported, most of them belonging to public administration organisations (policymakers) and CSOs. Stakeholders from the private sector composed of firms, start-ups, and SMEs or payors were the least represented in the three regional networks. In this regard, the regional partners underlined some difficulties arising from stakeholders' identification and engagement process from the private sector, which could also suggest that the business and innovation system is detached from the regional (scientific) knowledge production and from the public sector. Additionally, the development of similar previous European projects in the field of health and innovation in the region facilitated the stakeholder mobilisation process. This was for instance the case of Murcia region and the InDemand project[3].

With respect to the compliance of the quadruple helix of innovation, the broad involvement of society organisations characterised predominantly by patient associations in the case of Murcia and Örebro highlights the relevance of co-creation processes where the citizen/end-user perspective is integrated into the innovation cycle. This core principle represents an essential focus of the RRI perspective. On the contrary, the 4P model of healthcare proved to be insufficient in portraying the diversity on the institutional landscape in the regions. It disregards the essential role of academia (universities and research centres) in knowledge dissemination and its contribution to innovation dynamics.

Based on the results of the policy mapping exercise, there is no overarching RRI-policy in the regions. For the three territories, the most developed RRI keys were *Gender equality*, and *Open Science* converging towards Open access, with national or regional policies in place. Örebro was the region with the most diverse RRI keys among policy frameworks, with science literacy and scientific education (SLSE) and ethics keys covered in their policy instruments. As such, RRI does not appear to be grounded as a concept in the territories, however, RRI practices can be easily found. Concerning the ethics RRI key, bioethics is generally regarded as biomedical and clinical research, yet the more general concept of integrity is not addressed at the policy level (except in Örebro). The Swedish research strategy has three overarching guidewords to indicate the future choices: 'Knowledge, quality and integrity', also including strengthening and coordination of science communication, and new infrastructures for knowledge dissemination (SLSE RRI key). From a policy mix perspective, in Cyprus and Spain no reference to science literacy and science education could be found. Likewise, in all three regions there is no specific mentioning on how research should engage with the public stakeholders (public engagement). In the current situation, European policy has translated this lack of public engagement and communication into the 'new' citizen science policy perspective. This raises questions since the traditional citizen science is about citizens supporting science initiatives, albeit the European idea refers to the public having access to and engaging in science, in a less 'data collectors' manner. Only Örebro region is mentioning citizen science as a new policy avenue. In this regard and during a reflection session carried out in 2020 (interregional workshop) addressing RRI needs and potentials, the common issue stressed within the three regional focus groups was the necessity to create permanent space or "arenas" for dialogue and deliberation. A collaborative space is essential for societal engagement in order to make decisions regarding the way healthcare services are provided, which technologies are developed and adopted, and how services are organised. This space is particularly relevant during the needed identification process and definition of innovation priorities in health (and in general in the territory) in a more open, inclusive, responsive, and socially aligned manner. This aspect can be considered as a first important indication for institutional RRI changes to promote at the regional level, with the active collaboration of key actors from the different innovation communities.

2 Vosviewer is a software for constructing and visualizing bibliometric networks: https://www.vosviewer.com/
3 https://www.indemandhealth.eu/indemand-murcia/

IDENTIFICATION OF REGIONAL PRIORITIES

SCIENTOMETRIC ANALYSIS AND REGIONAL STRENGTHS

Figures 1 and 2 illustrate the outcomes for Murcia region, as an example of the results for the scientometric analyses performed in each region intended to support the identification of the regional strengths. This region constitutes an interesting case study due to the clear connection revealed between the topics identified as capabilities and the priorities addressed by the RIS3 instrument. In contrast, the analyses exposed a misalignment between the policy agenda and the issues that surfaced from the Call for Needs-process aiming to recognise local needs in healthcare and innovation. A visualization of the prioritized fields is shown in Figure 1, which corresponds to the measurement of the revealed comparative advantage (RCA). It encompasses the years 2014 to 2018 and analyses a total of 14,433 publications including articles, reviews, and conference proceedings.

In the case of Murcia, fields in relation to environmental science and agriculture shape a dense area in Figure 1 (left side of the image - green cluster). Some of the relevant fields concerning the biomedical and health science field are food science and technology, ophthalmology, dentistry, oral surgery and medicine, cardiac and cardiovascular system, urology and nephrology, hematology, immunology (at the bottom of the image - blue cluster). Highlighted fields at the interface of health and social science are rehabilitation, sport science, nursing and psychology/psychoanalysis (right side of the image - red cluster). Additionally, further information to be extracted from Figure 1 concerns the proximity of the fields (nodes) in which the region would have a better chance to specialize based on its current skills. As an example, as Murcia performs well in Rehabilitation (marked with a black circle), the region could diversify their skills into closer and related fields such as sport science, that appear adjacent to this field in the image below.

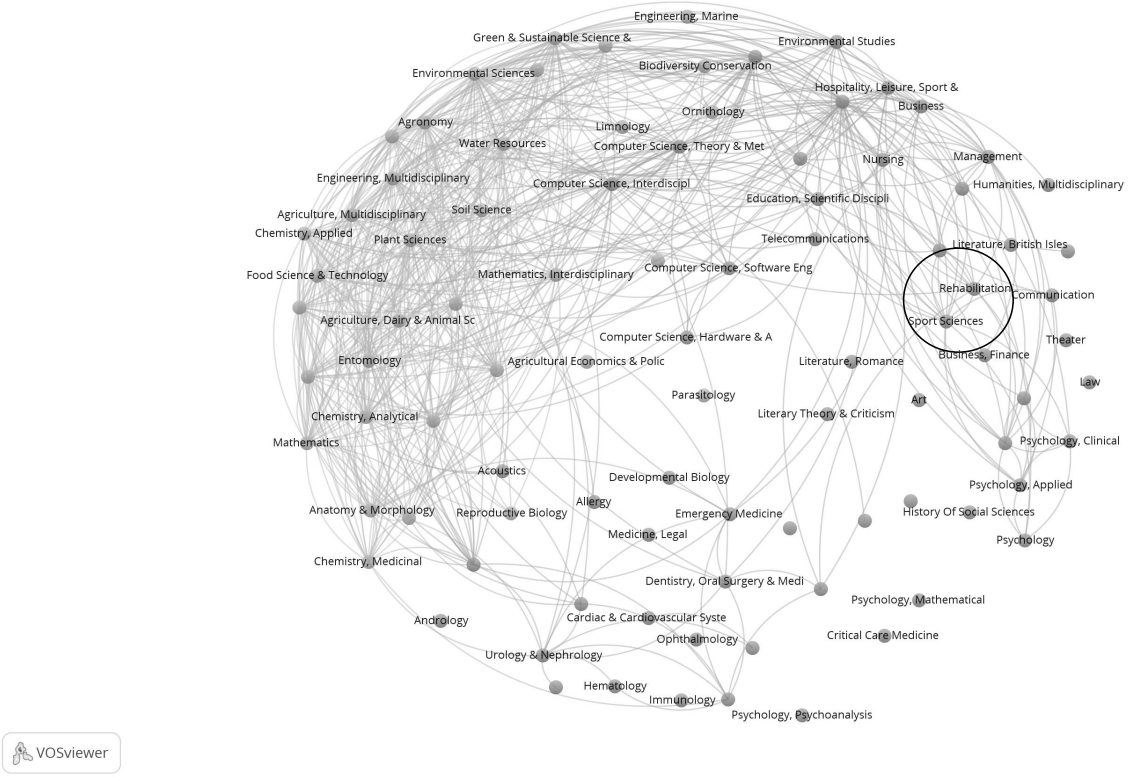
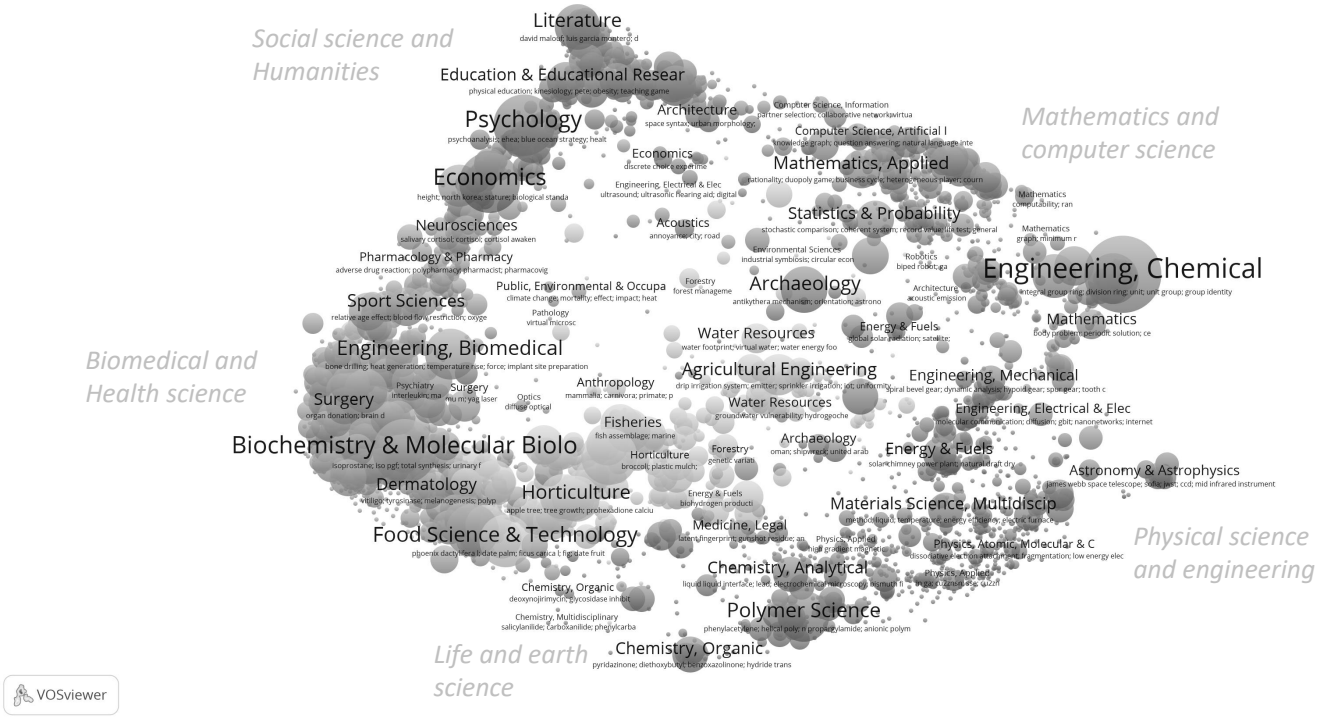


Figure 1. Results of relatedness analysis depicting fields of science with a Revealed Comparative Advantage (RCA) in Murcia.

An additional example of the scientometric analyses performed is the following visualisation portraying the most relevant scientific fields and topics in Murcia. The colours represent the main fields of science, and each circle symbolizes a micro-level field, where the bigger the circle (node), the higher the number of publications produced in that specific micro-field. Figure 2 presents an overview of the topics arising as significant from each main field (e.g., social science, engineering, health science). As stated in the previous smart specialization report, Murcia region has an extensive development of the fields related to agriculture, plant science and nutrition, and environmental science. Similarly, the micro-level field analysis shows a high relative number of publications or level of specialization on these fields and also in connection to Biochemistry & Molecular Biology and Pharmacology & Pharmacy fields.

Figure 2. Results of the micro-level scientific field analysis using the relative number of publications for Murcia.



ALIGNMENT OF REGIONAL POLICIES, STRENGTHS AND NEEDS

Identifying local needs in the context of a European project shows that strengths in one particular area using the knowledge base do not necessarily relate or align to local healthcare practices and innovative activities. The contribution of local capabilities and their active use require adaptation and adoption to local cultures. To balance misalignment and create synergy at the local level is not happening per se and adjustment of stakeholders' dynamics requires active engagement. In the same way, local ownership and commitment develop gradually over time and seldom refer to RRI or innovation, but rather to specific activities. The following table summarises the results obtained from the policy mapping exercise, the identification of the capabilities (strengths) employing scientometric analyses, and the priorities and needs defined at the regional level by the "Call for Needs" process.

Table 1. Overview of the policy topics for RIS3 and RRI policies, the strengths, priorities and needs identified for each region.

REGION/COUNTRY	POLICY		STRENGHTS	NEEDS
	RIS3	RRI policy	Knowledge base analysis	Call for Needs
Murcia - Spain	Agriculture, plant science and nutrition, environmental science. quality of life for well-being	Gender equality, open access, science literacy and scientific education (SLSE)	Environmental science (agri-food chain): dietetics and nutrition. Biomedical: ophthalmology, dentistry, oral surgery, sport science	Early detection of progression in multiple sclerosis
Cyprus	Health, ICT and biomedical applications, e.g., early warning, diagnosis, and early medical care provision.	Gender equality, open access	Genetics and heredity pediatrics, rehabilitation, biomedical social science, psychology, cardiology, nursing	Provision of medical services to citizens living in rural and remote areas
Örebro (Sweden)	Health and social care, open social efforts, accommodative health care. Health robotics	Gender equality, open science, science literacy and scientific education (SLSE) and ethics	Gerontology, nursing, psychology/ psychiatry, gastroenterology and hepatology, automation & control (robotics)	Involuntary loneliness among elderly

MURCIA

For Murcia we could observe that innovation policy instruments such as S3 established clear leadership in sectors such as the agri-food value chain, including agriculture, livestock, fishing and the food industry, and the environmental field as well. Organisations are primarily economically specialized in agricultural inputs and services. Likewise, the analysis of the knowledge base (RCA and micro-level fields) for the region showed similar topics as strengths for Murcia. In its S3 document, Murcia has defined broad health-related priorities with a focus on the quality of life and wellbeing.

As a result of the call for needs-process in Murcia, the region received proposals for the treatment of different chronic illness (e.g., lumbar and cervical pathology, osteoarthritis, pelvic floor disorders), and after the selection process, early detection of progression in multiple sclerosis was given priority. It is worth noting that the call for needs-process did not specify a particular topic to receive the local demands. Instead, it was open to reveal potential new demand-driven needs for health-related innovations in the territory. This may have had a direct influence on the detachment of the needs detected by the region and the strengths identified from the knowledge base and the RIS3 instrument for Murcia region. In this way, the potential strengths detected in Murcia do not overlap with the expressed priorities and needs, albeit chronic illness could be treated by health promotion such as food and nutrition and sports. It should be emphasized that Spain has the highest life expectancy in the EU and social inequalities in health are less pronounced than in many other countries. However, many years of life in old age are lived with some chronic diseases and disabilities, increasing demands on health and long-term care systems.

CYPRUS

The regional priorities of Cyprus are partially aligned with the needs detected. It was possible to observe (Table 1) that topics addressed by RIS3 policy are in line with the priorities and needs identified by the region. Cyprus has defined health concerning ICT and biomedical applications as a priority in their S3 document. As a result of the feedback obtained during the stakeholders' engagement process and demands identified by Cyprus in the call for needs, the selection indicated telemedicine as a local demand with a special focus on the provision of medical services to citizens living in remote areas who do not have easy access to healthcare services and prescribed medicines. The topic matched with the areas addressed by RIS3 policy framework (ICT and biomedical applications), however, did not employ directly the existing capabilities in the health science fields (nephrology, cardiology, paediatrics, rehabilitation, psychology) – fields for which Cyprus was not aware of its potential. In this context it is relevant to note that in healthcare the public sector is dominant. The links between the public sector and the R&I system are less developed, and therefore smart specialised, RRI-based innovation develops less easily.

ÖREBRO

The region has defined health and social care in its S3 priorities strategy. The biomedical and health science field analysed by the relatedness analysis (RCA) from their knowledge base supports the health innovation area. Within this area, the fields of expertise align well with social care such as gerontology, nursing, psychology/psychiatry. Additionally, health robotics as a priority could build on a sophisticated knowledge base within the automation and control field. The topics covered by the regionally submitted needs addressed demands for social contacts among the elderly to tackle loneliness, together with the development of technical skills to use digital tools to counteract this issue. Thus, the demand anticipated by the project partners resulted in bottom-up, demand-driven health needs, which align well with their territorial strengths and broader priorities. In Örebro, the responsibility for the provision of health care to the elderly is shared by the county's municipalities and region Örebro county. The recent "Swedish Government Official Reports" (SOU) report (2020) also refers particularly to elderly care during the pandemic and reflected on the un-preparedness of the health system.

It is worth mentioning that one challenge remains in this territory: the actors that could bring together knowledge, innovation and a healthcare miss possibilities for public engagement among the regional stakeholders. This aspect has been emphasized not only for Örebro region, but for Cyprus and Murcia as well.

RRI IMPLEMENTATION

Awareness of RRI varies considerably across stakeholders, many having no prior knowledge of the concept. However, the overall impression is that there is a positive attitude towards orienting territorial research and innovation systems in RRI terms, however, we identified substantial differences across stakeholders regarding how RRI can be framed. Commonly, stakeholders frame RRI intuitively, from their personal experiences and world views (e.g., in terms of research integrity), or align it to a dominant discourse within their organizations (e.g., CSR for the industry). Yet, common key elements of a perceived RRI approach emerge. Many expressed the view that scientific research and innovation should be oriented towards societal needs in the region and be connected to society with territorial actors. Stakeholders often stress principles of inclusion, deliberation and reflection through collaboration and participation (e.g., co-creation) and continuous, open dialogue between different actors and society.

CONCLUSION

Our approach can assist policymakers and other actors in designing and implementing RIS3 strategies that respond to local needs and preferences. By combining information on the relative strength of regional knowledge production activities (e.g., science and technology outputs) with information about regional stakeholders, local needs, and policies, we can specify priorities that can help to maximise the regional development potentials. Furthermore, our analyses show that scientific capacities that could be useful for regional development do not necessarily align with the demand-driven regional needs. Demand driven research priority setting for funding schemes is very much in sync with RRI, nevertheless, the smart specialisation paradigm does not always adequately include regional needs. Notable is that actors formulating demand-driven needs are not always aware of potentially interesting local knowledge for innovative developments. The first and foremost step in supporting territorial RRI is engagement and understanding local cultures. Recommendations

should move towards searching for innovation opportunities on the basis of RRI-based local needs, in view of the local strengths of the knowledge base. It is about the translation of project contexts to local contexts and making sure that changes remain when projects are gone.

The integration of qualitative and quantitative methods to understand territorial specific characteristics constitutes a novel and promising approach, conveying regional relevant scientific and technological information that was previously unavailable, and link it to the regional priorities. The overall application of this approach appears highly beneficial with still some opportunities for enhancement.

Further efforts aimed at the integration between the RIS3 and RRI policy approaches are necessary for a better social alignment of the innovation decision-making process by establishing bridges between existing and new territorial actors of the regional R&I healthcare system. This includes in the process different knowledge perspectives and creates the conditions for the building of collective responsibility toward responsible innovation in health or "territorial RRI".

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