Societal impact of Research Infrastructures final protocol

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1. Introduction

How to evaluate societal impact of a Research Infrastructure (RI)? That is the core question of task 1.2 of the ACCELERATE project. The question may sound straightforward; the answer is not. RIs in general, including the members of ACCELERATE, have their own set of properties; no two RIs are alike. RIs operate in a complex and complicated environment. Each RI relates to a variety of actors, and every actor seems to have a different expectation of what the RI actually is, and what it contributes to society. When it comes to evaluation, it lacks established practices. In short: a challenging task.

KNAW-RI has developed an approach/protocol for the evaluation of societal impact with and for ACCELERATE members CERIC, ELI-DC, ESS, FRM II and HZG. The approach is built upon expertise, evaluation studies and academic concepts and relates to RI and European Research Infrastructure Consortium (ERIC) policy developments. The current document is the second and final version of the protocol. It is more hands-on than the previous *D 1.3 General societal impact protocol (final draft): A light on societal impact of ERICs and RI*. Both D 1.3 as well as the paper *The political context of Research Infrastructures* (Van Elzakker and Van Drooge, 2019) describe some of the underlying analyses and principles in more detail. See box 1.

CERIC, ELI-DC, ESS, FRM II and HZG have tested the draft protocol. They have reported necessary changes, not so much regarding the concepts, but in the way the user is guided through the preparation of an evaluation. In this version, some aspects are more articulated, conceptual and background information is presented in boxes and more attention is paid to the development of impact pathways. One aspect is added, the overarching narrative, in other words a concise introduction to the RI and its societal impact.

The current document is not focussed on a specific type of evaluation. Rather it allows an RI to prepare for very different evaluation situations. What information to present, how much information to provide and in what form, depends on the specific requirements of the evaluation and on the context of the evaluation. But the underlying ideas and principles can be used in most, if not all evaluations.

On the more practical side, the protocol is constructed as follows. Chapter 2 describes the issues with societal impact, the current trends to tackle these issues and the principles of the ACCELERATE approach. In the absence of established evaluation practices, and because an RI can be subject of very different evaluations, Chapter 3 is dedicated to the preparation of an evaluation. A number of archetypal impact pathways is presented in Chapter 4 and Chapter 5 provides a recap. Several textboxes describe concepts that are key for the ACCELERATE approach. Annexes include the evidence base, a glossary of terms and a reference list.

Box 1. ACCELERATE and societal impact of RIs

Everything can be a research infrastructure

The policy definition of Research Infrastructure is inclusive and not restrictive. What is referred to as RI has been negotiated, expanded and stretched over time. A large variety of projects and activities can be identified as an RI. This is true for ACCELERATE members as well. Some are up and running RIs, while others are being built, yet are already referred to as RI. Some members are an organisation of their own, while others are part of a bigger organisation and are not evaluated as a separate entity.

A research infrastructure can be anything

What an RI does, and what is expected in terms of societal impact, depends on formal agreements. Yet often implicit expectations and perceptions of stakeholders of what the RI is, are important as well. Every actor or stakeholder seems to have a different perception of an RI. And each perception relates to a different impact or contribution. These perceptions can be discussed and negotiated between the RI and its stakeholders. One example is the current trend to refer to an RI as a peace project. And we have witnessed how representatives of a member state articulated how they saw one of the ACCELERATE partners and what they expected. This was in line with the efforts made by the management, yet it was not part of any formal document, statute, nor strategy report.

Impact of and impact on

Societal impact of an RI is sometimes associated with a certain "anything" (see above), and the impact therefor is impact <u>of</u> this something. Statutes often describe what an RI is and does, and so do stakeholders and RIs. Societal impacts expected are the result of the RI being and doing that. In ACCELERATE, RIs enable materials research, develop innovative ways of working, etc. The result can be different types of impact. The materials research enabler can have an impact on science, on innovation, on human capacity, etc. Different types of impact can be the result of

And on the other hand, RIs are expected to have an impact <u>on</u> a certain area or aspect of society. In ACCELERATE, impacts expected are for instance on the European Research Area and on certain regions. Different types of activities and strategies can contribute to these impacts. Gender equality, Open Access and transnational cooperation (to name some ERA priorities) are the result of different activities of an RI.

2. (Evaluating) societal impact of a Research Infrastructure

RI management, their funders, members, users, local authorities and other stakeholders increasingly attach importance to societal impact of RIs. And consequently to its monitoring and evaluation. As ESFRI (2017) mentions, there is "increasing political and social pressure at all levels for RIs to demonstrate the positive contribution they make to society in general, including the impact on regional and national economies, and the benefits they offer to our citizens through the science they deliver, such as better healthcare, a cleaner environment or developments to communications and transport." These are not easy tasks. This chapter describes the main issues, the current trend to tackle these issues and the specifics of the ACCELERATE approach.

2.1 The issues

Several issues can be identified.

No two RIs are alike

Every RI has a unique set of properties. Each RI operates in its own context, with its own governance structure and statutes. And with specific stakeholders and their particular expectations, from regional development boards that expect an economic contribution to the region, to the European Commission that expects the ERICs to contribute to the ERA goals. These expectations regarding societal impact are often high. Most RIs aim for a variety of impacts, and most pathways to the impact are unique.

It lacks a shared understanding of societal impact and a shared evaluation practice

Societal impact and its evaluation are challenging. Impact is often the result of a complex process, to which organizations and factors outside of the sphere of influence of an RI contribute. It takes time before an impact becomes manifest, often years, if not decades. Even if and when an impact becomes manifest, it is near impossible to undisputedly attribute the impact to the RI. Also, there are no ready-made blueprints or implementation schemes for impacts; impact is context-dependent. There are no tested formulas or conversion factors to predict an impact. And when it comes to evaluating societal impact, there are no agreed upon methodologies, no agreements whether to focus on the impact itself, or to include the preceding process as well, no validated and unbiased indicators of impact, nor common agreements on what value to attach to an impact. Having said that, Box 2 describes how societal impact is understood throughout this document.

Box 2. Defining societal impact

Impact

Impact is sometimes referred to as: real-world change. An RI contributes to that real-world change. It usually doesn't achieve it solely on its own. Impact occurs at multiple levels and timeframes – there can be short-term, intermediate and long-term effects. (Westhorp, 2014).

Impact or contribution

This real world change is sometimes the focus of an impact evaluation, for instance in a cost-benefit analysis. However, there is growing consensus that the process preceding an impact is important to take into account as well. This process includes various actors, RIs as well as others, and a range of contributions these actors make to the impact, by making resources available to carry out certain activities.

Societal impact

Societal impact is the effect of the RI's activity on the social fabric and well-being of communities, individuals and families, and on society as a whole. It includes economic, social and educational impact as well as structuring effects of the RI (OECD 2019).

In this protocol *societal* refers to each and every impact, other than what is usually referred to as scientific impact. Societal can refer to economic impact (on a region for instance), social impact (such as on a specific group of people), educational impact (through outreach to schools and training activities), innovation impact (through novel materials or production processes); as well as to impact on trust in science (to which most public engagement activities aim to contribute), or on the environment (including negative impacts); as well as structuring effects of the RI (such as on the community of RIs and its users).

There are efforts to evaluate the societal impact of a single RI

There are one-off efforts to describe the societal impact of a specific RI, some looking forward and calculating potential future impacts (Alluvium 2016, Technopolis Group 2018a), others looking backwards and capturing impacts that have become manifest (OECD, 2014, Technopolis Group, 2018b). However, a general approach that can be applied to a number of RIs is not available. Organisations such as the OECD (2019) and the ESFRI (2017) have articulated the need for such a harmonized societal impact approach, yet it is also clear that a standard set of impacts and indicators does not do justice to the complex situations and differences between RIs.

2.2 Emerging trend: versatile understanding of societal impact of RIs

Yet an emerging trend is visible in recent publications from organisations such as ESFRI (2017) and OECD (2019) and in H2020 projects, including RI-Paths (Kroll and Zenker, 2019). This trend is very much in line with the approach developed by ACCELERATE. It comes down to a versatile approach towards societal impact and its evaluation in general and to societal impact (evaluation) of RIs in particular. Such an approach takes the complexity of the specific RI and its context into account. This versatile approach allows an RI to prepare for a variety of different societal impact evaluations.

We identify three core aspects of such an approach: (1) context specific understanding of what an RI is; (2) relating societal impacts to objectives and activities and (3) rich and diverse evidence.

2.2.1   Flexible and context-specific understanding of an RI

The current trend when evaluating the societal impact of an RI, is to take the unique properties of an RI and of its context into account. Because of the differences between RIs, one-size-fits all approaches and standard sets of indicators are not adequate. In order to do justice to the specific context and properties, a societal impact evaluation approach needs to be flexible.

Impact of what?

The ACCELERATE approach differs from some other approaches in that it does not use a classification of RIs as a starting point or ordering principle (single-sited / virtual; building phase / in operation; etc.). Properties are important and should not be ignored, on the contrary. But a standard classification seems too rigid.

Strategic objectives

Strategic objectives differ considerably between RIs and during the lifetime of an RI. To the extent that the question arises: impact of what? OECD (2019) identifies a number of different strategic objectives of RIs, including "to be an enabling facility to support

innovation" and "to assume social responsibility towards society." Very different types of impact relate to these different strategic objectives / "whats" (see box 1).

Perceptions of stakeholders

There are other compelling differences as well and these relate to the context in which an RI operates, and its stakeholders. Different stakeholders have different perceptions of what an RI is, and expect different contributions and impacts. An RI might contribute substantively to the reputation of a region and it might enable the production of medical isotopes, even if those are not strategic objectives. But certain stakeholders, whether the regional development board or cancer patients, might attach importance to these objectives.

In short: a context-specific understanding of what an RI is and of what impact to expect

The ACCELERATE approach focuses on the unique properties of the individual RI and the context of the RI. This is in response to the requirement to take the variety of expectations of funders, members and stakeholders into account.

2.2.2 Relating societal impact to strategic objectives, expectations and activities

To continue along the line of the previous paragraph, societal impact is not an isolated feature of an RI. On the contrary. Impact is related to the strategic objectives of the individual RI and to the expectations of its stakeholders. It also relates to what the RI actually does and the resources it makes available, in other words to its strategy. This contextual interpretation of societal impact differs from the current tendency in academia with regards to scientific impact. However, it is in line with recent societal impact initiatives.

Modelling impact and the pathway to impact

The relation between what an RI aims for and what it does can be conceptualized and modelled. Thinking about impact conceptually and in models helps to provide insight into what contributes to impact. This includes the resources the RI makes available (inputs), what the staff of the RI do (activities), the results of these activities (outputs) and the further use of the results (outcomes). The downside is that it makes the impact process look straightforward and linear. In reality impact is often the result of a long, intricate and iterative process, that includes feedback, other actors and influences. See box 3 for more information regarding impact models.

Having conceptualised impact, several issues can be identified.

Box 3. Models

A number of models is used to systematically analyse and depict an impact process. Different models use similar elements.

- inputs: The resources the RI mobilises in order to perform its activities (OECD, 2019). It includes financial, human and material resources.

- activities: Actions taken and work performed by (the staff of) the RI, through which inputs are mobilized to produce specific outputs (OECD, 2002).

- outputs: sometimes referred to as results. RI's products that result from its activities (OECD, 2019). It includes capital goods and services provided

- outcome: sometimes referred to as use. The short-term and medium-term effects of the activities and outputs (OECD, 2002). It includes effects on knowledge, attitude, skills and practice.

- impact: sometimes referred to as: real-world change. An RI contributes to that real-world change. It usually doesn't achieve it solely on its own. Impact occurs at multiple levels and timeframes – there can be short-term, intermediate and long-term effects. (Westhorp, 2014).

There are several basic models:

- Logical Framework depicts inputs, activities, outputs, outcomes and impacts. It provides a clear picture of these elements. However, it provides limited insight into causality, other than input and activities lead to output, outcome and impact.

- Impact pathways are more detailed than a logical framework. They show links between outcomes and impacts and provide information regarding causality. They provide more of a narrated vision and can be based on a Theory of Change.

- Theory-based approaches address causality and take the context into account. It makes assumed change mechanisms explicit: the theory of change.
  A full theory of change is developed with all actors involved and affected: the research organisation, its funders, users, other stakeholders and those affected. It is often used in development research projects.

From attribution and time lag, to contribution

The time lag between the moment of evaluation and the manifestation of impact is an issue. Evaluation often happens before societal impact becomes manifest, even when it is an ex post evaluation, looking back in time. Both the evaluation exercise, as well as the societal impact that is subject of the evaluation, can be rather intangible. A related issue is that of attribution, or the extent to which observed effects can be ascribed to a specific RI. It is hardly possible to identify or calculate this extent, from the long and intricate process that includes other actors and influences.

Thinking in terms of contribution solves the problems of attribution and time lag. Contribution means addressing what an RI aims for (the strategic objectives) and what it does. It makes societal impact and its evaluation more tangible. Contribution flips the focus and allows to evaluate what an RI aims for and how.

From standard impacts to archetypal impact pathways

The ACCELERATE approach focuses on an RI's contribution to societal impact. Impact pathways represent the contribution an RI makes to a certain impact: it includes activities of the RI that lead to immediate results that are being used by a range of other actors. The RI can anticipate future use and impact through dedicated activities. Pathways differ, from one impact to the other.

This protocol does not provide a standard list of impacts; rather it presents archetypal pathways. Each relates to one or more members of our project consortium, but not necessarily to all members in every part of the lifecycle and to each of their stakeholders. When the societal impact of a certain RI is being evaluated, an RI selects the most relevant pathways to impact and refines and enriches each pathway for its specific situation.

From responsibility to sphere of control and accountability ceiling

Further use and impact are not entirely within the sphere of control of the RI and they are not just the responsibility of the RI. Other actors and factors play a significant role as well. This complex and complicated situation makes it difficult to think about impact in terms of responsibility of the RI. However, further use and impact are within the sphere of influence and certainly the sphere of interest of the RI. This allows to identify or discuss the extent to which an RI is accountable for its contribution to a societal impact, and beyond which its control and influence is simply too little.

In other words, the RI is or can be held accountable for its contribution to societal impacts. This includes the strategic objectives and activities in anticipation of further use and impact.

In short: societal impact is the result of a strategy of the RI and a process to which the RI contributes

Impact pathways represent what an RI contributes to societal impact. It enables to present the strategy of the RI and allows to indicate to what extent the RI is accountable.

2.2.3   Societal impact evaluation requires rich and diverse evidence

Finally, the range of contributions an RI makes, the variety of impacts, the time lag and the complex process require a rich and diverse set of data or evidence. This includes a narrative of what and how the RI aims for. It includes evidence of the contribution the RI makes: activities, results and use. It is not limited to evidence or indicators of the societal impact itself. Societal impact evaluation requires a mix of quantitative indicators, case studies, and narratives.

ACCELERATE takes into account that there are no indicators for societal impact that speak for themselves. Whenever possible ACCELERATE refers to available sets of indicators for societal impact and key performance indicators. But without the context and the bigger picture, the information the data provide has little meaning. In this approach, the relation between the impact and the indicator is articulated. Indicators provide information, when what they indicate is understood.

In short: there is no single societal impact indicator that says it all; indicators do not speak for themselves; societal impact requires different sources of evidence

2.3 Core of the approach: impact pathways

An impact pathway relates a strategic objective of an RI, or a stakeholder's perspective on what an RI is, to what the RI does. It is a model of the process between the two. An impact pathway includes the outputs or results and outcome or further use in between. An impact pathway provides insight into what the RI intends to contribute to an impact and how.

This protocol presents a number of archetypal impact pathways. Each relates the RI (as enabler of excellent science, as coordinator etc.) to a certain goal (to contribute to societal challenges, to contribute to the ERA etc.).

The user is guided through a series of issues in a loop wise way. The impact is addressed first, after which the context and strategic objectives and the strategy are addressed. From there on, the inputs, activities, output and outcome lead towards the impact again. The reason the user is guided first from the impact backwards in time, is that this allows to articulate the rationale of a strategy. It also enables to indicate assumptions and preconditions that are thought necessary for an impact. The indicators are identified at the end. Indicators are proxies, they don't fully describe an impact, nor do they fully cover a contribution to an impact. So they are introduced after the impact pathway is developed.

- A societal impact pathway begins with a description of the <u>societal impact</u> aimed for.
- Next is <u>context</u>ual information. This includes the description of relevant stakeholders; the societal situation to which the RI aims to contribute / which it aims to change; and the properties that allow the RI to make this contribution.
  It includes (made explicit or not) the sphere of control that is within reach of the RI, the sphere that the RI is able to influence and the sphere of interest, that the RI aims to contribute to.
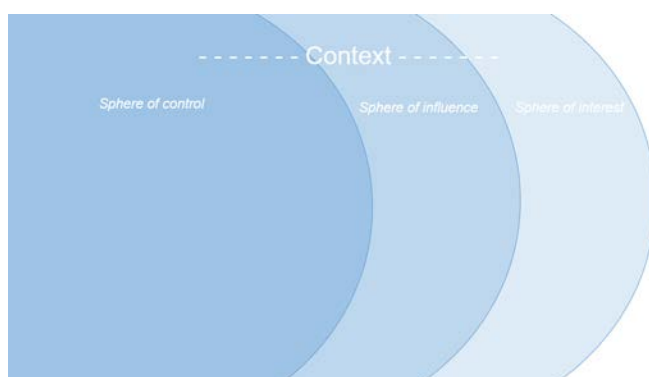

- The <u>strategic objective</u> of the RI describes what the RI aims to achieve or contribute to the societal impact. The unique properties of an RI determine the type of contribution or achievement, and this should be apparent.
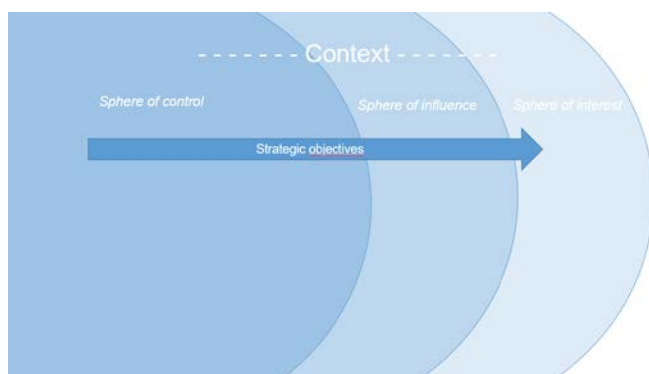
- This is even more so regarding the specific contribution of the RI, in terms of what it will do to contribute to the societal impact. This is the RI <u>strategy</u>,
- Together this forms the basis for the <u>narrative</u> of what and how the RI aims to contribute to a certain societal impact.
- Next is the concrete description of what the RI actually and in practice makes available and does. It is the articulation of the strategy, using the elements of a model:
  - <u>Inputs</u> relate to the resources the RI has or makes available, in terms of funding, staff, facilities or otherwise.
  - <u>Activities</u> are the actions taken and work performed by RI staff and management, using the inputs and producing outputs.

- o <u>Outputs</u>, sometimes referred to as results, are the products that result from the activities. They can be considered deliverables that help fulfil strategic objectives.
- o <u>Outcomes</u>, sometimes referred to as use, are the short-term and medium-term effects of the outputs (OECD, 2002). It includes effects on knowledge, attitude, skills and practice.
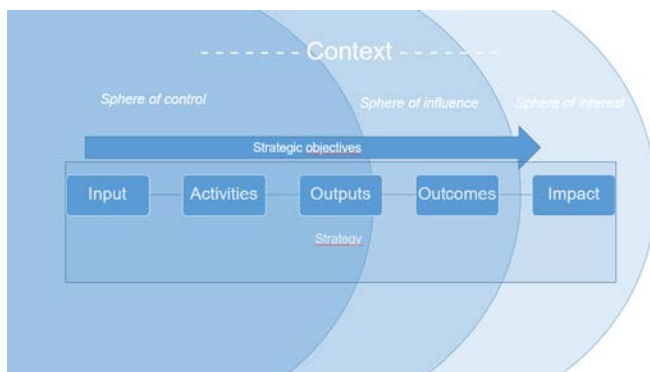
- <u>Indicators</u> can now be added to what has been described so far. These indicators enable substantiation or monitoring of the above. It includes quantitative indicators (a number, a ratio, a percentage, a series) and qualitative indicators (such as in the form of a case study or derived from interviews and questionnaires). It can include evidence regarding inputs, activities, outputs, outcome and impact.
  An indicator is only a proxy. Therefor an explanation of what the indicator actually indicates, why the indicator is chosen, is justified.
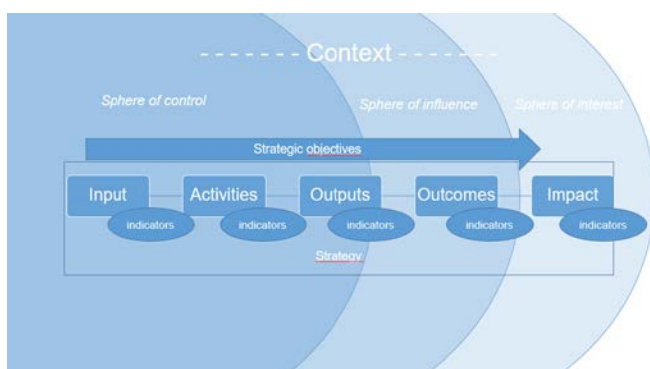
- Finally, the <u>data</u> can be added to the indicators.

A basic script is presented for several archetypal impact pathways. When choosing and using indicators, it is advised to articulate assumptions, at least for internal monitoring purposes.

Element	Explanation
Impact	The societal impact that the RI aims for.
Context	The situation the RI aims to change or contribute to. Relevant stakeholders and their expectations. Specific properties of the RI.
Strategic objective	What the RI aims to achieve both in the medium as well as on the long-term.
Strategy	What the RI plans to do or does in order to achieve the objectives and how it plans to do. It includes considerations and choices, as well as assumptions. So far the elements for an overarching, well-argued and substantiated narrative are articulated.
Impact pathway	Next is the detailed description of the strategy, along the lines of the impact pathway: Input The resources the RI makes available, in order to perform activities that relate to an objective. Includes staff, funding, facilities. Activities What the RI does, in terms of actions taken and work performed by the RI, through which inputs are mobilized to produce specific outputs. Output RI's products that result from its activities. Outputs can be considered as deliverables that help fulfil strategic objectives. Sometimes referred to as: results. Outcome The effects of the results; the short-term and medium-term effects of the outputs. It includes effects on knowledge, attitude, skills and practice. Sometimes referred to as: use.
Indicators	The evidence that enables substantiation or monitoring of the above. It includes quantitative indicators (a number, a ratio, a percentage, a series) and qualitative indicators (such as in the form of a case study or derived from interviews and questionnaires). It includes evidence regarding inputs, activities, outputs, outcome and impact. An indicator is only a proxy. Therefor an explanation of what the indicator actually indicates, why the indicator is chosen, is justified.
Data	The numbers and descriptions.

3. Preparation of a societal impact evaluation

This chapter provides guidance on how to position an RI and its societal impact in a specific societal impact evaluation. It prepares for the development of the impact pathways that are described in the next chapter. Four issues are addressed: the context of the societal impact evaluation, its requirements and design, the development of an overall narrative of the RI and the practical organisation by the RI.

The assumption is that it is not feasible to monitor and evaluate all societal impacts possible. There is a broad range and diversity of societal impacts to which an RI contributes. Certain societal impacts are more important for a specific stakeholder than others. Equally, certain societal impacts are more important for a specific RI, might be the raison d'être, and others are of lesser importance. Ideally there is a strong relation between the societal impact strategy of the RI and the societal impact expectations, reporting and evaluation requirements as well as the way the RI monitors impact.

3.1 Context of the societal impact evaluation

There are different reasons for an evaluation of societal impact. From an external organisation and (external) requirements for the societal impact assessment, to the initiative of the RI to monitor or report on its societal impact. The option to shape the goal, scope, evidence, form and audience of the evaluation is influenced by the context; whether externally initiated or internally decided makes a difference. Nevertheless, the issues in the remainder of this chapter are relevant in every case.

Next to that, there are different societal impact reporting and assessment situations. They range from ex-ante societal impact assessment during the initiation phase through internal monitoring and reporting requirements, to statutory described ex-post societal impact evaluation. The issues in this chapter apply to all these situations. They even apply to situations that do not relate to evaluation, such as the development of a societal impact strategy, the design of a suitable monitoring system and the communication on societal impact on websites and in annual reports.

However, since the focus is on evaluation of societal impact of an RI, the format of evaluation is used as the leading principle. Evaluation is, in a nutshell and in this specific document, an organised assessment of an RI's societal impact. Certain specific aspects in this chapter might not apply to every situation, but the underlying principles will.

Q: what is the context of the societal impact evaluation?

3.2 Design and procedure of the societal impact evaluation

Evaluations differ and requirements regarding evidence vary. What type of evidence and how to report depends on the goal of an evaluation, the specific evaluation question, the

target audience (Giffoni, 2018). This section addresses the design and procedure of the societal impact evaluation. It allows to prepare for a specific evaluation.

3.2.1 The goal of the evaluation and the central evaluation question

By and large there are two main evaluation goals: to decide and select and to learn and improve. Different goals require different types of evidence.

- The aim of a summative evaluation is to decide whether or not to start, fund or continue. The overarching question is whether the proposal for or achievement of societal impact is good enough, or which one is best. In some cases evaluation criteria and minimum thresholds are clearly communicated, such as in proposals for the EU Framework Programmes. In other cases little is known about criteria or thresholds, for instance when a potential member state decides about its membership of an ERIC.
- The aim of a formative evaluation is to improve or reorient. The overarching question is what is necessary to achieve the societal impacts that the RI aims for and that are expected of the RI. The result of such a reflexive evaluation is a number of recommendations for the RI with the eye on improvement.

Some evaluations are neither formative, nor summative; accountability is the main goal. The central question is whether the RI has acted or will act according to requirements and agreements.

In an evaluation, one or more questions can be leading. Some questions are generic and broad: what is the societal impact of the RI? Other questions are more specific: what is the contribution to the ERA goals? Sometimes the evaluation question remains implicit.

Q: what is the goal of the evaluation?

Q: what is the central evaluation question?

3.2.2 The definition and understanding of societal impact

When evaluating societal impact, the question is how societal impact is understood and what societal impacts are relevant. Is the focus a specific impact, contribution or activity of the RI? Is the focus on the impact itself, or does it include the process towards the impact, such as inputs and activities, results and use?

Q: what is meant by societal impact?

3.2.3 The evidence of societal impact

Evidence of societal impact can be required and presented in many forms and formats. An RI might be expected to present a proposal describing the societal impact it aims for, or a report describing the societal impact it has contributed to so far. In some cases, additional evidence is appreciated and representatives of the RI or its stakeholders are interviewed, or additional desk research is being done by an external evaluation agency.

The type of evidence for societal impact varies from some quantitative data, through qualitative evidence in the form of case studies, to an overarching narrative explaining the vision, strategy, aims and activities of the RI regarding societal impact, including assumptions.

Q: what evidence of societal impact is required? what indicators?

3.2.4 Commission and assessment

External organisations are often involved in a societal impact evaluation. In most cases there is an organisation that commissions or requests the evaluation. This can vary from the board of an organisation, through an evaluation agency, to a ministry. Next to that, there is often a committee that actually assesses and formulates a judgement, for instance an ad-hoc evaluation committee or a professional consultancy or audit organisation.

These external actors determine the evaluation to a great extent. The commissioning organisation because of the issues mentioned in the preceding paragraphs. The assessment committee because it actually assesses the evidence and formulates a judgement. It attaches a value.

Q: who commissions the societal impact evaluation?

Q: who assesses the societal impact?

3.2.5 Organisation of the societal impact evaluation

In some cases, procedures and documents are available that describe the evaluation process. An evaluation protocol describes the rationale and design of an evaluation procedure. It usually includes aspects described so far. Terms of Reference (ToR) describe similar aspects, but are dedicated to a specific societal impact evaluation. A protocol or ToR is not always available, yet the aspects these documents address are relevant.

Q: is a protocol available for the societal impact evaluation?

Q: are dedicated Terms of Reference available for this specific societal impact evaluation?

3.3 Internal preparation of the societal impact evaluation

We now move on to the preparation of the evaluation by the RI. The design and procedure of the societal impact evaluation influence to a great extent what information the RI presents, both in terms of content as well as form. Whatever the requirements are, and whether they are clearly communicated or not, the internal preparation of a societal impact evaluation requires careful attention.

The management or board of the RI is responsible for the internal preparation. This includes the strategic choice of how to present the RI, including the main narrative and the impacts to focus on, as well as the practical organisation of gathering and presenting evidence.

3.3.1   Presenting the RI: the overarching narrative

An overarching narrative helps to structure the presentation of the RI and its societal impacts, whether or not this is required. It offers an aggregate view on the RI and provides insight into its context and properties, as well as its strategic objectives and choices. It supports the choice for, development and presentation of the individual impact pathways. It enables a coherent presentation of the RI and its societal impacts.

The development and presentation of the overarching narrative is similar to that of a specific impact pathway, although on a higher aggregation level and less detailed.

An overarching narrative describes the RI, its context and the main impact pathways. It can include specific properties that are characteristic for the particular RI, such as its operational phase, field of research, location, organizational structure or size. In other words, basic facts and figures as well as aspects that are very specific for the RI. It can describes the context in which the RI operates and its main stakeholders. In particular what the RI aims to contribute to, such as the state-of-the-art in a certain discipline, the economic situation in the region or the modus operandi in RI management. Finally, it can describe a limited number of key impacts. Impact that relate to the properties and context described and impacts relevant for the given evaluation.

3.3.2   Practical organisation

The design and procedure of the societal impact evaluation and the overarching narrative provide a structure for the presentation of the evidence. Next step is the practical internal preparation of the evaluation. The management or board is responsible for the availability of sufficient manpower and resources within the organization and for a clear internal division of tasks and responsibilities. Depending on the size and scope of the evaluation this can include the appointment of an internal project team.

Even in case of a small scale evaluation, others than those responsible can play a relevant role. Societal impact is linked with many, if not all, aspects of the organizational strategy and

with most processes. Internal departments, like HRM and finance, are a valuable source of information. In most cases, these departments are involved already in the impact strategy. And chances are that they need to act upon the evaluation as well. Often, data are already collected for other purposes, such as surveys on user satisfaction. Or there are other processes that closely relate to impact assessment, such as performance monitoring or annual reporting.

External partners play a role as well when it comes to the preparation of the evaluation. They are a source of information when it comes to user satisfaction or further use, and for the description of the context in which the RI operates.

4. The development of impact pathways

The impact pathways are introduced in Chapter 2. In order to illustrate the development of a specific impact pathway, this chapter presents a number of archetypal impact pathways.

The user is guided through a script with questions and issues, so as to allow for specification to its situation.

Example indicators are mentioned. They come from different sources, that are dedicated to develop indicators for RIs:

- ESFRI working group of which the coordinator of ACCELERATE is member (Kolar et al, 2019) – referred to as KPI #
- EU project coordinated by ACCELERATE partner ESS (Mangematin & Bally, 2018) – referred to as ESS (no number)
- the OECD (OECD, 2019) – referred to as OECD #

Element	Pathway: RI as a facility for industry
Impact	The RI offers industry access to its facilities, so that industry can innovate or make certain products. Impacts can be the result of different strategic objectives and are along the line of: • Improved innovation capacity of industry • Availability of certain enhanced products • Developed capacity of industry • Contributed to a societal challenge
Context	A description of the situation that the RI aims to contribute to, of specific properties of the RI, of specific stakeholders: • Type of innovation (product, process,…); specific industry or companies; potential of RI • Market / need for the enhanced products, potential of the RI to support preparation • Need to build capacities of staff of specific companies; potential of RI • Description of the societal challenge and what the RI can specifically contribute
Strategic objective	A description of what the RI aims to do and what it aims to achieve by offering access to industry: • Enable (specific) industry to innovate certain products or processes • Support preparation of (a certain market share of) enhanced products • Train a certain number or percentage of staff of certain companies • Contribute something specific to a certain societal challenge
Strategy	A description of the strategy regarding industrial access. It includes how the RI promotes industrial use and specific schemes developed, as well as the rationales regarding choices and conditions
Input	A description of the resources the RI makes available, what it has in place for industry. For example, but not limited to: • Employment of ILO staff • Access procedures • Specific facilities for industry
Activities	A description of what the (staff of) the RI does. For example, but not limited to: • Outreach activities targeted at industry • Services provided for industrial users • Training of staff to work with industrial users • Collaborations with other RIs to learn and improve
Output	A description of the results of the activities dedicated to industry access. For example, but not limited to: • Improved level of service for industry • Firms are familiar with the RI • Firms use the RI • Enhanced products manufactured at RI
Outcome	A description of what follows next: what industry is expected to do with the results. For example, but not limited to: • Industrial users use the results of their collaboration with the RI (change, abandon or continue certain products or processes) • Industrial users make and distribute certain enhanced materials • Industrial users share the results of their collaboration with the RI • Long term relationships with certain industrial users
Indicators and data	The choice of indicators, with a description of what it indicates. Presentation of the actual data to the indicator.
Context	The description of the context can be substantiated with data: • regarding the specific industry sector the RI aims to contribute to • regarding the market or market share • regarding the capacity of industry staff • relating to the societal challenge

Strategic objective	The strategic objectives can include target values or growth percentages the RI aims for
Input	Indicators for resources made available, for instance (depending on strategic objective) • Experimental time available (KPI 1) • Staff (OECD E27)
Activities	Indicators for what (staff of) RI does, for instance (depending on strategic objective): • # activities (KPI13) • Description of participants
Output	Indicators for results, for instance (depending on strategic objective): • # users from industry (for instance OECD T25) • Revenue from industry for use (share of revenue; in relation to target) (KPI12) • description of projects with industry • # of Collaborative projects with industry (OECD T24) • user satisfaction (user survey) (OECD S7)
Outcome	Indicators for further use, for instance (depending on strategic objective): • Share of (co-) publications with industry (KPI11) • Patents with a commercial use (OECD T18) • Volume of enhanced materials / % of a certain market
Case	Case study usually covers several, if not all phases. It can be used to illustrate a strategic objective. Case of: • Improving innovation capacity • Support manufacturing certain products • Building capacity • A certain contribution to a specific societal challenge

Element	Pathway: RI as a contractor
Impact	The RI commissions companies to develop equipment or deliver services, so that the RI can be built/upgraded, and so that firms and the regions where these firms are located benefit. Impacts can be the result of different strategic objectives and can be along the line of: • A (new) market developed • Increased competitive advantage of certain companies • Capacity build in high-tech industry • Return on investment for member countries
Context	A description of the situation that the RI aims to contribute to, of specific properties of the RI, of specific stakeholders: • (New) market potential and need for it; companies and technologies involved; potential of RI • Market situation of the companies; market trend; potential of RI • Need to build capacity; potential of RI • Type of agreements with member states, for instance in kind scheme Plus: • General information regarding the needs of the RI to commission, the volume and type of work that needs to be commissioned • Information regarding the potential of the region or member state
Strategic objective	A description of what the RI aims to do and what it aims to achieve as a contractor • Contribute to the development of certain market • Create competitive possibilities for certain companies • Train a certain number of industry staff • Realise a certain return on investment for a member state
Strategy	A description of the overall strategy. It includes procurement policies and schemes as well as the rationales regarding choices and conditions
Input	A description of the resources the RI makes available, and frameworks that are in place. For example, but not limited to: • Funding for construction/maintenance • Procurement procedures/rules
Activities	A description of what the (staff of the) RI does relating to procurement. For example, but not limited to: • Activities anticipating the development of certain markets (networking etc) • Tendering activities • Training activities
Output	A description of the results of procurement by the RI. For example, but not limited to: • The contracts signed • The services and training provided • The networks established
Outcome	A description of what follows next. For example, but not limited to: • Knowledge developed and capacity built at contracted firms • Contracted firms apply knowledge/skills gained in a different context • New technologies being developed and marketed • Further collaboration as a result of contract • Further income generated as a result of contract
Indicators and data	The choice of indicators, with a description of what it indicates. Presentation of the actual data to the indicator.
Context	The description of the context can be substantiated with data regarding • the volume of contracts the RI aims for • the market

	• the situation in the member state
Strategic objective	The strategic objectives can include target values or growth percentages the RI aims for
Input	Indicators for resources made available, for instance (depending on strategic objective): • Available funding € • Description of procedures
Activities	Indicators for what (staff of) RI does, for instance (depending on strategic objective): • Description of (targeted) activities • Volume of procurement
Output	Indicators for results, for instance (depending on strategic objective) • Public procurement and contracts (OECD E31) • # in kind activities (ESS) • expenditure in a certain region / industry (ESS; similar to OECD E30) • # offers and awards per region (ESS) • Number of regional and/or total suppliers (similar to OECD E35) • Collaboration with suppliers (ESS) • Share of revenue from RI (contracting partner) (similar to KPI 12)
Outcome	Indicators for further use, for instance (depending on strategic objective) • Patents with a commercial use (OECD T18) • Subcontracts (by contracting partner) • Further collaboration as a result of contract • Description of further activities as a result of contract • Further income generated as a result of contract
Case	Case study usually covers several, if not all phases. It can be used to illustrate a strategic objective.

Element	Pathway: RI as a coordinator
Impact	By acting as a coordinator and research hub the RI contributes to the establishment and structuring of (specific) research networks and communities. Impacts can be the result of different strategic objectives and can be along the line of: • A (specific) scientific community that is established • Increased standards and increased capacity of members / partner facilities
Context	A description of the situation that the RI aims to contribute to, of specific properties of the RI, of specific stakeholders: • The need for a certain community; information on the initial situation; potential of RI • Initial situation of members / partner facilities; potential of RI
Strategic objective	A description of what the RI aims to do and what it aims to achieve as a coordinator: • Take a leading role in the establishment of a certain field • Create and implement standards for RI operation
Strategy	A description of the overall strategy. It includes coordinating activities well as the rationales regarding choices and conditions
Input	A description of the resources the RI makes available, and frameworks that are in place. For example, but not limited to: • Funding for network activities • Employment of personnel dedicated to network activities
Activities	A description of what the (staff of the) RI does relating to coordinating. For example, but not limited to: • Organize network events • Develop novel practices • Develop standards • Integrate research activities in a specific field • Attract or integrate funding resources • Collaborate with other organizations • Commission technology development
Output	A description of the results. For example, but not limited to: • New relationships • Collaborative projects • Introduction of novel practice • Standards developed • Events organised
Outcome	A description of what follows next. For example, but not limited to: • A more visible community • Capacity being build • Improved operation of facilities • Adoption of shared standards • Better integration in international networks • More efficient use of resources
Indicators and data	The choice of indicators, with a description of what it indicates. Presentation of the actual data to the indicator.
Context	The description of the context can be substantiated with data regarding the current situation
Strategic objective	The strategic objectives can include target values the RI aims for
Input	Indicators for resources made availale, for instance (depending on strategic objective):s • Staff (OECD 27)

Activities	Indicators for what (staff of) RI does, for instance (depending on strategic objective): • Description of (targeted) activities • Number of events organised for target groups (KPI 13)
Output	Indicators for results, for instance (depending on strategic objective): • Number of participants (KPI 13) • Description of practices, standards, projects
Outcome	Indicators for further use, for instance (depending on strategic objective) • Structuring effects on the scientific community (S10) • Description of use of standards and practices
Case	Case study usually covers several, if not all phases. It can be used to illustrate a strategic objective.

5. Using the approach / protocol

The ACCELERATE proposal mentions that evidence of societal impact is of vital importance for RIs. It implicitly suggests that societal impact predominantly relates to further use of research enabled by an RI. Enabling research is indeed the prime task of RIs. At least during the operational phase; not so much during the building phase. And as long as the RI or ERIC itself actually enables research, less so if it enables and coordinates other facilities. And even up and running RIs that enable research, are expected to be so much more than research enablers. They are expected to contribute to a diverse range of societal sectors, relating to an equally diverse range of activities. This calls for a societal impact evaluation approach that takes these diverse expectations and contributions into account.

The proposal also calls for a participatory process, in order to ensure that the approach or protocol answers to the needs of the RIs involved. During the project it became clear how complex and complicated the environment of the RIs are. The expectations regarding societal impact of RIs are high, yet are often implicit and unarticulated. Practices and procedures to evaluate societal impact of research projects and organisations begin to develop, but this is hardly the case for the evaluation of societal impact of RIs. It is unclear how a certain societal impacts will be valued, and it is not always known whose value it is.

This is the context in which this protocol is developed. It is aimed to enable an RI to prepare for any societal impact evaluation, regardless of what societal impact is expected and regardless of the evaluation procedure. What information to present and how to present the information depends on the specific evaluation, yet the basics are described here.

The participatory process was indeed a key element of this task. The result of the task is not just a document. The discussions, questions, concerns, answers and options were not only instrumental for the development of this document. These interactions were also productive in the sense that they resulted into insight upon which one or the other partner acted.

A few final remarks remain.

Objectivity: who formulates the judgement

The approach enables RIs to pro-actively anticipate societal impact evaluation. It enables the RI to indicate how the societal impacts it reports on are linked with what the RI aims for and what is expected of the RI. It allows to present what it contributes to impact convincingly. In all, the approach invites the RI to present a clear and transparent narrative. The risk is that a normative judgement becomes part of the information the RI provides, for instance by mentioning how good or important an achievement is. If an RI is asked to provide information regarding its societal impact, that will be evaluated by others, it is advised that the RI refrains from judgements.

Evidence of impact: indicators are proxies

The approach is in line with the state-of-the-art in societal impact evaluation, in that it focuses on the pathway to impact, the contribution of the RI to the impact and indicators that allow to substantiate this. This way, many issues with societal impact and its evaluation are addressed, such as the absence of clearly formulated and measurable impacts, the difficulty of attributing a societal impact to an RI and the time lag.

Having said that, it should be stressed that indicators are only proxies of societal impact. An indicator does not equal the impact. However, it can indicate whether the RI contributes to a societal impact, what it contributes and to what extent. Also, indicators do not speak for themselves. How to judge or appreciate the data, depends on the situation and on who evaluates. Therefor this protocol does not present a list of unbiased and self-evident indicators.

On the other hand, the protocol does refer to indicator sets developed in other projects and by other organisations. The use of well-defined indicators enhances evaluation. It might eventually lead to a more established practice.

Causal evidence: articulating assumptions

Just as indicators for impact were an issue throughout the project, so was causality. Does an impact pathway "prove" causality? No, it doesn't. But it does allow insight into strategic choices and considerations of the RI. And it does allow to articulate assumptions regarding causality. The development of a theory of change explicitly addresses assumptions. Ideally, a theory of change forms the basis for an impact pathway. In the ACCELERATE approach, the user is invited to develop an impact pathway starting at the impact and to argue back in time to what the RI actually contributes. This is a deliberate choice, since it allows to identify assumptions and preconditions. Ideally, the RI and its stakeholders jointly develop a theory of change. The diversity of stakeholders and expectations suggest that it is important for an RI to do so, if only in order to manage expectations. At the same time, that diversity of stakeholders and expectations makes it very challenging to do so.

Further use and relation with other projects and initiatives

Throughout the protocol, we referred to other projects and initiatives. The essence of ACCELERATE, i.e. the highly contextual approach, the relation between strategy and impact, the use of impact pathways, fits with the current trend. Other projects are dedicated to specific evaluation situations and propose indicators. Users of ACCELEATE can benefit from that. And the ACCELERATE approach can be used by others outside of the project as well.

ANNEXES

Annex 1: Evidence base

A wide variety of impacts is expected from an RI, some of which go above and beyond the mission or primary goal of an RI, and exceed scientific impact. There are no common agreements on what+ societal impact is, how it becomes manifest, nor what value to attach to an impact. There are no ready-made blueprints or implementation schemes for impacts. There are no tested formulas or conversion factors to predict an impact. Assessing impact, especially non-scientific impact, is challenging.

At the same time, impact has become part of the "social contract" between science and society. The legitimation of public spending on science is that society will benefit from science. "Scientific progress is essential" because when put to practical use, it will "bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited national resources, and will assure means of defense against aggression" and this implies "more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study" (Bush, 1945). However, in the last decade or two, the trust that science will obviously contribute to society has decreased, There is a growing need to demonstrate the value of science, and the impact of public spending on science (Nightingale & Scott, 2007; Donovan, 2011; Martin, 2011).

Since then, there is a growing body of academic literature dedicated to societal impact and its assessment. Journals such as Research Evaluation, Science and Public Policy, Research Policy and Minerva publish regularly on the subject. Next to that, there are consultancy studies and reports dedicated to the societal impact of a specific research organisation or programme, that are often rooted in the same body of academic literature on societal impact and its assessment. Examples are development research (for instance CGIAR, (Schuetz, Förch, & Thornton, 2014)), health research (for instance the Payback Framework, (Wooding, Hanney, Buxton, & Grant, 2004)) and in the field of Research Infrastructures (for instance reports by Technopolis, including (Griniece, Reid, & Angelis, 2015)). Finally, we see the academic literature shine through recent developments in research policy documents dedicated to societal impact of Research Infrastructures, such as (ESFRI, 2017) and (OECD, 2019).

Below we describe a number of issues with impact, and the way these issues are dealt with in literature.

In general, it takes a long time before an impact becomes manifest, and many actors are involved. Moreover, the relation between the intervention or the organisation on the one hand and the societal impact on the other is indirect rather than direct. Finally, societal impacts include a wide range of changes, including but not limited to economic, social, technological, health, environmental changes, that become manifest diffused in time and space (Godin & Dore, 2003). This makes it difficult to determine to what extent an organisation is responsible for an impact. A (not extensive) list of issues, based on (Bornmann, 2013) and (Joly et al., 2015):

Attribution: an impact is often the result of many actors and events. This causes challenges when aiming to estimate the extent to which an organisation has attributed to an impact (Joly et al., 2015). In case of an ex ante assessment, this becomes even more apparent, since the impact has not become manifest yet. A change of focus from attribution (the extent to which an impact can be ascribed to an organisation or intervention) towards contribution (the efforts of the organisation or intervention, that are expected to add to an impact) helps to overcome this (ibid.).

Contribution mapping (Kok & Schuit, 2012) depicts the research process and the actors involved and focusses on anticipatory efforts aimed to enhancing impact. Similarly, the FP7-project "Social Impact Assessment Methods for research and funding instruments through the study of 'productive interactions' between science and society" (SIAMPI) studied the interaction processes between researchers and stakeholders (Spaapen & van Drooge, 2011). By studying these productive interactions, they argue, the focus remains close to the process of knowledge production and the necessary communication between researchers and stakeholders.

Time lag or temporality: many impacts only become manifest after years, if not decades. The risk when applying a limited timeframe, is an overemphasis on short-term benefits. The Payback Framework (Donovan & Hanney, 2011) was originally developed to determine the impact of a number of grants from the UK Arthritis Research Campaign, long after the grants were awarded (Wooding et al., 2004). A dedicated logic model for arthritis research was developed, representing the complete research process up to impacts on society. In the UK REF 2014 research evaluation exercise, research units were required to present impact case studies based on research the department has done; it is allowed to use underpinning research of up to 25 years prior to the assessment period (REF2014, 2012)

This is not feasible for ex ante assessment, nor for most ex post assessments, where the period is far shorter. Again, by shifting the focus on the contribution, it becomes apparent what an organisation actually contributes. Models are often used, such as the previously mentioned Payback Framework (Donovan & Hanney, 2011; Wooding et al., 2004) and contribution analysis (Kok & Schuit, 2012). They model the expected or hypothetical relation between the effort (organisation, project, programme) and the impact.

The impact "mechanism": another issue is the mechanism that precedes impact. There is consensus that there is no clear and isolated linear path between an effort and an impact (Bornmann, 2013; Joly et al., 2015); on the contrary, the path is understood as non-linear, complex and complicated (Rogers, 2008). So recent approaches aim to open up the black-box of impact generation (Godin & Dore, 2003; Joly et al., 2015). There is attention for processes (see above: Payback framework (Donovan & Hanney, 2011), contribution mapping (Kok & Schuit, 2012) , SIAMPI (Spaapen & van Drooge, 2011), ASIRPA (Joly et al., 2015)), for procedures and arrangements (Bozeman & Sarewitz, 2011), for the role of networks of actors and for scaling up and scaling out processes (Douthwaite, Kuby, van de

Fliert, & Schulz, 2003). In order to accommodate the complex, complicated and insecure relation with impact, a model or theory is often used.

Use of models: several of the studies mentioned, model impact. An impact model is a simplified representation of the process towards impact; it is a hypothesis or theory of how impact is understood to come about (Jordan, 2010; Canada Treasury Board, 2012). The model or theory accommodate the complexity and the uncertainties involved in impact. Three models are commonly used as the basis for a tailormade model: logic framework, impact pathways and theory of change. All three make use of the same elements or building blocks. They include inputs, the resources made available, staff, funds, equipment and facilities; activities that are undertaken with the inputs and that are necessary to realize or make the outputs; outputs or results of the activities; outcome or further use of the outputs; and impact, or the change that becomes manifest. The underpinning theory differs in complexity (McLaughlin & Jordan, 2010).

Logic Framework depicts inputs, activities, outputs, outcomes and impacts. The basic logic model provides a simple and single linear path (Rogers, 2008; W.K. Kellogg Foundation, 2014). It provides limited insight into causality, other than that there is a relation between input and activities on the one hand, and output, outcome and impact on the other. It doesn't include an explanation how they work together (De Silva et al., 2014). When the mechanism towards impact is poorly understood, a logic framework is less useful (Greenhalgh, Raftery, Hanney, & Glover, 2016) . A potential pitfall is the development of a "logic-less frame" (Gasper, 2000), when simply filling in a standard framework, without addressing the relationship between the elements.

Impact pathways are more detailed than a logical framework. It shows links between outcomes and impacts and suggests causality. Impact pathways provide more of a narrated vision (Douthwaite et al., 2003; Kearnes & Wienroth, 2011; Fryirs, Brierley, & Dixon, 2019)

Theory of change is the most comprehensive model presented here. A theory of change is an hypothesis of how and why an impact (the change) is thought to become manifest. Assumptions, what is supposed to happen, and preconditions, necessary requirements, are part of a theory of change. These are extra elements, on top of the commonly used input, activity, output, outcome and impact. A theory of change is best developed in collaboration with stakeholders; both those that are or need to be involved, and those that are affected by the change. The result is a shared vision of the aspired change or impact. Moreover, the theory of change is a causal understanding of the processes or pathways leading towards the impact (De Silva et al., 2014).

Recap: The complex and complicated path towards impact is addressed in the academic literature. Issues such as attribution, time-lag and the uncertain impact mechanism might not be fully solved, yet there is consensus of adequate solutions. In short: modelling impact is a common way to accommodate the complexity and uncertainty. And in particular theories of change address the uncertainties explicitly.

Annex 2: Glossary of terms

Accountability: Obligation to demonstrate that work of the RI has been conducted in compliance with agreed rules and standards; or obligation to report fairly and accurately on performance results vis-a-vis mandated roles and/or plans. (OECD, 2002)

Accountability ceiling: Level beyond which an RI stops accepting responsibility for achieving outcomes. The ceiling of accountability is often drawn between the impact and the longterm outcome you stop using indicators to measure whether the outcomes have been achieved and therefore. (De Silva, 2014)

Activities: Actions taken and work performed by the RI, through which **inputs**, such as funds, technical assistance, staff and other types of resources are mobilized to produce specific **outputs**. (OECD, 2002)

Assumptions: Hypothesis about causal linkages or factors that could affect the progress or success of the RI. Assumptions are made explicit in **theory** based evaluations where evaluation tracks systematically the anticipated results chain. (OECD, 2002)

Attribution: The extent to which observed effects can be ascribed to a specific RI. (OECD, 2002)

Case study: a description of an example.

Contribution: what the RI adds to an impact. The assumption is that an impact is the result of several causes at the same time, none of which is sufficient for impact on its own. (DFID, 2012)

Evaluation: Systematic and organized assessment of the design, implementation and results of (in this case) societal impact of an RI. Evaluation also refers to the process of determining its worth or significance. Evaluation in some instances involves an assessment of actual and expected results and the identification of relevant lessons.

> **Ex ante evaluation**: An evaluation that is performed beforehand
>
> **Ex post evaluation**: An evaluation that is performed afterwards
>
> **Formative evaluation**: Evaluation intended to improve or reorient (Better Evaluation 2019)
>
> **Summative evaluation**: Evaluation intended to decide whether or not to start, fund, continue, replicate or scale up (based on Better Evaluation, 2019)

Impact: Impact is the real-world change that is affected by the RI. The RI contributes towards achieving that real-world change and usually doesn't achieve it solely on its own (OECD, 2019). Impact occurs at multiple levels and timeframes – there can be short-term, intermediate and long-term changes. (Westhorp, 2014).

Impact pathway: A mechanism by which causal links between **inputs**, **activities**, **outputs** and **outcomes**, and their intended impacts can be mapped (OECD, 2019)

Input: The resources the RI makes available to perform its **activities** that relate to an **objective**. (OECD, 2019). It includes staff, funding, facilities.

Interview: An oral method to collect data, in which an interviewer asks a set of (semi) structured questions to a respondent, in order to better understand the respondent's unique perspectives, opinions, and world-views. (Better Evaluation, 2019)

Mission: defines the purposes and **activities** of an RI, the services and products delivered and which communities of users are served. The mission is normally described in the statutes of an organization and provides the framework or context within which the RI's **strategy** and strategic **objectives** are formulated (OECD, 2019)

Monitoring: A continuing function that uses systematic collection of **data** on specified **indicators** to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds. (OECD, 2002)

Narrative: An overarching, well-argued and substantiated description, that includes the context in which the RI operates, its **strategic objective** and **strategy** and the choice of indicators. (QRIH, 2017)

Outcome: The likely or achieved short-term and medium-term effects of the outputs (OECD, 2002). It includes effects on knowledge, attitude, skills and practice. Sometimes referred to as: use.

Output: RI's products that result from its **activities**. Outputs can be considered as deliverables that help fulfil strategic objectives (OECD, 2019). Sometimes referred to as: results.

Qualitative indicator: People's perceptions and judgements on a selected topic. Qualitative indicators are non-numerical and are assessed through **case studies**, **surveys** and in-depth **interviews**.

Quantitative indicator: Measure of quantities or amount based on objective and available data. Quantitative indicators can be a number, an index, a ratio or a percentage.

Questionnaire: A method to collect data, using a specific set of written questions which aims to extract specific information, about attitudes, preferences and factual information, from the respondents. (Better Evaluation, 2019)

Societal impact: The effect of the RI's **activity** on the social fabric and well-being of communities, individuals and families, and on society as a whole (OECD, 2019). It includes, economic, social and educational **impact** as well as structuring effects of the RI.

Stakeholders: Agencies, organisations, groups or individuals who have a direct or indirect interest in the RI or its evaluation. (OECD, 2002)

Strategic objective: What an RI aims to achieve in the medium and / or long-term future. Strategic objectives guide current and future courses of action. (OECD, 2019)

Strategy: What the RI plans to do or does in order to achieve the objectives (based on Mintzberg et al, 1998)

Theory of Change: An hypothesis of how an impact is thought to become manifest and under what conditions. It articulates how inputs and activities are thought to produce results, how the results are thought to be used and how the use is thought to contribute to impact. It explicitly addresses causal relationships (Better evaluation, 2019).

Annex 3: Literature

Alluvium Consulting (2016) *Assessment of the Atlas of Living Australia's Impact and Value*. Produced for the CSIRO. Canberra

Better Evaluation (2019) retrieved from https://www.betterevaluation.org/en

Bornmann, L. (2013) "What is societal impact of research and how can it be assessed? A literature survey" *Journal of the American Society for Information Science and Technology*, 64(2), 217–233. https://doi.org/10.1002/asi.22803

Bozeman, B., & Sarewitz, D. (2011) "Public Value Mapping and Science Policy Evaluation" *Minerva*, 49(1), 1–23. https://doi.org/10.1007/s11024-011-9161-7

Bush, V. (1945) *Science: The Endless Frontier. Report to the President on a Program for Postwar Scientific Research*. Washington, D.C: U.S. Office of Scientific Research and Development.

Canada Treasury Board. (2012) *Theory-based approaches to evaluation: Concepts and practices*. Retrieved from http://epe.lac-bac.gc.ca/100/201/301/weekly_checklist/2013/internet/w13-03-U-E.html/collections/collection_2013/sct-tbs/BT22-131-2012-eng.pdf

De Silva, M. J. et al (2014). "Theory of Change: A theory-driven approach to enhance the Medical Research Council's framework for complex interventions" *Trials*, 15(1), 267. https://doi.org/10.1186/1745-6215-15-267

DFID (2012) *Broadening the range of designs and methods for impact evaluations. Working Paper 38.* London: DFID

Donovan, C. (2011) "State of the art in assessing research impact: Introduction to a special issue" *Research Evaluation*, 20(3), 175–179. https://doi.org/10.3152/095820211X13118583635918

Donovan, C., & Hanney, S. (2011) "The 'Payback Framework' explained" *Research Evaluation*, 20(3), 181–183. https://doi.org/10.3152/095820211X13118583635756

Douthwaite, B., Kuby, T., van de Fliert, E., & Schulz, S. (2003) "Impact pathway evaluation: An approach for achieving and attributing impact in complex systems" *Agricultural Systems*, 78(2), 243–265. https://doi.org/10.1016/S0308-521X(03)00128-8

ESFRI (2017) *Long-term sustainability of research infrastructures* Milano: Università degli studi di Milano, Dipartimento di fisica

Fryirs, K. A., Brierley, G. J., & Dixon, T. (2019) "Engaging with research impact assessment for an environmental science case study" *Nature Communications*, 10(1) https://doi.org/10.1038/s41467-019-12020-z

Gasper, D. (2000) "Evaluating the 'logical framework approach': Towards learning-oriented development evaluation" *Public Administration and Development*, 20(1), 17–28.

Giffoni, F. et al (2018) *RI Paths Task 3.2 State of play – literature review* Retrieved from https://ri-paths.eu/

Godin, B., & Dore, C. (2003) *Measuring the impacts of science: Beyond the economic dimension*. Retrieved from www.csiic.ca/PDF/Godin_Dore_Impacts.pdf

Greenhalgh, T., Raftery, J., Hanney, S., & Glover, M. (2016) "Research impact: A narrative review" *BMC Medicine*, 14(1), 78. https://doi.org/10.1186/s12916-016-0620-8

Griniece, E., Reid, A., & Angelis, J. (2015) *Guide to Evaluating and Monitoring Socio-Economic Impact of Investment in Research Infrastructures* Tallinn, Estonia: Technopolis Group.

Joly, P.-B., Gaunand, A., Colinet, L., Larédo, P., Lemarié, S., & Matt, M. (2015) "ASIRPA: A comprehensive theory-based approach to assessing the societal impacts of a research organization" *Research Evaluation*, 24(4), 440–453. https://doi.org/10.1093/reseval/rvv015

Jordan, G. B. (2010) "A theory-based logic model for innovation policy and evaluation" *Research Evaluation*, 19(4), 263–273. https://doi.org/10.3152/095820210X12827366906445

Kearnes, M., & Wienroth, M. (2011) "Tools of the Trade: UK Research Intermediaries and the Politics of Impacts" *Minerva* 49(2), 153–174 https://doi.org/10.1007/s11024-011-9172-4

Kok, M., & Schuit, A. (2012) "Contribution mapping: A method for mapping the contribution of research to enhance its impact" *Health Research Policy and Systems / BioMed Central*, 10, 21. https://doi.org/10.1186/1478-4505-10-21

Jana Kolar , Marjan Cugmas & Anuška Ferligoj (2019) *Towards Key Performance Indicators of Research Infrastructures* https://arxiv.org/abs/1910.00304

Kroll and Zencker (2019) *Research Infrastructure Impact Assessment Pathways.* Assessed https://ri-paths.eu/wp-content/uploads/2019/11/2.-Findings-of-RI-PATHS-project_Kroll-and-Zenker.pdf

Vincent Mangematin & Frederic Bally (2018) *BrightnESS 20180823_Deliverable_D1.7.docx*

Martin, B. R. (2011) "The Research Excellence Framework and the 'impact agenda': Are we creating a Frankenstein monster?" *Research Evaluation*, 20(3), 247–254. https://doi.org/10.3152/095820211X13118583635693

McLaughlin, J. A., & Jordan, G. B. (2010) "Using logic models". In: Joseph S. Wholey, Harry P. Hatry, Kathryn E. Newcomer (eds) *Handbook of practical program evaluation* San Francisco: Wiley

Mintzberg, H. Ahlstrand, B. & Lampel, J. (1998) *Strategy Safari: A Guided Tour Through the Wilds of Strategic Management* New York: The Free Press.

Nightingale, P., & Scott, A. (2007) "Peer review and the relevance gap: Ten suggestions for policy-makers" *Science and Public Policy*, 34(8), 543–553.

OECD (2002) *Glossary of Key Terms in Evaluation and Results Based Management* Paris: OECD

OECD (2014) The Impacts of Large Research Infrastructures on Economic Innovation and on Society: Case Studies at CERN. Paris: OECD

OECD (2019). *Reference framework for assessing the scientific and socio-economic impact of research infrastructures* (OECD Science, Technology and Industry Policy Papers No. 65). https://doi.org/10.1787/3ffee43b-en

QRIH (2019) Retrieved from https://www.qrih.nl/en

REF2014. (2012). *Assessment framework and guidance on submissions*. Retrieved from https://www.ref.ac.uk/2014/media/ref/content/pub/assessmentframeworkandguidanceon submissions/GOS%20including%20addendum.pdf

Rogers, P. J. (2008). "Using Programme Theory to Evaluate Complicated and Complex Aspects of Interventions". *Evaluation*, 14(1), 29–48. https://doi.org/10.1177/1356389007084674

Schuetz, T., Förch, W., & Thornton, P. (2014). *Revised CCAFS Theory of Change Facilitation Guide.* Retrieved from https://cgspace.cgiar.org/bitstream/handle/10568/56873/UPDATED%2520TOC%2520FACILI ATATION%2520GUIDE%2520.pdf

Spaapen, J. B., & van Drooge, L. (2011). "Introducing 'productive interactions' in social impact assessment" *Research Evaluation*, 20(3), 211–218. https://doi.org/10.3152/095820211X12941371876742

Technopolis Group (2018a) *Impact assessment of the Einstein Telescope*. Amsterdam: Technopolis Group

Technopolis Group (2018b) *ICOS Impact Assessment Report.* Amsterdam: Technopolis Group

Van Elzakker, Isabelle & Van Drooge, Leonie (2019) "The political context of Research Infrastructures: Consequences for impact and evaluation". *fteval Journal*, vol. 47, pp. 135-139 https://doi.org/10.22163/fteval.2019.342

Westhorp, Gill (2014) *Realist impact evaluation: an introduction*. London: Overseas Development Institute

W.K. Kellogg Foundation. (2014). *Logic Model Development Guide*. W.K. Kellogg Foundation.

Wooding, S., Hanney, S., Buxton, M., & Grant, J. (2004). *The Returns from arthritis research*. Santa Monica, CA: RAND.