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Concepts and methods to measure societal impacts – an overview

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1 Introduction

A critical analysis of the topic "societal impacts" is relevant and necessary for several reasons. These are:

1) The topic of societal impacts is currently at the top of the agenda in both (applied) science and in research and innovation (R&I) policy.
2) There is no uniform understanding of what a societal impact is in the literature. Definitions of societal impacts often refer to other impact dimensions (RRI, policy impacts, SSH impacts, cultural impacts, health impacts and sustainability indicators).
3) There is a great deal of confusion surrounding the topic of societal impacts. It has references to (1) impact measurement (Theory-based impact evaluation (TBIE), Theories of Change (ToCs), I-O-O-I (Input-Output-Outcome-Impact) models, impact pathways, participatory impact pathways, public value mapping, payback framework), (2) other discourses such as mission orientation and addressing the Sustainable Development Goals (SDGs), and (3) questions concerning research assessment (responsible metrics, metrics tide, the Leiden manifesto).

This report addresses these challenges as follows: We present the different definitions of societal impacts in the next chapter (chapter 2.1) and the different strands of discourse that contribute to the societal impacts topic. We distinguish the discourses on societal impact in a narrower sense (chapter 2.2) from related discourses (chapter 2.3). The paper closes with some conclusions (chapter 3).

Please note: This report concentrates on research funding and therefore excludes the societal impacts that (can) come about through sectoral policies. Second, following the logic of programme evaluations, we primarily adopt an ex post perspective, although we know that societal impacts (can) play an important role in ex ante impact assessments as well. Finally, it was not (yet) examined to what extent interaction effects occur between the different impact areas.

2 Current state of research

The following description of the current state of research focuses on existing conceptual and methodological approaches to measuring societal impacts. Before we describe the individual methods in more detail, the first step is to explain what is understood under societal impacts in the context of research and innovation policy (chapter 2.1). Then we present different concepts for defining, operationalizing and measuring societal impacts (chapter 2.2). The third section features references to current R&I policy discourses (chapter 2.3).

2.1 Definition: What is a societal impact?

Before we take a closer look at the issue of societal impacts, we should first ask what an **impact** is. According to the British Research Excellence Framework (REF 2012, p. 48), an "impact" is "*an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia [...]*". In addition, a kind of consensus has emerged in evaluation research and practice that an impact is a medium- to long-term change that goes beyond the direct beneficiaries of an intervention. Impacts are therefore different to "**outputs**" as the directly measurable effects of an intervention that occur among its direct target groups, and to "**outcomes"** as broader and more medium-term effects among the beneficiaries. It should also be noted that, in addition to the temporal component, a distinction is commonly made between direct and indirect as well as intended and unintended impacts.

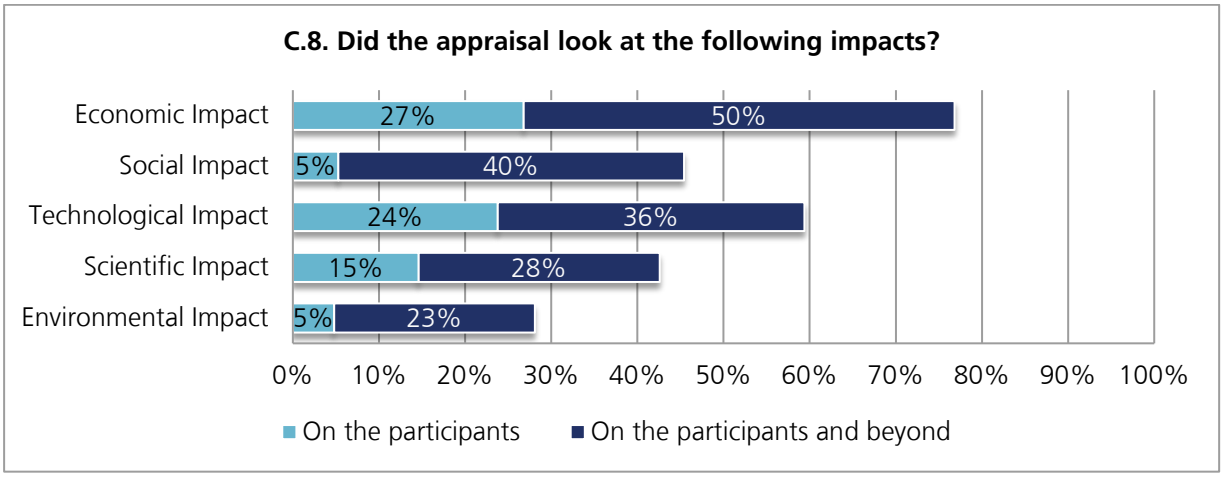
(At least) three things should be distinguished when referring to **societal impacts**: social impacts, societal impacts, and social impact analysis. **Social impact analysis** (SIA) has its roots in the evaluation of large infrastructure projects and aims at assessing the advantages and disadvantages for the local population. Another branch of SIA aims at identifying "social benefits" and the results of social entrepreneurship activities (http://en.wikipedia.org/wiki/Social_impact_assessment). According to the "International Association for Impact Assessment" (IAIA 2013), SIA can be defined as follows: "Social impact assessment includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions" (http://en.wikipedia.org/wiki/Social_impact_assessment). Correspondingly, SIAs focus on **ex ante studies**. In addition to the specifically considered impact dimensions, SIA also has a **process component,** namely the requirement that non-experts and potentially affected parties be involved during both the design and implementation of a project or programme. Given this background, it is clear that SIA is a very specific approach that can only be partially transferred to the research and innovation system context.

Another important definition concerns the question of the difference between "**societal impacts**" and "**social impacts**" or whether indeed there is a difference. The literature is not entirely clear here, as one EU expert group has criticized as well: "The very concept of social impact usually used in the literature is problematic and it **may refer to a wide range of issues, including policy impact** [...]. According to the literature review, specific and commonly used indicators are almost inexistent, or the existing ones are just proposals [...]. Most agencies and models do not consider social impact and policy impact at all. Sometimes, they mention them as criteria to be considered, but without specific indicators" (European Commission 2018, p. 50). Various authors from academia (Bornmann 2013, p. 218; Holmberg et al. 2019, p. 3) highlight that the terms are often used interchangeably and synonymously, with Holmberg emphasizing that "social impacts" "often refers to a more personal level of influence, affecting people directly or indirectly (Vanclay et al. 2015)." In principle, however, a distinction has become widely accepted in the EU that "**social impacts**" **are relatively**

comprehensive and include economic, societal, cultural, environmental, human rights and partly also policy impacts (European Commmission 2017; European Commission 2005), **whereas societal impacts targets aspects of society in the narrower sense**. EU definitions of "social impacts" often also include the aspect that these are used to describe a contribution to solving major challenges, for example public health, security and employment (see also chapter 2.3). The definition by Reale et al. (2018, p. 299) also follows on from this: "Wider impacts include the possibility of providing solutions to perennial policy problems (policy impact), and creating interventions **to improve societal challenges** (societal impact)".

Regardless of the concrete definition, the increasing importance of social or societal impacts can be traced using the **SIPER** database (Science and Innovation Policy Evaluation Repository) or its preceding project, INNO-Appraisal. Analysing the 171 evaluation studies collected within the INNO-APPRAISAL project (2007-2010) shows that economic impacts – both direct and indirect – were analysed most frequently, followed by technological impacts, and a closer look reveals that social impacts were mainly discussed with regard to non-beneficiaries (Daimer and Bührer 2010, p. 160). As explained in more detail below, this supports the view that societal or social impacts are often perceived and investigated as one area of impact that goes beyond the actual target group and thus the narrower objective of R&I programmes.

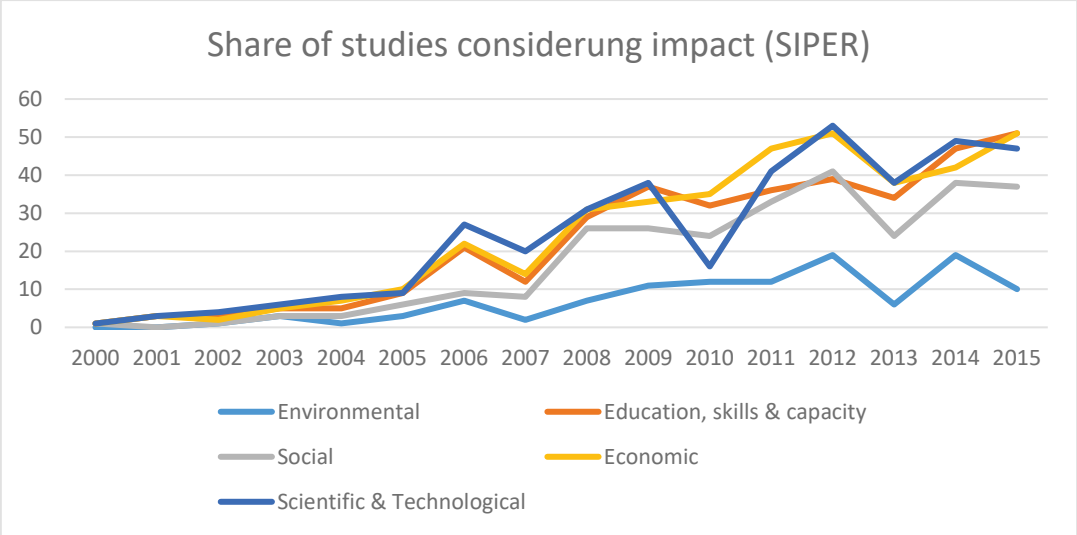
Figure 1: Meaning of social impacts in programme evaluations



Source: Daimer and Bührer (2010, p. 133)

When comparing this with the further development, it becomes clear, not only that impacts have been increasingly investigated since 2000, but also that societal impacts have not yet been able to catch up with scientific, economic or education-related impacts (cp. figure 2).

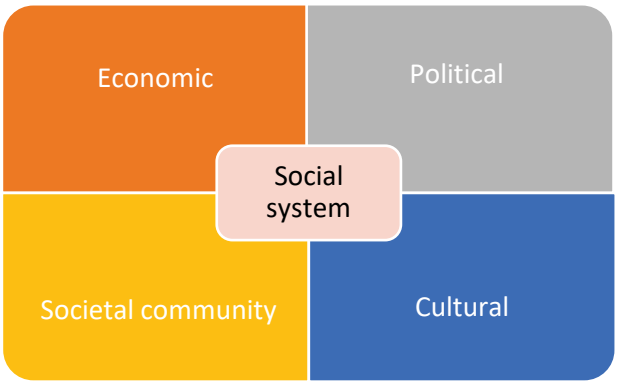
Figure 2: Development of the analysis of social impacts in programme evaluations



Source: Bührer et al. (2021, p. 2)

Looking at the key sociology literature can help to position oneself in these discussions. According to Talcott Parsons, the author of seminal sociological works such as "The Structure of Social Action" (1937) or "The Social System" (1951), a social system consists of four subsystems including the economic, cultural and political. However, according to most approaches and the view which we take here, societal impacts refer primarily to the "societal community" and are thus based on a narrower definition.

Figure 3: The social system according to Talcott Parsons



Source: own illustration

From an empirical viewpoint, most studies of societal impacts in the past have examined goal attainment and economic impacts, such as increased employment, but not aspects that target the societal community in Parsons's sense, such as community building. This has only changed more recently, as the following explanations make clear.

2.2 Concepts for operationalizing and measuring societal impacts

More than fifteen years ago, the European Commission emphasized the need to systematically consider the effects of its programmes promoting research and technology beyond purely economic effects by encouraging so-called **extended impact assessments (EIA**) and thereby targeting mainly social and environmental effects (European Commission 2005, p. 9). Accordingly, in 2005, an expert group addressed the compilation of potential impact dimensions including the area of

"social impacts", and published this as the **Ricci Report** (European Commission 2005). A total of 14 main dimensions are presented in this report under "social impacts", each with various underlying individual dimensions.

The following table shows this compilation (European Commission 2005, p. 12/13). It is clear that social impacts, as described above, not only refer to "community" in a narrower sense, but to the entire social system including its economic and cultural subsystems. Only the political subsystem is left out here. Social impacts as presented in the Ricci Report are thus a prominent example of the wide-ranging requirements associated with such impacts.

Table 1: Social impacts in the context of EU research framework programmes (European Commission 2005)

Social Impact Area	Issues addressed by RTD
Human rights	• Increasing equality of opportunity and entitlement, including among gender • Ensuring that ethical issues are appropriately and effectively addressed • Ensuring compatibility with the EU's Charter of Fundamental Rights
Social cohesion	• Reducing social exclusion • Reducing risks of poverty
Economic cohesion	• Reducing disparities of income for particular sectors, groups of consumers, citizens, workers
Employment	• Increasing employment opportunities (job creation, enterprise creation) • Increasing quality of employment and of the working environment
Human capital formation	• Improving educational achievements in the population • Increasing training and life-long learning opportunities • Increasing skills and learning capability/flexibility, both within and outside the research community
Public health and safety	• Improving the health of the population • Reducing safety risks • Improving nutrition, food quality and safety
Social protection and social services	• Improving accessibility to health services • Improving long-term sustainability of health services
Liveable communities	• Improving quality of housing, infrastructures, services and the living environment in general
Culture	• Preserving cultural diversity while increasing integration • Preserving and exploiting cultural heritage
Consumer interests	• Improving consumer information and choice • Reducing consumer risks
Security	• Preventing crime and increasing protection against terrorism • Improving the protection of networks and infrastructures • Increasing the interoperability of integrated systems and services
Governance	• Increasing participation and social capital formation (through increased accountability, democracy, citizens and stakeholders' empowerment, active citizenry)
International cooperation	• Promoting cooperation among Member States to reduce inequalities, achieve convergence and enhance social cohesion • Promoting socio-economic conditions (e.g. welfare, qualify of life, etc.) in non-EU countries
Role of SMEs	• Increasing and enhancing the potential contribution of SMEs towards job creation, social cohesion, regional development, etc. (through the improvement of their technological capabilities and their increased involvement in research networks)

Impacts can be analysed ex ante as well as ex post. In their guidelines for **ex ante impact assessments** (European Commission 2009, p. 35), the European Commission defines a total of eleven indicators in the field of social impacts. These are: employment and labour markets; standards and rights related to job quality; social inclusion and protection of particular groups; gender equality, equal opportunities/non-discrimination; individuals, private and family life and the protection of personal data; governance, participation, good administration and access to justice, media and ethics; public health and safety; crime, terrorism and security; access to and effects on social protection, health and educational systems; culture; social impacts in third countries. Again, alongside societal impacts in the narrower sense, such as inclusion, participation and equal opportunities, these feature economic, cultural and also political dimensions.

Summary 1: Note on policy impacts

There are different systematics for defining and surveying **policy impacts** as well. Reale et al. (2018, p. 300) define these as follows: "Political impact of research occurs when knowledge is transferred, that is, when decision makers and/or social actors employ the published and disseminated results as the basis for their policies and/or actions (Flecha 2014)". The results of the EU Policy Group to establish a monitoring system for Horizon Europe, which are described in more detail below, differentiate between the following policy impacts: "**collaborations with policy-makers**" (indicators: invitations and consulting from policy-makers, participation or presentation of findings in policy debates) and "**use of research findings in policies"** (indicators: evidence of influence on new policy, regulation, strategy or other documents; evidence of influence on changes of existing policies; use or cited in policy debate and processes of policy-making; consulting and interactions with policy-makers) (European Commission 2018, p. 52). In the wake of the EU-funded project RI-Paths, there was a very broad definition of policy impacts for research infrastructures (Helman et al. 2020, p. 16): a. **Policy, regulations, standards and institutions** (evidence-based policy-making; influence on R&D strategies, new standards, regulatory frameworks, data management policies), b. **Science diplomacy** (building international partnerships to address common problems; promotion of science as a priority in the international arena); c. **Co-funding and sustainability** (develop co-funding models with funders at local/regional/national/EU level; optimization of research funding and ensuring strategic fit with the overall EU RI landscape; creating models of RI sustainability); d. **Ethics and trust in science** (development of research ethical codes of conduct; guidelines for responsible research and innovation).

As seen above, so far, most EU publications have presented a broader understanding of the impact dimensions then defined as social impacts. In the course of introducing the **key impact pathways** to measure the impact of the EU Framework Programmes, however, there has more recently been a focus on **societal impacts**. An expert group has proposed the following dimensions for these: (European Commission 2018, p. 52):

Table 2: Indicators of societal impacts (EU Monitoring Expert Group 2018)

Dissemination (presence in the media, public, …)	Citation or mention in the media, public debate in the media, number of participants or audience, public lectures/public audiences, public or professional debate
Use of research findings in non-academic documents (e.g. in guidelines, teaching materials,…)	Use of research in guidelines, articles in professional journals Research cited in advocacy publications Citation and use of research in educational documents
Changes in behaviours or practices	Shift in public attitude Funding Evidence of sale Change to professional standards, behaviour or practice, improved working practices Professional evaluations and impact reviews "Satisfaction measures (for example, with services)."
Improvements to society	Social improvements Improvements to health Improvements in quality of life Improvements in the experience of individuals Improvements in the environment Improvements in services Other improvements
Public engagement	Public engagement

The following are worth highlighting in this compilation: 1) Contributions to grand challenges are illustrated and references made to the Ricci dimensions mentioned at the start (e.g. improvements to health, to the environment). 2) Dissemination aspects are given their own category. 3) Public engagement is mentioned separately. What this means for ISI's own systematic will be described in more depth in the final chapter.

In parallel to the EU Commission's efforts at the beginning of the 2000s to develop indicators and parameters to measure the social impacts of its Framework Programmes, approaches were developed in innovation research to identify additional potential effects of innovation policy measures beyond narrow economic impacts. An article by Georghiou (1999, p. 76), for instance, cites the following relevant effects of the European Framework Programmes: quality of life, environmental protection, development of infrastructures, regulation and policy. Effects of learning and **behavioural additionality** were also emphasized, which can be manifested in structural changes like new networks and the establishment of standards, among others (Georghiou 1999, p. 75, further approaches to measure impact at EU level, see Rojo 2003). These studies laid the foundations for **productive interactions,** the most prominent concept to date to measure social impacts, which are based on the EU-funded project SIAMPI.

The SIAMPI project (Social Impact Assessment Methods for research and funding instruments through the study of Productive Interactions between science and society) focused on the process of knowledge production and the interactions between participants as a key "social impact" (cf. Spaapen and van Drooge 2011; Siampi final report). Participants include the researchers themselves and other stakeholders that are not specified in more detail to start with. According to the study's authors, an interaction is considered productive if the generated knowledge is applied or used. Essentially, the result of a productive interaction is understood as a change in behaviour (Spaapen and van Drooge 2011, p. 212). Three possible forms of interaction with stakeholders, i.e. the researchers' environment, are differentiated: (1) Direct interactions, e.g. face-to-face, by telephone

etc., operationalized by the number of researchers holding multiple positions, membership in advisory committees or presentations in front of lay audiences; (2) indirect interactions, e.g. through texts or other artefacts, operationalized by a quantitative indicator called CRA (contextual response analysis), which can be used to measure the interest in certain reports and papers (on the internet, via the search for keywords), and (3) financial interaction, e.g. due to research contracts etc., operationalized as contracts, licences, project funds, jointly used infrastructure, industry-funded PhDs etc. (Spaapen and van Drooge 2011, p. 213, 217). As a result, this approach does not examine factors such as the quality of life, social security etc. that can be regarded as social impacts, but rather the effect of research on society in so far as this can be observed as changes in behaviour (Siampi final report, p. 1f.). The authors stress that social impacts cannot always be clearly distinguished from other impact dimensions. They see the closest points of contact to economic and cultural factors and weaker links to technical and environmental effects (Siampi final report, p. 5f.).

It should be emphasized that the Siampi approach seems suitable to go beyond an analysis of societal impacts in the context of evaluating measures (see below). There is another important perspective that should be considered when analysing societal impacts, whether this is done as part of (classical) programme evaluations or impact assessments, or in more academically driven approaches to measuring the societal impacts of research and research funding. Reale et al. (2018, p. 305) make a similar distinction: either indicators and metrics are developed to measure "impact" in terms of progress, or the extent is examined to which conditions were created that support the emergence of impact, which links back to productive interactions.

The idea to focus on **interaction as the key driver** of utilizing scientific knowledge as a prerequisite for generating societal impacts was already around much earlier, as expounded in Landry et al. (2001). In principle, four models can be distinguished: science push, demand pull, dissemination model and interaction model (ibid. p. 334). In their study, they were able to show that interactions and therefore the behaviour of researchers is the decisive influencing factor for the utilization of scientific knowledge.

Sivertsen and Meijer (2018) introduced an additional idea to the debate, namely the distinction between **normal impacts** and **extraordinary impacts**, which is also linked to the concept of productive interactions. Normal impacts are defined as "the more-or-less active, productive and responsible interactions between (units of) research organisations and other organisations according to their purposes and aims in society" (p. 1). In contrast, extraordinary impacts are defined as "more rare incidences where traditional and typical or new and untypical interactions have unexpected widespread implications for society" (ibid.). While the authors' view is that the British REF (Research Excellence Framework) targets extraordinary impacts, and this is often understood on an individual level and in the direction from research to society, normal impacts can and should answer the question "how the interaction is functioning on a daily basis on both sides according to organisational purposes and aims" (p. 3). The authors argue that, at least in cases which emphasize formative and learning purposes, the interactions should be examined and understood from both directions. Against this background, they recommend looking not only at "normal impacts", but also focusing on the relationships and interactions between science and society: "**Societal impact evaluation needs to consider both sides in the relations between research and society**. The main purpose of the evaluation should be the improvement of the relations, rather than the assessment or funding of one side of the relation. Typologies of impact (e.g. cultural and heritage preservation) needs to be supplemented by an identification of the relevant inter-actors or sectors in society, resulting in a typology of inter-acting organizations (e.g. museums)" (p. 5). They also argue for focusing on the organizational rather than the individual perspective and thus for considering the overarching issues of strategy, incentive systems for cooperation with third parties etc.

2.3 Related discourses: From impact research to fundamental issues of research and innovation policy

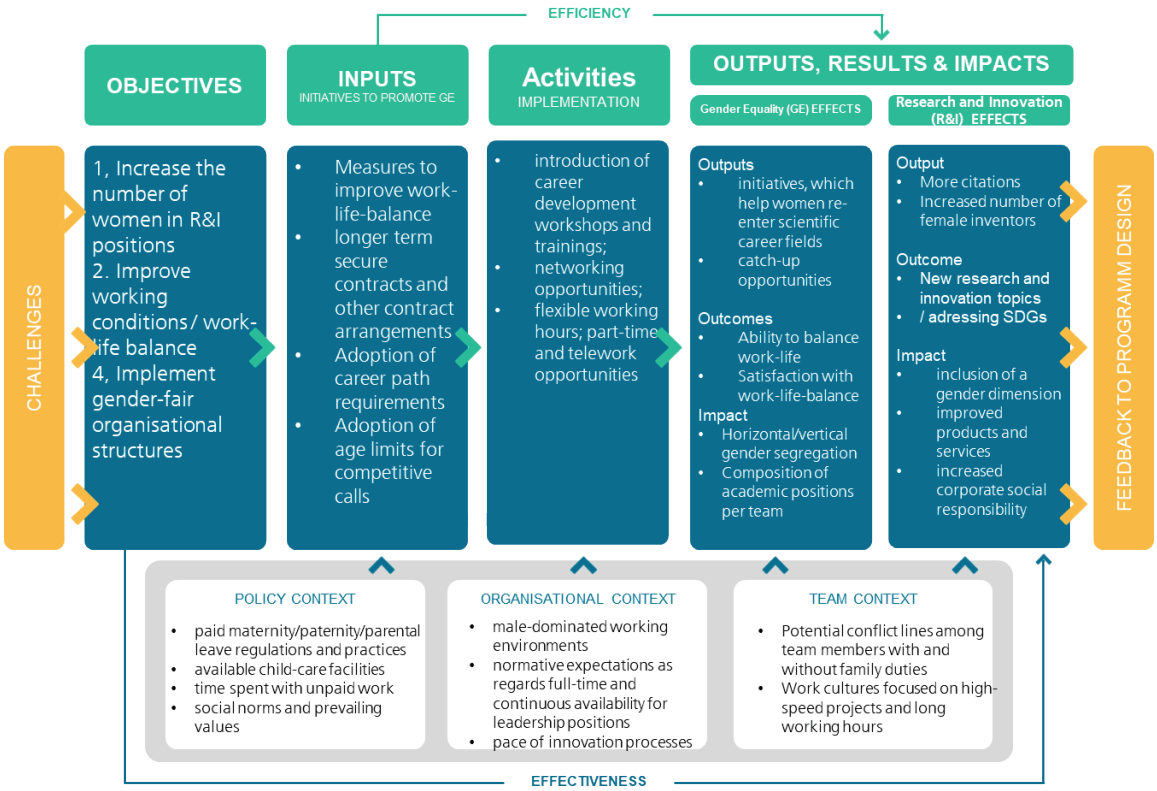
Embedded in impact research: Conceptual and methodological approaches

It is hard to think about the topic of societal impacts without thinking about how this is embedded in the discourses on evaluation and impact assessment. Regardless of the aspects related to content (keyword: What is a societal impact?) as presented in section 2.2, embedding it in the impact research discourse targets questions of the measurability of impacts. The key challenges of impact assessment have been summarized by the European Court of Auditors (2008) as follows: attribution problems, timing problems (the time lag before impacts appear), the causality problem, measurement problems. The latter relates to issues of data availability and suitable indicators, the comparability of results, aggregation, but above all the need to understand dynamics properly and take them into account in evaluations.

Theory-based evaluation (TBE) or theory-based impact evaluation (TBIE) (see Leeuw 2003; Leeuw 2012, Nonie subgroup 2 Impact Evaluation) is one of the most promising approaches to address these challenges and especially to solve the "black box" problem of evaluations (Astbury and Leeuw 2010). This is a heuristic that examines change primarily in terms of which factors have contributed to an observed change, without claiming to precisely define or model explicit cause-effect interactions. TBIEs focus on the "Why and how?" Directing the question towards "Why does something have an effect?" implies elaborating a theoretical understanding of how something should logically take effect in order to achieve the desired outcome, i.e. intervention theory. Or, as formulated by Bloch et al. (2014, p. 106): "[...] given a focus on informing future use, the question of why and how the impacts were achieved are as equally important as the question of what the impact itself was".

The theory-based impact evaluation approach (Kalpazidou Schmidt and Graversen 2020) uses "**theories of change (ToC)"** as a model for the ways in which change is expected and, ideally, also indicates how the effects have come about (Mayne and Johnson 2015). These are similar to the **logic model**, which is often used in development interventions and illustrates a plan, programme or project in a brief, visual format (McLaughlin and Jordan 2004; Knowlton and Phillips 2012), but includes an explicit reflection on the assumptions underlying an evaluation. Mayne and Johnson (2015) state that a theory of change develops a framework that reveals how an intervention will take effect. In this way, a tested and verified ToC can be the starting point for assessing the contribution of the intervention or the programme to the measured effects and is thus in line with a growing strand of research that discusses how a theory of change can contribute to assessing and understanding policy interventions (Funnel and Rogers 2011; Rogers 2008). The theory-based evaluation concept EFFORTI provides a graphical illustration of how to implement the above-mentioned requirements of modern impact assessments. This originated in the observation of equal opportunity measures, but its basic structure can be applied to different contexts (https://efforti.eu/efforti-toolbox-intro).

Figure 4: Example of a theory-based and context-sensitive impact model

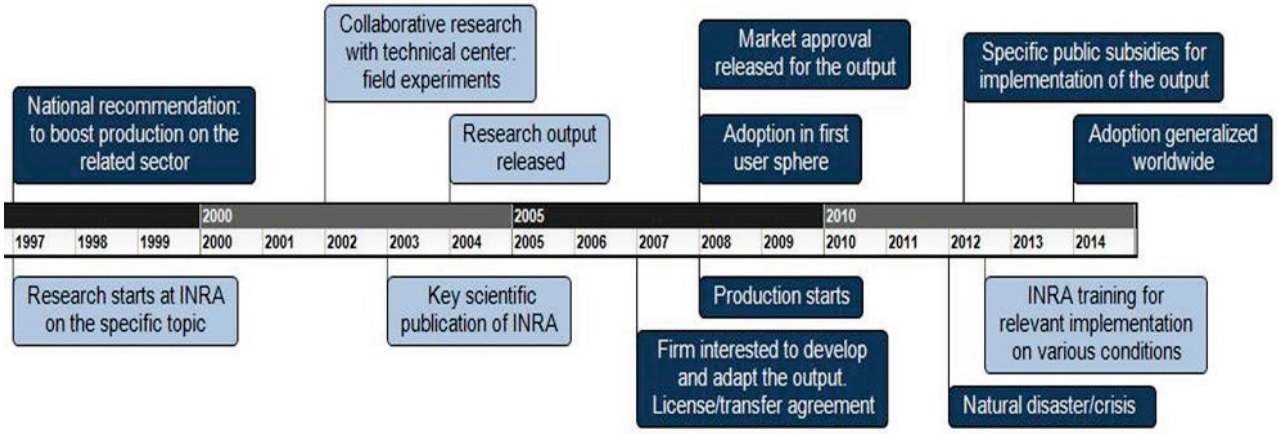


Source: own illustration

Other suitable models for measuring societal impacts are **I-O-O-I models** (Input-Output-Outcome-Impact), which map an ideal kind of process chain, starting from an impulse/input through short-, medium- to longer-term results and are closely related to logic models. Participatory impact pathways, public value mapping or the payback framework are also mentioned in the literature, but not described in greater detail here. It is important to emphasize that the more recent impact assessment approaches take account of the fact that an observed intervention is often only one factor among many that contribute to a change, and that it is therefore of fundamental importance to consider the obstructive and supportive context factors in the impact models or ToCs. Given this background, these more recent approaches often prefer to talk about a **contribution** rather than an attribution.

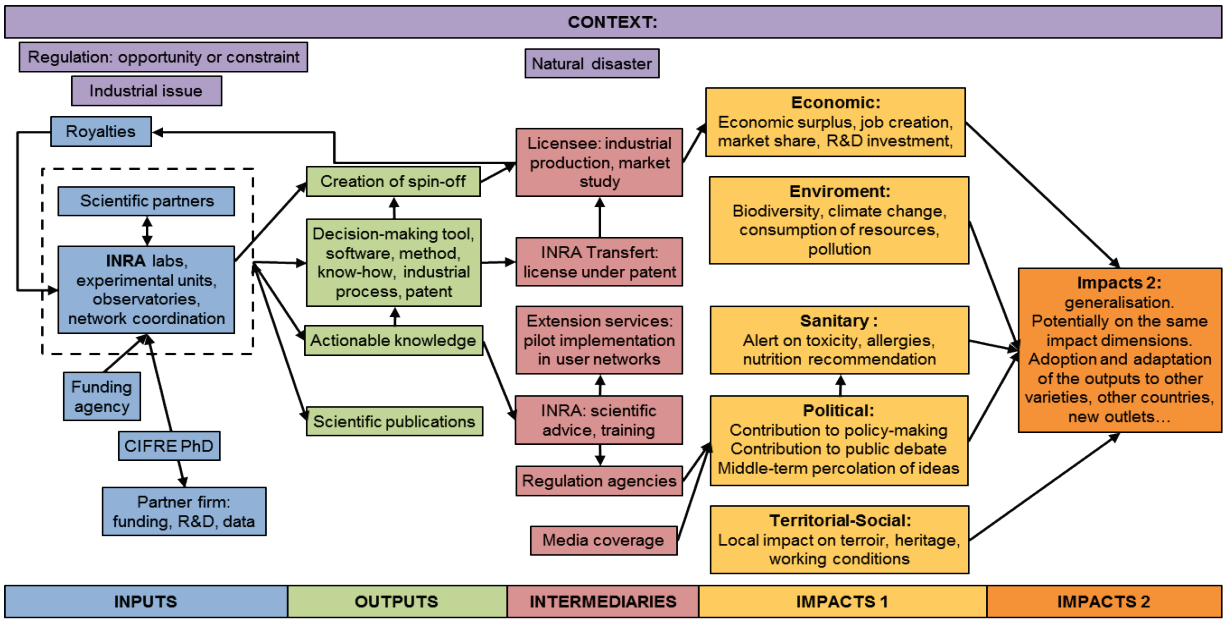
The work using **impact pathways** also shows clear similarities to the ToC approach. Here, too, impact pathways based on well-founded assumptions are considered as well, or precisely because, in the end, it is difficult to make concrete measurements of impacts. The **ASIRPA** approach (Socio-Economic Analysis of the Impacts of Public Agricultural Research) is a well-known example here. This was developed for agricultural research, but its basic idea is easily adapted to other fields. ASIRPA examined the impact of the research portfolio of a French agricultural research organization (INRA) and produced a large number of standardized case studies (Joly et al. 2015). The emergence of research results in final products and processes were examined, these were traced back to research activities, and the involved actor networks and impact mechanisms were analysed and finally, aggregated and classified. The following figures illustrate the method selected there:

Figure 5: Example of an impact chronology (events and context)



Source: Joly et al. (2015, p. 446)

Figure 6: Example of an impact pathway



Source: Joly et al. (2015, p. 447)

Current examples of applying impact pathways include the European Commission's approaches to assessing the impacts of the European Framework Programmes (Bruno and Kadunc 2018) and the impact pathways to survey the effects of research infrastructures (**RI Paths**). The European Commission's **key impact pathways** described in the programme's documents for the planned Horizon Europe Framework Programme are primarily aimed at the following: (1) To tell a "story" about the framework programmes as a whole, according to their respectively defined goals (similar to the "narratives" that are becoming increasingly relevant in applied innovation research); (2) To develop realistic indicators, in order to map short-, medium- and long-term progress, (3) To reduce the efforts for those being evaluated after project completion, (4) To allow for a distinction between management/process and performance indicators. Against this background, the authors have suggested nine key impact pathways including concrete indicators, three for each area of scientific impacts: economic, technological, and societal impacts. **Societal impacts** are defined here as fol-

lows: "Societal impacts: Strengthen the impact of research and innovation in developing, supporting and implementing **EU policies**, and support the **uptake of innovative solutions** in industry and society to address **global challenges**" (Bruno and Kadunc 2018, p. 8). We follow up this orientation towards global challenges as an anchor for measuring "societal impacts" below and describe this in more depth.

In contrast to this approach, there are also the indicators for surveying societal impacts that were selected in the EU project RI Paths to model different impact pathways of research infrastructures, as shown in the table below (Helman et al. 2020, p. 16). Numerous aspects are already apparent here that also play a central role in the EU discussions about responsible research and innovation (RRI) (see below).

Table 3: Societal impacts for research infrastructures (Helman et al. 2020)

Societal Impact Area	Description
a. New solutions, technologies, open access data and software for societal use	• New technologies, methodologies, instruments, treatments for application to citizens' everyday lives • long-term value of scientific discoveries and technological innovation • **open data** and software for the use of other organizations (industry, civil society)
b. Knowledge benefits for society in different domains	• Knowledge for addressing societal challenges and contributing to reach UN Sustainable Development Goals – SDGs • raising awareness of societal challenges • contribution to scientifically literate society
c. Public awareness and engagement	• General public understanding of the benefits of science; **public engagement** (e.g. through outreach, training of journalists, etc.) • rational society (e.g. countering fake news)
d. Environmental impact	• Corporate (RIs) Environmental Sustainability • the ecological footprint of RIs; participation in Fairtrade
e. Cultural impact	• Cultural goods benefits for society such as contribution to art, movies, books that **popularise science**, etc. • in a long run, this leads to more societal awareness about the benefits of science • the advancement of instrumentation for conducting research triggers also a cultural shift in the way knowledge is created and disseminated
f. Social inclusion	• RIs may contribute to social inclusion by integrating people from under-represented groups in their staff • adoption of practices for promoting **gender equality** • corporate social responsibility practices

Responsible Research and Innovation

As already mentioned above, the societal impacts listed in table 3 for research infrastructures make several references to concepts that are at the core of **Responsible Research and Innovation** (RRI). Specifically, these are the aspects of open access, public engagement, science communication and gender equality (highlighted in table 3). In general terms, RRI intends to create a new and improved relationship between science and society. The EU Commission defines RRI as "a process where all societal actors (researchers, citizens, policy makers, business) work together during the whole R&I process in order to align R&I outcomes to the values, needs and expectations of European society" (von Schomberg 2013). RRI has been also been defined as "... a transparent, interactive process in

which societal actors and innovators become mutually responsive to each other with a view on the ethical acceptability, sustainability and societal desirability of the innovation process and its marketable products." (Call FP7-SiS-2012-1). Five to six so-called RRI keys are often used when implementing RRI (public engagement, open access, science education, gender equality, governance, ethics, partially also science communication), that also establish the connectivity to the indicators for societal impacts mentioned above in the context of RI Paths.

Several indicators were developed over the course of two EU-funded projects to set up a RRI monitoring system (**MoRRI** – Monitoring the evolution and benefits of RRI, 2014-2019; **SuperMoRRI** – Scientific Understanding and Provision of an Enhanced and Robust Monitoring system for RRI, 2019-2024), which could also be used to survey societal impacts. The starting point for the indicators of the MoRRI-project was an intervention logic (see Peter et al. 2018). Correspondingly, a distinction was made between inputs (responsible practices), the outputs resulting directly from them, and longer term outcomes or impacts. The indicators referred exclusively to the national level, even though they were often produced by aggregating data at the level of individuals or organizations. In addition, so-called benefit indicators were developed within MoRRI, which refer to the following dimensions: scientific, economic, democratic and societal (Peter et al. 2018). Looking at **societal benefits**, the following three expected RRI benefits initially resulted from the work on MoRRI: 1) **Better** alignment of research with societal needs, 2) Promotion of social justice, gender equality, solidarity, fundamental rights, 3) Society learns from science. Adding "**democratic benefits**" to this gives the aspects "**empowerment of citizens"** and "**better informed decision-making**" (Peter et al. 2018, p. 38). Other benefit indicators were developed within the context of a large-scale survey of researchers (Bührer et al. 2017):

- **Societal benefits**: Changed approach to risk, More competencies among locals and citizens, Outreach to disadvantaged groups, Improvement of curricula and enlarged competencies among students, Increasing interest in science.
- **Democratic benefits**: Elimination of gender bias in participation in R&D, inclusion of citizen knowledge, reduction of R&I-related conflicts, empowerment of citizens.

This shows that RRI indicators have a clear focus on the societal community in the Parsonian sense.

Based on similar considerations, the EU expert group monitoring the EU Framework Programme (2018) suggested including the field of **citizen engagement** as part of the key impact pathways. The reasoning why citizen engagement should be understood as an impact dimension of societal impacts is that participation processes are important for the legitimacy, accountability and transparency of research and innovation. This can, according the authors, improve trust in institutions and create an ownership of the results of research and innovation (European Commission 2018, p. 59). It is also emphasized that research can become more efficient by involving citizens as they convey what society wants and needs. Ultimately, the assumption underlying the inclusion of citizens is that: "**Research and innovation projects that incorporate citizens in knowledge creation are more likely to generate usable and applicable knowledge that responds to the needs of European society**. Research and innovation programmes that engage citizens beyond the project are **more likely to achieve the uptake of outcomes by citizens and lead to improvements**" (European Commission 2018, p. 59).

While the MoRRI indicators have largely followed the logic of the RRI keys, the possibility to use the four **RRI principles** of "**anticipation, reflexivity, inclusion and responsiveness"** (Stilgoe et al. 2013) in the academic literature to develop indicators of societal impacts has hardly been done so far, despite being very promising with regard to a process perspective. Whereas it is often difficult to capture societal impacts as an outcome, and almost impossible to attribute a (funding) impulse to a subsequent event in complex and dynamic systems, it is often relatively easy to empirically survey factors that can be reasonably assumed to contribute to the emergence of societal impacts.

Once again, this brings us back to **productive interactions** and impact pathways or TBIEs, which also take or support precisely such perspectives. The MoRRI final report provided a first approach in this direction (Peter et al. 2018, p. 46): The following was concluded with reference to the concept of productive interactions and impact pathways: "Impact pathways are more likely to lead to societal-level benefits when the **number and diversity of stakeholders** that are committed to such efforts, including researchers, is relatively high".

Current thinking on the impact analysis of research projects that aim to involve society have a slightly different focus. An Austrian working group started by defining the goals of participation with the following result (see fteval Working Group on Impact Assessment. Impact of RTI-Policy on the relationship between science and society. Blog Post (v 1.22, 8/2/2021), p. 2):

- "Promote public understanding of science and science literacy;
- increase the **legitimacy** of RTI policy interventions and support the **co-ownership** of society in science and research;
- increase the **relevance, responsiveness and inclusiveness** of science and research, ensuring that its outcomes align with the needs, values and expectations of society;
- improve **transparency and society's trust** in science and research".

In addition, the authors point out the large variety of participation possibilities: (1) along the research cycle, from the planning phase through execution up to dissemination of the results, (2) when assessing project proposals and research programmes, and (3) in strategic decision processes such as participating in setting research agendas (p. 3). In the end, the authors arrive at the conclusion that can once again be interpreted in the sense of a productive interaction: "The relationship between science and society must be considered in all of its dimensions, bearing in mind that this relationship is embedded in a **complex system of formal and informal interactions** that are open to change over time. RTI policy interventions to create and maintain such interactions are themselves important mechanisms for opening a space to shape the relationship between science and society and **define collaboratively the benefits** of this relationship" (fteval, p. 9).

The discourses on "responsible metrics" should be regarded separately from this. These are primarily aimed at making the existing procedures for evaluating research more responsible, as called for by numerous researchers in the context of DORA and the Leiden Manifesto, among others (Wilsdon et al 2017; Hicks et al. 2015; DORA (Declaration on Research Assessment 2012).

SDGs, Grand (Societal) Challenges, mission orientation

As already mentioned above, especially the approaches at EU level frequently define societal impacts as those that make **a contribution to solving global challenges** or **addressing the SDGs**. The expert group for monitoring the (future) EU Framework Programme Horizon Europe defines societal impacts as follows: "Societal impact: related to strengthening the impact of research and innovation in **developing, supporting and implementing EU policies**, and support the uptake of innovative solutions in industry and society to address global challenges;" (European Commission 2018, p. 5). The justification for this is that missions or the SDGs are democratically defined goals, in contrast to topics that are primarily defined by research. In the authors' opinion, this is where the societal impact results: "This approach implies a major advance for science and for society: putting scientific knowledge at the very service of society" (European Commission 2018, p. 43).

In studies of the impact of social science and humanities research, reference was also made to the Grand Challenges, SDGs or missions (König 2019). The starting point is the observation "that there are **problems so wicked** that we require particular efforts to cope with them. Obviously, science – and new scientific knowledge – is key to understanding those problems, to alleviating them and also to preparing for potential fallouts" (König 2019, p. 4). The **key impact pathways** in the field of

societal impacts proposed at EU level by the expert group correspondingly focus on addressing and solving major challenges and achieving EU missions, but also mention the involvement of society and the contribution of EU-financed research to political decisions (European Commission 2018, p. 59ff.). Meanwhile, the European Commission has published its Key Impact Pathway Indicators (European Commission 2022a, 2022b). The main indicators are shown below

Table 4: Societal Impact Key Impact Pathway Indicators (European Commission 2022a, 2022b)

Key Impact Pathway	Indicators	Baseline Definition and Benchmark Definitions
Addressing Union policy priorities and global challenges through R&I (KIP4)	*Short-term (results):* Number and share of results aimed at addressing identified Union policy priorities and global challenges (including SDGs) Including number and share of climate-relevant results aimed at delivering on the Union's commitment under the Paris Agreement	Baseline: Top 3 SDGs by **share of total publication output for the EU (excl. UK) in 2015-2020** that potentially contribute to them Benchmarks Top 3 SDGs by **share of H2020 projects** that potentially contribute to them; Top 3 SDGs by **share of H2020 investment** that potentially contribute to them; **Share of H2020 projects** that potentially contribute to Union policy priorities; Top 3 SDGs by **share of UKRI funding in 2011-2020** that potentially contribute to them
	Medium-term (solutions): Number and share of innovations and research outcomes addressing identified Union policy priorities and global challenges (including SGDs) Including number and share of climate-relevant innovations and research outcomes aimed at delivering on the Union's commitment under the Paris Agreement	Baseline: Top 3 SDGs by **share of patent applications for the EU (excluding the UK) in 2015-2020** that potentially contribute to them Benchmark: Top 3 SDGs by the **share of H2020-funded publications** that potentially contribute to them
	Longer-term (benefits): Aggregated estimated effects from use/exploitation of results funded by the Programme on tackling identified Union policy priorities and global challenges (including SGDs), including contributions to the policy and law-making cycle (such as norms and standards) Including aggregated estimated effects from use/exploitation of results funded by the Programme to deliver on the Union's commitment under the Paris Agreement, including contributions to the policy and law-making cycle (such as norms and standards)	

Key Impact Pathway	Indicators	Baseline Definition and Benchmark Definitions
Delivering benefits and impact through R&I missions (KIP5)	*Short term (R&I mission results):* Results in specific R&I missions	Baseline: Relevant baselines defined under other KIPs Benchmark: Relevant benchmarks defined under other KIPs
	Medium-term (R&I mission outcomes): Outcomes in specific R&I missions	Baseline: Relevant baselines defined under other KIPs Benchmark: Relevant benchmarks defined under other KIPs
	Longer-term (R&I mission targets met): Targets achieved in specific R&I missions	
Strengthening the uptake of R&I in society (KIP6)	*Short-term (co-creation):* Number and share of projects funded by the Programme where EU citizens an end-users contribute to the co-creation of R&I content	Baseline: Number of projects in which Union citizens and end users contribute to the co-creation of R&I content without programme intervention Benchmark: Number of projects in which Union citizens and end users contribute to the co-creation of R&I content
	Medium-term (engagement): Number and share of participating legal entities which have citizen and end-user engagement mechanisms in place after the end of projects funded by the Programme	Baseline: Share of research-performing organisations in the EU that had mechanisms in place for public engagement Benchmark: see above
	Longer-term (societal R&I uptake): Uptake and outreach of co-created scientific results and innovative solutions generated under the Programme	

Evaluation of research

As mentioned at the outset, there is a significant strand of studies on societal impacts, whose origins can be traced back to observing programmes' impacts. In addition, however, there is also a distinct discourse on the societal impacts of research itself, which will be explored in more detail here. The discourse surrounding the "**impact of research**" has different drivers, including the **legitimisation** of public funding, increased questioning of (publicly financed) research, the calls for greater **responsibility** of research towards society and here especially the expectations that research can and should make a contribution to **solving urgent global problems**. Closely related to these requirements are the expectations that research should be co-productively shaped together with societal actors and should be implemented with greater inter- and transdisciplinarity and directed more towards problems and applications (see, e.g. Renn 2019; Müller-Christ 2017). These debates can be classified along a paradigm shift of research from "classical", "normal", "Mode 1" research (characterized by research questions primarily defined in an academic context, disciplinary orientation, quality control based exclusively on criteria inherent to science, knowledge production without considering its context of use, see Nowotny et al. 2003; Frederichs 1999; Gibbons et al. 1994; Weingart 1997) towards "post-normal science", "**Mode 2**", but also "responsible research" (RRI),

which is concerned with how to anchor responsibility as a central value in research and innovation processes and cultures (European Commission 2014; Lindner et al. 2016; Bogner et al. 2015). The debate about research quality and the definition of excellence, which is mainly an Anglo-American one, also contributes to this (see, e.g. Stern 2016; IDRC 2016; Belcher et al. 2016, RAND Corporation 2015; Darbyshire 2008). This primarily concerns the question to what extent the **quality of research** needs to be redefined in light of changing challenges and expectations of research, what this implies for the definition of excellence, and what suitable framework conditions would have to look like in order to be able to realise excellent research.

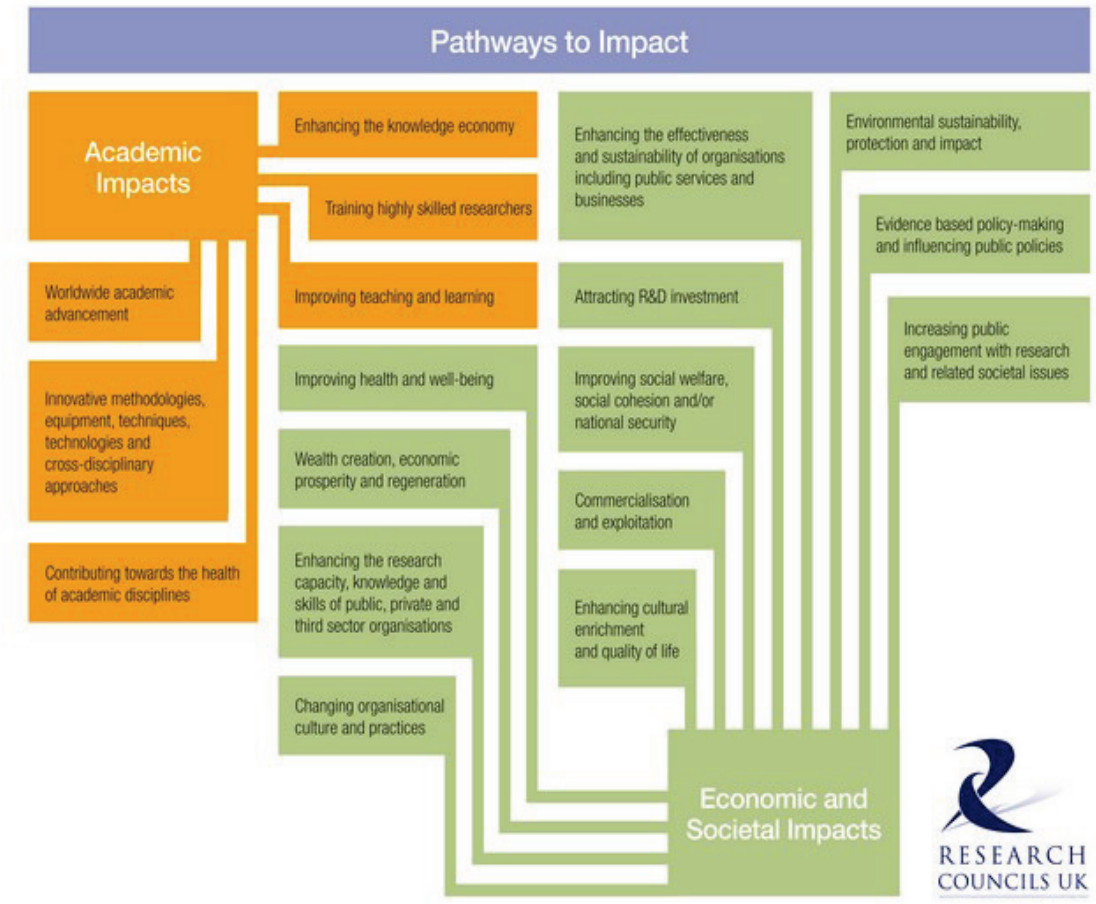
The **debate on excellence** always quickly returns to the question of the relevance and thus the "impact" of research. An intensive debate has taken place in many OECD countries in the last years, focusing on the contribution to achieving societal goals (see also the EU definition of societal impact as a contribution to solving the grand challenges). These debates have also contributed to the formation of different networks, such as AESIS (Network for Advancing & Evaluating the Societal Impact of Science). There is the underlying expectation here that defining impact as a goal of research will actually result in a higher impact. This is countered by the argument that the potential impacts of research are still uncertain at the time of the research process itself and only become evident over time (see the comments above by the European Court of Auditors on the challenges of impact assessment). In contrast to the quantitative bibliometric measurement of the impact of research (Martin 1996), so far, analyses of societal impacts have tended to apply qualitative approaches (Milat et al. 2015; Wilsdon et al. 2015) due to the sometimes very long delay between research results and their impact in practice (Donovan 2011) and the inability to clearly attribute individual research results to changes or innovations in society (Morton 2015). Concrete proposals for how to measure the societal impact of research are presented below.

Some of the most fundamental work on the impact of research comes from Wilsdon et al. (2015), who compiled the current state of the debate on measuring the impact of research as part of their analysis of the "**Metrics Tide**" or "Responsible Metrics" (Wilsdon et al. 2017). They define "societal impact" as follows: **"Research has a societal impact when auditable or recorded influence is achieved upon non-academic organisation(s) or actor(s) in a sector outside the university sector itself** – for instance, by being used by one or more business corporations, government bodies, civil society organisations, media or specialist/professional media organisations or in public debate. As is the case with academic impacts, societal impacts need to be demonstrated rather than assumed. Evidence of external impacts can take the form **of references to, citations of or discussion of a person, their work or research results**" (Wilsdon et al. 2015, p. 6). The benefits or impact of research can be indicated in very different ways. Wilsdon et al (2015, p. 44, 45) give the following examples: "references to, **citations** of or discussion of an academic or their work; in a practitioner or commercial document; in media or specialist **media outlets**; in the records of **meetings**, **conferences, seminars, working groups** and other interchanges; in the **speeches or statements** of authoritative actors; or via inclusions or referencing or **weblinks** to research documents in an external organisation's websites or intranets; in the funding, commissioning **or contracting of research** or research-based **consultancy** from university teams or academics; and in the direct involvement of academics in decision-making in government agencies, government or professional advisory **committees**, business corporations or interest groups, and trade unions, charities or other civil society organisations".

The British Research Excellence Framework REF apply a broad definition of "impacts" namely as "**reach and significance**", as described by Wilsdon et al. (2015, p. 126). The following note is important for our own conclusion: "The impact assessment was made by a process of expert review, with **users of research from outside of academia** playing an important role" (ibid.). The following

figure illustrates that British research funders also use the impact pathways approach when measuring societal impacts. It is important to note that 1) economic and societal effects are not separated and 2) a whole range of different aspects are subsumed under "societal impacts" as was previously the case for "social impacts". Specifically, these are environmental and sustainability impacts, for example, policy impacts in the form of evidence-based policy-making, increased citizen engagement, cultural enrichment etc. This confirms the comment we made at the beginning of this paper, that there is no uniform definition of societal impacts.

Figure 7: Impact pathway illustration in UK (Wilsdon et al. 2015, p. 105)



Source: Wilsdon et al. (2015, p. 105)

As well as the UK, other European countries have also established assessment procedures for research that consider different kinds of "impacts". According to a study by Technopolis (2014, p. 43f.), these are the UK (REF), France (AERES), Belgium/Flanders (IOF), although only Italy (ANVUR) and the UK include societal impacts, while France and Belgium focus on impacts in the area of research and innovations (Wilsdon et al. 2015, p. 28). The Standard Evaluation Protocol (SEP) in the Netherlands should also be mentioned: "From 2015 onwards, the assessment involves three criteria: quality, societal relevance, and viability" (Wilsdon et al 2015, p. 25).

Molas-Gallart (2015, 2012) points out that when assessing the impacts (or public value) of research, it is important to consider what the goals of the assessment are. He differentiates three goals of evaluation: allocating funding, control and learning, improving practices (Molas-Gallart 2015, p. 117). If the assessment is to allocate funding, he believes indicators that are easy to collect and compare are required, while formative goals are more concerned with considering details and contextual factors, as is possible, for example, using a **case study approach** (Molas-Gallart 2015, p.

118). In concrete terms, he elaborates on the necessary methodological approach of a **context-sensitive, formative assessment** of societal impacts: "A focus on processes requires the use of research methods capable of providing a fine-grained **understanding of the ways in which research generates public value**, and the contextual factors that facilitate or hinder such processes. This work is very time consuming (and therefore expensive), and yields a type of result (awareness of the importance of specific, context-dependent factors) that is useful to improve practice, to adapt policies, and to tweak implementation routines, but can only provide contributory help to make decisions on the distribution of resources" (Molas-Gallart 2015, p. 121f.). Wilsdon et al. (2015) also highlight the suitability of case study approaches, as these can be used to illustrate **complex interrelationships** and it is no coincidence that these were also applied within the framework of ASIRPA: "Others also argue that academics who create impact by building long-lasting partnerships with groups and organisations will not be able to demonstrate the depth and detail of impacts through metrics or data alone. A key concern from some critics is that impact metrics focus on what is measurable at the expense of what is important" (Wilsdon et al. 2015, p. 44). At the same time, however, they point out that there are voices in academia that view case studies as "fairy tales of influence" and, against this background, tend to advocate the use of indicators (Wilsdon et al. 2015, p. 49). In addition to the positively rated case study approach, the superiority of **peer reviews** compared to indicator systems is also emphasized: "No set of numbers, however broad, is likely to be able to capture the multifaceted and nuanced judgements on the quality of research outputs that the REF process currently provides. (Wilsdon et al. 2015, p. 136).

The potential of **altmetrics** to identify the impact of research is also highlighted when surveying the societal impacts of research. Experiences made within the British REF (Research Excellence Framework) show that scientific "output" is often correlated with the "impact" measured with the help of altmetrics, i.e. that conventional scientific excellence and the impact of research can be mutually dependent (Wilsdon et al. 2015, p. 48). The idea to use altmetrics in addition to classical bibliometric methods is grounded not least in the observation that "even where government documents, for example, quote academic work these references are not citations in the traditional sense and are therefore not picked up by bibliometric analysis. **Grey literature produced by academics tends to be more used by policymakers but its impact is difficult to capture**. Firstly citations are not made in the usual way and secondly academics have been slow to realise the importance of using tagging information such as DOIs in order to allow these references to be tracked (Wilsdon et al. 2015, p. 45)".

Finally, it should be mentioned for **Germany** that surveying the societal impacts of research is still in its infancy. Both the **Research Core Data Set** (see Wissenschaftsrat 2016, 2020) and the surveys done as part of the **Pact for Research and Innovation** only contain initial approaches. In the Research Core Data Set, only spin-offs and patents are mentioned as possible transfer dimensions alongside publications. In the Pact, the interaction with society is currently only surveyed qualitatively, apart from transfer activity with industry, which is mapped using third-party funding and start-up activities, among others. In terms of content, aspects such as science communication, science education and citizen science fall under the heading of "Science and Society" (GWK 2020, p. 28).

3 Conclusion

The comments made so far have (hopefully) illustrated the high degree of complexity of the debates on "societal impacts". The most convincing, because the most distinguishable, seem to be those approaches that relate "societal impacts" in the narrower sense to the **societal community**, as these can be clearly distinguished from missions/SDG-related goal attainment (e.g. public health) or economic, cultural or political impacts, which we believe are worth considering separately. Furthermore, we do not believe the approach of interpreting pure dissemination or "uptake" as "societal impacts" is very convincing, as the dissemination or awareness of a research result or an innovation in no way means that an impact will actually occur (see European Commission 2018, p. 52). In our opinion, dissemination and uptake should rather be understood as a process indicator or short-term and tangible output. A wider application of altmetrics including the analysis of social media such as e.g. facebook, twitter or other platforms might be of help for mapping these processes.

In view of the difficulties with capturing societal impacts in the sense of a long-term change and with tracing this back to a specific impulse – a research result, funding (attribution problem), those approaches are of particular importance that focus on the **conditions** under which societal impacts **emerge** (especially **productive interactions**). This is also largely the consensus in the relevant literature: "[…] there is an issue where substantial consensus is emerging: the importance of social interactions as the main foundation through which research results find applications that generate social value" (Molas-Gallart 2015, p. 120).

A final aspect should also be mentioned: There are growing demands in evaluation research to conduct assessments (even more so than in the past) with the **active involvement** of different stakeholder groups. This can consist of asking non-academic user groups about their perception of the "impacts" of research. However, it can also include a process component, namely that stakeholder groups and/or affected parties are systematically involved during the design, implementation and validation phases of the results of an evaluation. Such approaches are certainly easier to implement in formative assessments than in summative ones, even if they are still possible in the latter, but in principle they are strongly dependent on the purpose of the evaluation.

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