Open Science for Knowledge Co-Creation: Methodological Framework and Empirical Evidence

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Abstract

The research presented in this article seeks to provide a compelling evaluation framework that can be utilized as a tool toward empirically examining the Open Science implementation in national R&I ecosystems. The need for such a framework is overwhelmingly grounded both in the motivation of the European Commission to promote stakeholder participation in all aspects of research and academic studies focusing on the benefits of Open Science. The framework is applied in evaluation of Lithuanian R&I ecosystem.

1. Introduction

The term 'Open Science' has its origins in the Open Access movement which started in the 1990s together with the rapid development of online technologies [1]. Today its definition goes beyond the sharing of research data and covers a wide range of activities (e.g. citizen science, transdisciplinary research, university driver interactions) aimed at making the research not only transparent but also collaborative. Such Open Science (OS) approaches provide a foundation for efficient science communication, establishing connections and obtaining society's higher trust in science. The academia in general and researchers individually should not work in silos anymore but invest more efforts in collaboration with the citizens, industry, policy-makers and non-governmental organizations. This was the principal idea behind the new European Research Area policy paper by the European Commission [2]. The COVID-19 pandemic also spurred the need for collaboration and implementation of open initiatives among various stakeholders to thwart the global crisis. While Open Science definitions are variable and ambiguous [3][4], the value of Open Science as a concept is almost universally accepted by the of the scientific community. Such collaborations can extend the potential impact of the research to communities, organizations and government [5]. Additionally, they contribute to the careers of the researchers through increased citations and media attention, a larger collaborative network, and exposure to new career and funding opportunities [6], [7].

Despite the calls for more collaboration in science, establishing the ecosystems that synthesize and interconnect knowledge of different stakeholder groups remains a challenge. The current research fails to propose a theoretical perspective to guide the inquiry on the dynamics of transparent and collaborative Open Science implementation. To tackle this gap, the article first reports on a conceptual Open Science maturity evaluation framework of Research and Innovation (R&I) ecosystems. We then apply this framework to the Lithuanian R&I ecosystem. In doing so, we reflect on and suggest potential refinements and improvements both to the ecosystem and to the proposed framework. The remainder of the paper is organized as follows. Section 2 presents a brief literature overview, focusing on the previous research efforts on Open Science evaluation. In Section 3, the proposed conceptual framework and evaluation strategy to capture multiple dimensions of Open Science implementation in R&I ecosystems is presented and explained. Section 4 presents a quick-scan of the Lithuanian R&I ecosystem and uses the framework to analyze the data. Section 5 provides overview of recommendations for Lithuanian R&I ecosystem. This paper concludes with the suggestions on how the framework might further be developed and overview of avenues for further research.

2. Previous work

Previous work on Open Science evaluation has focused more on the measurable impacts of Open Science for quality assurance (i.e. open publications). [8] and later [9] looked into quantitative and qualitative indicators tracking the openness and transparency of publications. [10] explored the stakeholder understanding of Open Science. [11] defined an Open Science evaluation framework based on three pillars: hardware, software and peopleware. Several EU-level science and technology monitors also assess some quantitative aspects of OS including the European Innovation Scoreboard, ERA progress reports, the Digital Scoreboard and Responsible Research and Innovation trends. Figshare publishes 'State of Open Data reports' [12]. The OpenAIRE platform is an EU-funded infrastructure programme specifically focused on monitoring Open Access data

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for research publications [13]. The review of previous work, shows there is almost no agreement on what kind of indicators might capture or allow the evaluation of collaborate aspects of Open Science and its implementation.

3. Evaluation Methodology

Traditional theories of innovation focus on linear and one-directional flows of information from the lab to market application [14]. Recent academic thought, however, increasingly supports the idea that convergence of expertise, knowledge and resources are needed when addressing the interdisciplinary problems [15]. Following the paradigm change, a number of novel conceptual frameworks were introduced deconstructing the collaborative practices of knowledge creation [16], [17]. In reviewing them, the notion of ecosystem revealed its importance with different qualifiers such as innovation ecosystem [18] [19], social innovation ecosystems [20], open innovation [21] and ecosystems of shared value [22]. In the same manner, the Open Science movement highlights the social element of innovation by promoting research collaboration and co-creation. Hence, the evaluation methodology is based on a notion that co-creation processes in Open Science should be approached through the view of the ecosystem since it embraces a much wider sociocultural system than pure dyadic relationships between research/industry or research/civic society.

In order to fully understand the complex research and innovation ecosystems, the approaches able to explain their intangible characteristics, properties, abstract concepts and processes are needed. In this regard, qualitative perspective allows to capture a much broader picture and nuances and describe the nature of the changes in the ecosystem more thoroughly. A qualitative perspective is also relevant in the evaluation of still-emerging concepts such as Open Science where quantitative data collection opportunities on ongoing or potential collaborations are still limited. Based on these considerations, the R&I ecosystem conditions favorable for Open Science are set to be explored empirically through a combination of qualitative methods in a three-step process presented below.

Step 1: Ecosystem analysis and data collection

The initial step of the R&I ecosystem analysis includes data gathering based on the conceptual evaluation framework. The combination of theoretical insights from empirical studies on complex ecosystems, co-creation and Open Science applications provides complementary insights and allowed us to put forward a conceptual framework capable of explaining the structural features of R&I ecosystems enabling the implementation of Open Science. The framework is based on the analysis of factors identified through the literature review and exploratory study. Previous work by the author details the theoretical influences of each dimension and the underlying logic of the framework [23], [24]. Brief descriptions of evaluation dimensions are provided in Table 1.

Table 1. Dimensions of the evaluation framework

Dimensions	Brief description
Framework conditions	
Context of implementation	The context of Open Science implementation i.e. socio-economic, cultural and political aspects defining the country in the focus of analysis.
Policies and funding	The alignment between policy statements and intended outcomes of Open Science policy structures and agendas.
Infrastructure for openness	Structures and services needed for Open Science to operate (e.g. services, protocols, standards and software that the academic ecosystem needs in order to perform its functions during the research lifecycle). Skills necessary to use and manage the infrastructure.
Systemic conditions	
Diversity of actors involved	Evaluation of the capacities of different stakeholder groups to participate in co-creative processes (barriers and drivers of participation).
Intermediaries	Individuals and organizations serving as intermediaries in Open Science and co-creation processes
Shared vision and trust	Coordinated actions and trust between the actors in the ecosystem.
Consistent and dynamic communication	Current flows of communication between different stakeholder groups; Barriers to consistent and dynamic communication
Feedback and monitoring	Feedback and monitoring processes at the national and institutional levels focused on Open Science activities

Source: defined by author in [23], [24]

The framework suggests that in evaluation of research and innovation ecosystems two important dimensions have to be considered i.e., framework conditions (structural factors that are amendable

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through policy interventions) and systemic (dynamics, linkages, and networks of the co-creation process) conditions. The dyadic approach provides a portrayal of national research and innovation systems where framework conditions regulate how systemic conditions can realize their full potential for knowledge co-creation.

The data collection is set to utilize the existing documentary resources for Open Science implementation in terms of relevant strategies and infrastructures. In parallel, interviews with Quadruple-Helix stakeholders (i.e. civic society, research community, governmental organizations and industry) should be conducted to uncover their needs, drivers and barriers relating to their participation in Open Science initiatives. The objective of these interviews will be not only to understand ecosystem elements but also to explore the dynamics of ecosystem evolution.

Step 2: Data analysis and diagnosis

A successful ecosystem is the result of a process of continuous evolution, which is often long, complex and slow and its development may have different stages of maturity [25]. The maturity stage has an indirect effect on co-created knowledge [26], [27]. Hence, the diagnosis phase uses the data collected in Step 1 to determine the level of maturity of each evaluation dimensions. With the understanding that R&I ecosystems are not a one-dimensional organism, we can define the factors that make an ecosystem mature. [28] suggests that the ecosystem passes through the nascent, emergent and mature phases of development (see Table 2).

Table 2. Maturity of ecosystem elements

Nascent	Emergent	Mature
Context of implementation		
Lack of consciousness and intention towards OS in policy development, economy and participation of public.	Disperse initiatives and interest in policy, economy and participation of general public favoring OS.	Policy, socioeconomic and participation conditions favorable to Open Science.
Policies and funding		
Random, uncoordinated or non-existent policies favoring elements of OS.	First iterations of ecosystem development through new co-creation-focused policy and funding measures.	Government applies OS-friendly policies; Diverse funding landscape; OS is clearly defined and documented.
Infrastructure for openness		
Fragmented initiatives related to disperse elements of Open Science.	Some awareness on infrastructure importance. Initial albeit fragmented initiatives for improvement.	Infrastructure for knowledge sharing set and continuously improved based on the needs of the ecosystem actors.
Diversity of actors		
Low inclusivity and connections between homogenous groups of actors.	Fragmented and unstable connections between homogenous groups of actors.	High inclusivity and intense connections between heterogeneous actors.
Vision and trust		
Lack of unified vision and trust among the actors of the ecosystem.	Trust-based relationships between actors of the ecosystem. Lack of unified vision and common goals.	Transparent ecosystem with a unified vision and high levels of trust between the actors.
Communication between the actors of ecosystem		
Lack of networking and communication activities between actors of the ecosystem.	Growing networking and communication opportunities between different actors in the ecosystem.	Consistent and dynamic communication between actors of the ecosystem.
Intermediaries		
Transactional intermediaries and specialists focused on limited number of actors.	Generalists, balancing the tensions between the actors in the ecosystem.	Change agents, thought leadership.
Feedback mechanisms		
No monitoring, evaluation and identification of good practices.	Fragmented monitoring efforts focused on at least quantitative aspects of Open Science.	Systemic and continuous processes of meaningful feedback.

Source: developed by author, 2022

Looking at this spectrum for each evaluation dimension, one can see that there is a clear path for ecosystem development towards maturity and co-creation. The process towards maturity, although simple, is not easy since many policies and support mechanisms have to be put in place to ensure that the actors of the ecosystem have enough opportunities to meet their full potential.

Step 3: Recommendations

The maturity model serves to bring together an

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otherwise, complex and abstract set of ideas and simplifies it into one clear picture. Doing so allows to assess the level of maturity for each element of evaluation and identify the potential strengths and limitations of the ecosystem. The recommendations seek to outline the desired scenario that the actors of R&I ecosystem should aim to reach as an answer to the problematic areas identified.

4. Application of the Evaluation Framework in Lithuanian R&I Ecosystem

To explore the use of the evaluation methodology in practice and to assist with its further development, we apply it to a single locale – the Lithuanian R&I ecosystem.

First, we utilized a qualitative data collection approach to obtain the data from 20 interview respondents representing multiple stakeholder groups in Lithuania (3 policy makers, 2 science communication managers, 3 representatives of university administration, 2 industry representative, 7 researchers, 1 NGO representative, 2 representatives of academic libraries). Interviewees were selected with snowball and convenience sampling techniques, based on the expert's ongoing working experience in R&I ecosystem of Lithuania, their existing interest and involvement in Open Science discussions and practices (e.g. participation in conferences, projects related to Open Science) and their availability for the study. The interviews were semi-structured, prompting interviewees to explicitly articulate their conceptions of and reactions to "openness" in science. The interviews were conducted during the period between August 2021 and January 2022. The ensuing interview data were analyzed according to the major themes of the conceptual framework using text analysis software Nvivo.

Second, the content analysis of strategic documents of Lithuanian institutions shaping and implementing the research and study policy in Lithuania was conducted. Initially, a large number of institutional and national documents published from 2015 to 2022 was collected including the annual reports, institutional plans, strategic plans, relevant policies and procedures aimed at implementation of Open Science elements. All of these documents were accessible via the official websites of selected organizations. A total of 241 documents were collected. Second, the documents were compiled into a spreadsheet to organize them. Third, the documents were uploaded to Nvivo and coded based on the dimensions of the evaluation framework. The nature of documents predetermined that the analyzed content was relevant to the analysis of the framework conditions.

Qualitative studies are prone to subjectivity biases by the informants and the researchers. In order to address it we have deployed multiple triangulation types, and proceeded with checks with other studies and available resources on R&I in Lithuania to validate the accuracy and to strengthen the rigor and trustworthiness of our findings. Despite the precautions, further research across different contexts is encouraged in order to gather additional insights.

4.1. Framework conditions

Context of implementation - The openness of science is a concept whose realization is still in its infancy in Lithuania, with significant political, socio-economic and cultural barriers. The policy context is hindered by the low levels of R&I activities and the unused potential of human resources coming as a result of highly fragmented planning and funding processes [29]. The socioeconomic context is generally favorable given the steady growth of Lithuania's economy. However, Lithuania does not make the most of the opportunities provided by the investment in research and innovation resulting in below-the-EU-average levels in school outcomes and labor market levels of tertiary programmes [30]. The culture of participation in Lithuania faces significant challenges with the civil society in Lithuania being passive and making little use of its rights and opportunities to participate in solving the public matters of the country [31]. The digital skills of Lithuanian citizens were ranked below the EU average [32] which imposes their limited capabilities to participate in often ICT-intensive Open Science initiatives. The documentary analysis and interview programme showcased that despite the identified barriers, there are some encouraging signs of change. Innovation policy and public participation matters are gaining an increasing attention among the Lithuanian policy-makers. Significant progress has been made over the past years with a focus on the creation of innovation-friendly framework conditions and initiatives supporting the public engagement. Given the considerations outlined, the evaluation dimension could be defined as *emergent.*

Policies and funding - Science policies and R&I funding measures established by the national governments, funding agencies and research-performing organizations determine the incentives and constraints of stakeholders and shape their behavior [33]. Across the different levels of policies, our assessment suggests that there is limited progress on rewards and incentives geared towards openness. Where progress is being made on policies towards Open Science, there is often a lack of adequate funding to support their implementation.

More concretely, the results of documentary analysis of national policy-making institutions were not encouraging in terms of favorability to Open

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Science. The term 'Open Science' is not mentioned explicitly. However, some elements of openness (e.g. co-creation with industry, Open Access features) were mentioned in the strategic planning documents (e.g. Law on Higher Education and Research defines Open Access). The analysis of strategic documents of R&I funding agency and other policy-implementing uncovered a much more intensive openness narrative (e.g. Open Access guidelines are approved by Research Council of Lithuania). However, the alignment between policy statements and intended outcomes in the ecosystem is not clear since the actions tied to openness and indicators which measure the elements of openness and co-creation are lacking. Although changes are taking place in individual areas of R&I ecosystem, there is no clear direction and confrontations exist between the actors. This hinders the emergence of a systemic approach and agreement on how to more rationally and efficiently direct resources. Finally, in the context of research performing organizations, the openness narrative varied across the entities with some having clear guidelines on Open Science implementation (e.g. Vilnius University) and others ignoring the concept all together. However, institutionalized incentive structures are misaligned with the values of openness and collaboration. In general, the strategic focus is given to the criteria of excellence and development of student competencies rather than to elements of openness. The analysis of policies and funding of in Lithuanian R&I ecosystem showcased that the level of maturity of this dimension is *nascent*.

Infrastructure for openness - The infrastructure is defined as the structures and services needed for Open Science to operate (e.g. services, protocols, standards and software).

In this context, Lithuanian R&I ecosystem does not operate in a vacuum and is highly influenced by the developments in the European Union. OpenAIRE, Open Research Europe and European Open Science Cloud projects served as pilots for mainstreaming the openness infrastructure in the European Research Area, Lithuania included. While the emerging open infrastructure efforts are promising, the tools and systems operate independently and lack a transparent and clear long-term national policy on research infrastructure. Another area of improvement revealed by the study is the training of researchers and staff at different levels (i.e. changes in research/work habits). Training of researchers and staff at different levels is needed—to embrace and support Open Science. No individual effort will succeed if the central administration is not convinced of the worth of Open Science, thereby promoting changes in institutional policies, infrastructure, and staff allocation. The outlined considerations suggest that the infrastructure dimension can be defined as nascent.

4.2. Systemic conditions

Diversity of actors involved - The interview programme and documentary analysis showcased highly fragmented links between different actors of the Lithuanian R&I ecosystem. Notably, there is a disparity in progress and motivation among different actors and organizations. The barriers for collaboration in Open Science initiatives differed across the actor groups (see Table 3).

Heterogeneity of actors involved is increasingly recognized as an important feature of co-creative processes. However, the analysis of stakeholder perceptions showcased limited capacities of

Table 3: Barriers to actor participation

Actor group	Barriers to participation
Researchers and/or research teams	Incentives and career advancement system based on the traditional way of conducting research; Lack of awareness on what Open Science is and how to conduct it properly; Multiple responsibilities and time constrains of the researchers; resistance to communicate and be a public figure; Risk-averse nature of academics.
Research performing organizations	Institutional barriers (lack of institutional support; lack of interdisciplinary teams; and need for changes in the strategic planning); Technical barriers (lack of technical support staff; limited infrastructure for openness). Cultural barriers (arrogance of the academic community; resistance to change; culture of individualism; limited capacity to accept criticism).
Citizens and civil society	The context of citizen engagement (low participation levels; limited and fragmented links between science and society; lacks of critical thinking skills and curiosity); Citizen engagement strategies (public not willing to be engaged on their own; science provides limited relevance; lack of tested and context relevant engagement strategies).
Industry and business organizations	The industry does not perceive academia as an equal partner; Collaborations with academia are perceived as a distraction; Collaborations just for official requirements; Academics unable to perceive underlying business needs; Links between industry and academia are established mostly through personal contacts and not government-supported networks and initiatives.
Governmental organizations	Unclear responsibilities and boundaries of institutions; Lack of flexibility in funding options and rates; Lack of officials with relevant competencies; Funding focused on infrastructure and not people.

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Libraries	Despite the bottom-up pressures (i.e. requirements of EU, increasing importance of Open Access practices) the changes still stem mostly from personal initiative of librarians and lacks institutional support
Media and journalists	Traditions of science journalism are limited; Scientific knowledge too complex to broadcast in mainstream media outlets; Limited willingness of researchers to communicate

Source: developed by author, 2022

ecosystem actors to collaborate predetermined by lack of awareness, resources, training and funding for Open Science activities. The findings suggest that the maturity of the evaluation dimension can be defined as *nascent*.

Shared vision and trust - In order to ensure diversity among the ecosystem actors and encourage them to actively participate in Open Science initiatives, it is important for the actors to seek shared values and have a clear vision. In most cases, coordinated actions and trust reduce conflicts and serve as a way to create synergies. The interview programme showcased that the Lithuanian R&I ecosystem lacks a shared vision and trust among the stakeholders on different levels of cooperation (e.g. between academia, industry and even amongst the research performing organizations). The incoordination between the stakeholders of ecosystem is influenced by the difficulties with translating the relevance of Open Science and co-creation to the stakeholders. The ecosystem lacks a coherent definition of Open Science and different stakeholders employ different terminology. Another dimension hindering trust in the ecosystem is competition among different stakeholder groups. The findings of the evaluation study suggest that the maturity of this dimension is *nascent*.

Consistent and dynamic communication - Collaborative activities imply drawing on and integrating knowledge from different actors to create the most valuable outcome for the ecosystem. Such knowledge integration requires novel communication strategies which reduce the risk and misunderstanding. The interview programme revealed major issues with communication in the ecosystem (i.e. lack of regular open discussions, debates and awareness-raising activities among the ecosystem actors). The research data suggests that Lithuanian researchers do not have the required competencies and support for successful communication and engagement strategies. Two major factors influence the situation. First, the lack of support from their institutions and governmental organizations in gaining the necessary skills (e.g. there are no science communication courses or training available neither for young researchers, not for seasoned academics). Second, limited willingness of the researchers themselves to experiment with various communication methods and reach wider audiences. The level of maturity of evaluation dimension is *nascent* given the findings outlined.

Intermediaries - Intermediaries facilitate the interactions and build relationships between heterogeneous actors in the ecosystems which often do not have the required experience and capacities. Desk research and interview content showcased a limited number of individual and organizational intermediaries willing and able to serve as facilitators of interaction between different stakeholder groups in Lithuanian R&I ecosystem. However, there are some examples of successful mediation. Most notably, the role of academic libraries has been discussed in spreading awareness of Open Access benefits and requirements. Given the limited numbers of intermediaries the level of maturity is defined as *nascent*.

Feedback and monitoring mechanisms - To promote open R&I policies and initiatives, their impacts need to be continuously evaluated. The evaluation showcased that despite the existence of policies, regulations and guidelines on at least some elements of Open Science (e.g. Open Access) on institutional and national level, there are no studies or ongoing monitoring exercises which determine if the stakeholders are conducting their activities based on outlined. The lack of feedback and monitoring processes in Lithuanian R&I ecosystem suggest that the maturity of dimension is *nascent*.

5. Recommendations

The overview provided in Section 3 allows to reflect and suggest potential refinements and improvements to Lithuanian R&I ecosystem. At the level of each dimension, we have looked at areas where little progress has yet been made. Currently, both the framework and systemic conditions are of low maturity and insufficient to support the Open Science implementation. The evaluation framework allowed to identify the possible blockers and how these might be addressed going forward.

The analysis of the factors limiting the favorable framework conditions has highlighted a lack of development, coordination and implementation of Open Science policies. This is due to the high degree of institutional fragmentation and limited interactions between different institutions. Despite direct and indirect mentions of Open Science in a number of strategic documents and commendable first steps at the implementation level, Open Science elements are included only formally and do not meet the core requirements of research ethics, public participation and transparency. The evaluation of research

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institutions is based mainly on a quantitative assessment of peer-reviewed scientific outcomes, without considering the principles of openness.

In the absence of stricter guidance from national authorities, research institutions are free to develop Open Science activities in the means and at the speed of their choice. Despite the availability of guidelines at some institutions, the dissemination of research data is neither mandatory nor controlled, leading to a wide range of practices and perceptions of openness. The study shows that the technical infrastructure needed to ensure openness principles in Lithuania exists, but there is a lack of basic understanding of Open Science practices among researchers.

The insights from the study suggest that although changes are taking place in individual areas of science and innovation in Lithuania, there is no clear direction, and the existing confrontation between ecosystem actors and individual institutions hinders the formation of a systematic approach towards a more rational and effective targeting of resources. At the same time, it shows that openness in science is not easy or free. These changes require long-term commitment, political will, and financial resources, which are currently insufficient in the Lithuanian Open Science ecosystem.

During the analysis of systemic conditions, a number of individual initiatives by scientists and institutions towards public engagement activities (e.g. increasing science outreach activities, and first citizen science projects) have been identified. Increasing numbers of stakeholders such as libraries, business institutions and citizens are involved in scientific activities. However, the majority of Open Science initiatives are still targeted at members of the scientific community. For example, Open Access articles and databases can improve the work of researchers, but they are of little use to the general public. Most members of the public require basic knowledge on how to evaluate scientific literature or need to receive information on research results in a more understandable (i.e. non-scientific) language.

Knowledge from different actors needs to be integrated in order to co-create value for the whole ecosystem. Such knowledge integration requires new communication strategies and tools. The informants interviewed during the study highlighted a fundamental lack of communication and discussions between the different actors and institutions in the ecosystem. One of the main factors limiting coherent and inclusive cooperation is the lack of communication intermediaries. Intermediaries such as associations, libraries, or individuals able to bring together different stakeholder groups could facilitate the interactions between heterogeneous ecosystem actors lacking the necessary expertise and skills.

The results of the study revealed that the Lithuanian Open Science ecosystem lacks a common vision and trust between different stakeholder groups, i.e., between academia and society, between businesses and even between research organizations. Despite the existence of policy guidelines at institutional and national levels on the elements of Open Science, there is no consistent research or regular monitoring to determine whether stakeholders are acting in line with the requirements outlined.

6. Conclusions and Further Research

The research presented in this article has sought to present a compelling evaluation framework that can be utilized as a tool toward empirically examining Open Science implementation in national R&I ecosystems. The need for such a framework is overwhelmingly grounded both in the motivation of the European Union to promote stakeholder participation in all aspects of research and studies exemplifying the benefits of Open Science. Although both the practice and research agree on the importance of co-creation as a new type of organizing, how to design them for co-creation to happen in academic context is researched to much a lesser extent.

The application of the model in Lithuanian R&I ecosystem allowed not only to identify the potential bottle-necks of implementation but also provided insights on how the evaluation methodology could be improved in the future. First, the underlying conceptual framework was based on a synthesis of prior systematic literature reviews. Although such an approach is suitable in a rapidly growing field of interest, the results are not free from subjectivity. In other words, the conceptual rigor is indirectly influenced by the emerging stage of knowledge co-creation, open science and innovation ecosystems literature. Second, the qualitative approach is also prone to subjectivity biases by the interviewees and the researcher. In addition, evaluation of complex and emergent socio-technical systems, is unavoidably partial, context-specific and temporary. Hence, further work is needed to formulate more specific measures and indicators of Open Science implementation.

Despite the limitations and possible improvement outlined, this research suggests implications for both research and practice. In terms of research, the research contributes to the literature by deconstructing the social rather than technological links in Open Science implementation. Such an outlook is important given the increasing attention of policy-makers both in the European Union and globally for multi-stakeholder cooperation in science. In a more practical perspective, the research findings are expected to be informative and instructional for national and international researchers, policy-makers, researchers, administrative staff of education and research institutions, NGOs and business organizations. Effective measurement and management of the Open Science implementation geared for co-creation would

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strengthen the confidence of the public in the science system and enable collective problem-solving in multiple contexts.

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