Interreg
Danube Transnational Programme
ResInfra@DR

A Practical Guide on Ex Ante Evaluation for Research Infrastructures

Interreg
EUROPEAN UNION
Danube Transnational Programme
ResInfra@DR

A PRACTICAL GUIDE ON EX ANTE EVALUATION OF RESEARCH INFRASTRUCTURES

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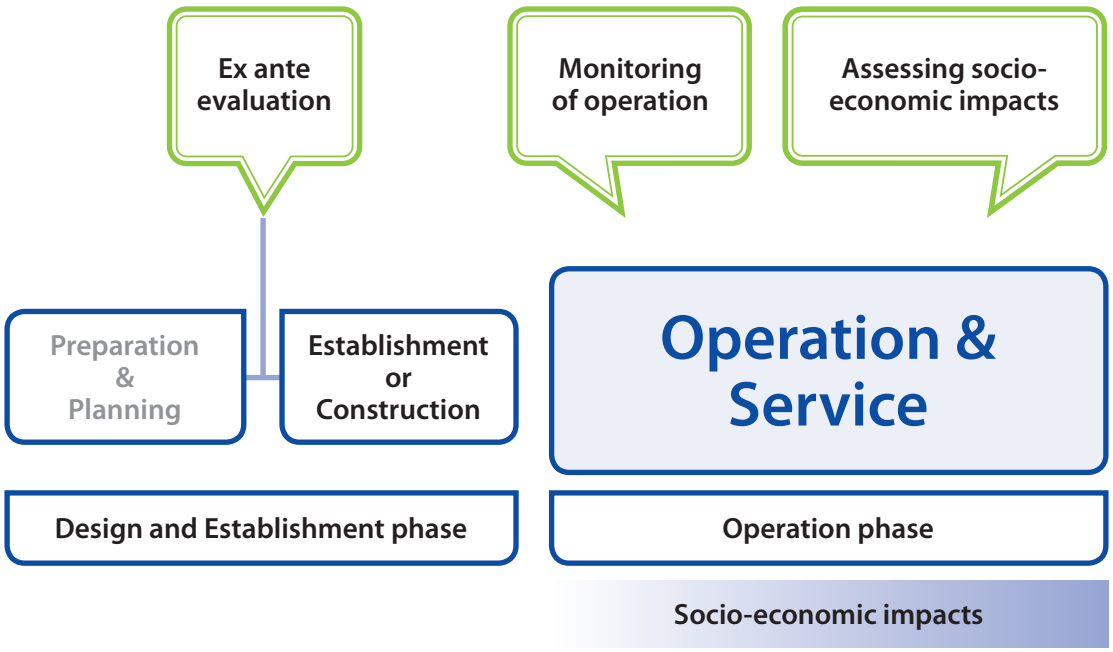
EXECUTIVE SUMMARY

The ResInfra@DR project has aimed at upgrading the knowledge of policy-makers and policy delivery organisations involved in the funding of research infrastructures (RIs), and RI managers. Thus, it has facilitated a dialogue process for RI stakeholders in the Danube macro-region; organised training workshops for RI policy-makers, managers and reviewers; compiled a registry of competent reviewers for RI evaluations; and arranged pilot peer learning activities to help existing RIs improve their operations and planned RIs to fine tune their investment plan and business model.

For a more detailed account of these activities and their results, please consult: http://www.interreg-danube.eu/approved-projects/resinfra-dr

The project has produced three guidance documents for RI policy-makers, managers and reviewers on ex ante evaluation, monitoring and assessment of the socio-economic impact of RIs, thus covering the life cycle of RIs.

Life cycle of RIs, the relevance of ex ante evaluation, monitoring and socio-impact assessment at different stages of the life cycle



Source: ResInfra@DR, 2019

These guides, including this one, have been developed by the ResInfra@DR consortium with input from RI policy-makers, managers and reviewers at several workshops and a concluding consultation meeting. Together, these three documents aim to provide an overview of the relevant processes and methods to improve the management of RIs leading to better utilisation of their precious and unique capacities, enhance performance, and pronounced socio-economic impacts.

This document considers the major aspects of ex ante evaluation of proposed RI investment projects, aimed at either building new RIs or upgrading existing ones. Evaluation *is a systematic process of assessment* of a policy tool, policy programme, an entire policy mix, including implementation and impact, or the operation and performance of an organisation. *Ex ante evaluation is conducted prior to the implementation* of a strategy, piece of legislation, programme or project, in our case an investment project aimed at building a new RI or upgrading an existing one.

It is worth conducting an ex ante evaluation before making a final decision on whether to invest in building a new RI or upgrading an existing one, as it offers several benefits for various stakeholders, including RI policy-makers, managers, funding agencies, staff members, taxpayers, businesses and local authorities.

The various ways of planning and organising an ex ante evaluation of an RI – internal vs. external; commissioning internal vs. external and domestic vs. foreign experts; bottom-up vs. top-down approaches – as well as their pros and cons, are considered in a separate section.

The level of analysis, as in the case of the other two ResInfra@DR guidance documents, is an individual RI. In other words, this document does not consider the benefits or practical aspects of using ex ante evaluation methods in the context of devising national RI roadmaps, even if some of the methods and approaches discussed here can also be used for that purpose. Aspects related to membership fees to join major international RIs are not considered directly, either. Again, this aspect is a major issue for such cases, thus ex ante evaluation would be a crucial part of the decision-making process.

There is no ex ante evaluation approach or method that fits all situations. This guiding document, therefore, does not advocate for the use of one method or another. Rather, it considers the *advantages and disadvantages* of the available methods and approaches, as well as the ways in which they can be applied. These methods are characterised in more detail in the Annex of this document, with the intention of *assisting stakeholders in choosing their own tailored method for conducting an ex ante evaluation*. Further references for each described method or approach are also provided. These methods and approaches can be applied on their own or in combination. Their selection and application should always be context specific, and made in accordance with the specificities of a given RI and its landscape.

1 INTRODUCTION

Definition of evaluation and ex ante evaluation

Evaluation *is a systematic process of assessment* of a policy tool, policy programme, an entire policy mix, including implementation and impact, or the operation and performance of an organisation. Setting evaluation criteria in advance helps in maintaining focus and objectivity. Evaluation is a multi-actor, multi-level process involving those who commission an evaluation and use the results (e.g. ministries or funding bodies), along with those who organise and conduct an evaluation and the evaluators who contribute with their assessments.

Evaluation serves the purpose of accountability, which is particularly important when public funds are being spent. Evaluation can provide useful information and considerations for learning, thus improving policies and programmes, as well as their implementation, the performance of organisations, the relevance and efficacy of institutions ("the rules of the game"), management practices, etc.

This guidance document focuses on ex ante evaluation of a planned new research infrastructure (RI) or major upgrade of an existing RI before substantial funds are invested.

As the term clearly indicates, ex ante evaluation **"is conducted prior to the implementation of a strategy, piece of legislation, programme or project".** (EVAL-INNO, 2011, p. 14)

In the context of making decisions regarding RIs, operating and evaluating them, various methods are relevant for different purposes. The main features of ex ante evaluation, monitoring, interim and ex post evaluation are summarised in Table 1.

TABLE 1: CHARACTERISTICS OF EX ANTE EVALUATION, MONITORING, INTERIM AND EX POST EVALUATION OF RESEARCH INFRASTRUCTURES

Ex ante evaluation	**Monitoring**	**Interim evaluation**	**Ex post evaluation**
Design stage	Operation of RI	Operation of RI	When a major stage has ended
■ identifies and documents the needs to be addressed by the RI ■ documents the results to be obtained ■ establishes the feasibility of planned activities ■ can shape the design of the RI ■ can contribute to the selection of interventions ■ assesses the likelihood of a success scenario	■ consists of a systematic collection of data regarding the progress of the RI ■ keeps track of implemented activities ■ ensures that the implementation process continues in the intended direction	■ documents progress and implementation of different interventions ■ shapes RI operation/ programme implementation ■ offers evidence on early effects	■ focuses on results and the contribution of the RI to changes produced ■ contributes to policy review by assessing the effective use of public funds

Source: Summary based on the EVALSED Sourcebook, 2013

The level of analysis, just as in the case of the other two ResInfra@DR guidance documents, is an individual RI. In other words, this document does not consider the benefits or practical aspects of using ex ante evaluation methods in the context of devising national RI roadmaps, even if some of the methods and approaches discussed here can also be used for that purpose. Aspects related to membership fees to join major international RIs are not considered directly, either. Again, this is a major issue for such cases, thus ex ante evaluation would be a crucial part of the decision-making process.

Expected benefits of ex ante evaluation

It is worth conducting an ex ante evaluation before making a final decision whether to invest in building a new RI or upgrading an existing one, as it offers several benefits for various stakeholders, including RI policy-makers, managers, funding agencies, staff members, taxpayers, businesses and local authorities. Table 2 summarises the main benefits of conducting an ex ante evaluation process for a planned new RI or a major upgrade of an existing one.

TABLE 2: EXPECTED BENEFITS OF CONDUCTING AN RI EX ANTE EVALUATION ON RIS

Policy-makers	■ **considerations if the RI fits into the existing RI landscape** and matches the needs of the scientific community ■ information about **synergies and complementarities** that can be developed with other policies ■ information on **how policy should be designed** and what actions should be taken that can lead to better results ■ information on **types of actions** that can be undertaken in order **to multiply effects** of the RI, e.g. clusters, innovation hubs, business incubators, transport and utilities infrastructures ■ foundation for monitoring and future evaluations of the RI ■ potential to increase and **multiply socio-economic effects on society**: fitting the RI into the bigger picture in relation to big societal challenges
RI managers	■ a systematic set of arguments to **convince decision-makers when applying for funding** ■ information is provided on **how the given RI can be designed** to produce excellent results and offer relevant services ■ information is gained regarding **potential risks** (e.g. related to the implementation process and environmental impact) and measures that can be undertaken to address them ■ increased and more efficient **exploitation of the data generated by the RI** (by reinforcing the data management policy and introducing these policies) ■ improved financial **sustainability** of the RI ■ **foundatio**n for monitoring and future evaluations of the RI
Funders of RI (funding agencies, universities, academies of science, NGOs)	■ **considerations if the new investment fits within the RI landscape** and answers real needs ■ **prevention of double funding** by ensuring that similar and sufficient services and equipment are not already available ■ identification of ways to obtain **greater value for money** ■ **accountability** and **transparency when spending public money** ■ **foundation** for monitoring and future evaluations of the RI
RI staff members	■ increased communication and performance within the RI, especially in the case of following a more participatory approach ■ a clearer overview of what to expect regarding the operation and impact of the RI ■ better career planning, e.g. what training programmes to participate in
Other actors that can benefit from an ex ante evaluation	■ **local firms and entrepreneurs, as well as firms interested in investing in the region,** can devise future actions and strategies by considering scenarios that include the existence of the planned RI ■ **local authorities**, based on success scenarios, can initiate actions and negotiations to attract investors ■ **taxpayers** have transparency regarding the way in which public money is being spent

Source: ResInfra@DR 2019

Main types of research infrastructures

When preparing an ex ante evaluation, it is important to keep in mind that RIs are rather different, and thus it is crucial to distinguish at least the main types from various angles. In practice, of course,

a more fine-grained distinction is needed, e.g. when an ex ante evaluation is devised, a set of indicators are selected, and collected pieces of information are interpreted, assessed and used to assist policy or managerial decisions.

According to the **level of maturity** (life cycle of a research infrastructure)

- proposal
- design and construction
- operation
- decommissioning

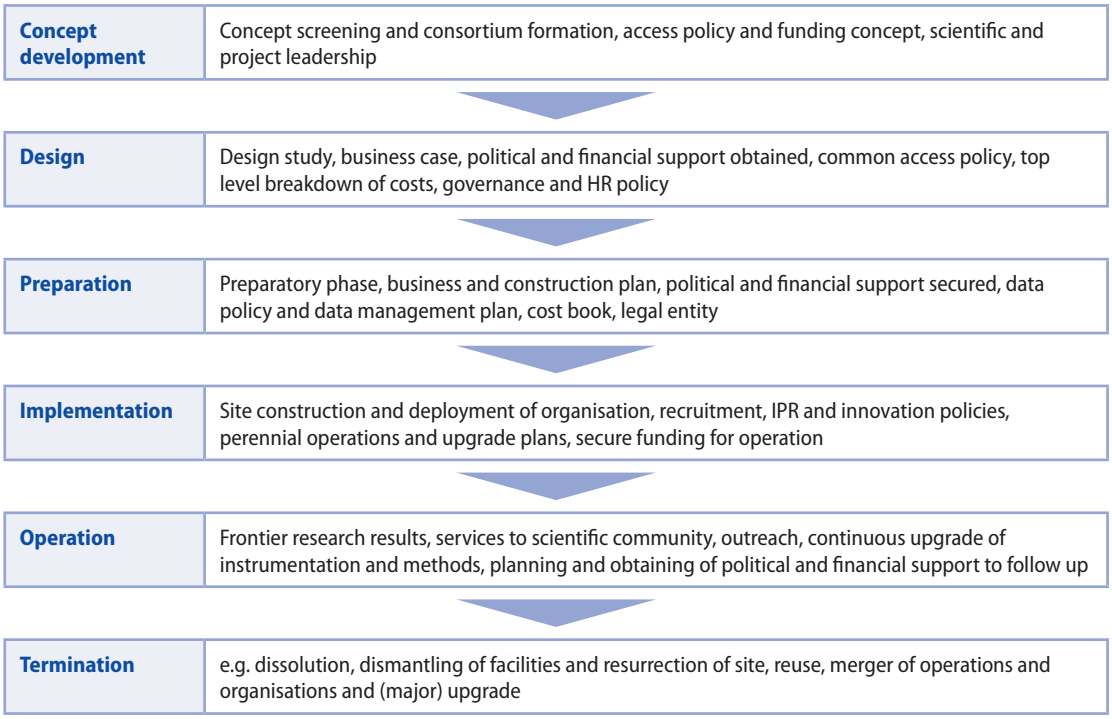
According to its **structure/distribution**

- single-site RI (placed in a single location, example: MYRRHA; EST, European Solar Telescope)
- distributed RI (housed in several locations, example: CERIC, DANUBIUS RI, ELI)
- e-infrastructures (example: PRACE)

According to their **geographical scope/relevance**

- regional
- national
- macro-regional
- pan-European

FIGURE 1: LIFE CYCLE OF RESEARCH INFRASTRUCTURES

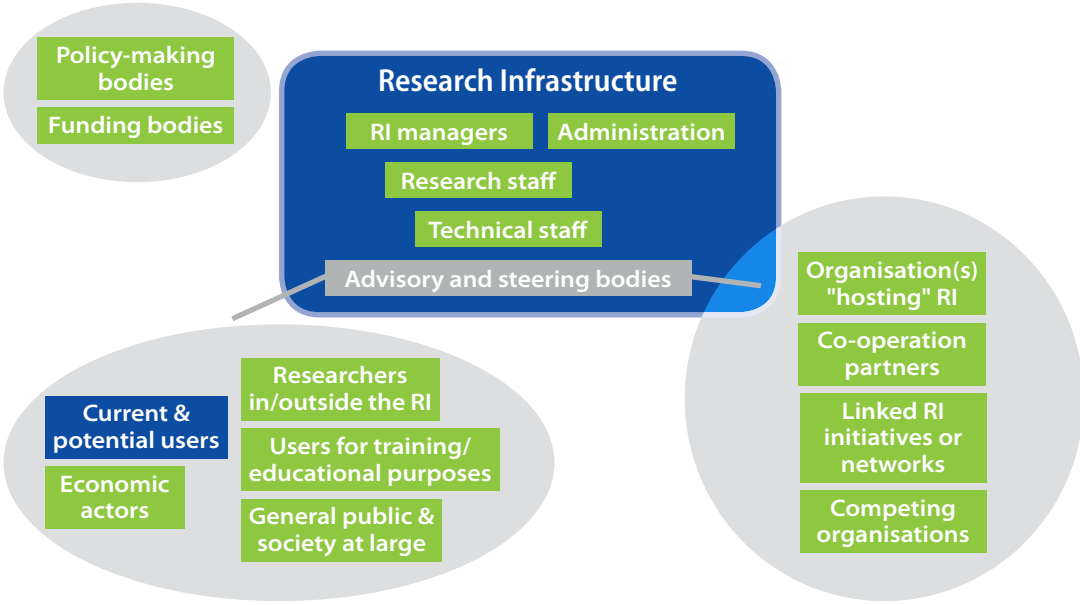


Source: ResInfra@DR 2019; Figure adapted from the RI life cycle – EU approach figure included in the "European approach to Research Infrastructures: priority setting, implementation, monitoring" presentation held by Dominik Sobczak, ESFRI Executive Secretary, DG Research & Innovation, European Commission, during the RESINFRA@DR WP3 Concluding Consultation Meeting, Budapest, Hungary, 27 November 2018

Stakeholders of research infrastructures

The most relevant stakeholders of RIs assembles on a first place policy stakeholders on regional, national and also international scale which are involved in the strategic setting and the (prospective) funding. A second group includes the organisation hosting an RI, the main cooperation partners involved can comprise also linked or networked RIs, but also specific competing RIs are relevant. Thirdly, main beneficiaries are the expected users within or outside of the RI as researchers, related education operators. Users comprise as well companies as economic actors and the general public and society as a large. Depending on the specific setting stakeholders may/may not contribute to advisory and steerign bodies of an RI. Looking inside the RI, also the specific workshare will define roles comprising potentially managers, researchers, technicians or administrative support staff.

FIGURE 2: OVERVIEW ON STAKEHOLDERS OF RESEARCH INFRASTRUCTURES



Source: ResInfra@DR 2019

Section 2 considers the various ways of planning and organising an ex ante evaluation of RIs – internal vs. external; commissioning internal vs. external and domestic vs. foreign experts; bottom-up vs. top-down approaches –, as well as their pros and cons. It is followed by a brief characterisation of the major tools of, and approaches to, ex ante evaluation of RIs (Section 3), while a more detailed description of these tools and approaches are presented in the Annex. Section 4 draws the major implications for RI policy-makers and managers.

2 ORGANISING AND MANAGING AN EX ANTE EVALUATION

2.1 Steps in managing and organising an ex ante evaluation

FIGURE 3: MAIN STEPS OF AN EX ANTE EVALUATION

Source: ResInfra@DR 2019

Step 1: Scoping

Identify the research infrastructure to be evaluated and set the time horizon for which the ex ante evaluation aims to provide information: what period of time will be taken into consideration by the evaluation? The longer the time horizon, the greater the uncertainty, as it is becomes harder to identify what new influencing factors might appear in the more distant future. Set the spatial limitations in accordance with the planned RI's geographical relevance: regional, national, macro-regional, pan-European, or global.

Methods to be used include: desk research; interviews with RI managers and technicians; review of the RI proposal, strategies, and other relevant documents.

Step 2: Identify the RI's intervention logic

- Is there a needs assessment study available?
- What is the overall context of the RI?
- Are the strategic objectives, the expected impacts and the impact pathways identified in a convincing way?
- Are the required financial resources available?
- Network analysis: identify all relevant stakeholders, their roles, the relationships among them, and their interest in the RI
- Landscape analysis: Are there similar and complementary RIs in the region, the country or in Europe? How does the RI under evaluation situate itself within the scientific landscape?

Methods to be used include: desk research, in particular a thorough review of the RI proposal, strategies, and other relevant documents; interviews with RI managers, technicians, members of the scientific community, representatives of funding agencies, local, regional, and national authorities.

Step 3: Design the evaluation

- Formulate the evaluation questions
- Identify the set of indicators to be used
- Select the appropriate methods for specific evaluation tasks
- Plan a baseline study

At this stage, the evaluation team is advised to develop an inception report, which can serve as a basis for the final evaluation report. Usually, inception reports include information about the scope and beneficiaries of the evaluation report, a first literature review, the evaluation design and questions, draft or final versions of data collection forms, a calendar of the evaluation process (milestones, deliverables, division of labour, etc.), information about the involved team and other items, depending on the context.

Step 4: Collect data

- Complete a baseline study
- Apply the selected instruments: e.g. conduct surveys and interview RI managers, scientists, technicians, public authorities

Step 5: Integrate the collected data and compile the evaluation report

- Synthesise and interpret the collected data
- Draft the evaluation report and executive summary
- Derive conclusions and recommendations
- Present the draft report to the client and discuss any further requests
- Consider the comments, suggestions and requests received and produce the final version of the evaluation report

It is recommended that the client(s) and the evaluation team stay in contact during the entire evaluation process. The client needs to make sure that the evaluation team has all the necessary information and documents at its disposal. The evaluation team is advised to periodically inform the client about the progress being made.

2.2 Who initiates and who finances an ex ante evaluation?

An ex ante evaluation can be initiated either by funding bodies or by the RI itself (or its host organisation), as it can serve different purposes.

When funding bodies are considering conducting or commissioning an ex ante evaluation, it might be mainly for **accountability reasons**, that is, to ensure that the allocated budget will be spent wisely, especially as in many cases the money come from public funds; funding agencies and taxpayers need to know what they can expect in return. In other cases, funding agencies are considering which RI to fund or whether to fund an RI.

Compared with an evaluation commissioned by funding bodies, an ex ante evaluation requested **internally** (by the host organisation or the management of a planned RI investment project), might also have a strong focus on the **learning and improvement** functions of evaluation. These include learning about possible unintended effects (either positive or negative), improving future implementation processes, identifying expected output and potential measures for improving impact.

The distinction between these client types, however, is not so rigid, as all evaluations can serve a mix of functions and purposes, depending on each unique case.

Ex ante evaluation can be financed by funding bodies, the RI itself or its host organisation. An ex ante evaluation can be a costly exercise. The cost of an evaluation should be proportional to the amount to be invested and the complexity of the planned RI. Budget plans should consider the evaluation

questions to be covered and methods to be applied, as well as whether the evaluation is internal vs. external and will be conducted by domestic vs. foreign experts.

2.3 Who conducts the evaluation?

When devising an ex ante evaluation, it is crucial to thoroughly consider whom to commission: internal vs. external and domestic vs. foreign experts, or mixed teams, and the concomitant advantages and disadvantages of these different compositions. These are summarised in Tables 3–4.

TABLE 3: PROS AND CONS OF COMMISSIONING INTERNAL VS. EXTERNAL EXPERTS

	Internal experts	**External experts**
Pros	■ better knowledge about, and understanding of, the RI and its context (including political aspects) ■ access to the RI and its personnel ■ reduced costs ■ increased availability to participate in meetings and activities when required ■ capacity to collect information when the RI is less willing to give important information to external experts ■ better utilisation of evaluation results: due to better knowledge of the RIs specificities, internal evaluators might be able to produce findings that are more likely to be implemented	■ more adequate specific skills and expertise ■ perceived objectivity and open- mindedness, with no obvious stake in the RI: this aspect weighs even more in the case of public funding ■ capacity to collect information: in certain cases people find it easier to open up to a stranger, with whom they do not work in the RI ■ increased willingness to criticise: external evaluators might find it easier to raise uncomfortable issues when necessary ■ better utilisation of evaluation results can be ensured through a participative approach, that is, working closely with stakeholders
Cons	■ increased risk of subjectivity and reduced willingness to criticise, due to potential negative professional and social consequences ■ lack of expertise and experience in using evaluation methods	■ higher costs (fees, potential transport and accommodation costs) ■ potentially decreased availability to participate in meetings and activities ■ reduced understanding of the RI's specificities compared with an internal evaluator ■ certain clients might also apply pressure not to criticise, or evaluators could be less willing to criticise due to a highly participatory approach

Source: ResInfra@DR 2019

TABLE 4: PROS AND CONS OF COMMISSIONING NATIONAL VS. FOREIGN

	National experts	**Foreign experts**
Pros	■ better knowledge about, and understanding of, the RI ecosystem and political context ■ easier access to the RI and its personnel (common language) ■ better understanding of the RI's context ■ reduced costs (lower fees, not required to travel great distances) ■ increased availability (not required to travel great distances)	■ if the new RI has (or will have) international relevance, it is desirable to have international experts on the evaluation team (for increased credibility) ■ evaluation is likely (and perceived) to be more objective (as the chances of having a conflict of interest are lower) ■ potentially higher level of methodological expertise and more diverse experience

	National experts	Foreign experts
Cons	■ increased risk of subjectivity, potential conflicts of interest ■ reduced willingness to criticise, due to potentially negative professional and social consequences ■ potentially lower level of methodological expertise and less experience	■ higher costs (potentially higher fees, accommodation and transportation costs) ■ language barriers ■ reduced availability to attend meetings due to geographical distance ■ reduced understanding of the institutional framework of the RI's country ■ reduced understanding of the political context and nuances behind the RI

Source: ResInfra@DR 2019

When conducting an ex ante evaluation, one possibility is to set up a mixed team, composed of internal and external (both national and foreign) experts. This way, one can combine the benefits stemming from the expertise and independence of external experts together with the RI- and country-specific knowledge of RI staff members.

2.4 Bottom-up vs. top-down ex ante evaluations

Bottom-up vs. top-down approaches to ex ante evaluation can be distinguished in two different ways: (1) regarding the aspects on which the evaluator chooses to focus first; and (2) regarding the types of stakeholders involved and their contribution to the evaluation design and process. These two approaches are compared in Table 5.

TABLE 5: MAIN FEATURES OF BOTTOM-UP AND TOP-DOWN EX ANTE EVALUATIONS

	Bottom-up	Top-down
Type 1	■ foundational aspects regarding the evaluated RI are considered first, such as the needs and the specificities of the client ■ the evaluation design is built in accordance with the context and specificities of the RI	■ the evaluator first decides upon the evaluation indicators to be used ■ the indicators and the methods are chosen in accordance with a certain evaluation purpose ■ the evaluation design is not completely tailored to the specificities of the RI
Type 2	■ the evaluation design is established through a participatory process, in which as many stakeholders are consulted as possible ■ stakeholders' opinions are taken into consideration to the same degree	■ the evaluation design is decided together with the client (who commissions the evaluation) ■ other types of stakeholders are not given much attention, or if they are involved, their opinions do not weigh as much as of those of the client

Source: ResInfra@DR 2019

3 TOOLS AND APPROACHES

It is worth recalling the main functions of an ex ante evaluation for a planned major RI investment. It can:

- assess whether the needs of the scientific community and the other users have been correctly identified;
- improve the quality of the programming process by systematically considering the major aspects;
- verify the relevance of the strategy and objectives included in the RI proposal in relation to identified needs;
- assess whether the RI proposal and strategy for its development are coherent internally and consistent in relation to other relevant strategies and documents at regional, national, macro-regional and European levels;
- assess whether the set objectives and expected impacts are realistic, especially considering available resources.

Typically, there are five main evaluation criteria. The standard questions related to these criteria are as follows:

- **Relevance**: To what extent are the objectives of the planned RI investment relevant in relation to needs and priorities at national, macro-regional and European levels?
- **Efficiency**: Are allocated resources adequate in relation to the expected outputs and results? What is the expected return on investment?
- **Consistency and coherence**: Are the proposed objectives and activities logically correlated with the socio-economic analysis? Are they mutually consistent and well anchored with the objectives and interventions at regional, national, macro-regional, and European levels?
- **Utility**: Are the expected effects satisfactory from the point of view of direct or indirect beneficiaries?[1] What potential risks could be anticipated at this stage?
- **Financial sustainability**: Will the expected results be durable over time? What will happen to the RI if it does not receive further public funding?

The tools and approaches described in this document do not exclude each other. They can be combined and used together, taking into account the context and scope of evaluation. In other words, this guidance document is not a "blueprint" for an ex ante evaluation. Rather, it is a **sourcebook of methods and techniques that can be implemented when conducting the ex ante evaluation of a research infrastructure.**

1 For further details, consult the EVALSED Guide, p. 35.

TABLE 6: OVERVIEW OF THE RI LIFE CYCLE CORRELATED WITH STAGES IN THE EXTENDED PROCESS OF MONITORING AND EVALUATION

<table>
<tr><th>Context/ needs</th><th colspan="3">Design of an RI proposal</th><th colspan="2">Design (final version) and build RI</th><th>Operation phase</th><th colspan="2">Decommissioning</th></tr>
<tr><td>Initial needs assessment</td><td>RI design – log frame</td><td>Planning of monitoring and evaluation</td><td>Baseline study</td><td colspan="3">Implementation (Intermediary evaluation can be conducted during the operation phase)</td><td>Final impact assessment</td><td>Lessons learnt are used in designing future policy programmes/ RIs</td></tr>
<tr><td>Initial assessment of context and needs</td><td colspan="4">Ex ante evaluation and planning</td><td colspan="4">Monitoring and evaluation</td></tr>
</table>

Source: ResInfra@DR 2019

3.1 Qualitative vs. quantitative methods for data collection and analysis

Both qualitative and quantitative methods can be used for data collection and analysis in ex ante evaluation of RIs. Their major characteristics, as well as their pros and cons, are summarised in Table 7.

TABLE 7: QUALITATIVE VS. QUANTITATIVE METHODS FOR DATA COLLECTION AND ANALYSIS WHEN EVALUATING RESEARCH INFRASTRUCTURES

Qualitative	Quantitative
■ takes into consideration the specificities of a given RI ■ there is a risk of subjectivity ■ RIs cannot be compared by using methods specific to this approach	■ difficult to demonstrate all RI impacts solely using quantitative indicators ■ there is no common framework to measure overall impacts and effectiveness ■ cannot handle multiple causalities, where a single impact may have more than one attribution ■ there are major life cycle and time-frame challenges for measurement and modelling

Source: ResInfra@DR 2019

3.2 Overview of suggested tools and approaches: pros and cons, when to use them

Ex ante evaluations can be performed in relation to RIs from different perspectives, such as: evaluation of the RI proposal (scientific excellence and relevance, coherence, feasibility, and financial sustainability), when funding agencies are trying to decide which RI to finance or whether to finance a given RI investment; and evaluation of the RI's potential evolution and future impacts (scientific, technology and innovation, socio-economic).

An ex ante evaluation of potential socio-economic impacts can also be presented as an additional argument in obtaining financing.

TABLE 8: AN OVERVIEW OF EX ANTE EVALUATION TOOLS AND APPROACHES

	Pros	Cons	When to use it?
Baseline study	■ Documents the state of affairs before the RI was built or upgraded ■ Provides baseline data necessary for monitoring, intermediary and ex-post evaluation ■ Useful in calibrating more realistic future targets	■ When data are collected from primary data sources, it might require extensive human and financial resources ■ When data is collected from secondary sources, the accuracy of the study depends on the availability and quality of existing data	■ It is preferable to be included in any type of ex ante evaluation; it can be combined with other methods and tools
"Make or buy?" analysis	■ Shows whether the RI should be constructed or upgraded ■ Compares the costs and benefits of building a new RI to the costs and benefits implied by using already existing facilities and services	■ This tool is not sufficient when considering conducting an ex ante evaluation Therefore, it should be accompanied by other methods and tools	■ When making the initial decision on whether a new a RI should be built or an existing one upgraded ■ This tool is useful before the design phase of an RI
Business plan	■ Provides a clearer picture of what is required aside from setting scientific objectives ■ Usually demanded by funding agencies	■ It differs from regular business endeavours, as the core activity of an RI is pursuing scientific objectives and the socio-economic impact of pure science can only be observed in most cases with a significant time lag	■ During the preparatory phase
Cost-benefit analysis (CBA)	■ Used to justify an investment and ensure accountability ■ Quantifies the RI's benefits in monetary terms and assesses whether those benefits exceed the costs associated with the RI	■ Some benefits are difficult to express (calculate) in monetary terms ■ Difficult to perform, due to the uncertainty of pure scientific activities; on top of that, some of the benefits might occur after a long period of time	■ This method is sometimes requested by funding agencies
Feasibility study	■ Helpful in determining whether the RI is technically and financially feasible ■ Identifies potential (scientific, technical, and financial) risks, and possible actions that can be taken to tackle them	■ Difficult to cover the entire spectrum of results and benefits, because they might appear after a long time ■ Some benefits are difficult to express (calculate) in monetary terms	■ Useful for both funders and RI managers ■ Early in developing the RI proposal, before a lot of resources have been spent on the RI proposal
Landscape analysis	■ Documents already existing RIs and their services ■ Useful in identifying research community needs and potential gaps	■ Not sufficient on its own. should always be combined with other methods and tools. In turn, it can also be used as part of other methods	■ A must-do during the concept development phase

	Pros	Cons	When to use it?
Gap analysis	■ Determines what steps need to be taken to move from a current state to a desired, future state	■ Insufficient on its own; it should always be combined with a landscape analysis and complemented by other methods	■ Can be used together with a landscape analysis at the level of a research system or an individual RI (for finding out what steps need be undertaken to obtain the desired future state)
Theory-based impact evaluation (TBIE)	■ Useful when building the logic model and identifying causal relations, contribution and attribution ■ The theory of change can provide an insight about the underlying assumptions and logic model of the RI	■ It is difficult to attribute effects to causes and isolate the effects caused by the RI from those caused by other contextual factors ■ Contribution analysis is less demanding than attribution analysis	■ Its principles can be applied to all types of approaches
Some elements from counterfactual impact evaluation (CIE)	■ Compares the changes expected to occur in situation 1, in which the RI has been built with those occurring in situation 2, in which the RI is absent ■ Can serve as a compelling argument in favour of the proposed RI by showing how a region and its research system would perform with and without the RI	■ Difficult to estimate what would occur when the RI is built and in its absence ■ Difficult to determine in a sound way the causal links between the RI and its expected impacts, as some of the latter might be due to other factors ■ Creates high expectations	■ Although CIE is usually used ex post, some of its elements can be applied ex ante when coupled with foresight methods

Source: ResInfra@DR 2019

4 CONCLUDING REMARKS

Investing in new research infrastructures, as well as maintaining and upgrading existing ones is a major challenge for RI policy-makers and managers. The use of modern decision-making methods and practices, among them the ex ante evaluation of RIs, can assist these decision-makers considerably in their day-to-day activities. The need for these methods can be best demonstrated by highlighting three major RI issues.

First, the most visible and pressing factor is the sheer cost of building new RIs and upgrading existing ones. Envisaged RIs, which are crucial for dealing with fundamental scientific, environmental or other socio-economic challenges, and thus are to be built in the coming years, tend to be expensive projects. Not all these new investments can be financed, and thus choices have to be made, and other sources of funding should also be mobilised. Second, given the importance of RIs – their role in addressing major scientific, technological, societal, economic and environmental challenges, and thus the socio-economic consequences of their operation, along with the financial implications of building and maintaining appropriate RIs – difficult strategic decisions must be made. Third, many RIs are exploited below the desirable level. Some experts, therefore, suggest that a shift in emphasis is required away from concerns about funding new or upgraded RIs and towards better use and management of existing RIs. Funding, interoperability, open access on the basis of merit, meeting educational and training needs, and data conservation are thus central management concerns. These issues require strategic responses that take a long view, the necessary strategic capabilities, however, are underdeveloped at many RIs. Moreover, better co-ordination of RIs is needed, both at national and EU levels, to achieve more efficient utilisation of resources and skills. Further efforts are also required to reduce the duplication and sub-optimal use of resources given the current lack of co-ordination.

For the above reasons, ex ante evaluation, monitoring of RIs, and assessing their socio-economic impact are of crucial importance when making major strategic decisions on new RI investments, or when making efforts to improve an RIs' operation and performance. The ResInfra@DR project has complied guidance documents on these three important decision-preparatory methods.

The documents are available at
http://www.interreg-danube.eu/approved-projects/resinfra-dr

The main purpose of ex ante evaluation of RIs is to systematically and thoroughly consider whether it is worth spending a considerable amount on an RI investment project before a large sum of money is actually spent. Ex ante evaluation of RI investment projects is beneficial for RI policy-makers, managers and other stakeholders. For RI policy-makers, it informs considerations on whether the RI fits into the existing RI landscape and matches the needs of the scientific community. It also provides information about synergies and complementarities that can be developed with other policies, as well as how policy should be designed, and what actions should be taken that could lead to better results. For RI mangers, it offers information on how an RI can be designed to produce excellent results and offer relevant services, as well as on the potential risks (e.g. related to the implementation process and environmental impact) and measures that can be undertaken to address them. It also improves

the chances of achieving financial sustainability. Further, it provides a foundation for monitoring and future evaluation of an RI.

The major implication for decision-makers (RI policy-makers or managers) who consider conducting an ex ante evaluation before investing significant funds is rather straightforward: there is no approach or method that fits all situations. This guiding document, therefore, does not advocate the use of one method or another. Rather, it considers the advantages and disadvantages of the available methods and approaches, as well as the ways in which they can be applied. These methods are characterised in more detail in the Annex of this document, with the intention of assisting stakeholders when choosing their own tailored method for conducting an ex ante evaluation. These methods and approaches can be applied on their own or in combination. Their selection and application should always be context-specific, and made in accordance with the specificities of a given RI and its landscape.

REFERENCES

Academy of Finland (2018). National evaluation criteria for research infrastructures. Retrieved from: https://www.aka.fi/globalassets/20arviointi-ja-paatokset/liitteet/firi_evaluation_criteria_2018.pdf

ACCELERATE (2018). Industry Innovation and the Role of Research Infrastructures. How CERIC-ERIC could help hundreds of firms to easy access the solutions on materials development, processing and use. Retrieved from: http://www.accelerate2020.eu/

ACCELERATE (2018). State of Open Access Procedures at Research Infrastructures. Retrieved from: http://www.accelerate2020.eu/

ACCELERATE (2018). Synergies in European Research Infrastructure Funding. The example of CERIC ERIC. Retrieved from: http://www.accelerate2020.eu/

Bohmert, D. (2016). Presentation: Strategy Report on Research Infrastructures Roadmap 2018: Methodology, ICRI 2016, Cape Town South Africa. Retrieved from: https://www.esfri.eu/sites/default/files/u4/20161004_Methodology_Db.pdf

Bollinger, I. (2017). InRoad Consultation Report: Prioritisation, Evaluation and Funding of Research Infrastructures in Europe. Retrieved from: https://www.inroad.eu/wp-content/uploads/2017/11/InRoad_Consultation_Report_201711.pdf

Brottier, F., Gliksohn, F. (2012). Presentation: ELI' s experience in the ex ante evaluation of socio-economic impact

Center of Industrial Studies, University of Milano (2016). Cost-Benefit Analysis in the Research, Development and Innovation sector. Retrieved from: https://www.csilmilano.com/docs/WP2016_01.pdf

Council of the European Union (2018). Competitiveness Council Conclusions. Governance of the European Research Area: Retrieved from: https://era.gv.at/object/document/4421

ESFRI Roadmap (2016). Retrieved from https://www.esfri.eu/roadmap-2016

ESFRI Roadmap (2018). Retrieved from https://www.esfri.eu/roadmap-2018

ESFRI (2016). Questionnaire for submission of proposals for Roadmap 2018. Retrieved from: https://www.esfri.eu/sites/default/files/docs/ESFRI%20Roadmap%202018_Proposal_Submission_Questionnaire_Public.pdf

European Charter for Access to Research Infrastructures (2016). Retrieved from: https://ec.europa.eu/research/infrastructures/pdf/2016_charterforaccessto-ris.pdf

European Commission (2013). Assessing the projects on the ESFRI Roadmap. A high level expert group report. Retrieved from: https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/esfri.pdf

European Commission (2013). EVALSED Sourcebook: Methods and Techniques

European Commission (2016). Report on the Consultation on Long Term Sustainability of RIs

European Commission (2017). Sustainable European Research Infrastructures. A call for action. Retrieved from: https://ec.europa.eu/research/infrastructures/pdf/swd-infrastructures_323-2017.pdf

European Commission, Directorate - General for Regional and Urban policy (2014). Guide to cost-benefit analysis of investment projects - Economic appraisal tool for Cohesion Policy 2014-2020

EVAL-INNO (2011). RTDI Evaluation Standards. Retrieved from: http://www.southeast-europe.net/document.cmt?id=521

EVAL-INNO (2011). State-of-the-art Report on Evaluation Practices, Potentials and Needs in South-East Europe. Retrieved from: http://www.southeast-europe.net/document.cmt?id=522

EVAL-INNO (2011). RTDI Program Evaluation Guidelines. Retrieved from: https://wbc-rti.info/object/document/14744

EvaRIO (2013). Case study: EMBL-EBI. Retrieved from: http://evario.u-strasbg.fr/uploads/autres-docs-BETA/EvaRIO_CAse_Study_EMBL-EBI.pdf

EvaRIO (2013). Core study: Adapting the BETA method to the case of the evaluation of the impact of RIs. Retrieved from: http://evario.u-strasbg.fr/uploads/autres-docs-BETA/D52_PART_I_EvaRIO_Core_study.pdf

EvaRIO (2013). Final report Synthesis of Results. Evaluation of research infrastructures in open innovation and research systems. Retrieved from http://evario.u-strasbg.fr/uploads/autres-docs-BETA/EvaRIO_Synthesis_of_Results.pdf

EvaRIO (2013). List of BETA-EvaRIO metrics and indicators. Retrieved from: http://evario.u-strasbg.fr/uploads/autres-docs-BETA/List_of_BETA-EvaRIO_metrics_and_indicators.pdf

EvaRIO (2013). Policy recommendations. Retrieved from: http://evario.u-strasbg.fr/uploads/autres-docs-BETA/D52_PART_III_EvaRIO_Policy_Recommendations.pdf

Griniece, R., Reid, A., and Angelis, J. (Technopolis Group) (2015). Evaluating and Monitoring the Socio-Economic Impact of Investment in Research Infrastructures

InRoad (2017). Funding of Research Infrastructures. Report on Literature Review. Retrieved from: https://www.inroad.eu/wp-content/uploads/2017/08/InRoad_D4_1_LIteratureReview.pdf

Kolar, J., Harrison, A., Gliksohn, F. (ACCELERATE project) (2018). Key performance indicators of Research Infrastructures. Retrieved from: http://www.accelerate2020.eu/key-performance-indicators-of-research-infrastructures/

LERU (2017). Four Golden Principles for Enhancing the Quality, Access and Impact of Research Infrastructures. Retrieved from: https://www.leru.org/publications/four-golden-principles-for-enhancing-the-quality-access-and-impact-of-research-infrastructures

MOSTA (2015). Policy Brief: Social and Economic Return on Investment in Research and Development. Retrieved from: https://mosta.lt/images/leidiniai/Social_and_economic_return_on_investment_in_research_and_development.pdf

OECD (2010). Establishing Large International Research Infrastructures: Issues and Options. Retrieved from: http://www.oecd.org/science/inno/47027330.pdf

OECD (2014). International Distributed Research Infrastructures: Issues and Options. Retrieved from: http://www.oecd.org/sti/inno/international-distributed-research-infrastructures.pdf

OECD (2014). The Impacts of Large Research Infrastructures on Economic Innovation and on Society: Case Studies at CERN. Retrieved from: http://www.oecd.org/sti/inno/CERN-case-studies.pdf

OECD (2019). Reference framework for assessing the scientific and socio-economic impact of research infrastructures. Retrieved from: https://www.oecd-ilibrary.org/docserver/3ffee43b-en.pdf?expires=1557318471&id=id&accname=guest&checksum=48E205961BEBCD1598C8DCD557033F34

RAMIRI – Realising and Managing International Research Infrastructures (project). Retrieved from: http://www.ramiri.eu/; http://www.ramiri.eu/2012-Resources.html; http://www.ramiri.eu/2011-resources.html

Research Policy Institute, Lund University (2004). Impacts of Large-Scale Research Facilities – A Socio-Economic Analysis

Rochow, R., Peró, M., Pook, K., Tchonkova, D., Marinova, D., Gheorghiu, R. and Niță, V. (2011). FenRiAM full guide – Proposal for a Foresight-enriched Research Infrastructure Impact Assessment Methodology

Rossi, G. (2013). Proposal to ESFRI on Indicators of Pan-European relevance of Research Infrastructures. Retrieved from: https://www.esfri.eu/sites/default/files/FI13_46_14_ESFRI%20Indicators_report_4.pdf

Some of the publications listed here are available online via this link:
http://download.resinfradr.eu

ANNEX: A BRIEF OVERVIEW OF EX ANTE EVALUATION TOOLS AND APPROACHES

The overview of methods and approaches presented below is meant to serve as a **list of options**, with a focus on **each method's relevance for policy-making** to be consulted by interested parties. Its purpose is to **assist stakeholders when choosing their own tailored method for conducting an ex ante evaluation.**

It also needs to be stressed that the process of ex ante evaluation is interlinked with other parallel processes, such designing an RI proposal and setting strategic objectives.

When characterising these methods, one must keep in mind the following practical questions: What does a certain method offer? When should it be used? What preconditions are required before considering its use? What are its specific features? What are the usual steps to apply a given method?

Baseline study

A baseline study summarises the "Facts about the condition or performance of subjects prior to treatment. The essential result of the pretest part of the pre-test/post-test approach." (Evaluation Thesaurus apud. EVALSED Guide, 2013, p. 94)

In this case, a baseline study documents the state of affairs before an RI has been built or upgraded. It represents an important element in performing any type of evaluation: ex ante, intermediate or ex post evaluation. When conducting an ex ante evaluation, a good understanding of the current situation is needed to be able to compare it with future scenarios, to capture or foresee the possible results of an RI.

Example

To assess whether a planned RI will contribute to the creation of new jobs in the region, it is necessary to document the state of affairs in this regard: how many people are currently working in the region per sector of activity? What is the level of education? What is the unemployment rate? The data collected will serve as a *historical point of reference*, and help evaluators estimate potential progress. If there is a certain unemployment rate (referring both to highly-skilled people and workers in the construction and services sectors) in the region and it is expected the RI will create a certain number of direct jobs and an estimated number of indirect jobs, then estimations can be made regarding the potential decrease in the unemployment rate.

Another benefit of collecting baseline data is the provision of relevant information for setting realistic targets (useful to both RI policy-makers and managers). For example, if the unemployment rate in the region is high and the RI is expected to create only a few and very specific direct jobs, for which skilled people are not available in the region, building the RI will not reduce the unemployment rate in the region.

TABLE A1: NEEDS ASSESSMENT AND BASELINE STUDY

Terms	Explanation	Practical relevance
Needs assessment	Documents the context of the RI and the state of affairs in its region. Identifies needs before the RI is designed Can provide information on whether and how the RI design can be coupled with other policies and measures to increase socio-economic impact in the region	Identifies the needs of the scientific community Can include a landscape analysis for mapping already existing similar and complementary RIs Can be used to identify socio-economic needs and challenges, e.g. high unemployment rate, lack of adequate transport infrastructure. Hence, policy-makers could devise and launch policies for improving transport infrastructure that can benefit the RI's operation and multiply economic impacts in the region
Baseline study	Documents the state of affairs before the construction and operation phase of the RI Involves collecting data on impact indicators that will be used to measure progress The collected data will serve as a point of reference when conducting ex ante, intermediary or ex post evaluation	An impact indicator could be the number of children from the region that have participated in "Open days of science" types of events. The baseline in this case is the number of children who had attended "Open days of science" before the RI was built. Thus, the actual value of this indicator refers to the increased or unchanged visibility of science

Source: ResInfra@DR 2019

In many cases, it is sufficient to rely on secondary data sources, such as previous studies and reports, strategies, and needs assessments to set values for chosen indicators. However, when the available information is not sufficient, conducting a thorough baseline study requires more extensive – and more time-consuming – data collection efforts, using primary sources (e.g. interviews and surveys).

Further references

European Commission (2013). EVALSED: The resource for the evaluation of Socio-Economic Development - Evaluation guide. Retrieved from: https://ec.europa.eu/regional_policy/en/information/publications/evaluations-guidance-documents/2013/evalsed-the-resource-for-the-evaluation-of-socio-economic-development-evaluation-guide

EUROSTAT. Statistics explained, Glossary: Baseline study, Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Baseline_study

IFRC. Baseline Basics. Retrieved from: https://www.betterevaluation.org/sites/default/files/Baseline%20Basics%202013.pdf

Rochow, R., Peró, M., Pook, K., Tchonkova, D., Marinova, D., Gheorghiu, R. and Niță, V. (2011). FenRiAM full guide – Proposal for a Foresight-enriched Research Infrastructure Impact Assessment Methodology

Zivetz, L. and Chekan,Ch. (August 2017). ValuingVoices, Building the Evidence Base for Post Project Evaluation: Case study review and evaluability checklists, Retrieved from: http://valuingvoices.com/wp-content/uploads/2017/08/Valuing-Voices-Checklists.pdf

"Make or buy?" analysis

What does it offer?

A make-or-buy analysis compares the costs and benefits associated with building and operating a new RI (or those required to upgrade an existing RI) to the costs and benefits involved when using the facilities and services offered by existing RIs.

This type of analysis can answer questions such as: Would the RI satisfy certain needs? Can those needs be satisfied by already existing facilities and services offered? At what level are those available: regional, national, transnational? Which option would be more advantageous: satisfy these needs through "buying" the services of available RIs, or building ("making") a new RI?

When to conduct: The question of "make or buy" should be the first raised when considering an RI investment.

Analytical steps

Landscape analysis: To calculate the costs and benefits involved in using the facilities and services offered by existing RIs, a landscape analysis is needed to identify the relevant facilities and services.

Calculating the costs of "making": These costs include all expenses associated with the entire life cycle of the planned new RI, including planning costs, initial investment costs, operating and decommissioning costs. (For a detailed breakdown and explanation of these costs, please consult the section on 'feasibility study').

Calculating the costs of "buying": These costs include all costs related to using the facilities and services of existing RIs. The process of documenting costs starts from data obtained through landscape analysis. The costs and feasibility of "buying" will also be determined by the proximity of similar research facilities. Depending on distance, additional costs for transportation and accommodation might need to be considered.

Calculating the costs of a third option: An optimal solution might be to establish **a long-term partnership** with RIs that already offer some of the services and facilities required to satisfy the identified needs. In this case, the planned new RI would be built only to offer only those services and equipment that are not available at existing RIs.

Making the decision

The decision should be made by comparing the cost of the three above-mentioned options and selecting that which is most cost-effective. Usually, building and operating a new RI involves great expense. Thus, it is important to first consider whether it is more effective to "buy" the services of already existing RIs. Besides cost considerations, other reasons might also support "buying", e.g. a lack of expertise to operate a new RI, a low number of potential users for a new RI, or attractive opportunities to establish long-term collaboration relationships with similar RIs.

Other factors, however, might convince decision-makers to "make" a new RI. These include the desire for more control when using the new RI, as well as better quality control or proprietary technology that requires protection. Moreover, by building a new RI, additional socio-economic impacts can be generated both directly and indirectly, leading to an increased general level of welfare in the region. Difficulties in establishing partnerships with other RIs, political, environmental or social considerations, or greater guarantee of access may also influence a "make" decision.

Steps in making the decision

1) Quantitative analysis: comparing the costs of the above three options
2) Qualitative analysis: considering other pertinent factors that are difficult to monetise, such as the quality of services provided by other RIs or the level of experience and expertise of the research community existing in the region in managing and operating a potential new RI
3) Making a decision after thorough analysis of quantitative and qualitative factors

Further references

PWC (2011). Make or buy. Three pillars of sound decision-making. Retrieved from: https://www.strategyand.pwc.com/media/file/Strategyand_Make-or-buy-sound-decision-making.pdf

Sillanpää, I. (2015). Strategic decision making model for make or buy decisions. Retrieved from: https://www.researchgate.net/publication/281592584_Strategic_decision_making_model_for_make_or_buy_decisions

Business plan

What does it offer? "Plan the road ahead, so that you know where you are heading."

RIs are rarely profitable and their governance is different from the governance of a corporate organisation. Even so, devising a business plan in the preparatory phase will provide a clearer picture of what is required aside from setting relevant scientific objectives.

When to conduct: During the preparatory phase.

A potential outline

1) Executive Summary
   a) Overview of the business plan
   b) Main objectives of the RI proposal
2) Introduction
   a) Context and justification of the RI proposal (Why is the RI needed?)
   b) Details of the RI proposal
   c) Legal aspects (Who will be the host organisation/s? How will it be managed? Legal form of the RI)
   d) Details concerning the host organisation/s
   e) Details concerning the services that will be provided by the RI and about the facilities to which it will provide open access (and maybe how)
   f) Existing plans for the future and success criteria
3) Landscape analysis
   a) Overview of the research landscape in the fields covered by a respective RI
   b) SWOT analysis
   c) Target groups and beneficiaries analysis
   d) Analysis of similar RIs

4) Marketing strategy
    a) Marketing objectives
    b) Marketing strategies
    c) Target markets
    d) Open access mechanisms and pricing strategy
    e) Budget and timeline
5) Ensuring operability of an RI
    a) Location, premises, equipment
    b) Staff and suppliers
    c) Systems and procedures
    d) Internal rules on health and safety, quality control, legal compliance
6) Financial information
    a) Cash flow forecast
    b) Construction and set-up costs
    c) Operational costs
    d) Sources of funding
    e) Profit and loss statement
    f) Balance sheet
7) Annexes
    a) Detailed landscape analysis
    b) Letters of support from potential users: researchers, public and private entities
    c) Legal documents
    d) CVs of key staff members (especially scientific, technical and management staff)
    e) References, previous work of host organisation/s

Further references

ESFRI Long-term Sustainability Working Group (2017). Long-term Sustainability of Research Infrastructures Volume II. Retrieved from: https://ec.europa.eu/research/infrastructures/pdf/esfri/publications/esfri_scripta_vol2.pdf

InRoad (2018). Deliverable 5.4 Final recommendations on Best Practices and Common Standards for RI Business Planning. Retrieved from: https://www.inroad.eu/reports/

InRoad (2018). Deliverables 5.2-5.3 Best practices and common standards for RI business planning. Retrieved from: https://www.inroad.eu/reports/

Calvia-Goetz A. (2016), Presentation: Investing in Research Infrastructures: bankability, financial and business plans. A journey to develop RI financial and managerial maturity, 9th March, Amsterdam. Retrieved from: https://www.esfri.eu/sites/default/files/EoE_09-03-2016_Calvia_Goetz_0%5B1%5D.pdf

Examples of Business Plans for Research Infrastructures

AnaEE (2016). Business and Operational Plan. Retrieved from: https://www.anaee.com/business-plan

BBMRI-ERIC (2012). Business Plan v.21.1. Retrieved from: http://www.bbmri-eric.eu/wp-content/uploads/BBMRI-Business-Plan.pdf

ISBE Business Plan. First Edition (2015). Retrieved from: http://project.isbe.eu/business-plan/

EMBRC (2013). Business Plan. Retrieved from: http://www.embrc.eu/sites/embrc.eu/files/public/EMBRC%20Business%20Plan.pdf

Euro-BioImaging (2014). Business Plan. Recommendation from the Euro-BioImaging Preparatory Phase. Retrieved from: http://www.eurobioimaging.eu/content-page/euro-bioimaging-business-plan

Health-RI (2017). Executive summary Business Plan. Retrieved from:

https://www.health-ri.org/sites/healthri/files/Executive%20summary%20Health-RI%20business%20plan.pdf

Infrastructure for Systems Biology Europe (2015). ISBE Business Plan (living document). Retrieved from: http://project.isbe.eu/business-plan/

Cost-benefit analysis (CBA)

What does it offer?

CBA quantifies the RI's benefits in monetary terms and assesses whether those benefits exceed its costs. This method is usually used to ensure accountability for funders and contributors.

The main steps in conducting a cost-benefit analysis

Establish the time horizon: How far into the future is the analysis going to look? It is suggested to consider a time horizon that covers the entire life cycle of the prposed RI, until its decommissioning.

Determine costs

- Identify all costs necessary for the entire life cycle of the proposed RI: planning, building, operation, decommissioning.
- The calculation should be repeated for each year included in the analysis.

Calculate benefits

Once identified, all types of benefits – tangible and intangible,[2] direct and indirect – need to be translated into monetary terms. All benefits should be related to the main economic agents: firms, consumers, employees, taxpayers.

Examples of categories of economic benefits include (Florio, 2016):

2 In the case of unknowable or difficult-to-calculate costs, shadow prices can be used to assign monetary value to less tangible benefits. Some of the most common tools for doing so are: contingent valuation, revealed preferences and hedonic pricing. E.g. contingent valuation is an economic technique based on surveys, used for valuating non-market resources, such as the preservation of biodiversity.

- **Technological spillover** (benefits for firms; e.g. discounted incremental social profits **Πjt** generated by companies (**j**) of the RI's supply chain which have benefitted from a learning effect);
- **Human capital formation and training** (benefits for employees; e.g. increased earnings gained by the proposed RI's students and former employees from the moment they leave the project, against a counterfactual scenario);
- **Knowledge output** (benefits for users; the sum of the present value of papers authored by the proposed RI's scientists ($P0t$) and the value of subsequent flows of papers produced by other scientists that use or elaborate on the RI's scientists' results, divided by the number of references they contain ($Pit\ kit$, with $i = 1, \ldots n$), and the value of citations each paper receives, as a proxy of the social recognition that the scientific community acknowledges the paper (Qit with $i = 0, \ldots n$);
- **Cultural effects** (benefits for users; outreach activities carried out by the RI produce cultural effects on the general public g, which can be valued by estimating the willingness to pay for such activities by the general public)
- **Services provided to users** (benefits for users who are better off because of the delivery of innovative services provided by the RI).

Compare expected benefits to expected costs

"The expected economic net present value of the RDI infrastructure ( ) over the time horizon (T) is defined as the difference between expected benefits and costs valued at shadow prices and discounted at the social discount rate (r)." (Florio, 2016)

Questions to be taken into consideration:

- Who is paying the costs?
- Who is receiving the benefits?
  - First stakeholder analysis is required to answer this question

Further references

European Commission (2014). Guide to Cost-Benefit Analysis of Investment Projects. Economic appraisal tool for Cohesion Policy 2014-2020

Florio, M. (2016). The Socio-Economic impact of large-scale research infrastructures: LHC and CNAO, ALBA. Presentation held in Barcelona, 7th October. Retrieved from: https://indico.cells.es/indico/event/91/material/slides/0.pdf

Florio, M., Sirtori, E. (2014).The Evaluation of Research Infrastructures: a Cost-Benefit Analysis Framework, Working Paper no. 2014-10. Retrieved from: https://ideas.repec.org/p/mil/wpdepa/2014-10.html

Jones C., Williams J. (1998). Measuring the social rate of return to R&D, *Quarterly Journal of Economics*, vol. 113, Issue 4, pp. 1119–1135

OECD (2015). Frascati Manual 2015. Guidelines for Collecting and Reporting Data on Research and Experimental Development. Retrieved from: http://www.oecd.org/sti/frascati-manual-2015-9789264239012-en.htm

Feasibility study

What does it offer?

A feasibility analysis can establish whether a RI is viable or not. It is the preliminary evaluation of an RI proposal, conducted in order to establish whether a proposal is worth pursuing.

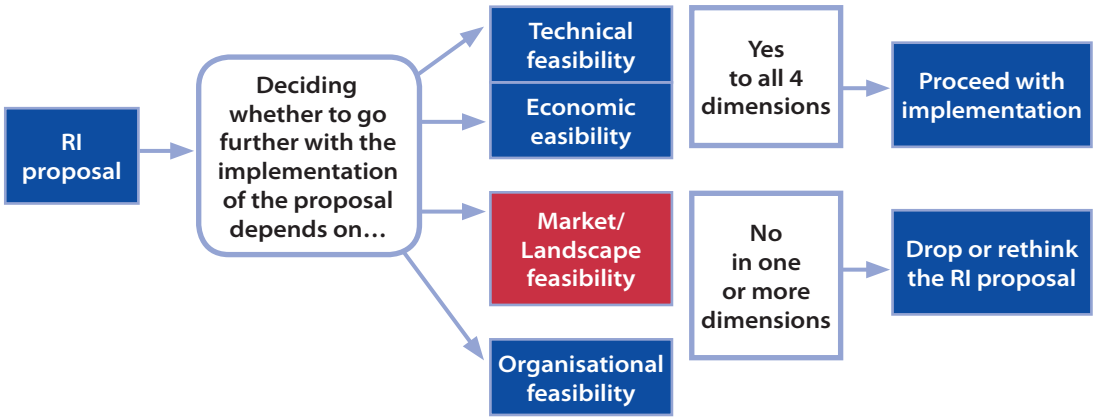
All RI proposals involve feasibility risks, thus the aim is to identify those risks and assess their significance to be able to tackle them if and when they occur. Feasibility studies are useful for sponsors and RI managers.

When to conduct: Early in the development of an RI proposal, before a lot of resources have been spent on the proposal.

Main dimensions

- Technical feasibility
- Economic feasibility
- Market feasibility or landscape analysis
- Organisational feasibility

FIGURE A1: MAIN DIMENSIONS OF A FEASIBILITY STUDY



Source: ResInfra@DR 2019

Technical feasibility: Can the RI be built (upgraded)?

- Adequacy of the technical development plan
- Sources of risk: list each source of risk and elaborate on how risks can be tackled. Examples:
  - Lack of familiarity with the technology required for building the proposed RI: Are there qualified technicians and/or constructors to build it? Has someone used it before? How new is the technology?
  - Risks associated with the size of the proposal: the number of people who need to be involved, the time needed to implement the proposal.

Economic feasibility: Will the benefits outweigh the costs?

- Identify costs (both for building and operation) and benefits
- Assign values (in monetary terms) to costs and benefits
- Determine the available budget
- Assess financial viability

The focus should be on calculating the return on investment (ROI) and net present value (NPV). For this, a cost-benefit analysis can be done.

Costs related to the entire life cycle of a RI need to be considered. These are as follows:

- Planning costs
- Initial investment costs
  - Acquisition of real estate
  - Construction
  - Acquisition and/or development of devices and equipment
- Operating costs
  - Maintenance costs (rent, electricity, water, cleaning services)
  - Personnel costs (per category: management, scientific, technical, administrative)
  - Materials costs (costs of raw materials used during operation)
  - Cost to update equipment (required to keep the proposed RI up-to-date)
  - Membership fees
- Decommissioning costs

Organisational feasibility

- Assess the strategic alignment
  - Are the proposal's goals aligned with regional, national or European strategies and with the interests of the research community?
- Evaluate the impact on various stakeholders
  - Is there widespread and strong support for the proposal at regional, national or European level?
  - Are there any users who would be particularly interested in using the RI?
- Availability, experience and expertise of personnel

Summary observations

It is essential to continuously review and revise the feasibility study.

- How well are the previously identified risks being managed?
- Are any adjustments needed?
- Are there any new risks that have appeared?

Further references

European Commission (August 2013). Assessing the projects on the ESFRI Roadmap. A high-level expert group report.

JASPERS Knowledge Economy and Energy Division (April 2013). Project Preparation and CBA of RDI Infrastructure Projects, Working Paper. Retrieved from: http://www.jaspersnetwork.org/display/for/Project+Preparation+and+CBA+of+RDI+Infrastructure+Projects

Landscape analysis

What does it offer?

A landscape analysis identifies already existing relevant RIs. Before establishing a new RI, it is of fundamental importance to consider the needs of the research community and the facilities and services offer by the already existing RIs. By doing so, gaps can also be identified and analysed, and thus it can be determined whether the proposed new RI would better meet existing needs.

The main steps in conducting a landscape analysis

- Identify all existing relevant RIs, both private and public, which operate in the same research fields where the proposed new RI would work;
- List all products and services provided by the identified RIs, as well as the facilities they offer access to;
- Collect relevant data regarding the profile of these RIs;
- Organise them according to different criteria: geographic location and proximity to the proposed new RI;[3,4] access policy (competition based, free-of-charge or fee access etc.); and other criteria that would be considered necessary;
- List potential users and organise them according to different categories, frequency and quantity of access time;
- List and document private and public organisations that provide funding for RIs active in the research fields to be covered by the proposed new RI;
- Conduct interviews and/or surveys with representatives of the research community and with other relevant stakeholders in order to verify obtained data and gather new information. The interviews and surveys can also be used to identify gaps in terms of facilities and services and further needs of the research community;
- Document the availability of human resources necessary for operating the proposed new RI;
- Based on results obtained through desk research and consulting relevant stakeholders, identify existing gaps and assess if and how the RI proposal could address those gaps.

3 This criterion might not be relevant to RIs in humanities and social sciences or for e-infrastructures.

4 In some cases, even though there are already other research facilities that offer access to similar facilities and services as those of the proposed new RI, the latter might still be of interest to many potential users for whom distance represents a hurdle. If the demand exists, the proposed new RI can be set up.

Methods that can be used:

- Desk research to explore existing literature and information available on-line about relevant RIs;
- Interviews with members of the research community and other relevant stakeholders;
- Surveys addressed to members of the research community and to other relevant stakeholders.

Further references

ESFRI Roadmap 2018 (2018). Landscape Analysis (section 2). Retrieved from: http://roadmap2018.esfri.eu/landscape-analysis/section-2/

European Commission (2017) Horizon 2020 and the Research Infrastructures Landscape. Retrieved from: https://ec.europa.eu/research/infrastructures/pdf/ri_landscape_2017.pdf

Pastori, G. (2016). Presentation: Strategy Report on Research Infrastructures Roadmap 2018: Landscape, ICRI 2016, Cape Town, South Africa

RISCAPE – European Research Infrastructures in the International Landscape (project), What is a landscape analysis?, Retrieved from: https://riscape.eu/riscape-project/landscape-analysis/

Rossi, G. (2018). Updating the Landscape Analysis of Research Infrastructures for the ESFRI Roadmap 2018. (presentation). Retrieved from: http://www.e-rihs.eu/wp-content/uploads/2017/06/Rossi-_Updating-the-Landscape-Analysis-of-Research.pdf

Gap analysis

What does it offer?

Gap analysis determines what steps need to be taken in order to move from a current state to a desired, future state. It is also called need-gap analysis, needs analysis or needs assessment. [5]

When to conduct: This method can be combined either with a landscape analysis to identify the current state and determine the gaps that need to be covered at the level of a specific research system to achieve the desired future state, or applied at the level of an individual RI to establish what steps should be taken to bring an RI to a desired future state.

As this document addresses ex ante evaluation of RIs, we consider the gap analysis conducted to identify the existing needs in a region, country, or macro-region where the planned new RI is to be established.

The main steps for conducting a gap analysis

- establish what exists already in the region and the research field in which the new RI is intended to be built, user access requirements, etc.;
- identify the gaps that exist and the needs of the scientific community to be satisfied;
- identify the gaps that can be covered by the proposed new RI;
- list the factors needed to achieve future objectives.

5 This definition has been adapted from the definition given by Business Dictionary online platform: http://www.businessdictionary.com/definition/gap-analysis.html

Further references

Ball, J. (2018). Gap Analysis (definition on online platform projectmanagement.com). Retrieved from: https://www.projectmanagement.com/wikis/233055/Gap-Analysis

Buddenbohm, S., Barthauer, R. (2018). Gap Analysis of DARIAH Research Infrastructure

Romier, G., Jeannin, X., Campanella, M., Duma, C. (2017). e-Infrastructure Gap Analysis (EOSC pilot). Retrieved from: https://eoscpilot.eu/sites/default/files/eoscpilot-d6.1.pdf

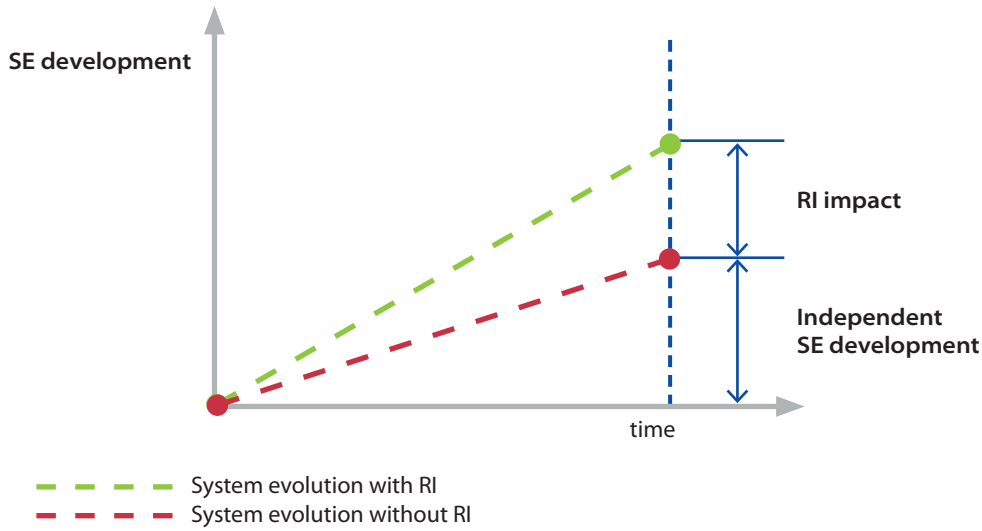
Some elements specific to counterfactual impact evaluation (CIE)

The main objective of CIE is "to quantify whether a given intervention produces the desired effects on some pre-established dimension of interest" (EVALSED, 2013). As for ex ante evaluation of RIs, the relevant specific questions would be: *Can the desired change be attributed to the RI that is going to be built? Will the desired change be due to the RI or would it occur anyway?*

The challenge in the case of this approach is finding a credible approximation of what would occur (i) in the situation in which the RI proposal is implemented and (ii) in the absence of the RI. The difference between the two situations represents the estimated effect or impact of the planned RI.

CIE, in its original form, involves the use of a so-called control group to measure the change produced by a given intervention on the treatment group. In other words, CIE is mostly intended to be used for ex post evaluation. Hence, this method cannot be applied in its entirety for the ex ante evaluation of RIs. Yet, some of its elements can be applied in ex ante evaluation. Instead of the treatment group, we can consider a hypothetical situation in which the RI exists and produces certain impacts. Instead of the control group, we can take a hypothetical future situation in which the RI is absent. Then the changes that are expected to occur in these two hypothetical situations can be compared: the differences that emerge from this comparison represent the potential impact of the planned new RI.

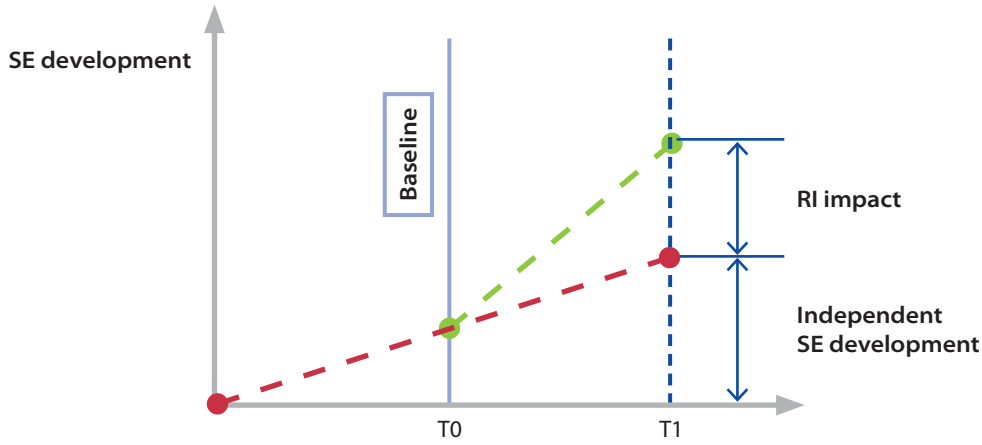
FIGURE A2: THE RI IMPACT SHOWN AS A DIFFERENCE BETWEEN SUCCESS AND BASELINE SCENARIO



Source: Figure reproduced from the FenRIAM Guide: "The RI impact shown as a difference between success and baseline scenario" (p.110)

By using this approach, one can consider what would happen if a proposed RI is built and becomes operational or if it does not exist. The key questions are as follows: How would the region look in "x" years with the RI? (success scenario) How would the region look like in "x" years without the RI?

FIGURE A3: BASELINE AND THE SYSTEM EVOLUTION WITH AND WITHOUT THE PLANNED NEW RI



System evolution with RI
System evolution without RI
Baseline = how the system looks at the moment we are considering building a RI

T0 = present moment when the Baseline study is done as part of the ex-ante evaluation, and we are considering if and how to develop a Research Infrastructure

T1 = a hypothetical moment in the future, set by evaluators to delimitate the time horizon taken into consideration by the evaluation process.

Source: ResInfra@DR

A baseline study's role is to provide a picture of how the region looks in terms of evaluation indicators when the building of a planned new RI is under consideration.

In the context analysis, it is also necessary to consider existing trends which might provide clues as to how the system is going to evolve in the absence of the proposed new RI. That is why Figure 2 also includes an illustration of the region's development before the baseline study is conducted. In order to know what to expect from a scenario in which the planned new RI does not exist, previous development trends should also be considered. In this way it is possible to better distinguish changes that are likely to occur as a result of the proposed RI and those that will be produced anyway, by other influencing factors.

Further references

European Commission (2012). Designing and commissioning of counterfactual impact evaluations. Retrieved from: https://crie.jrc.ec.europa.eu/?q=content/counterfactual-impact-evaluation-cie

European Commission (2013). EVALSED Sourcebook: Methods and Techniques

EU Science Hub. Counterfactual Impact Evaluation. Retrieved from: https://ec.europa.eu/jrc/en/research-topic/counterfactual-impact-evaluation

Rochow, R., Peró, M., Pook, K., Tchonkova, D., Marinova, D., Gheorghiu, R. and Niță, V. (2011). FenRiAM full guide – Proposal for a Foresight-enriched Research Infrastructure Impact Assessment Methodology

Theory-based impact evaluation (TBIE)

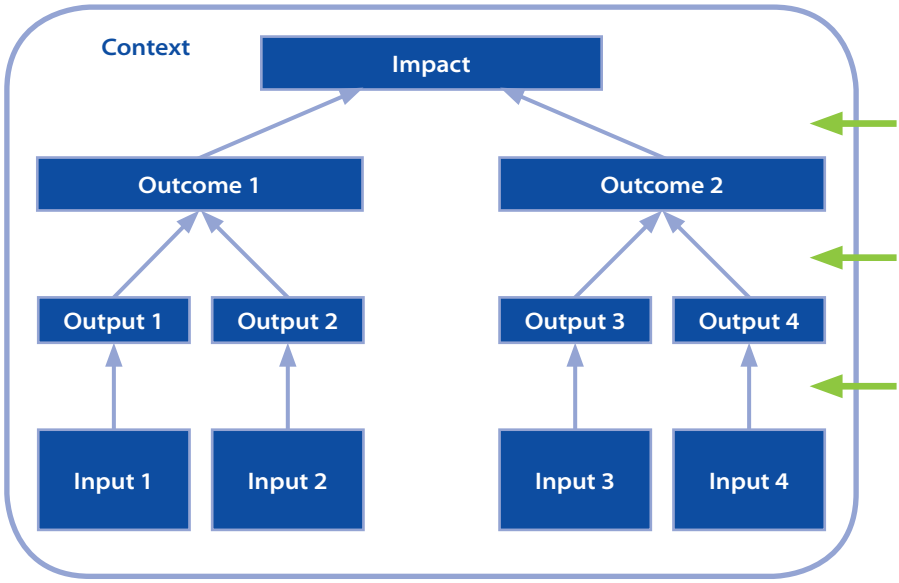
"Impact evaluation is an assessment of how **the intervention** being evaluated **affects outcomes**, whether these effects are **intended or unintended**. The proper analysis of impact requires a **counterfactual** of **what those outcomes would have been in the absence of the intervention**." (OECD, 2006)

"An impact evaluation provides information about the impacts produced by an intervention - **positive and negative**, intended and unintended, **direct and indirect**. This means that an impact evaluation must establish **what has been the cause of observed changes** ('impacts') referred to as **causal attribution** (also referred to as causal inference)." (Peersman, 2015)

The main principles of TBIE can be applied to all types of approaches, that is, it would be useful in building the logic chain, as well as in identifying causal relations, contribution and attribution.

Examples of methods specific to TBIE include: theory of change; realist evaluation; contribution analysis; general elimination methodology; process tracing; most significant change; success case method; outcome process mapping; qualitative comparative analysis; policy scientific approach; prospective evaluation synthesis; and elicitation method.

FIGURE A4: THEORY OF CHANGE



Source: ResInfra@DR 2019

Building and then applying the theory of change can be included in all types of evaluation, as it can provide useful insight into the assumptions and logic upon which the proposal to build a new RI is based. Theory of change can provide an in-depth analysis of the logic chain of the proposed new RI, by providing clarifications regarding the relations and mechanisms that correlate different elements

of the RI, such as its input (financial resources, human resources), and expected outputs, outcomes, and impacts.

Further references

Carter, R. (2012). Theory-based evaluation approach approach (GSDRC Helpdesk Research Report)', Birmingham, UK: Governance and Social Development Resource Centre, University of Birmingham. Retrieved from: https://gsdrc.org/publications/theory-based-evaluation-approach/

European Commission (2013). EVALSED Sourcebook: Methods and Techniques

Government of Canada (2012). Theory-Based Approaches to Evaluation: Concepts and Practices. Retrieved from: https://www.canada.ca/en/treasury-board-secretariat/services/audit-evaluation/centre-excellence-evaluation/theory-based-approaches-evaluation-concepts-practices.html

Peersman, G. (2015). Impact evaluation. BetterEvaluation. Retrieved from: http://www.betterevaluation.org/themes/impact_evaluation

Riche, M. (2012). Theory Based Evaluation: A wealth of approaches and an untapped potential. Retrieved from: https://ec.europa.eu/regional_policy/sources/impact/evaluation/conf_doc/helsinki_mri_2012.pdf

GLOSSARY

Baseline study	A study which documents the state of affairs before an RI has been built or upgraded. It represents an important element in performing any type of evaluation. When conducting an ex ante evaluation, it is first needed to have a good understanding of the current situation as to be able to compare it with future scenarios.
Business plan	A document and tool useful for laying out the financing (estimates of costs and incomes, sources of financing) and operations model of an RI, in relation to many other aspects regarding the latter, such as technical and scientific aspects, the user community, lifecycle stages, potential risks, and other.
Cost-benefit analysis	An analysis which quantifies the RI's benefits in monetary terms and assesses whether those benefits exceed the costs associated with a respective RI. This method is usually used to ensure accountability for funders and contributors.
Counterfactual impact evaluation	A method of evaluation aimed at identifying the effects or impact that can be directly attributed to a specific intervention. For measuring the produced change, it involves doing a comparison between two types of groups – a treatment group (which has benefited from the intervention) and a control group (which has not benefited from the intervention, and selected on the basis of its similarity to the treatment group). Only certain elements from this method can be used in the case of an ex ante evaluation. More details in this regard can be found in the dedicated section.
Ex ante evaluation	Evaluation conducted prior to the implementation of an intervention, which, among other, identifies and documents the needs to be addressed by a RI, the results to be obtained, shapes the design of the RI, assesses the likelihood of a success scenario, and assesses the feasibility of planned activities.
Evaluation	A systematic process of assessment of the worth and merit of an intervention (in our case, of a RI).
Feasibility study	A type of study which can establish whether a RI is viable or not. It is the preliminary evaluation of an RI proposal, conducted in order to establish whether a proposal is worth pursuing. Its aim is to identify potential feasibility risks and assess their significance in order to be able to tackle them if and when they occur.
Gap analysis	A type of analysis which determines what steps need to be taken in order to move from a current state to a desired, future state. It is also called need-gap analysis, needs analysis or needs assessment.
"Make or buy" analysis	An analysis which compares the costs and benefits associated with building and operating a new RI (or those required to upgrade an existing RI) to the costs and benefits involved when using the facilities and services already offered by existing RIs.
Landscape analysis	A type of analysis which identifies already existing relevant RIs. Before establishing a new RI, it is of fundamental importance to consider the needs of the research community, the already existing RIs and what

	facilities and services they offer. By doing so, gaps can also be identified and analysed, and thus it can be determined whether a new RI would better meet existing needs.
Stakeholders	All relevant actors who have an interest in the RI or are affected by it (directly or indirectly).
Theory-based impact evaluation	A type of evaluation which focuses on mapping the causal chains (or the theory of change of the intervention) which link the inputs and processes to the outputs and outcomes attributed to an intervention, as same as on testing the underlying assumptions behind each of the respective links.

ABBREVIATIONS

CBA	cost-benefit analysis
CIE	counterfactual impact evaluation
CERIC	Central European Research Infrastructure Consortium
DANUBIU	Research infrastructure the International Centre for Advanced Studies on River-Sea Systems
EC	European Commission
ELI RI	Extreme Light Infrastructure (research infrastructure)
EST	European Solar Telescope
MYRRHA	Multi-purpose hYbrid Research Reactor for High-tech Applications
OECD	Organisation for Economic Co-operation and Development
PRACE	Partnership for Advanced Computing in Europe
RI	research infrastructure
TBIE	theory-based impact evaluation

LIST OF TABLES AND FIGURES

This guide has been developed by the ResInfra@DR consortium, with input from research infrastructure (RI) policy-makers, managers, and experts at several workshops and a concluding consultation meeting. It is part of a series of three guidance documents, dealing with ex ante evaluation, monitoring, and the assessment of socio-economic impacts of RIs. Together, these three documents aim to provide an overview of relevant methods and processes which can be used to improve the planning and management of RIs, leading to better utilisation of their precious and unique capacities, enhanced performance, and more pronounced socio-economic impacts.

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