

SYSCODE CO-DESIGN FOR SOCIETY IN INNOVATION AND SCIENCE

DELIVERABLE 1.1: RRI RESEARCH LANDSCAPE

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Glossary of used terms

Definition	Definition
EU	European Union
TOC	Table of Contents
RRI	Responsible Research and Innovation
STI	Science, Technology and Innovation
WP	Work Package

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Executive Summary

This deliverable identifies, records and compares previous and ongoing EU framework initiatives and projects which have developed and tested relevant RRI approaches and methodologies. This deliverable builds upon the work of the partners within the consortium leading or participating in previous EU projects, as well as the results of other EU projects. The main purpose of this is to establish a knowledge base and produce lessons learnt to inform the subsequent development of methodologies to be performed in WP2, WP3, and WP4 providing insights on the state-of-the-art on how co-creation in RRI is currently conceptualised and introduced in different contexts. A summary of the main findings of this report is given below:

- The EU has funded a range of projects and produced a number of policies that identify co-creation as an important part of RRI. Despite co-creation not being referred to as one of the pillars of RRI, one of the key requirements of RRI is for societal actors to work together during the whole R&I process so that the outcomes are better aligned with the values of society. In particular, projects argue that involving citizens in shaping technology and innovation is a key way of bringing science and society closer together. Rather than co-creation, the term ‘public engagement’ has tended to be used in RRI when referring to participatory activities.
- Projects working on conceptions of RRI aspire to citizen-led practices, in which citizens become the decision-makers and exhibit higher levels of control. Within this approach, science, as much as the public, are problematized and subject to debate and contestation.
- In practice however, the level of participation adopted by projects that operationalize RRI range from co-creation to consultation, with many tending to fall towards the consultation end of the spectrum.
- Throughout policy, theory and practice, there were calls to institutionalise co-creation processes such that participants are sufficiently rewarded to take part and that it becomes embedded in the innovation process.
- Methods and objectives of co-creation need to be explicit and carefully selected to be appropriate to the subject, context and people. There may be differences between the national-level institutional, regulatory and industrial policy making structures, making certain types of co-creation activities naturally more successful in certain contexts.

1 Introduction

SISCODE (Society in Innovation and Science through **CO-DE**sign) is an EU-funded H2020 project which aims to provide insight into how design processes and tools may be incorporated into Responsible Research and Innovation practices and Science, Technology and Innovation policy design. Currently, co-creation is flourishing in Europe as a bottom-up, design-driven phenomenon in, for instance, maker spaces, fab labs, and social innovations. The project aims to analyse favourable conditions which support the effective introduction, scalability and replication of co-creation activities. This will provide a knowledge base to cross-fertilise RRI practices and policies.

This report, which forms the basis of Deliverable 1.1, documents the place of co-creation in the RRI Research Landscape. We do this by examining how co-creation has been understood and operationalized in previous EU funded projects and policies. This will establish a knowledge base and series of lessons learnt from previous projects, to inform the subsequent stages of this project. But we also hope that this review of the current state of thinking and practice around co-creation in RRI, will also be of value to other related projects.

The report begins with a description of the methodology used for this task. We then go on to describe how co-creation and its challenges is understood in projects that were working on the theory of RRI, contrasting it with how co-creation has been actioned in projects that were operationalizing RRI and the lessons learned from these.

In the third section, we look at how co-creation in RRI is conceptualised in European Union policy documents and how they describe the drivers and barriers to its success.

Finally, we bring the insights from these three sections together and conclude by drawing together the overarching lessons learned and challenges for the future of co-creation in RRI.

2 Methodological framework in reviewing RRI projects and policy documents

Over the past five or more years, the European Commission has funded 48 projects relating to RRI. We set out to review the key learning points emerging from these projects, in particular focusing on how co-creation was understood and implemented.

The SISCODE project team brings together considerable experience and expertise in these RRI projects, with a number of project team members having participated in previous relevant projects. As a starting point then, initially, members of the SISCODE project were asked to complete a questionnaire on EU-funded projects they had previously worked on within the areas of RRI and/or co-creation. A copy of the questionnaire is included in Appendix A. The key findings of the questionnaires are given in section 4.1.1.

The completed questionnaires highlighted that the projects could be ordered into two categories: those which conceptualise RRI in a theoretical way, and those which apply co-creation practices practically through exercises and/or experiments. Viewing them in this way, we also set out to explore whether or not the aspirations of theoretical projects were implemented in practice.

A list of all EU funded projects looking at RRI was produced by identifying the projects funded through the *Science with and for Society* (H2020-SWAFS) work programme; and two specific calls of the *Societal Challenge 6* work programme (*Co-creation for Growth and inclusion* - H2020-SC6-CO-CREATION-2016-2017; *Understanding Europe - Promoting the European Public and Cultural Space* - H2020-SC6-CULT-COOP-2016-2017). Following that, to ensure our list was comprehensive, a keyword search was carried out on the CORDIS database, through which a number of additional projects with elements of RRI and/or co-creation research were identified within work programmes such as *ICT (Future Internet Research and Experimentation - FIRE)*; and *Smart, Green and Integrated Transport*. A full list of the projects identified is included in Appendix B.

The deliverables produced by each of these projects were then identified by searching Cordis and the individual project websites. Projects which were yet to complete their deliverables were then excluded from our list. This produced a list of 20 projects (highlighted in bold in appendix B).

The project deliverables were then reviewed with key information on lessons learnt extracted. These were then manually coded twice with the first iteration pulling out themes and the second iteration focusing on how these were treated within the projects. In addition, EU policy documents relating to RRI and co-creation were analysed in order to identify the aspirations of policy makers concerning co-creation in STI Policy making. Documents were firstly gathered by conducting a search of EU reports which contained any of the words: “co-creation”, “citizen participation”, “public participation”, “social innovation”, “STI policymaking”, or “responsible research”. The former three were chosen as they refer to specific participatory processes among stakeholders and integrate what is considered participatory practice. The latter three terms were chosen as there has recently been much work conducted on public participation within these fields specifically. Secondly, documents were eliminated if they did not elaborate upon “co-creation”, “shared responsibility” or “decision-making”. Thirdly, if they did not mention these, it was checked if the only reason for this was concerning the terminology and/or language they used being slightly different. Finally, recent STI policy reports were checked to see if they mentioned the keywords from the first stage but not in the context of methods/strategies of implementation. This search produced documents which spanned the time frame 1995-2018.

3 Review of RRI projects: survey findings

- **Language and terminology.** To begin, we were aware that while the term co-creation was relatively new to some, ideas around stakeholder participation in science and technology development and decision-making were not. For instance, ‘public engagement’ is one of the ‘keys’ of RRI. So how are these exercises spoken of in the RRI context? We found that a full range of terms was used to describe participatory activities. While the most commonly used terms were ‘public engagement’, ‘knowledge exchange/mutual learning’ and ‘stakeholder engagement/involvement’, we also found ‘dialogue’, ‘diversity and inclusion’ and ‘codesign’ in use;
- **Purpose of participation.** Language is usually chosen to reflect purpose. Furthermore, there are a number of reasons why an organisation would wish to adopt a participatory approach. So, did these different terms indeed reflect a different outlook or purpose for participation? Asking projects to be explicit about what they saw to be the purpose of co-creation, we found that in general, most projects saw co-creation to be a way of including diverse perspectives in their work. It was also seen as a way to align the values of science with society and for developing, shaping and testing a product or idea;
- **When did co-creation take place?** Advocates of participation argue that co-creation needs to take place at all stages of the innovation process – from problem framing, through to product testing. Indeed, our survey found that both in theory and practice, the focus was on participation throughout the innovation process – including during the earliest stages of problem framing and ideation;
- **What was open for discussion?** Similarly, the full spectrum of questions appeared to be open for discussion in RRI exercises – ranging from the kind of future being built with science and technology, to the acceptability of a particular technology. Practical projects in particular mentioned that the social and ethical issues relating to technologies was subject of discussion.

4 Analysis of theory-based RRI projects focussing on theory development

In this section we review the lessons learned for co-creation from EU funded RRI projects that set out to develop the theoretical ideas behind RRI.

The projects reviewed are listed in Appendix A. In all cases we looked at the project websites, CORDIS, and the key deliverables to derive the key lessons learned (as described in methodology section above).

4.1 Lessons Learned

- **Great aspirations for what can be achieved with co-creation.** Within projects focusing on the theoretical application of RRI, opportunities of engaging the public in scientific research has been mapped. In particular, the RRI Tools project (Smallman, Kaatje and Faullimmel 2015) looked at the opportunities which would be created by bringing science and society closer together. They found that stakeholders believed that by involving the public in decisions around science and innovation a sense of shared responsibility could be generated and a technologies and policies better aligned to public interests and social needs would be produced. As a result, stakeholders argued that co-creation had the potential to bring science and society closer together and avoid future controversies. Citizen involvement is also associated with more democracy, better accountability and more effective policy decisions (Reyolds and Gabriel 2016) (Smallman, Kaatje and Faullimmel 2015). This includes a less hierarchical society with more informed and engaged citizens alongside a research and innovation system grounded in everyday experiences. Transparency of processes will also be endorsed, leading to greater trust in scientific advancements. In addition, fair and open communication is related, including honesty about the uncertainty of long-term consequences of scientific developments, reflecting openly on both the negative and positive consequences (Demeny and Kakuk 2016). By involving wider perspectives, it is thought that failures in regulation of technologies may be addressed at an earlier stage. By developing engagement which is genuinely inclusive, projects also argue that open and transparent, mutual trust can be fostered (Randles, Gee and Edler 2015). Openness and transparency are conditions for accountability, liability and thus responsibility. When considering these potential benefits, it is important to note the point made in the RRI Tools project – that these

aspirations are significant but are based upon normative expectations rather than evidence;

- Need to be clear about objectives of co-creation and participation exercises.** Within the Nano2all project (Kupper and Schuijjer 2018), participants of a dialogue session referred to ‘participatory democracy’ as a system in which citizens’ views are heard and have the power to influence the development of research and innovation. Participants suggested three strands through which we may begin to establish a participatory democracy: 1) promoting a scientific culture and critical attitudes among citizens, 2) promoting the involvement of civil society organisations (CSOs), and 3) increasing the willingness and ability of industry, researchers and policy-makers to listen to the voice of citizens. However, projects highlighted how public engagement can be perceived by the citizens as simply a Public Relations (PR) exercise used by politicians and decision-makers. Parallels may be drawn between the perception of engagement as a marketing tactic and Corporate Social Responsibility (CSR) of organisations. The latter is often viewed as a team within PR used, most often in private organisations, to improve public opinion of the company (Edler, Randles and Gough 2015) (Hahn, et al. 2017) (Kupper and Schuijjer 2018). Here, it may be perceived that engagement activities are simply used as tools to collect information to back up decisions which have already been made (Kupper and Schuijjer 2018). Instead, institutionalisation of engagement activities is required to be embedded within organisations and research culture (Watermeyer and Rowe 2014) (Demeny and Kakuk 2016) (Kupper and Schuijjer 2018). There may also be issues about the motives of all actors involved in engagement. Projects have identified that industry in particular is often perceived to have profit-driven intentions, at the expense of the society, and there may be doubts as to whether the engagement is genuine or simply a PR exercise. There may also be doubts as to whether the engagement will be bi-directional or simply a dissemination exercise (Dreyer, Koskow and Dratsdrummer 2018). A number of projects (Kupper and Schuijjer 2018) (Edler, Randles and Gough 2015) have recommended that the goals of each stakeholder must be made public knowledge before the engagement process can occur so that conflicting interests can be uncovered. For the participation process to be seen a legitimate and credible, strong trust is required across diverse communities (Edler, Randles and Gough 2015). In terms of policy making and public engagement, citizens have asked for greater

transparency regarding how the findings of the engagement process have led to policy-related decisions (Kupper and Schuijjer 2018). Furthermore, for better engagement to be achieved, full transparency of the engagement process is required at all levels: rationale, purpose, and method of the activity; the roles and relationships of the actors involved; dealing with expected results and how the results are used; and intended impact. Transparency may be a core value of many CSOs, thus engagement with these requires it to be a precondition (Kupper and Schuijjer 2018) (Jansen, et al. 2016). Many citizens see the potential impact that their input may have in decision-making as a driving factor to engage. When this link is not seen and when the impact of participation is not demonstrated, citizens become discouraged to engage further. Feedback on what was used, why and how, would provide them with a better understanding and greater trust in the activities (Kupper and Schuijjer 2018) (Demeny and Kakuk 2016). Thus, long-term monitoring and evaluation is required after projects have ended. Commonly accepted indicators need to be developed. In addition, keeping participants regularly informed means their expectations are managed (Demeny and Kakuk 2016). Policy outcomes may be difficult to trace however and only have impact in the long run. Without evidence that their input has been taken seriously however, citizens may begin to distrust engagement activities as they may only serve as an ‘alibi’ to policy makers to pursue decisions which have already been made. Beyond this, a further challenge is managing participant expectations (DITOs Consortium 2016). By making clear the activity, goal, process, expected outcomes and future activities this may be controlled. In addition, by using continuous feedback mechanisms highlighting what has been done with each engagement activity citizens feel valued and gain understanding of the policy making process (DITOs Consortium 2016) (Blagovesta, et al. 2017);

- **Support for participants from all stakeholder groups needed.** Throughout the reports, the need for support for participants from all stakeholder groups to participate in co-creation was evident. In many projects, a gap between scientists and society was described (for instance (Hahn, et al. 2017)). On one hand, the public expressed concerns about their own ignorance of scientific topics and debates. On the other hand, the RRI Practice (Hahn, et al. 2017) project highlighted that in some cases scientists are still seen to be living in ivory towers, contributing to a negative perception of them in the media and public eye. While dialogue between these two

groups was seen to help narrow this gap, it was also clear that support is needed to do this. Projects reported that citizens and third sector actors fear they do not have the necessary knowledge and skills to engage in participatory activities around science, technology and innovation, scientific methods and policy (Dreyer, Koskow and Dratsdrummer 2018) (Kupper and Schuijjer 2018). For instance, participants of PROSO (Promoting Societal Engagement in Research and Innovation) project claimed that they do not receive adequate communication about current scientific research from neither policy makers, nor scientists themselves (Blagovesta, et al. 2017). Citizens may also be unwilling to engage in dialogues around technical and complex issues for fear issues will be presented in an impenetrable way with little connection to the everyday lives of citizens (Dreyer, Koskow and Dratsdrummer 2018). This lack of relevance makes engagement more challenging and unsatisfactory. There is also a perception that researchers and scientific experts are incomprehensible, use jargon, and are unaware of the policy world (Bauer, Bogner and Fuchs 2016). Sometimes citizens may claim topics are not of interest to them as they are at a very early stage of development and may not be written about in media sources consumed by the public. In such cases, this may lead to participants feeling unable to contribute to discussion and engage with experts in the field (Kosow, et al. 2018). Third sector actors, who may be useful as intermediary actors between the public and scientists may also perceive themselves as ignorant for similar reasons (Kosow, et al. 2018). Some participants of the PROSO project have noted they believe the participants' opinions will be too greatly influenced by scientists' views in cases where the public have not been provided with accessible information beforehand. In addition, it has been noted that this method of policy making may lead to poor quality results and decision making (Blagovesta, et al. 2017). For many projects, linking co-creation to science education more strongly was seen as a way to help circumvent this issue – through early education activities (Waarlo 2014) and through accessible resources in the case of participating adults. The PROSO project highlighted the need to provide participants with accessible, continuous and attractive information and education opportunities to citizens on scientific topics. The use of a one-directional flow of information from researcher to participant may discourage citizens from taking part. By giving citizens a more active role in the engagement activity, they are more likely to become invested in the process and thus more inclined to participate and educate themselves. Thus, integrating methodologies which both educate the public and engage them in a two-

way communication are those which have the greatest potential to create the most meaningful citizen contribution to R&I (Dreyer, Koskow and Dratsdrummer 2018). Projects conclude that participants need carefully produced briefing material prior to a co-creation exercise and that the evidence, the briefing report and general information provided to participants prior to an engagement exercise must be accurate, adequate and trusted in order to be effective; hence it must be robust, open, inclusive, contextualised and sourced from a variety of different stakeholder from different regions of the spectrum (Edler, Randles and Gough 2015). It was not just citizens identified as needing support to participate in co-creation activities however. Projects noted that some researchers have exhibited reluctance to participate in co-created research initiatives as they are concerned this will lead to the loss of autonomy and creativity in their research, which are often perceived as fundamental to being a researcher. In instances where researchers or communicators have engaged with the public successfully in co-creation activities, those involved have felt that the experience provided an opportunity to identify and reflect on undiscovered aspects of their professional practice (Watermeyer and Rowe 2014). Promoting and sharing positive experiences is therefore important to encourage more participation. In addition to this, the view of the public may be voiced by third sector organisations (TSOs) such as environmental charities or consumer organisations. Such third sector organisations may feed the views of the public into research strategies, policy debates and funding programmes (Blagovesta, et al. 2017). Advisory committees may also be opened up to third sector organisations. It has been suggested that this may be through funding organisation involving TSOs in funding decisions on societally relevant research and monitoring of such research simultaneously to project implementation and reviews of overarching research programmes. The public will then gain the power to co-define what societally relevant research is through TSOs. Possible tensions between policymakers as top-down actors and co-creation as a bottom-up process have been highlighted (Ahmed, et al. 2017). By involving policy makers in bottom-up processes of co-creation, the capacity of the exercise may be limited by forcing it into traditional structures of policy making (Howaldt, et al. 2014). Carefully selecting and preparing policymakers to participate is also important in the success of co-creation activities;

- Citizens need to be put in the driving seat.** The Nano2all project (Kupper and Schuijjer 2018) in particular highlighted that the selected topics of discussion in co-creation or public dialogue situations are often technology-led, which pushes the citizen into the ‘non-expert’ role and limits their participation as an equal actor. Instead, it is suggested that public participation initiatives should be framed around issues experienced by citizens in everyday life; this leads to challenge-based forms of public engagement. Framing of the research topic should be focused around reasons the issue is important to citizens (Dreyer, Koskow and Dratsdrummer 2018). Citizens may be involved in participatory agenda-setting exercises by using concerns experienced by participants, e.g. traffic in their town or the wider processes of globalisation, as incentives to involve them. Citizens may contribute to the design of research agendas by co-shaping visions of the future. Such visions can aid policy makers prioritise basic and long-term directions of research (Kosow, et al. 2018). Open calls seeking citizens to define their own societal challenges and needs also allows citizens to play a more active role in agenda-setting of research. Importantly, when research is framed to be relevant to citizens, and engagement processes deal with practical issues with a clear relation to everyday life, citizens may feel more incentivised to participate. These may be local or regional issues which may later be linked to national or global concerns. Invitations are also more compelling when they relate to interests, experiences, or fears of groups within the same context. This is supported by instances of participants failing to engage once they decided the issue was not relevant to them (Kosow, et al. 2018). By treating engagement as a bi-directional process required to influence the policy stream as opposed to one-off exercises, citizens begin to have more control over the STI policy-making process and research process. It does however need to be structurally embedded without too much bureaucracy (Hahn, et al. 2017) (Watermeyer and Rowe 2014). Concerns raised by citizens and their responses to them may emerge from local challenges or needs (Domanski and Kalteka 2017). It is found that citizen engagement exercises may lead to suggestions which requires local knowledge and reflects the cultural landscape of the exercise (Blanco, et al. 2017). This may be viewed as a possibility to engage with citizens more meaningfully by focusing on local needs and values and promoting science as a part of cultural identity. By involving citizens in decision making and ensuring they feel part of the science world and policy making process, science may then be absorbed as a part of the local cultural identity (Kupper and Schuijjer 2018).

Awareness may be raised about what science and technology have done in the country. In some cases, it has been mentioned that citizens should act critically, raising problems, performing their own research and providing solutions, voicing criticism and questioning politicians (Kupper and Schuijjer 2018). One project dubbed this ‘informed citizenry’, allowing for critical attitudes and ensuring public debates (Kupper and Schuijjer 2018). The use of citizen science as a route towards this may be an option. Other methods have been suggested such as engaging artists such as writers and filmmakers with science and innovation issues. These artists then have the freedom to explore possibilities of the future, increasing public debate and awareness (Kupper and Schuijjer 2018) (Blagovesta, et al. 2017);

- **Sessions need to be well facilitated.** In order to create better dialogue between researchers and the public, there is a need for people who are able to play the role of a mediator between the two. This may mean redefining the role of researchers themselves to include this – so they understand that their role is to listen and interpret as much as to act as an ‘expert’ or the use of other intermediary actors. For scientists themselves to take up this role, more training is required to enable researchers to develop such skills and there are also calls to make sure that such activities are valued within the academic career framework (Hahn, et al. 2017). The role of civil society organisations (CSOs) was highlighted as a possible route to ensuring all appropriate sectors of society have their voices heard. When employing engagement activities issues may arise when dealing with many scientists from different backgrounds in the same room, e.g. physical chemists and chemical physicists. There is a need to align goals, objectives, procedures, and measures across all actors to achieve consistency and clarity when speaking about the scientific area (Arnaldi, et al. 2016). Objects which are shared, e.g. data may be useful to focus on in order to translate between different fields (Arnaldi, et al. 2016). In addition, the mediation between industry and society will be different to that between publicly funded researchers and society as funding structures and processes may differ (Hahn, et al. 2017). Common values may be shared between industry and the public sector so, by focusing on approaches to tackling societal challenges, conflicts may be overcome (Waarlo 2014). Having many researchers’ opinions at the same event however may also increase the legitimacy of the engagement, as citizens recognise the opposing views and do not feel misled. In addition, the engagement may deepen and sustain impact around the grand

challenges as the public begin to understand the complexity of the issues at hand (Ahmed, et al. 2017). In cases in which the methods used to engage the public are unfamiliar or create uncomfortable situations, e.g. web-based tools or video/audio recordings, some participants may be marginalised. This creates the risk of developing policy for those of higher socio-economic status who may be more familiar with the engagement techniques. Instead, methods and tools of engagement should be chosen depending on the participating group and context (Bauer, Bogner and Fuchs 2016);

- **Participation and co-creation need to be incentivised and institutionalised.** Often, participation means citizens coming to events or workshops after work or during weekends. In addition, participation may result in additional costs such as child care and travel. This dedication of time and financial resources comes at a cost and should be included as a claimable cost associated with the engagement exercise if no stipend is provided. In cases of engagement with CSOs, engagement initiatives need to hold some reciprocal value for them. The activity should be mutually beneficial. Scientists who were involved in public engagement exercises voiced their frustration in not including these as criteria on CVs for recruitment and/or promotion. In order to institutionalise public engagement, there needs to be a commitment through, e.g. university mission statements. They did however note that in doing so it would require ‘new’ views to come forward over ‘old’ (Smallman, Kaatje and Faullimmel 2015) and to include this within the perception of hierarchy/status within the academic community. There is a current request from all parties that public engagement activities should be formalised within research organisations. Generally, societal engagement usually occurs through the individual efforts of scientists and are informal and not centralised within universities, usually taking the shape of side projects (Hahn, et al. 2017). It does not often count towards academic promotion (Arnaldi, et al. 2016). Both public engagement and science education are conducted in a fragmented way compared to ethics and gender for which formal policies and procedures are in place. There is therefore a need to institutionalise engagement activities to be a part of an organisational culture. Currently, there is an over-reliance on individual champions in the form of those in powerful positions within organisations. This could be in universities or governments. When roles or leadership changes however these commitments may weaken (Ahmed, et al. 2017). Social

engagement may also be inconsistent as it has not yet been formalised (Ahmed, et al. 2017) (Hahn, et al. 2017). There is a need for an overarching strategy or explicit shared understanding of roles supporting co-creation of policy and public engagement (Domanski and Kaltefleiter 2017). The Voices project highlighted the move by the commission itself to transition citizens' contribution to more meaningful impact (Watermeyer and Rowe 2014). The project was seen as an empowerment mechanism, mobilising public opinion. There is also a need for training of researchers to conduct societal engagement activities and, as mentioned previously a redefinition of 'excellent research'.

4.2 Tensions and challenges identified in theory-based projects

- **Mission driven focus vs public setting agenda.** In order to make science more accessible to the public, framing of research questions around grand challenges is seen to improve understanding and transparency of research. Grand Challenges allow research to be relevant to citizens' everyday lives, allowing them to become more invested in research or research policy (Demeny and Kakuk 2016) (Dreyer, Koskow and Dratsdrummer 2018). However, there is an argument that this does not allow for citizens to frame the initial research challenges (Edler, Randles and Gough 2015).
- **Redefining 'excellent' research.** Projects have highlighted how, in order to implement calls focused on grand challenges and for public participation to be core to research, a redefinition of 'excellent research' must take place (Hahn, et al. 2017). Should excellent research be redefined, decision making and evaluation processes of funders would also need to be adapted such that 'world class research' may become 'responsible research'. One solution would be to reframe research councils as funders, policy advisors and societal actors, and as such, responsible for the innovation they fund. It has been noted that science and corporates need a cultural change and a 'flip' towards impact pathways which promote and enable thinking towards end goals as described by grand challenges (Hahn, et al. 2017).
- **Economic vs. societal needs.** Often, societal needs are intertwined with economic benefit. Currently, there exists a presumption that new technology will create societal benefits through benefits to the economy (Hahn, et al. 2017). The issues which

research projects propose to challenge or solve however are still decided by the scientists. Instead, participatory research-agenda setting may be done through greater citizen participation. Currently, there exists a trade-off between research for societal benefit and commercialisation (Hahn, et al. 2017). There is a need for parameters to show how challenges are approached so that differences may be made between those which produce commercial or social gain. There needs to be a rebalance in understanding the public's priorities between science, technology and innovation research for economic development or societal gain (Hahn, et al. 2017) (Dreyer, Koskow and Dratsdrummer 2018) (Kupper and Schuijjer 2018);

- **Understanding and integrating co-creation as an Iterative Process.** Visions of futures created by citizens should be adaptable in order to account for dynamic, changing contexts over time (Edler, Randles and Gough 2015). It must also be recognised that clashing views may also vary temporally and may be managed by an adaptive approach to future visions. Continuous engagement also may make it easier to uncover root interests and concerns of citizens allowing more meaningful solutions to be co-developed (Blagovesta, et al. 2017). There is a need to respond adaptively to emerging knowledge, perspectives and norms. Reflection upon previous actions and their effects must also be conducted in order to better shape future goals. In addition, some projects have noted the conventional approaches to policy making assume a linear process and draw a distinction between policy formulation and implementation. It has been argued however that the two are interlinked and policy outcomes may change during implementation. Thus, an iterative, adaptive approach to policy which is driven by the views of citizens has been suggested (Domanski and Kalteka 2017). Some grant-funded projects do have engagement activities inbuilt but may be time-limited as they end once the project ends. There needs to be more mechanisms to ensure engagement continues after the project, e.g. through new projects (Domanski and Kalteka 2017). Citizens have observed a need for a platform which enables continuous dissemination and discussion between, e.g. medical patients, scientists and citizens.
- **Measures for Evaluation.** There is a need for measures or indicators of evaluation of co-creation activities, uncovering, for instance, its effectiveness and impact. Case studies of societal impact of 'good quality' are required. Projects argue that this may

not necessarily be quantified and may be through the form of narratives of how research affects society (Hahn, et al. 2017). Others have suggested initiatives which map and measure activity, attempting to measure its impact and contribution over a long period of time after the project (Domanski and Kalteka 2017). Long term mapping on a large scale is required as some immediate effects may be difficult to measure.

5 Analysis of deliverables of experimental-based RRI projects

In this section we review co-creation in the deliverables of RRI projects that set out to apply it in practice. We explore how co-creation is used, lessons learned, the barriers, drivers and challenges.

5.1 The key features of co-creation activities

Co-creation activities are seen as mechanisms to achieve three distinct objectives: 1) to develop solutions to grand societal challenges (Hennen and Pfersdorf 2014) (Steir and Dobbers 2017) (Marina Team 2017); 2) to understand public values and integrate these within the R&I process (Aarrevaara 2016) (Marina Team 2017); and 3) to develop user-centred approaches to policy and R&I design (Aarrevaara 2016) (DeEP Project Team 2015) (Llamosas and Clifton 2017) (Llamosas and Clifton 2017) (IDEO; Design For Europe; Nesta 2017).

The co-creation activities are mainly described using terms which refer to bi-directional dialogue and engagement including: public engagement; stakeholder engagement; participatory processes; inclusive engagement; multi-actor dialogue; participatory involvement; societal engagement; citizen involvement; and public deliberation and consultation. These terms however may be used to describe activities which exhibit degrees of tokenism on the ladder of citizen participation (Arnstein 1969). In some cases, terms associated with degrees of citizen power are used such as: co-implementation; co-design; co-production and co-creation. Use of such terms may also be associated with degrees of tokenism, thus it is important to consider the activities taking place and their associated outcomes.

5.2 Desirable outcomes of co-creation activities within the context of the project

The desirable outcomes of co-creation activities are often given as either the need to uncover the views of the public and ensure their voices are represented in order to better shape scientific research, or to develop more democratic, and thus better designed policy and public services. The projects themselves may be categorized into those which seek to uncover one of three categories: 1) societal views to scientific developments; 2) drivers and barriers to co-creation; and 3) citizens' visions of the future.

5.2.1 Projects focusing on societal views

- **CITADEL:** Focuses on co-creation of shared values between the government, organisations and citizens. There is hope that the interaction itself will be beneficial as public administrators will be better able to develop the design and delivery of public services with the input from citizens. Co-creation was seen as a process to better design public services (Llamosas and Clifton 2017) (Breuer 2017).
- **CONSIDER:** Co-creation is seen as a process to incorporate the views of the public through CSOs in research. As their interests differ to those of researchers, they voice opinions which have not been heard and influence the research agenda through extending the scope of the research (Rainy and Goujon 2012).
- **Engage2020:** Public engagement is seen as a process in order to create better democratic science policy. Public opinion on scientific developments are to be gauged to develop judgements and decisions to inform science policy. The ambition is to get researchers, policy makers and the public to collaborate and co-create knowledge and co-produce innovation (Hennen and Pfersdorf 2014).
- **PE2020:** Co-creation is seen as a mechanism for the contribution of participatory approaches to develop better governance practices. To create tools and instruments for dynamic and responsive governance in science in society (Aarrevaara 2016).
- **Sparks:** Public participation is seen as a method to ensure the voices of society are represented within the R&I process through awareness raising and engagement (Pletosu, Deaubeuf and Goffredo 2018).

5.2.2 Projects focusing on drivers and barriers

- **ACCOMPLISSH:** Co-creation is used in relation to SSH disciplines: establishing a platform for dialogue where stakeholders jointly and equally, identify barriers and enablers of co-creation – with the intent of initiating, widening and optimizing co-creation. Co-creation is understood as a process and was used to establish how to better address multidisciplinary research and create impact (Steir and Dobbers 2017).
- **LIPSE:** Identified drivers and barriers of co-creation in different geographical contexts. By categorizing countries into strong or weak local governments, the

influence of citizens in decision-making can be explored. It is hoped co-creation will enable policy recommendations and the project will aid in recommending appropriate instruments for co-creation in different contexts. Co-creation is seen as a process and in some cases, the activity itself is seen as the most valuable outcome as it enables diverse perspectives to be brought together and heard (LIPSE Project Team 2015).

5.2.3 Projects focusing on visions of the future.

- **CIMULACT:** Co-creation was used for citizens to develop visions of the future. The work is about scientific orientations and the selection of priorities, thus with a link to policy objectives. Co-creation was seen as a process to create a co-created vision.
- **MARINA:** Identified actions and solutions towards marine and societal challenges. The public were consulted as what their visions, needs and desires are, understanding and creating solutions and federated communities, suggesting policy options concerning R&I. Co-creation is seen as a process to elaborate policy options (Marina Team 2017).

5.3 Characteristics of the co-creation activities

The methods most often mentioned to engage with the public were:

- Focus groups;
- Workshops;
- Written Communication;
- Development of Storyboards;
- Ethnography;
- Science Café;
- Conferences;
- Pop-up Science Shops;
- Incubation Activities;
- Scenario Workshops;
- Dialogue.

Co-creation is treated as an exercise used to:

- Define societal issues;
- Guide Research Orientation;
- Create dialogue around Policy Making;
- Crowdsource Ideas;
- Gather Data for Science Projects;
- Policy Making.

It was rare however for all citizens to be involved in all stages of the process within the same project, e.g. citizen participation is used to define societal issues but not to crowdsource ideas within the same project and vice versa.

Projects were generally placed within the consultation and placation levels of the ladder of citizen participation (Arnstein 1969). The CONSIDER project itself noted “The CSO role attribution also indicates that CSOs are rarely able to discuss the research project design from its start. Only 30% of project coordinators indicate that CSOs are involved from the start of the project. The majority report they are involved at the planning stage only” (Rainy and Goujon 2012). Thus, the CSOs were not involved in defining the issue. Often, the activity itself is described as consultation (Hennen and Pfersdorf 2014) (Steir and Dobbers 2017) (Missions Publique, Fraunhofer Institute for Systems and Innovation Research, Strategic Design Scenarios, Politecnico Milano 2017).

5.4 Actors and hierarchy in the engagement process

In all cases except some case studies from the PE2020 project, either researchers, the government or science communicators were those in control of the co-creation activity with citizens being invited to contribute. In all cases all stakeholders were given an equal voice to participate within the activity itself, but the decision-making power is still held by researchers and policy-makers, e.g. in deciding what research proposals to take forward. This indicates that the level of engagement still resides within tokenism (Arnstein 1969).

5.5 Lessons learnt through the co-creation activities

From engagement activities many projects have produced deliverables outlining the lessons learnt. CITDEL and LIPSE both mentioned the need to involve the public from the beginning, and throughout the research/policy making process to create a sense of ownership which in-turn increases loyalty towards the service/policy and strengthens long-term engagement (LIPSE Project Team 2015) (Llamosas and Clifton 2017). The opinion of the public is

sometimes voiced through Civil Society Organisations (CSOs). In the case of the CONSIDER project it was recognized that projects in which these groups tend to be sidelined to negligible roles, conflict situations between scientists and the public are more likely to arise. Indicators of negligible roles include: no recognition, CSOs not held at an equal status to research institutes; no influence on agenda setting; input only at later stages. Projects with at least two CSOs with influential roles face little or no conflict. It is suggested the CSOs play an intermediary role within the project (Rainy and Goujon 2012).

When conducting engagement activities a few observations have been made by the Engage2020 project team to ensure good participation (Hennen and Pfersdorf 2014). These include:

- The purposes and objectives of engagement should be clear and well-articulated to participants before the activity takes place.
- Engagement should begin as early as possible in the policy making process.
- A culture of transparency should be fostered.
- Both aspirations and concerns of citizens should be addressed with as many perspectives presented as possible.
- The expectations of citizens should be managed by being clear as to the extent to which participants may influence outcomes.
- Methods should be used which are appropriate to the objectives of the engagement. Many methods may be used when objectives require it.
- Evaluation mechanisms should be built into all stages of engagement.

When using engagement activities for policy making, it has been noted that the step referred to as 'prototyping' in design projects is often neglected due to time constraints (IDEO; Design For Europe; Nesta 2017). It was observed that by dedicating more time to engagement during the early stages of policy making, less changes are required further down the line.

Furthermore, it is important to understand policy contexts before attempting to implement co-creation. State traditions and administrative contexts are different among countries (LIPSE Project Team 2015).

6 Co-Creation in STI policy making: a review of policy documents

EU policy documents were also analysed to uncover what the aspirations of policy makers are concerning co-creation in STI Policy making. The methodology was described in Section 2. An overview of gaps and inconsistencies of public participation and engagement in science was compiled by assessing the science, technology and innovation policy making processes described and acknowledged in EU policy briefs and reports. These gaps and inconsistencies are for example, when and how the decision of inviting the public to participate in research is formed, who has the power to decide whether certain groups of public actors should participate, how does the voice of the public matter, and how often the public should be informed, consulted and engaged, among others. The aim of this literature review is to gain an understanding as to whether or not the aforementioned gaps and inconsistencies have been or could be overcome by introducing and applying co-creation.

Science is a human enterprise internationally recognised as a key driver of economic and social prosperity, and nationally recognised as a means of contributing to a national worth, prestige and well-being (Ozolina, et al. 2012). The relationship between Society and Science is affected by the undergone transfer of the knowledge gathered and interchanged between these two spheres. Science has contributed greatly to technology and innovation advancements on which Society relies. The Science “works together with or intertwined into other societal, cultural and historical factors” (Gulbrandsen 2016).

How the scientific outputs (products, services, systems and policies) reflect and relate to the daily life of Society? How do they reflect on coherent human development — are societal needs being addressed through scientific, technological and innovation advancements? Weber & Andrée (Weber and Andree 2015) indicate there should be stronger connection between Research and Innovation (R&I) policy making and other EU policies that approach to certain aspects of cultural, societal and economic development.

The ongoing impact was stressed by Helga Nowotny, former EU research policy and head of the European Research Advisory Board, who insisted on the reciprocity between Science and Society, stressing the need for Science to establish a dialogue with society in order to deal with “uncertainties, contradictions and contingencies”. Nowotny and co-authors (Nowotny, et al. 2001) referred to this process as “co-evolution”, to emphasise how science and society

evolve simultaneously and are interlinked, necessitating continual reassessment and reflexivity. (Gulbrandsen 2016) stresses that acknowledging co-evolution between Science and Society can be supported through overlapping actions and mutual support activities. Further, the author refers to staging an operational framework which can contribute to:

- Eliminating the time between knowledge production and its application;
- Eliminating invasiveness of science and tackling and bringing about the inclusive solutions to the topics/approaches that are determined as the societal priorities.

Consequently, while the scientists need to practice reflexivity over social impact and implications that their research has, the public need to become more conscious in which way STI affect their lives. STI brought about changes that greatly influenced and had impact on new generations and the societal transformation of lifestyles and trends (Addarii and Lipparini 2017). In Responsible Research & Innovation (RRI), there should be reflection made on the approaches when considering varied social and economic needs, public expectations, and attitudes towards different sciences and technologies. The shared values and principles in RRI should constitute the normative framework for global governance of Science. There is a strong impact on societal spheres bringing up the new global challenges such as:

- New interconnected world with powerful digital systems;
- Occurrence of producer society rather than consumer;
- Turning to the principles of resilience;
- The quest for the purpose remains central in people's lives.

6.1 Aims of public engagement in EU policy documentation

In the document “Reinforcing Resilience in an Inter-connected World: Lifestyle Changes in Relation with Science and Innovation”, there is a recommendation entitled “New Forms of Conducting Research and Creating Innovation” (Stenros and Heikinheimo 2015) where it is stated that innovation means involvement of citizens and that citizen participation should be increased — the bottom-up approach should be applied in innovation ecosystems. For example, when public institutions with traditional operational framework seem partly defeated with solving complex and/or wicked problems the citizens and innovators “will become active contributors” (Stenros and Heikinheimo 2015) through appropriated digital tools and global communities. Hence, (Sutcliffe 2011) addresses the interest of citizens to contribute to the Science when:

- The public feels that their views will be taken into consideration, especially in subject-matters of clearly direct relevance (health issues, social services issues, among other);
- They are equal and equitable co-creators of the desired results and impact.

The role of citizen participation and engagement in Research and Development (R&D) process can be contribution to (Sutcliffe 2011):

- Shaping a vision;
- Appropriating and helping to prioritise the directions of research;
- Co-deciding about inclusiveness of the cutting-edge science;
- Shaping applications of invention and their usage;
- Co-deciding about disposing or recycling.

6.2 Public engagement mechanisms

Citizens can gain skills, knowledge and the capacity to engage in future democratic participation outside of the specifics of R&I governance (Democratic Society 2018). However, how and in which way publics will be invited to participate depends on the actor-coordinator of the innovation process. RRI challenges each actor-coordinator to “consider carefully what information and engagement people want and need to help them give an informed opinion and deliver it clearly and effectively,” (Sutcliffe 2011):

- What are the goals of citizens’ participation?
- Where and how exactly public should be participating?
- In what society should be participating to (co)create innovation?
- What are the provided means for citizens’ participation?

6.3 Issues surrounding co-creation and STI policy making

There is an ongoing reflection and debate on public participation and engagement, its aims, outcomes, and citizens’ views on governance of science (Felt and Fochler 2009). Public participation in science governance was mostly related to the issues of expertise and evidence from non-traditional sources and public engagement as a buzzword.

- **Expertise and evidence from non-traditional sources.** Firstly, society should be expected to feed and nurture expertise and evidence from non-traditional sources. This challenge can be overcome by raising awareness of policy makers so they may

gain an understanding of the potential of the public to contribute their knowledge of subject matters and their competencies to tackle contemporary issues. This means that methods need to be accepted and adopted that allow knowledge to be treated as equal, regardless of whether it comes from the public vs. the scientist or the individual vs. collective expertise (Mazzucato 2018). In addition, Sutcliffe (Sutcliffe 2011) highlights a further challenge of RRI being more innovative and inclusive by “embedding the involvement of the public within at all stages of research and innovation without wasting their time and other people’s money.” Consequently, building the values together with citizens (when incorporating citizens' values in STI), it is possible to create conditions for a meaningful participation and secure a commitment to research and innovation through dialogue. The conditions for connectivity and collective action are encouraged by sustained sense of ownership and shared social responsibility among individuals and collective — public, private and academic stakeholders.

- Public engagement as a buzzword.** The criticism falls on the concept of public engagement becoming a buzzword, interpreted differently by each individual/collective — depending on their context, their interest and the need to use participation in a process of certain development. Even the term ‘public’ is open to discussion and consideration – usually the term is used to refer to non-scientific audiences, but the point is often made in literature and practice that the public is not one homogenous group but instead made up of numerous ‘publics’, with different ‘stakes’ and levels of influence and vulnerabilities, who are not simply passive, but are actively constructed – or construct themselves – as an issue arises. Without normativity and agreement on the meaning of the concept of public engagement, it is easy to sustain ongoing debate. There is a possible threat of setting a colonialist approach in research participation to its means and ends, aiming at the participants (the one that take part in STI policy making) to involve in the actions not considered as the levels of active/meaningful participation on the “Citizen’s Ladder of Participation” (Arnstein 1969). This is tested by categorising the reports according to Arnstein’s Ladder of participation. It organises activities of engagement depending on the levels of participation of the ‘have nots’ - stakeholders at lower levels of power. In the case of co-creation of STI Policies, it is possible that those who have low levels of power would include the public. This may be tested by using the ladder of citizen

participation for the categorisation of activities, highlighting those which go through an empty ritual of public engagement and those which enable the ‘have-nots’ – the public – to have the real power needed to affect the outcome of the participation process. Public engagement without the redistribution of power is an empty and frustrating process for citizens. It allows the power holders to claim all sides were considered, but makes it possible for only some of the sides to benefit. The ladder is shown in Fig. 1 and displays the typology of eight levels of participation noticed by Sherry Arnstein (Arnstein 1969).

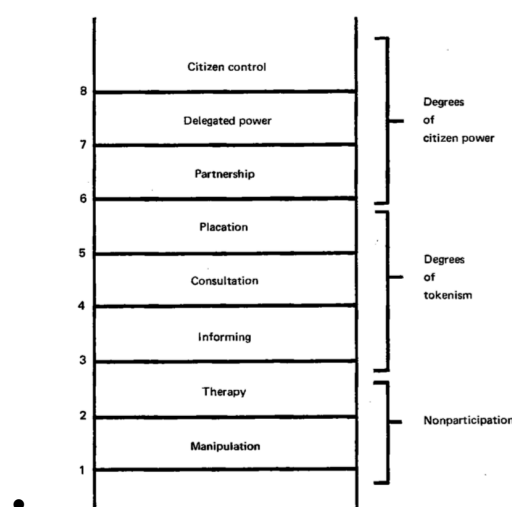


Figure 1- Eight Rungs on a Ladder of Citizen Participation. Taken from (Arnstein 1969).

The eight levels are briefly described as:

1. **MANIPULATION and THERAPY:** levels of ‘nonparticipation’ contrived by some to substitute for genuine participation. Enable power holders to ‘educate’ or ‘cure’ the have nots.
2. **INFORMING and CONSULTATION:** levels of ‘tokenism’ which allow the have nots to hear and have a voice. But they lack the power to ensure their views will be heeded by the powerful. No follow through or assurance of changing the status quo.
3. **PLACATION:** higher level of tokenism. Allow the have nots to advise but retain for the power holders the right to decide.
4. **PARTNERSHIP:** enables them to negotiate and engage with trade offs.
5. **DELEGATED POWER and CITIZEN CONTROL:** have not citizens gain the majority of decision-making seats, or full managerial power.

It is noted that the majority of reports (Democratic Society 2018) (Addarii and Lipparini 2017) (Slaus, et al. 2016) (Giovannini, et al. 2015) (Sutcliffe 2011) (Felt and Fochler 2009) (Ministério da Ciência, Tecnologia e Ensino Superior 2016) (Sociedade Portuguesa de Inovação (SPI) 2014) (European Commission 2013) reviewed still consider engagement as a top-down process mostly related to tokenism and the early stages of active participation.

- **Barriers to participation.** According to van den Hoven and co-authors (Van den Hoven, et al. 2013) European citizens have expectations that STI can tackle contemporary challenges such as the climate change, clean energy, an ageing population, social inclusion, among others, and contribute to the higher living standards by creating more jobs. However, the authors stress several barriers to the participation of citizens, stakeholders and civil society groups in the R&D processes (of research institutions or/and businesses): i) Insufficient funding for stakeholder participation; ii) Research processes not stipulating the inclusion of stakeholders; iii) Lack of awareness.
- **Overcoming issues surrounding public participation.** Even if there are barriers in engaging citizens to R&I processes, in the European report “Science The Diplomacy Europe’s Future: Open Innovation, Open Science, Open to the World” (Slaus, et al. 2016) there is an attempt to advocate creating a well-functioning eco-system that allows co-creation to become an essential tool for overcoming indicated barriers. In the proposed user-centric eco-system relevant stakeholders are collaborating along and across industry and sector-specific value chains to co-create solutions to socio-economic and business challenges.

6.4 Open innovation systems

The co-creation will take the places in different parts of the innovation eco-system and it will require knowledge exchange and demonstrated capacities from all the actors involved, from any sector (Slaus, et al. 2016). Thus, the authors describe the proposal for the Open Innovation ecosystem in Europe which is characterised by: i) Combining the power of ideas and knowledge from different actors (whether private, public or civil society/third sector); ii) Co-creating the new products and finding solutions to societal needs; iii) Creating shared

economic and social value, including a citizen and user-centric approach; iv) Capitalising on the implications of trends such as digitalisation, mass participation and collaboration.

- **Mission-oriented innovation policy.** In the published reports of the European Commission there is rare mention to policy strategy for steering tools and instruments that supply side of R&I (e.g. Horizon 2020). Mazzucato (Mazzucato 2018) proposes a systemic approach to STI policy making through mission-oriented innovation policy. This strategy employs instruments to promote the accomplishments of trans-sectoral and trans-disciplinary mission which can set concrete directions for the economy, achieving the “network of relevant public and private agents.” For example, according to Medina (Medina 2005), the EC’s Regional Innovation Strategies may build around the stakeholders’ map that includes: regional authorities, enterprises, sectoral organisations, universities/laboratories, technological centres, consulting support centres, local agencies and local authorities. In this aspect, the State needs to galvanise the interests of all relevant actors and organise itself around aforementioned “collective intelligence” and “mutual learning” (Medina 2005) to think accordingly and be capable of addressing bold policies that are based on shared opinions, needs and interests. The author stresses that the State will have to coordinate the efforts of this stakeholder network through its convening power, brokering trust relationship and by using targeted policy instruments (i.e. taxes, monetary incentives). The European public support for STI lacks funding for market-creating breakthrough innovations and this gap could be bridged by supporting bottom-up transformative innovative projects. Subsequently, accomplishing those parameters, the knowledge creation and diffusion flow of achieved results will be more effective when open to the society. Besides focusing on the elements such as research skills, excellent science, funding and intellectual property management, Slaus et al (Slaus, et al. 2016) stresses the need to concentrate on the demand for knowledge circulation — to assure that scientific production corresponds to the societal/end-users needs and that knowledge is accessible, clear and applicable.
- **Mission-oriented innovation policy: examples.** The Portuguese example (Ministério da Ciência, Tecnologia e Ensino Superior 2016) aligns with the proposed mission-oriented innovation policy approach. The Ministry of Science, Technology and Higher Education launched the initiative of Laboratories of Public Participation (PPL) with

the aim of stimulating public involvement in the construction of R&I agendas and in the debate of public policies for STI and the diffusion of knowledge. The initiative is implemented together with Ciência Viva Agency, SISCODE's partner, which is fully aware of the most recent international practices of involving society in the formulation of STI public policies. The first PPL "Northeast Transmontano: a region with knowledge" was carried out in close collaboration with the Polytechnic Institute of Bragança, the Municipality of Bragança and the Inter-Municipal Community of Trás-os-Montes, being formalized on January 28, 2016, in Bragança. The PPL is usually developed around thematic agendas for research and innovation and assigned valorisation of knowledge for the development of urban regions and/or local contexts. Specific topics such as city development, energy efficiency, agro-food and forestry, industry, space technology, cultural content, cyber-physical systems, are addressed. This initiative provides for the creation of open and plural spaces for reflection and debate on the production and dissemination of knowledge, as well as the systematic hearing of citizens, public and private institutions and governmental and non-governmental organizations, involving researchers, teachers and students of Higher Education. The PPL are thus embodying a new political agenda, committed to involving science and education institutions, employers, social and economic actors, public and private; in an accomplice relation of civil society to think about the future collective and commons. They also aim to bring researchers closer to the population in general, and especially to their young people, stimulating processes of public participation in the definition of scientific, technological and cultural development agendas. Another example of good practice are 'Social policy experimentation' (European Commission 2013) which are small-scale projects designed to validate policy innovations (or reforms) before they are adopted on a macro scale. A methodological approach and the guidelines are provided as well (European Commission 2011) which are organised around the: i) types of policy intervention designs; ii) evaluation of the policy intervention design impact; iii) measuring the efficacy of a policy intervention. The final two practices provide with a clear example of methodology and operational framework that the previous reports were lacking in its guidelines.

6.5 Outlook and future work on co-creation in STI policy making

To conclude, there were clear indications of reaching out for new approaches when Society is fully engaged in Science and vice versa. Discussion of the principles and values of a public participation in Science is reflected in existing policies (Democratic Society 2018). However, this does not mean that the discussion and achieved reflection have enough power to change order of the participatory methodologies. In addition, there are few gaps and criticalities to be recognised in STI policies that are underlined in “Green Paper on Innovation” (European Commission 1995), such as the needs of i) stronger monetary investments which would enable wider public and stakeholder involvement; ii) training and capacity-building processes (i.e. “scientific citizens” in Democratic Society (Democratic Society 2018)) of all actors engaged in the process of policy making and strategic application in R&I; iii) organising the efforts around the process of co-creation (Slaus, et al. 2016). Conversely, when referring to the co-creation approach there were no guidelines given on how to organise transformation in policy making practice and how to implement more successful R&I with public participation. In a Portuguese example of Laboratories of Public Participation, this gap was illustrated through a practical example.

To stimulate STI policy making practice it is important to establish new relationships and mutual trust among all stakeholders (European Commission 2018). Few questions still need to be answered:

- How should the participation in co-governing the Science be organised? What are the preconditions for such an approach?
- How to assure the quality of co-creation in STI policy making?
- How and in which way the policy instruments can support co-creation in STI policy?

7 Conclusions

To conclude, in reviewing the way in which co-creation has been dealt with in EU-funded H2020 projects and EU policy documents from 1995-2018, we have identified five overarching lessons that appear to be key to the success of co-creation:

- **Citizen-Led Innovation.** Projects which conceptualise co-creation in RRI theoretically demonstrate an ambition for innovation which is truly citizen-led, involving the public from the initial stages of participatory agenda-setting through to evaluation. In practice however, it is becoming apparent that many attempts at implementing co-creation result in citizen participation at a much lower level, with a number of examples sitting within a level that Arnstein describes as tokenism: citizens are consulted as to their ideas, values and visions as well as their concerns, but the decision-making power still sits with the policy-making and science communities. Our review has also highlighted the importance of being clear about the objectives of co-creation exercises – being honest with participants from the start if they are only being consulted and/or how their views will influence decision making. Relating to this, feeding the final outcomes of the co-creation exercise to those who participated was also flagged as important. Our research also identified a tension with the current move towards mission driven science and co-creation. While mission-driven innovation is currently seen as a key way to focus research and innovation on more social goals, this may be a double-edged sword: While mission-driven innovation puts social needs into the centre of research focus and frames science and innovation in terms citizens may understand, providing them with the opportunity to raise concerns should they see this as necessary, unless citizens are involved in setting the missions, the approach has the potential to exclude citizens from the discussions about which research to prioritise. This emphasises the need to ensure citizens are involved as power holders in the agenda-setting process in addition to framing research questions around the needs of society.
- **Embedding and institutionalising co-creation.** Throughout our research we noticed repeated calls for co-creation practices to be institutionalised within organisational culture. There were a number of suggestions for how this could be done - through institutional agendas and mission statements, changing the concept of ‘excellence’

and building co-creation requirements into research funding criteria, and acknowledging researchers' participation in co-creation as part of the scientific career framework and promotion process. In addition, it is important that co-creation is not seen as an added luxury or a side-project of enthusiastic researchers, but brought within and made to be fundamental to research projects themselves. At the same time, the citizen and CSO participants need to be incentivised to participate, by acknowledging the resources they have given up to be a part of the activity: financial as well as time.

- **Problematising experts and technologies – not just the public.** Many projects we reviewed have problematised the public, calling for more knowledge dissemination so that they have the resources to take part more successfully in the activity. However, the spirit of co-creation demands we do more than problematise the public and adopt a deficit approach. Instead, as a number of projects have, reflecting on the role of scientists and policymakers in the process is important too. For instance, more training scientists to be able participate in co-creation activities has been called for by a number of projects. However, we noticed little attention given to other power holders - such as policy makers - who, it has been observed, view the public as lacking in knowledge and skills. Beyond the question of skills and roles, co-creation requires a transfer of power from 'experts', such as researchers and policy makers, to citizens. Although this has not been explicitly stated, it is inferred from the need to better train science communicators and scientists in engaging with the public – helping them understand that this is part of their role in participatory exercises. Finally, co-creation requires the science itself to be problematised – or at least at stake within participatory exercises, such that citizen perspectives are allowed to shape science and technology. In this way it is possible for participation to move beyond market testing, or hazard identification, to true co-creation.
- **Context matters.** Many practical projects have provided advice concerning the engagement process itself. It is clear from our research that one size does not fit all and that appropriate methods and objectives for the participation activity in hand must be selected, to be appropriate to the context and people involved. In terms of context, this may include cultural context as well as the policy making context. There

may be differences between the national-level institutional, regulatory and industrial policy making structures which make certain types of co-creation activities naturally more successful in certain contexts and others in other contexts.

- **Benefits of co-creation.** Throughout the work reviewed in this report, it was clear that there were high expectations of the benefits of co-creation. But in some cases, project teams have noted that the benefits which arise from co-creation are not always the initial aspirations. Most often cited was the value of the stakeholder network build through these participatory exercises that may be drawn upon in other situations.

8 References

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Appendix A: List of EU Projects Reviewed

List of 50 projects. Those in red were selected to be analysed after the sifting process.

PROJECT	DELIVERABLES? Y/N	DURATION	COMMENTS
ACCOMPLISSH	Y	2016-2019	
CASI	Y	2014-2017	
CIMULACT	Y	2015-2018	
CIPAST	Y	2005-2008	Before 2010
CIPTEC	Y	2015-2018	Deliverables unavailable
CITADEL	Y	2016-2019	
COGOV	-	2018-2021	Incomplete
CONSIDER	Y	2012-2015	
CoSIE	N	2017-2020	Deliverables irrelevant
Co-Val	N	2017-2020	Deliverables unavailable
DeEP	N		
Design for Europe	Y	2014-2016	
DESIGNSCAPES	-	2017-2021	Incomplete
DITOs	N	2016-2019	
EUEngage	-	2016-2017	Deliverables unavailable
ENGAGE	N	2014-2018	Deliverables unavailable
Engage2020	Y	2013-2015	
Encot	N	2009-2011	Before 2010
GREAT	N	2013-2016	
HEIRRI	-	2015-2018	Incomplete
InSPIRES	N	2013-2016	Deliverables unavailable
INVITE	-	2017-2020	Incomplete
InDemand	-	2017-2020	Incomplete
IRRESISTABLE	Y	2013-2016	Deliverables unavailable
KNOWMAK	-	2017-2019	Incomplete
LIPSE	Y	2013-2016	
Make-it	Y	2016-2017	
MARINA	Y	2010-2014	
MORRI	Y	2015-2018	

Nano2all	Y	2015-2017	
NERRI	N	2013-2016	Deliverables unavailable
OrganiCity	Y	2015-2018	
PACE NET	N	2013-2016	Deliverables unavailable
PE2020	Y	2014-2017	
PIER	-	2014-2015	Deliverables unavailable
Progress	N	2013-2016	
PROSO	Y	2016-2018	
SATORI	-	2014-2017	
SoCaTel	-	2017-2020	Incomplete
SYNERGENE	N	2017-2013	
Res-Agora	Y	2013-2016	
RRI Practice	Y	2016-2019	
RRI Tools	Y	2014-2016	
SCALINGS	N	2018-2021	Deliverables unavailable
SIC Europe	Y	2016-2019	
SI-drive	Y	2014-2017	
SMART-map	Y	2016-2018	
Sparks	Y	2015-2018	
TEPSIE	Y	2012-2014	
Voices	Y	2015-2018	

Appendix B: Survey Questionnaire

Submitted by:

Name of project:

Website:

Date of project (start-end):

What are the key features the RRI activity? (Brief description of what was done)

How was co-creation described in this project? (Bold/tick all the relevant words below)

- ☐ Public engagement
- ☐ Public participation
- ☐ Stakeholder engagement/involvement
- ☐ Co-creation
- ☐ Co-design
- ☐ Co-production
- ☐ Diversity/inclusion
- ☐ Upstream engagement
- ☐ Dialogue
- ☐ Deliberation
- ☐ Knowledge Exchange/Mutual Learning
- ☐ Other (please give details)

What was the purpose of the co-creation activity in this context? (Bold/tick all relevant)

- ☐ Gathering public opinion
- ☐ Including diverse perspectives
- ☐ Testing the acceptability of a technology/product/idea
- ☐ Aligning values of science with society
- ☐ Shaping a technology/product/idea
- ☐ Developing an idea for a technology/product/activity
- ☐ Making technology more socially robust

☐ Other (please give details)

At what phase of research/innovation/policymaking process did co creation take place?

- ☐ Problem framing/understanding
- ☐ Ideation
- ☐ Market testing
- ☐ prototyping
- ☐ Product/service/process testing
- ☐ Implementation
- ☐ Impact generation
- ☐ Throughout

What level of participation was involved in the co-creation activity (Please bold/tick all that apply)

- ☐ Opportunity for public to hear about new science or technology and ask questions
- ☐ Public involved in data gathering
- ☐ Public involved in product/service/process development
- ☐ Public consulted on purpose of the scientific/technological programme
- ☐ Public involved in planning the scientific/technological programme
- ☐ Public involved in deciding challenge/problem to be addressed
- ☐ Public identify challenge/problem addressed

If the details are available, please give a brief description of the co-creation activity:

What was produced/what changed as a result of the co-creation activity?

What was/should be open for discussion in the co-creation activity?

- ☐ The purpose of the science/technology / problem being solved?
- ☐ The kind of world being created with the science/technology?
- ☐ Social and ethical implications of the science/technology?
- ☐ Whether or not the science/technology should proceed?

- ☐ Usefulness of the science/technology?
- ☐ Acceptability of the science and technology?
- ☐ Non-technological solutions to the problem being addressed?
- ☐ The kinds of expertise needed to look at the issue under discussion?

Who was involved in the cocreation exercise? Please list stakeholder groups

Who was in charge/hosting the co-creation exercise?

What are the limits of co creation in this instance? What barriers were encountered?

What lessons were learned?

Appendix C: Policy Documents Included in Review

The table below shows the EU Policy documents reviewed, the sector they address (urban planning, innovation, public services and welfare or territorial development), and key points addressing the general objectives of the co-creation activity, the phases at which co-creation is suggested to be implemented or occurs, and the actors involved and their roles within the process.

Report (APA style)	Sector <ul style="list-style-type: none"> - Urban Planning - Innovation - Public Services and welfare - Territorial Development 	Description <ul style="list-style-type: none"> - General objectives of the co-creation activity - Main phases in which co-creation occurs - Actors & Roles
European Commission. (2018). <i>SCIENCE, RESEARCH AND INNOVATION PERFORMANCE OF THE EU 2018 Strengthening the foundations for Europe's future</i> (p. 504). Brussels EU: DG Research and Innovation, European Commission.	Innovation	<ul style="list-style-type: none"> - General objective of co-creation action is not directly highlighted; it is about the process of iteration and collective engagement. - No actions taken in realisation of co-creation. - Stakeholders' network involves everyone, mostly public, private and academic stakeholders, not speaking about publics; Goes around the idea of ownership and mutual trust.
Democratic Society. (2018). <i>Citizen Participation in FP9: A model for mission and work programme engagement</i> (p. 35).	All	<ul style="list-style-type: none"> - Citizens gain power in and over RRI. - Public/Citizen involvement, co-production and collaboration with these in longer-term and deeper ways. - Everyone included in RRI projects.
Addarii, F., & Lipparini, F. (2017). <i>Vision and trends of social innovation for Europe</i> . Technical Report. Brussels: European Commission.	Social Innovation	<ul style="list-style-type: none"> - Co-creation as a systemic change approach. - Co-creating and co-managing social innovation experiences through building a narrative and bottom-up engagement. - White Paper directed to policy makers specifically; and in

		general, to public dealing with social innovation.
<p>Slaus I., Wallace H., Cuhls K., Soler M.G. (2016). <i>Science The Diplomacy Europe's Future: Open Innovation, Open Science, Open to the World</i>. Publications Office of the European Union</p>	Innovation	<ul style="list-style-type: none"> - Co-creation as an approach to Open Innovation. - Stakeholders are collaborating along and across industry and sector-specific value chains to co-create solutions to socio-economic and business challenges. - All stakeholders (private, public, civil, third sector).
<p>Weber, M., & Andrée, D. (2015). <i>A new role for EU Research and Innovation in the benefit of citizens: Towards an open and transformative R&I policy</i> (Policy brief No. ISBN 978-92-79-50184-5, doi 10.2777/334586, ISSN 1831-9424) (p. 21). Brussels EU: DG Research and Innovation, European Commission.</p>	Innovation	<ul style="list-style-type: none"> - No indication. - No approach taken. - Citizens as beneficiaries of HORIZON 2020; Policy makers need to intertwine the R&I policies with other EU policies, and strategically approach to implementation by thinking on citizens' challenges and needs.
<p>Stenros, A., & Heikinheimo, R. (2015). <i>Reinforcing Resilience in an Inter-connected World: Lifestyle Changes in Relation with Science and Innovation</i> (Policy brief No. ISBN 978-92-79-50357-3, doi: 10.2777/609934, ISSN 1831-9424) (p. 10). Brussels EU: DG Research and Innovation, European Commission.</p>	Social Innovation	<ul style="list-style-type: none"> - Indication and recommendation of citizen engagement and participation in Social Innovation projects. - The report doesn't specify the stage of co-creation, it addresses co-creation of innovation ecosystems in general. - All actors/stakeholders relevant to the challenge/theme should unite around the problem-solving and work together to bring up the solution: "the technologies meet art and humanities, e.g. in so called culture laboratories. People from different disciplines but also from different professions should be collaborating and co-creating studies, programmes, and research for the better integration of future technologies and human challenges."

Soete, L. (2015). <i>From the old ERA to a new era of "Open Knowledge Creation in Europe"</i> (Policy brief No. ISBN 978-92-79-51137-0, doi 10.2777/095079, ISSN 1831-9424) (p. 12). Brussels EU: DG Research and Innovation, European Commission.	Innovation	<ul style="list-style-type: none"> - Systemic approach to innovation through co-creation, codesign with all stakeholders. - No specific stage indicated, co-creation in general and all together. - All relevant stakeholders for innovation case. However, there is an indication to possible negotiation between bottom-up citizen engagement and the primacy of government.
Haering, B., & Weber, M. (2015). <i>New Initiatives for Growth</i> . Policy Brief by the Research, Innovation, and Science Policy Experts (RISE). Brussels: European Commission.	Innovation	<ul style="list-style-type: none"> - No direct indication, only stressed purpose-driven research; citizen's science; collaborative research. - No specific stage determined. - Citizens' role: Better solutions for Grand Challenges -> Ecosystems of innovation assuring conscious innovation.
Giovannini, E., Niestroy, I., Nilsson, M., Roure, F., & Spanos, M. (2015). <i>The Role of Science, Technology and Innovation Policies to Foster the Implementation of the Sustainable Development Goals (SDGs)</i> . Report of the Expert Group No. ISBN 978-92-79-52716-6, doi:10.2777/615177, KI-04-15-809-EN-N) (p. 60). Brussels EU: DG Research and Innovation, European Commission.	Innovation	<ul style="list-style-type: none"> - Co-creation as a collaborative approach and organisational framework. - Co-creation as a precondition for stakeholders' engagement.
van den Hoven, J., Jacob, K., Nielsen, L., Roure, F., & Laima, R. (2013). <i>Options for Strengthening Responsible Research and Innovation Report of the Expert Group on the State of Art in Europe on Responsible Research and Innovation</i> (Report of the Expert Group No. ISBN 978-92-79-28233-1, doi:	Social Innovation	<ul style="list-style-type: none"> - Absence of co-creation and its advancement in research. - The report recognises the lack of public engagement.

10.2777/46253) (p. 78). Brussels EU: DG Research and Innovation, European Commission.		
Ozolina, Z., Mitcham, C., Schroeder, D., Mordini, E., McCarthy, P., & Crowley, J. (2012). <i>Ethical and regulatory challenges to science and research policy at the global level</i> . Directorate-General for Research and Innovation, European Commission, Brussels	Innovation	<ul style="list-style-type: none"> - No mentions of co-creation. - Ethics in RRI — need to organise and implement public expectation assessment.
Sutcliffe, H. (2011). <i>A report on Responsible Research & Innovation</i> (p. 34). Brussels EU: DG Research and Innovation, European Commission.	Innovation	<ul style="list-style-type: none"> - Co-creation as an approach in RRI. - Involvement of the public within at all stages of research and innovation “without wasting their time and other people’s money”. - Not specified, no clear task divisions.
DG Research and Innovation, European Commission. (2011). <i>Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields</i> (No. ISBN 978-92-79-20404-3, doi 10.2777/58723) (p. 221). Brussels EU.	ICT Innovation	<ul style="list-style-type: none"> - No mentions of co-creation. The focus is on ethics in research. - No stages of co-creation. - Mentions of policy makers and their sense of responsibility when researching and developing ICT solutions.
GEOGHEGAN-QUINN, M. (2012). <i>Responsible Research and Innovation, Europe’s ability to respond to societal challenges</i> (Leaflet) (p. 4). Denmark: DG Research and Innovation, European Commission.	Innovation (STI, RRI)	<ul style="list-style-type: none"> - No indication of co-creation. - No stages of co-creation - Statement: “We can only find the right answers to the challenges we face by involving as many stakeholders as possible in the research and innovation process.”

<p>Gulbrandsen, E. (2016). From Science in Society to Society in Science. Retrieved from https://www.etikkom.no/en/library/topics/the-researchsocietal-relationship/from-science-in-society-to-society-in-science/</p>	<p>Innovation, All</p>	<ul style="list-style-type: none"> - Co-production of Science. - Co-production as a later stage of co-creation. - All actors engaged in SiS (Science in Society).
<p>Felt, Ulrike, and Fochler, Maximilian (2009). The Bottom-up Meanings of the Concept of Public Participation in Science and Technology. Published by the Department of Social Studies of Science, University of Vienna, October 2009. Available at http://sciencestudies.univie.ac.at/publications</p>	<p>All</p>	<ul style="list-style-type: none"> - Not concerned with co-creation, “just” values and principles of citizen engagement and participation. - Stages of co-creation are not indicated. - Critic on top-down and need of bottom-up initiatives meaning engagement of all relevant actors/stakeholders.
<p>Ministério da Ciência, Tecnologia e Ensino Superior. (2016, January 27). <i>Laboratórios estimulam envolvimento do público no debate de políticas de ciência</i>. Retrieved from https://www.portugal.gov.pt/pt/gc21/comunicacao/noticia?i=20160127-mctes-lab-part-pub</p>	<p>All</p>	<ul style="list-style-type: none"> - Co-creation as an approach to STI policy making. - Co-creation throughout the whole process/all stages (setting strategies/vision, values, insights gathering, concept development, codesign and co-production). - Involving citizens, public and private institutions and governmental and non-governmental organizations, involving researchers, teachers and students of Higher Education.
<p>de Medina Prata Pinheiro, J. (2005). <i>ESTRATÉGIAS REGIONAIS DE INOVAÇÃO EM PORTUGAL – Valorização das Experiências dos Programas Regionais de Acções Inovadoras</i> (Master thesis). University of Porto,</p>	<p>Territory</p>	<ul style="list-style-type: none"> - Co-creation regards to informing and consulting actors engaged in setting and implementing Regional Innovation Strategies (RIS); - Innovation is built on principle of bottom-up engagement and highest as possible consensus of all parties engaged in regional development; - The actors that engage in RIS:

<p>Porto.</p> <p><u>Based on a study and report:</u></p> <p>Sociedade Portuguesa de Inovação - SPI. (2005). <i>ESTUDO DO IMPACTO DAS ESTRATÉGIAS REGIONAIS DE INOVAÇÃO NA COMPETITIVIDADE E NO EMPREGO EM PORTUGAL</i> (p. 248). Porto, Portugal.</p>		<p>regional authorities, enterprises, sectoral organisations, universities/laboratories, technological centres, consulting support centres, local agencies, and local authorities</p>
<p>Sociedade Portuguesa de Inovação - SPI. (2014). <i>Estratégia de Investigação e Inovação para a Especialização Inteligente da Região Autónoma dos Açores – RIS3 AÇORES</i> (p. 156). Porto, Portugal</p>	<p>Territory</p>	<ul style="list-style-type: none"> - There is no clear use of terminology “co-creation” however it is connected to partial co-decision making when defining strategic priorities for RIS3 Azores project; - Co-creation in the stages of informing and consulting each target audience/stakeholders; - Actors engaged: Companies / Business Associations; Entities of the Scientific and Technological System; Entities of the Public Administration; Civil Society Entities;
<p>EC-European Commission. (2012). <i>Guide to Research and Innovation Strategies for Smart Specialisations (RIS 3)</i>. Regional Policy, Brussels.</p>	<p>Territory</p>	<ul style="list-style-type: none"> - No clear indication on co-creation, but there is a say regards to “RIS3 process needs to be interactive, regionally-driven and consensus-based.” - The part of informing and consulting, co-deciding. - Stakeholders: public authorities to universities and other knowledge-based institutions, investors and enterprises, civil society actors, and external experts who can contribute to the benchmarking and peer review processes.
<p>European Commission. Directorate-General for Regional Policy. (2013). <i>Guide to social innovation</i>. Publications Office of the European Union.</p>	<p>Social Innovation – Territory (theme)</p>	<ul style="list-style-type: none"> - There are real life examples of co-creation as phases of informing and consultation, conducted for regional strategy development in France (p46-47). - The actors engaged are: involved in

		consultations which included surveys of citizens, interviews with experts, consultation committees and talks with organisations such as trade unions and business representatives.
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