STOA

Science and Technology Options Assessment

Measuring scientific performance for improved policy making

STUDY

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Study

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AUTHORS

Bea Mahieu, Erik Arnold, Peter Kolarz.

For the Technopolis Group study team: Neil Brown, Tobias Fridholm, Flora Giarracca, Carlos Hinojosa, Andrej Horvath, Xavier Potau, Anita Quas, Anouk Tummers.

RESPONSIBLE ADMINISTRATORS

Theodoros Karapiperis (Administrator)
Gianluca Quaglio (Seconded National Expert)
Science and Technology Options Assessment (STOA)
Directorate for Impact Assessment and European Added Value
Directorate-General for Parliamentary Research Services
European Parliament, Rue Wiertz 60, B-1047 Brussels
E-mail: theodoros.karapiperis@ep.europa.eu

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ABSTRACT

In recent decades, developments in European research policy making have led to an enhancement of the *role and function* of evaluation to cope with the growing globalisation of research and the need to ensure effective research systems at the national level and in the European Research Area. These developments have led to a need for a more integrated way to understand research performance as well as its efficiency and effects, combined with a growing need for a *European view*.

The desire for better evidence for public management, a growing movement calling for open access to the results of publicly funded research and the vastly increased power of computing and communications coincide to support policy interest in steering and sharing research results and data about them. Current trends in the extended use of research information systems - at institutional, national and European level, set the context and create the opportunity for the development of a European research information infrastructure that could provide the basis for an improved research policy development in Europe.

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EXECUTIVE SUMMARY

This study had as its main objective to analyse the desirability and feasibility of creating a transnational system for collecting and monitoring research performance data (on inputs, outputs and productivity) and to identify relevant research policy options.

We structured our analysis looking first into the key policy drivers, i.e. the key reasons why there is growing pressure for monitoring and measurement of research in Europe – pressures that ultimately drive a desire for a more integrated way to understand not only research performance but also its efficiency and effects. We then analysed current approaches to research performance assessment in Europe, the concepts, methods and tools used, as well as benefits and challenges.

Based on this information, we considered the desirability and feasibility of creating a transnational system for the collection of research information and identified the policy options.

Key policy drivers

Policymakers and the wider public have changed their perception of the role of research during the past few decades. The post-War 'social contract' between science and society left the research community to a high degree free to choose what it researched. It was funded on trust, with the expectation that something socially as well as intellectually useful would come of it in the end.

Especially since the 1960s/70s, research is increasingly expected to support the attainment of explicit social goals, contribute to economic development and develop solutions for major societal challenges such as climate change. These expectations are translated into aspects of the way governance works, though governance is also influenced by wider trends in the way the state is managed. Under the influence of the so-called New Public Management, the state makes growing use of agency, with higher levels (such as ministries) setting broad objectives and establishing performance contracts with lower levels (such as agencies).

One consequence is that evaluation has become a key component of evidence-based policymaking, providing inputs to priority setting and strategy development. Its function has expanded in particular in the context of the growing globalisation of research and the need to ensure effective research systems, both at the national level and in the European Research Area. Its role remains contested however, with both the policy-making and the research communities seeking influence over how evaluation is conducted and what questions it tries to answer. Increased use of digital information provides an opportunity for both parties, to a certain degree, to 'have it their own way'.

Driven both by the New Public Management and the need to tackle societal grand challenges, there is at the same time a need for more decentralised research and innovation governance, with more actors becoming involved. The need for accessible information and 'strategic intelligence' has grown across all parts of the state. The growing availability of ICT-supported information generation and storage at all levels supports this trend.

Current trends in research performance assessment – methods and tools

The developments in the overall context for research policy making have led to major changes in research governance and as a consequence, to an enhancement of the *role and function* of evaluation in research policy making. Accountability, efficiency and effectiveness have become the key concepts that govern the relationships between government, public research-funding agencies and research institutions and evaluation has become an integral component of the evidence-based policy making processes, providing the needed input for priority setting and strategy development.

The New Public Management model and its distribution of the responsibility for research performance over the various levels of the research system also led to an expansion of the *scope and use* of evaluation. Actors involved in the development of information for evaluation and interested in the

use of its outcomes now span all levels of the research system, from policy makers to the researchers themselves. This trend has led to the creation of a system of distributed intelligence; it has also implied a broadening of the expectations and needs for evaluation.

To satisfy this set of policy demands requires a much higher level of data availability and analysis across multiple domains and countries than has previously been the case. Evaluations rely on a set of sources and tools for the collection of evidence. These range from aggregate STI indicators developed at European and global level (the OECD and Eurostat surveys and manuals) to information systems for the management of research.

Policy-makers at the European and national levels make a considerable use of STI indicators in order to benchmark the performance of the science and innovation systems in their countries. Due to the *inadequacy of the STI indicators* to satisfy the current information needs, there is also an increasing use of ad-hoc evidence collection projects. STI indicators provide information at an *aggregated* (country) level, and while important progress has been made in recent years to align these indicators better with policy needs, evaluation and indicator development experts overall agree on and highlight the need for micro-economic analyses and access to micro-level data. Micro-data are expected to facilitate a better understanding of the *processes leading to innovation* and to improve the assessment of the systemic impacts of research, in particular in the economic and social spheres.

In terms of sources for information, bibliometric data constitute an important source for performance benchmarking in the field of research, even though their relevance and adequacy to assess quality in research is contested. Research information systems, on the other hand, play a significant role at national and especially institutional levels; access to research information by means of open access repositories is important in particular for research groups and individual researchers. The trend is towards increasing development of *national* research information systems among EU member states, creating the opportunity for reaching a comprehensive and longer-term view on the performance of the research system in the country, its productivity and impacts.

The literature review in this study showed a growing need for a *European view* on research performance and impacts. This is to be set in the context of the globalisation and internationalisation of research as well as the increasing consistency between European and national research policies and the fostering of trans-national research collaborations, in both European and national research policies. Horizon2020 is a prime example of such increasing intertwining of European and national funding of research.

Experts recommend the development of a *multi-level research information infrastructure* – at the European level and beyond – that would provide access to more fine-grained and longer-term information on the inputs, outputs and outcomes of research and provide the basis for an improved evaluation framework. This concept is in line with current trends in extended use of research information systems and the launch of several initiatives to integrate or link these systems - at institutional, national and European level. It is also in line with current initiatives at a global level, including the Star Metrics programme that is currently running in the US, so there is room for the creation of synergies, setting at least the pre-conditions for creating an internationally integrated system.

The desirability of a transnational system for research performance assessment

We reached our conclusions on desirability based upon the needs of the different actors in the European research system and the challenges that the current data collection and assessment practices pose for them. We then considered to what extent a transnational system could respond to those needs and resolve the issues, with which the current approaches are struggling.

The needs and challenges for the collection of strategic information and the implementation of research performance assessments identified in this study lead to the conclusion that the actors at all

levels in the European research system are in need of a joined-up view of scientific progress, productivity and quality at the European level.

This would allow also for the further development of the European Research Area and provide an opportunity for 'horizontal' connections (i.e. within and among the research communities) and cross-fertilisation, thanks to the opening up of access to data for and on research.

We note that national paths for developing such interconnections exist, thanks to the current development of national research information systems. What is missing is the interconnection at European level, which has to pass through the national systems.

Presuming that the transnational research performance assessment system collecting information at the micro-level will take the form of a research information system, the specific added values of these systems can be expected to occur also in a transnational system:

- The current experience with national research information systems shows the value of these systems in terms of an improvement of strategy development capacities for all stakeholders involved.

- The efficiency and effectiveness gains that the national research information systems produced at the national level can be expected to occur also in the case of a European system, in particular in relation to the costs currently covered by the European Commission for the collection of the needed micro-data.

- Finally, the centrality of the research actors in the national research information systems, the attention to their needs and the search for a win-win situation in relation to the potential use of the system, and the alignment with the policies of open access to data cannot but be a positive factor also for the system at European level.

More specifically, benefits provided by an integrated European research information infrastructure would include:

- For research institutions: the possibility directly to compare and benchmark research performance with other institutions in Europe, taking into consideration the different missions of the institutions, their research infrastructures and national environments, thus improving the awareness of the institution's positioning in the European research landscape – beyond the analysis of bibliometrics

- For national funding agencies and policy makers: a comprehensive view of the complementarities of national research strategies versus other countries and the European Commission; improved basis for comparisons and benchmarking of national research performance with other countries, in line with the proper needs

- For the European Commission: improved efficiency in the collection of micro-data, improving data availability, reducing duplicates and enhancing the sustainability of data collection efforts

- For the research performance assessment community at large: the basis for an improved understanding of knowledge exchange mechanisms in the European research system, providing a comprehensive view on input and outputs

We consider it desirable that policy-makers at the highest levels in the European system make use of the opportunities offered by the latest developments in communication and information technologies and exploit the momentum created by the current development of national research information systems.

This would also ensure avoidance of the risk for a completely business-driven approach to the use of research information systems; it is not clear that such an outcome would serve the interests of researchers, funders or policymakers.

European policy-makers should therefore start setting the basis for the development of a European integrated research information system that would enable sharing data on research across the European Research Area – and beyond.

The feasibility of a European integrated research information infrastructure

We conclude that a European Integrated Research Information Infrastructure is <u>technically feasible</u>, thanks to recent technological developments and especially the maturity of the European CERIF standard, which allows seamless interlinking of datasets and/or research information systems, in different formats and including non-CERIF systems.

An eventual lack of comparability of data in different systems does not constitute a major technical problem thanks to the use of semantic tools. However, experts recommend the development of a <u>standard approach to the definition of outputs</u> and other indicators, allowing for the use of the data collected also from an STI indicator perspective.

The concept of a European integrated research information infrastructure is also consistent with the current policy framework in the European Union, in particular the ERA 2020 and Europe 2020 policies.

Such an integrated European research information infrastructure should not be considered as a substitute for existing national research information systems, but essentially as an additional layer on top of them. It should comprise a distributed infrastructure, inter-connecting existing national research information systems, thus allowing for querying depending on the needs as well as for the eventual exploitation of the data in terms of indicators and/or metrics. In this context, the cost for the development of such a system should be relatively limited.

The entire process will require a joint effort from all Member States and the relevant stakeholder communities, in particular for the identification of a standard approach to the definition of outputs and other indicators. This should include stakeholder organisations such as Science Europe (previously ESF/EUROHORCS).

All our interviewees, however, considered that the achievement of a common system or approach to the measurement of research performance was not manageable only through bottom-up initiatives. <u>Early-stage steering of the process</u> towards integration at the European level was considered to be fundamental in this context and from that perspective there is a need for coordination at the European policy level, hence by the European Commission.

Such coordination at the European level would ensure the inclusiveness of the process, involving all EU Member States and relevant stakeholder communities in the European research system, as well as facilitate an acceleration of the development of national research information systems.

Ownership of the monitoring activities in relation to the fulfilment of the ERA and current active support to the development of research e-infrastructures such as OpenAire in the field of Open Access Repositories and Eudat in the Public Sector Information sphere makes the European Commission the most plausible lead actor and coordinator.

Policy options

To support and encourage the development of an integrated European research information infrastructure, the policy options are:

- To recognise the need to overcome the current methodological challenges for science performance assessments and commit support to improvements both in theoretical concepts and the practice

- To support and coordinate the development of national research information systems in the European member states, ensuring interoperability and facilitating the acceleration of the implementation of these systems in Europe
- To support and coordinate the development of a standard approach to the definition of outputs and other indicators, recognising the need for its social construction in respect of the national needs
- To support and commit to the technical development of an integrated European research information infrastructure

1 INTRODUCTION

We start this report with an overview of the background for this study, i.e. its mandate and the analytical methods and tools used, and then set out how we have reported on the outcomes of our analyses and explain the structure of this report.

1.1 The mandate for this study

The overall **objective of this study** is to identify research policy options by understanding the feasibility and desirability of creating a transnational system for collecting and monitoring research performance data (on inputs, outputs and productivity). This would serve the public good by providing information needed for policymaking and enabling improved research performance monitoring by researchers, research-performing institutions and funders. In the first instance, the scope of such a system would be European, but the study should also consider how European efforts could be linked to more global ones.

The sub-objectives of the study are

- To understand and describe the *policy drivers, feasibility and desirability* for the development of a trans-national system for collecting and monitoring research performance data (on inputs, outputs and productivity) in Europe

- To understand and describe the *motives and opportunities* for significant stakeholder groups to cooperate in the standardisation and development of such systems across national borders

- To describe the *expected consequences* of doing so and recommend how and whether this should be done

- To analyse the *difficulties* in the development and implementation, including the major bottlenecks in the development of integrated research information systems, the issue of unique identifiers for researchers, publications etc, and the development of interoperable systems (CERIF and CASRAI standards)

- To outline policy options for a *framework for action* to engage the relevant stakeholders, at EU level (Commission and Parliament), national level (research/education and industry ministries), and international level (including Eurostat & OECD)

1.2 Methodological framework

We have structured our data collection and analyses as follows: the first task was focused on the collection of background information, setting the framework for the study. This took the form of a literature review.

The second phase of the study was geared towards collecting and analysing information on the practice of research performance assessments and the development of information systems in Europe, taking into account the position of all stakeholder communities i.e. the EU/European Commission, the national research funding/managing agencies and the research institutions/researchers.

This was based upon two main data collection methods: desk research and interviews, the latter complementing the information collected during the desk research. A workshop with key experts and national actors in the field of research performance management in Europe provided us with additional in-depth information.

For the desk research we based ourselves on studies published by various national and European entities as well as on evaluation reports and other relevant studies that could shed light on the context,

processes and practices in the countries concerned. The type of additional information that needed to be collected determined the selection of interviewees.

In total we interviewed 27 experts, officials in funding agencies or institutions responsible for research assessments and/or the national research information system. In several cases, multiple interviews were conducted. For this report, an additional interview was conducted with Richard Swetenham, Adviser for Open Data, European Commission, Directorate General for Communications Networks, Content and Technology (DG CONNECT). The full list of interviewees and their affiliations is available in Appendix C to this report. In Appendix D we reproduce the bibliography for this study, including the main references.

In our mapping exercise (the 'survey'), we covered 13 countries in Europe, i.e. 12 EU member states and Norway (Exhibit 1). The analysis covered countries in Northern, Western, Southern and Central/Eastern Europe as well as close to all of the most important research-performing countries. The only exception is Germany, for which the analysis presented problems within the limits of this study, due to the de-centralised research management in that country.

For these 13 countries we cover both the approach to research performance assessment and the use of research information systems. An exception is the Slovak Republic for which precise information on the approach to research performance assessment was not available. We found evidence on the existence or creation of national research information systems in 7 of these countries: Belgium, the Czech Republic, the Netherlands, Norway, the Slovak Republic, Sweden, and the UK.

The 16 EU Member states that are not covered in this study are: Bulgaria, Croatia, Cyprus, Estonia, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, and Slovenia.

Exhibit 1 Geographical scope of the analysis
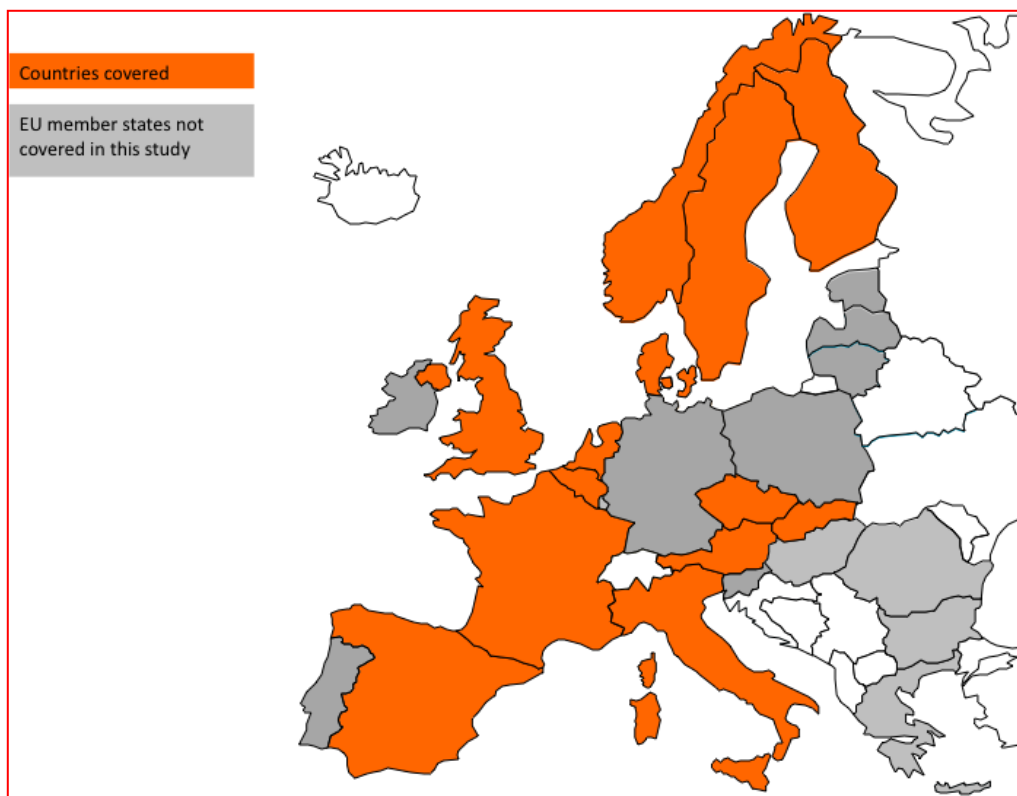
1.3 Reporting

We have reported on the outcomes of our data collection and analysis activities in the following reports:

- The literature review, setting the basis for the study

- The report "Current practice in the EU Member States – Case Studies" (D4.1), complementing this report by means of in-depth case studies

- The report "The landscape beyond the practice at national level" (D4.2 - Interview report), containing the outcomes of the analyses related to the more general context for research performance measurements and research information systems in Europe

- The "Outcomes of the workshop" report (D4.3), which informs on the main points for discussion and final considerations in the workshop at the European Parliament.

In this report we draw conclusions on the feasibility and desirability of the creation of a trans-national system for collecting and monitoring research performance data, and explore and describe policy options for a framework for action.

The report is structured as follows:

- In the first chapter we cover the key policy drivers underpinning the development of a transnational system for science performance assessments. We set out to explain some of the key reasons why there is growing pressure for monitoring and measurement of research in Europe – pressures that ultimately drive a desire for a more integrated way to understand not only research performance, but also its efficiency and effects

- In the next chapter we look into the current trends in research performance assessment, including the methods and tools used. This includes first a description of the overall trends related to changes in the policy demands and needs. We then describe the different sources of data and information, including a reflection on Open Access Repositories and the economics of knowledge and research. This is followed by a description of the research performance assessments at the different levels in the European research system, i.e. the European, national and institutional levels. We conclude that chapter reporting on the efforts made by the stakeholder communities in their search for standardisation at the European level

- In Chapter 4 we draw our conclusions on the desirability of creating a transnational system for the collection of data on research and research performance assessments. Such desirability depends on the needs for strategic information among the multiple actors in the research system, the current trends for research performance assessment at the various levels in the system, challenges and gaps, and the capacity of a transnational system in responding to those needs

- In Chapter 5 we conclude on the feasibility of the development of a European research information structure, covering the eventual technical and legal constraints. We also identify the policy framework under which such an initiative could be placed and the actors that can be expected to take charge of it

- The final chapter contains the identified research policy options

In the Appendices to this report we give an overview of the key indicators used for research performance assessments at the national levels (Appendix A) and the indicators for which data is collected in the national research information systems (Appendix B). We also list the experts that were interviewed in this study (Appendix C) and provide the list of references to the main articles and studies that were consulted in the context of the extended document and literature review (Appendix D).

2   KEY POLICY DRIVERS

This chapter sets out to explain some of the key reasons why there is growing pressure for monitoring and measurement of research in Europe – pressures that ultimately drive a desire for a more integrated way to understand not only research performance but also its efficiency and effects.

First we describe the policy context for research performance assessments and its major areas for development in Europe. In Chapter 2.2 we then describe the current trends in research governance and their consequences for the approach taken to research funding and research performance assessments.

2.1   The changing landscape of research and innovation governance in Europe

In this chapter we describe the policy context to research performance assessments in Europe. We focus our attention on three major areas for development: the concept of the 'knowledge economy', the importance increasingly attributed to the internationalisation of research, and the concepts and objectives underlying the creation of the European Research Area.

2.1.1   The role of science and research in the 'knowledge economy'

There is growing recognition of the role science and research can play in economic growth and social development. Research performing organisations are now considered key actors of economic and cultural growth and national competitiveness; they are expected to take responsibility for contributing to economic development through technology transfer and innovation, continuing education and social engagement.

Science is also called upon to contribute to the solution of societal challenges that national systems, Europe or even the world are facing. These range from threats to the European social welfare model as costs rise because of ageing and the ever-increasing demands on health and care services, to longer-term global challenges which will continue to increase in significance but which also require immediate attention. First amongst these are global issues like climate change, sustainability and the efficient management of limited resources.

From the late 1980s, especially through the emergence of the idea of 'national systems of innovation' that stressed the interdependence of industry, the state and the 'knowledge infrastructure' of higher education and research has overtaken the idea that innovation is generated from basic research in a linear way. An early precursor of this idea was Sabato's Triangle (Sábato & Botana, 1968) of the state, higher education and industry. In the context of Latin American economic development, Sabato himself viewed the state as the driving partner. National innovation systems approaches emerging from the late 1970s to the early 1990s give the leading role to companies, within this same triangle (Freeman, 1979) (Lundvall, 1992) (Nelson, 1993), while the Triple Helix idea makes the higher education and research system more central (Etzkowitz & Leydesdorff, 2000). Gibbons et al's idea of the mode of knowledge production shifting from the disciplinary, university, basic-research focused 'Mode 1' to a decentralised, interdisciplinary 'Mode 2' where knowledge is produced in the context of use also (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994) involves a transition from a linear to a systemic perspective (even if they got their history wrong: Mode 2 is the historically original form (Godin, 1998)).

Detailed analysis and critique of these approaches would require a great deal of space and divert us from the purposes of this paper. For the present discussion, the most important common feature of these newer ways of understanding innovation and its linkage to research is that they stress the

importance of bounded rationality, institutions and interdependence among different actors and activities. Implicitly (and in the case of the Mode 2 discussion, explicitly) they suggest that the systemic nature of research and innovation means that societies need widely distributed innovation and research capabilities – and, as an unstated corollary, widespread understanding of and access to researchers, research processes and research outputs.

This **systemic view of research and innovation** became the cornerstone of EU R&D policies by the beginning of the 2000s. Examples are European Commission policies and concepts such as the European Research Area (Busquin, 2000) and the Knowledge Triangle (see also Chapter 2.1.3).

A 2008 OECD review (OECD 2008) summarised the key characteristics of innovation systems as follows.

- Interconnection and interdependence are at the heart of the innovation system concept. The innovation systems perspective originated in deliberate opposition to simpler, more or less mono-causal views of innovation and the economy. Modern models of the innovation process are complex, with many linkages among actors. Innovation processes do not always start at one particular place (basic science or the market) but can be prompted by changes anywhere
- Innovative activity encompasses a wide range of phenomena, especially the re-use of the existing knowledge stocks in novel ways. It can be 'soft' as well as 'hard' and technological
- Innovation activities are much more than R&D. Many other activities are central to innovation processes
- Design, engineering and management play key roles in innovation systems
- Business enterprises are central actors in the system. They make the money and the jobs
- Demand, not just supply, drives innovation systems
- Innovation functions do not map tidily to organisations. Roles overlap and may change over time

2.1.2   The importance of internationalisation

Increasing levels of internationalisation has been a key trend in research over the past decades. It has occurred in a number of different ways and is a consequence of several different factors. As the theme of internationalisation will feature in several of the following sections – most notably in the contexts of policy trends, research governance and performance assessment practice – it is worth outlining its various facets at this point.

Drivers for internationalisation relate to ambitions of strengthening research excellence and innovation performance through enlarging the set of actors for collaboration and/or for getting complementary expertise, as well as enlarging the attractiveness of the R&D system in order to better the capability to compete in the global market, in other words, enlarging the innovation network. Interests of this type may exist at the level of research institutions themselves, or indeed at the level of governance.

Internationalisation in research

There are several factors driving internationalisation. Trondal (2010) notes that on one hand, emerging patterns of internationalisation can be seen as crafted by the university organisation and leadership, but, on the other hand, traditional patterns of internationalisation are fostered by the academic staff themselves and often organised through transnational communities of scholars. In the first instance, the internationalisation of research therefore refers directly to the <u>process of researching</u>, and to increased numbers of research projects carried out collaboratively by individuals in different parts of the world.

In addition to the process of researching, internationalisation has also occurred at the level of outputs. With most academic journals now available online, published research is easily available beyond

national boundaries, increasingly in the form of <u>open access repositories</u>. At the same time the boards of editors and reviewers of journals are increasingly drawn together from different countries. Adding a more formal institutional component, increasing numbers of disciplinary associations are now of an explicitly international scope (eg ISA, the International Sociological Association), launching journals and organising conferences in an international context.

Furthermore, internationalisation has occurred and greatly expanded in the area of <u>researcher careers</u>. This begins at the early career level via the expansion of the international market in higher education, resulting in increased numbers of students conducting their Undergraduate and early Postgraduate degrees outside of their home country, right through the academic career, with increased international advertising of vacancies allowing more internationalised career paths for researchers.

In other words, the current policy focus on building institutional capacity to foster internationalisation in the context of key target countries and research areas should be understood within the wider phenomenon of internationalisation of research that would almost certainly be occurring anyway, given researchers' own demonstrable interest in internationalisation.

Globalisation is widely discussed as a change driver in the institute world, as elsewhere. It can have quite different implications among different types of institute. Scientific research institutes share scientists' more general propensity to cooperate internationally. This happens more in 'basic' than applied disciplines and in small than large countries, as well as for extra-scientific reasons, such as former imperial links or mobility patterns (Frame & Carpenter, 1979). There is clear and continuing growth in international scientific collaboration (Wagner & Leydesdorff, International collaboration in science and the formation of a core group, 2008) (Adams, Guerney, & Marshall, 2007) although the rate of growth seems now to be tailing off, suggesting the approach of some kind of natural limit. Motivations for international cooperation in the research community visible in the literature include (Archibugi & Iammarino, 1999) (Beaver, 2001)(Wagner, 2006) (Edler, et al., 2007).

- Access to leading edge and complementary know how
- Combination of competences and data located in different countries to tackle issues too complex for researchers from one location
- Finding solutions for complex scientific and technical problems that could not be solved with domestic resources alone
- Cost and risk sharing, especially when large infrastructures are needed for basic science (e.g. particle accelerators) or product development (e.g. international telecommunication networks)
- Access to funds
- Recruitment
- Access to research subjects or data that are geographically specific
- Access to markets
- Influencing regulatory regimes or standards
- Improving the impact and visibility of one's research

Internationalisation policies

The array of factors and perspectives representing interests in and benefits of internationalisation are increasingly reflected in policy, both at the level of national and supranational bodies. A study looking into the reasons for the growing policy attention for international STI collaboration in the European member states (Boekholt et al 2009) listed as motives: "the aim to achieve research excellence, to attract scarce human resources for research and also to build STI capabilities through people and institutions" as well as some external developments such as "the globalisation of R&D, the urgency of certain global challenges, and the emergence of new players on the global research market".

Policy at this point in time is geared towards guiding the international proliferation of research activities into certain target countries and subject areas to increase benefits to national interests:

priorities have moved from internationalisation of researchers and research groups to embedment of institutions and individuals in international networks, and capability to attract foreigners (researchers, clients) as well as to localise and fund research activities abroad (researchers and units) (ESF 2012b, p6). A recent European Commission communication (EC 2013a) identified the following areas as key components of a comprehensive internationalisation strategy: international student and staff mobility; the internationalisation and improvement of curricula and digital learning; and strategic cooperation, partnerships and capacity building.

A recent EC study analysing international collaboration in research with the intent to develop a monitoring system (EC 2013b) highlights that EU member states all have some level of strategy to achieve these ends. However, given researchers' own interest in internationalisation of their activities, internationalisation policy is not so much designed to deal with the broad task of 'making internationalisation happen', but instead to give it a strategic direction reflecting national challenges and goals in relation to innovation systems and economic competitiveness. Policy therefore tends to be aimed at targeting cooperation with specific nations. These tend to be a combination of nations where historical ties already exist, where some degree of collaborative track record has been established, and where there are comparatively minor issues of language barriers. At the same time, policy is geared towards fostering collaboration with countries representing strategic economic opportunities. Thus, INCO notes that almost all EU member states target some or all of the major emerging economies, Brazil, Russia, India and China (Ibid, p21). These pragmatic policy considerations about where successful collaboration is most likely and where it is most beneficial are supplemented by additional specificities on particular thematic areas of research. Here too, whether explicitly defined by some states or implemented without explicit strategic definition, there is a strong focus on combining established national research strengths with the identification of areas deemed especially important in the context of global problems and economic opportunities. These include environmental technologies and research, clean technologies, renewable energy, sustainable climate mitigation, health (including medicine/pharmacology), biotechnology, ICT and nanotechnology.

The Expert Group on Global Governance of Science furthermore argued that in many instances, research governance systems and strategies are still defined by national boundaries. The Expert Group stated, "Science and innovation are currently limited by policies of 'techno-nationalism' or transnational corporate economic interests" (DG Research 2009a).

2.1.3 The European Research Area (ERA)

RTD policy in Europe has a long history, and has grown in scope and sophistication as well as budget over the past several decades, to reach its current position as one of the central components of the EU budget. Initially the focus was very much on R&D. From 2000 onwards, there was increasing focus on research as compared with the earlier concentration on industry policy and impact.

The ERA policy

The 2000 Communication on the ERA (EC 2000) argued that Europe lagged the USA and Japan in industrial competitiveness and the ability to make social and economic use of research. It proposed a unified research area, comparable with the idea of the EU as a common market for goods and services. This meant breaking down borders between the Member States in order to 'optimise at the European level' features such as policy coordination, overall investment in RTD, networking and the building of critical mass in RTD. Also targeted were increased human mobility and the bringing together of the scientific communities of the new Member States with those of the EU-15, the creation of more opportunities for female and young researchers and steps to make Europe a highly attractive place to do research based on common ethical values. Two months later, the Lisbon Declaration set Europe "a new strategic goal to become the most competitive and dynamic knowledge-based economy in the

world, capable of sustained economic growth with more and better jobs and greater social cohesion". Research and innovation actions building on the idea of the ERA were to be pursued but broader policies were also involved that included improved policies for the Information Society, modernising the 'European social model' and macroeconomic policies. Not long afterwards, the Council set the Barcelona target of spending 3% of EU GDP on R&D.

The idea of ERA has been evolving since it was introduced in 2000. In 2007, the Green Paper that 're-launched' the ERA (EC 2007) described its key features as:

- *An adequate flow of competent researchers* with high levels of mobility between institutions, disciplines, sectors and countries
- *World-class research infrastructures*, integrated, networked and accessible to research teams from across Europe and the world, notably thanks to new generations of electronic communication infrastructures
- *Excellent research institutions* engaged in effective public-private cooperation and partnerships, forming the core of research and innovation 'clusters' including 'virtual research communities', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources
- *Effective knowledge-sharing* notably between public research and industry, as well as with the public at large
- *Well-coordinated research programmes and priorities*, including a significant volume of jointly-programmed public research investment at European level involving common priorities, coordinated implementation and joint evaluation
- *A wide opening of the European Research Area to the world* with special emphasis on neighbouring countries and a strong commitment to addressing global challenges with Europe's partners

Today its aim, in effect, is to build a globally competitive research and innovation system optimised at the European level. The ERA concept is defined in the European Commission (EC) Communication of July 2012 (EC 2012a) as:

> *"A unified research area open to the world based on the Internal Market, in which researchers, scientific knowledge and technology circulate freely and through which the Union and its Member States strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges".*

The Europe 2020 strategy & the Digital Agenda

The ERA is a core element of the EU's Europe 2020 strategy (EU2020) for smart, sustainable and inclusive growth. This strategy sets out concrete targets to be achieved within the next decade in areas such as employment, education, energy use and innovation in order to overcome the impact of the financial crisis and put Europe back on track for economic growth.

In the Europe 2020 strategy, the European Union laid out the policy objectives "to become a smart, sustainable and inclusive economy", setting the priorities that "should help the EU and the Member States deliver high levels of employment, productivity and social cohesion." Due to the Euro zone crisis, a fourth priority has since been added: "to ensure that the Europe 2020 strategy delivers, a strong and effective system of economic governance has been set up to coordinate policy actions between the EU and national levels". It covers a reinforced economic agenda with closer EU surveillance; action to safeguard the stability of the euro area and actions to repair the financial sector.

It established three priority areas covering seven flagships designed to help Europe "emerge from the crisis stronger". Two of these flagship initiatives have strong links with ICT-related challenges and objectives and can thus be seen as the continuation of earlier information society policy strategies: the

Innovation Union and the Digital Agenda Flagships, both funded under the 'Smart Growth' priority area.

One of the Europe 2020 flagships is the **Digital Agenda**. Objective is to deliver "sustainable economic and social benefits from a digital single market, based on fast and ultra fast internet and interoperable applications." It proposes to better exploit the potential of Information and Communication Technologies in order to foster innovation, economic growth and progress. Digital Agenda addresses major market and system failures in the European economy: fragmented digital markets and a lack of interoperability, insufficient research and innovation efforts, rising cybercrime and risk of low trust in networks, a lack of investment in networks and a lack of digital literacy and skills.

At the core of this Flagship initiative lays the need to improve the *framework conditions* for research and innovation in order to reach a wider deployment and more effective use of digital technologies. The implementation of the European Open Data policy and fostering its uptake among the European member states is one of the action areas within this flagship.

The Open Access Policy

Policy drivers for Europe's Open Access policy are on the one hand, the creation of Europe as a knowledge-based economy, and on the other hand, the implementation of the ERA. The concept is that for Europe to maintain and enhance its global competitiveness, open access to knowledge is vital, not only to improve the production of knowledge but also the access to and dissemination of the results of scientific research, in particular those resulting from publicly funded and co-funded research. Closely linked to this perspective is the implementation of the ERA: give researchers access to a Europe-wide open space for knowledge and technologies in which transnational synergies and complementarities are fully exploited.

In the Impact Assessment accompanying the European Commission recommendation on "Access to and preservation of scientific information in the Digital Age" (EC, 2012c), the Commission stresses the political and economic importance of wide and instant access to scientific information. Listed potential benefits are:

- Acceleration of the research and discovery process, leading to increased returns on R&D investment
- Avoidance of the duplication of research efforts, leading to savings in R&D expenditure
- Enhanced opportunities for multi-disciplinary research, as well as inter-institutional and inter-sectorial collaborations
- Broader and faster opportunities for the adoption and commercialisation of research findings, generating increased returns on public investment in R&D and the potential for the emergence of new industries based on scientific information

Specific economic benefits have been estimated: "The overall economic benefit from increased access to (publicly and privately funded) scientific information for the EU 27 is estimated at €6 billion a year. This implies potential economic benefits from increased access to scientific publications emanating from public funding at €1.8 billion a year."

The EC High-level Group on Scientific Data argued in its report 'Riding the wave' (EC, 2010) that the most efficient way to address both the objective of widespread access to research, as well as its preservation for re-use, is to provide a collaborative and federated information infrastructure, at European level and well connected globally.

2.2   Trends in research governance

In this Chapter we describe the current trends in research governance as a consequence of the changes in the research policy concepts described in the previous chapter.

This regards in a first instance the New Public Management model and its consequences for the approach taken to research funding and research performance assessments (Chapter 2.2.1).

Also the concept of the European Research Area has its consequences on research governance in Europe, in particular following the current requirements to complete the ERA by 2014. We cover this in Chapter 2.2.2.

2.2.1   The New Public Management Model and its consequences for research funding and performance assessments

In this chapter we focus on the New Public Management model, its historical context and features, and the implications of NPM for the approaches to research funding. We also report on some lines of criticism to this current approach to research governance.

The changing social contract

In the post-War years and partly in reaction to the way science had been harnessed to political objectives in the 1930s and to the wider war effort, a 'social contract' emerged in the West that gave the scientific community a high degree of control in running the 'basic' science funding system. This was bolstered by the idea that there was an automatic connection between doing basic, researcher-initiated research and social and economic welfare. The essence of that social contract was that "The political community agrees to provide resources to the scientific community and to allow the scientific community to retain its decision-making mechanisms and in turn expects forthcoming but unspecified benefits." (Guston, 2000)

The 1960s and the 1970s saw resurgence of the pre-War desire actively to harness science – and especially technology – to societal needs, leading to the creation of innovation agencies, innovation-focused industry policies and other new ideas such as *grand projets* aiming to shift control more towards society. The OECD was instrumental in establishing the legitimacy of what it called 'science policy'. In 1963, the OECD organised the first international meeting of ministers of science and two years later it established a committee and an internal department for science policy. The 'OECD line' came to be that

1. Research should help reach national, politically-determined goals

2. Research should be planned and organised to that end

3. Research should be more interdisciplinary, in order to solve real-world problems

4. The universities were rigid, organised by discipline and unable to change themselves. They should be 'reorganised' in order to contribute more to the solution of societal problems and to reach national goals (Benum, 2007)

The growing focus on science policy in this sense was accompanied by increased state R&D budgets with a high mission content and new terminologies such as 'strategic research' (Irvine & Martin, 1984) and 'targeted research' (Elzinga, 1997) began to emerge. The continued roll-out of the 'New Public Management' has arguably reinforced the tend for this drift to continue (Hessels, van Lente, & Smits, 2009), notably through the introduction of 'performance based research funding systems' that count scientific and non-scientific research outputs and towards new funding practices among UK research councils that ask researchers to **predict** (and in the Research Excellence Framework to **demonstrate)** the societal impact of their work. In short, the terms of the social contract have shifted sharply against

the 'basic research' community's traditional values. Unsurprisingly, that community is largely not in favour of this development.

The New Public Management model

In the past two decades, governments throughout Europe launched major reforms (across the whole state, not just in relation to research and innovation) in an effort to modernise the structure and organisation of public management. The trend was towards implementing the New Public Management (NPM) model for public governance, setting a major focus on results and performance in terms of efficiency, effectiveness, accountability, quality of service, and the decentralisation of public management.

Major drivers for these reforms were the neo-liberalism wave at the end of the 1980s, developments in the socio-economic context and last but not least, the economic crisis (Pal 2007). International organisations such as the OECD (through its PUMA committee (PUMA 1995; PUMA 2005)) and the EU played significant roles in spreading the concept of NPM. Illustrative is the 1998 SIGMA paper (OECD/EU 1998) in which new EU Member States were urged to adopt reliability, transparency, predictability, accountability, adaptability and efficiency as 'key administrative values', to be "embedded in institutions and administrative processes at all levels". These desiderata have been mirrored in reforms of the European Commission from the end of the 1990s onwards.

Decentralisation is a key concept in New Public Management. It is based on the expectation that devolution of authority would lead to improved effectiveness and efficiency. It implies a profound change in the 'principal-agent' relationship, shifting from input management to output/outcome contract management and *'management by objectives'.* The result is a system of 'distributed governance': agencies and other public bodies with specialised functions are granted more management autonomy, accompanied by more stringent performance requirements, and accountability (OECD 2002). In effect, a *hierarchy of performance contracts* was established, connecting through ministers, ministries and agencies with research and innovation project performers –with varying degree of formality. These set out financial allocations, performance targets, and indicators by which performance is judged.

Exhibit 2 shows the hierarchy of performance contracts - explicit or implicit - between the different levels of the policy system in countries that follow the principles of New Public Management. In most places, evaluation follows a 'waterfall principle' where actors at each level evaluate actions at the level below them.

Exhibit 2 Hierarchy of Performance Contracts and Evaluation
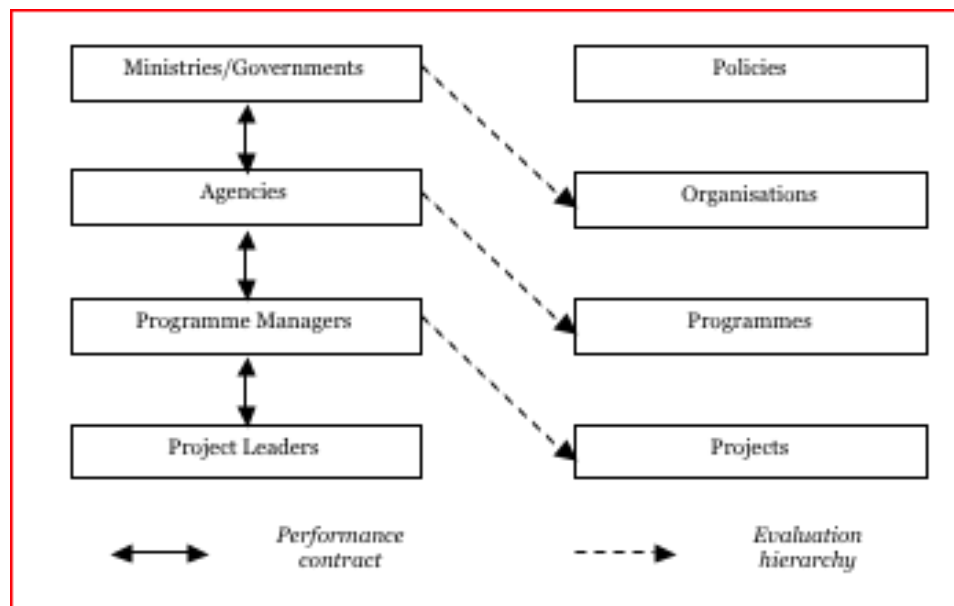
Source: (Arnold, Malkin, Good, Clark, & Ruiz Yaniz, 2009)

The New Public Management therefore combines ambitions from the era of top-down strategic planning, implemented through management by objectives, with a desire to understand and be responsive to needs. In practice, governance mechanisms need to combine the ability to plan strategically with a role in mediating among stakeholders to produce alignment among objectives. "Successful policymaking normally means compromising through a "reframing' of stakeholders' perspectives and joint production of consensus." (Kuhlmann, 2001) So governance is not just about 'steering' but about **creating arenas**, to decide the right direction in which to steer, and generate consensus-based commitment to steering in that direction.

The **vertical dimension of governance** is far from being the only important one (Arnold & Boekholt, 2003). First, societal actors and institutions outside the research community are likely to be increasingly involved in the governance of research and innovation. For agenda setting and prioritisation of actions, this implies that a variety of stakeholders need to be involved. Given the wider perspective, more strategic intelligence will be necessary to come to decisions and priorities. Second, governance mechanisms are needed that handle the systemic nature of research and innovation and the need for policies to be coherent and co-ordinated across institutional boundaries. This implies **horizontal co-ordination** along three lines

- *The co-ordination of different societal and economic goals of research and innovation*. In policy terms co-ordination and attuning between research and innovation policies for stimulating industrial growth, for the better use of information technology, environmental preservation, a healthy population, good quality food, and so on
- *The integration of knowledge creation and use.* In an innovation system this could involve bringing together those actors that focus on different roles in the knowledge production chain. In policy terms this involves the integration of science, research and innovation policy
- *The combination of knowledge from different disciplines* to tackle interdisciplinary research needs (e.g. bio-technology) and overarching societal problems that need such an interdisciplinary approach (e.g. climate change)

These governance factors all argue for increasingly open processes of generating and sharing strategic intelligence – and are therefore consistent with trends in the way research processes and results are

being captured and shared electronically, which we describe later on in this report. Governance also becomes increasingly complex as we move from a national to the European level. This complexity is tracked by the breadth and complexity of the information needed to produce strategic intelligence at the continental level.

Braun argues that **research** governance is especially complicated by the fact that the political and policy level lacks the expertise to allocate resources at the research level (Braun, 1993). Instead it hands over that management to the scientific community, despite the problems inherent in such a 'principal-agent' relationship where the principal lacks the ability to test the agent's honesty and effectiveness (van der Meulen, 1998) (Braun, 2003) . The degree to which the scientific community formally governs basic research funders varies. In Sweden, the research community elects the majority of the governing board members. In most other countries the control is less overt than this but the scientific community nonetheless makes most if not all of the specific funding allocation decisions. The influence of the beneficiaries in innovation funding governance, in contrast, is much smaller, at least at the level of project funding decisions.

New modes of public research funding

In most European countries, the New Public Management model combined with the integration of science and innovation policies affected the mode and scope of public research funding, both in relation to the competitive and institutional (core) funding. Policy-makers started *steering* research using funding as an incentive rather than controlling it through detailed prescription.

Priorities guiding decision-making for funding are thematic as well as systemic. They include areas of socio-economic relevance or strategic importance for the improvement of national competitiveness as well as initiatives to increase the quantity and quality of research outcomes or the quality of research in general, such as initiatives fostering critical mass building and international collaboration.

Institutional funding

The normal way to fund state universities in the post-War period was via a block grant. The trend has been for the ratio of competitive project funding to institutional funding to rise (Lepori, et al., 2007), suggesting increased external competitive pressure for research resources. Research councils initially dominated the external research-funding stream, responding to investigator-initiated ('bottom up') proposals. This imposed quality control through peer review of project proposals. As a consequence of the OECD's work to promote 'science policy', a new set of institutions ('innovation agencies') developed in many countries from the late-1960s that programmatically funded 'relevant' research. In Sweden, for example, the innovation agency (STU, set up in 1969) saw its role as funding research in the parts of the system that underpinned industrial needs – connecting non-academic actors like the major Swedish companies with the academic research community and making sure that enough knowledge and trained people were generated in the areas of contact between the scientific and other societal systems (Weinberger, 1997). The innovation agency thus generated 'focusing devices' (Rosenberg, 1976) (Arnold, Good, & Segerpalm, 2008) in the form of projects and programmes, implementing science policy through research-funding incentives that eventually affected the size and capabilities of parts of the research system.

University funding at the national level today tends to comprise three parts. An education ministry typically provides both institutional funding and money for 'excellence' research, the latter through a research council. Ministries responsible for industry and various other 'sectors' of society (energy, environment, defence, etc) may fund research in the university system, directly or through an innovation agency. In principle, the institutional funding is infrastructural in nature: it provides a basis for strategy and planning and for capacity to do research in the universities. The external funders provide incentives for particular kinds of research. The balance among the three flows – institutional, excellence and sector – influences the shape of the university research system.

Performance-based research funding

The trend over the past 10-20 years to make institutional funding at least partly conditional upon performance changes its role in ways that have not yet been spelt out in policy terms. One possibility is that it simply adds to the competitive pressure for universities to develop and implement strategies. Many performance-based research-funding systems (PRFS) now use the amount of external research funding as a quality indicator, so they can be used to magnify the effects of external funding – in the direction of 'excellence' or 'relevance' or both.

Performance-based research funding is a model that is increasingly adopted in European countries. Close to all countries covered in this study use this model for the allocation of institutional funding for research (Exhibit 3). In most cases, only a limited part of the institutions' core funding is defined through the PRF system, ranging from 5% to 20%. Exceptions are the UK and the Czech Republic where the PRF system governs more than 50% of the core funding. Spain, on the other hand, applies the PRF model only for the allocation of additional funding; in the Netherlands, so far research performance assessments have no financial consequences.

Exhibit 3 The influence of research performance assessments on institutional funding for research (2013)

	No influence on core funding		Influence on core funding		
	Not linked to funding decisions	Additional to the block grant	Less than 20%	Between 20% and 50%	More than 50%
Austria - BMWF			√		
Belgium (Flanders) - EWI		√	√		
Czech republic – Council of RD&I					√
Denmark - Agency for Science, Technology and Innovation (FI)			√		
Finland – Min. of Education & Culture (MINEDU			√		
France - AERES				√	
Italy - ANVUR			√		
Netherlands – KNAW/NWO/VSNU	√				
Norway - RCN			√		
Slovak republic – Council of RD&I			√		
Spain - CNEAI		√			
Sweden - Vetenskapsrådet, SRC			√		
UK - HEFCE					√

Performance-based research funding systems have for some years been hotly debated, and continue to be so (Geuna & Martin, 2003) (Barker, 2007) (Rodrigues-Navarro, 2009) (Butler, 2003) (Martin & Whitley, 2010)(Hicks, 2012) (Glaeser & Laudel, 2007) (Molas-Gallert, 2012). Issues raised include the tendency of established elites to dominate the design and implementation of these systems (Martin & Whitley, 2010) and their bias against interdisciplinary (Rafols, Leydesdorff, O'Hare, Nightingale, & Stirling, 2012) and heterodox approaches (Lee, 1998, 2013) in research. Over-reliance on indicators, especially if not tempered by judgement, risks causing perverse and unanticipated effects (Arnold, Good, Tiefenthaler, & Vermeulen, 2011) (Martin, 2011). Despite the many reservations, however, PRFS continue to proliferate and to be both sources and users of information and indicators about research performance.

An evaluation model beyond New Public Management?

Though science and research policy and the broad range of related evaluation systems have often been understood in the context of New Public Management, it is worth examining how an international research monitoring system might depart from the NPM model and in so doing, avoid some of the key problems associated with it.

Among the most significant criticisms have been claims that NPM does not honour its promise to deliver value for money in comparison to previous public management approaches, as well as assertions that NPM is not well suited to have the public good as its goal (Hood 1991). More significantly for the subject matter at hand, the NPM model has incurred several criticisms specifically in relation to evaluation systems in the context of science and research.

Evaluation systems versus stand-alone evaluations

Rather than being subject to occasional, stand-alone evaluations, methods of competitive funding, as well as criteria for the allocation of core-funding have necessitated standardised evaluation systems, to be uniformly and regularly applied to all institutions. First, this means a separation of qualitative enquiries into 'good practice' from the evaluation process – well-selected indicators may approximate to a reasonably widely held definition of good practice, but never directly assess whether that practice actually is 'good'. Second, this shift from stand-alone evaluations to evaluation systems requires definition of key indicators, which in turn limit the activities of evaluated institutions to those that can be expressed by those indicators (Dahler-Larsen 2013; 2012; van Thiel and Leeuw 2002). In other words, specifying indicators by which researchers will be measured can change the behaviour of researchers (see also Espeland and Sauder 2007). If the existence of an evaluation system changes the behaviour of researchers, then it is by definition unable to assess, whether the researchers were performing well prior to its existence.

Several authors have linked evaluation systems not just to principles of efficiency, economic and societal benefit but to the presence of an 'audit culture' (Power 1996; 1997; 2005; Dahler-Larsen 2012) where the auditability itself is the principal objective of evaluation. Drawing on Hood, a key author on this subject (Hood 2002), Dahler-Larsen summarises the rationale behind this:

> *…risk is managed and blame is shifted, as politicians seek to install "quality assurance systems" which – in the name of accountability – often tends to be used as risk-placing, blame-placing and responsibility-avoiding mechanisms by politicians themselves. (Dahler-Larsen 2013, p33)*

Erne concludes that evaluation systems utilizing predefined indicators undermine several premises of the classical understanding of research and academia. Specifically, he points to a reduction in the pluralism of research resulting from arbitrarily and narrowly defined indicators, as well as a breakdown of un-coerced cooperation, brought about by conflicts of interest between informal knowledge exchange and requirements to secure competitive funding (Erne 2007). Cooperating and

fulfilling the demands of evaluation systems is a laborious task for those being evaluated, often doing more to hinder practitioners in carrying out their work than aiding this process.

These points highlight several potential hazards relevant to the design and scope of an international research monitoring system.

However, in a comparative study of British, Dutch and German research evaluation systems, Simon and Knie suggest that evaluation procedures in science and research can be of genuine benefit (Simon and Knie 2013). Where researchers themselves are involved in designing the evaluation and carrying out part of the evaluation process (i.e. a 'bottom-up' approach involving 'peer review'), evaluations tend to be regarded more favourably (implicitly because peer review is a mechanism through which the research community retains influence).

To move from this point towards identifying a framework in which to situate an international research monitoring system, it is worth highlighting two lines of argument that attempt to move public management and the closely connected notion of evaluation systems beyond the framework of NPM: on one hand, Dahler-Larsen's notion of Evaluability Assessment, on the other, Digital Era Governance. Both lines of argument promote the idea of greater researcher control over the evaluation process.

The concept of Evaluability Assessment

Dahler-Larsen proposes to respond to the travails of NPM by arguing for a partial return to the old paradigm of stand-alone evaluations, with the key difference of emphasizing and refining the notion of Evaluability Assessment (EA) (Dahler-Larsen 2013). EA refers not to the question of whether evaluation of a particular institution (or institutions) is possible, but whether it is *advisable*. He sets out a list of criteria that can be drawn on to produce rationales for evaluation, sensitive to the context of what is to be evaluated, but also to the achievement of clearly specified aims, as in the NPM paradigm. His broad list of criteria includes asking questions such as:

> *"Does the object of evaluation have enough social impact or importance to warrant a formal evaluation system? […] Are the characteristics of the evaluated activities of such a substantial nature that they are appropriately represented by the indicators, standards and criteria of the evaluation system? […] How clear are the goals of the evaluated activities?" (Ibid, pp36-37)*

In effect, Dahler-Larsen argues for moving beyond the NPM paradigm by making available a range of possible criteria and indicators broader than evaluation systems can currently draw upon.

The notion of EA provides a framework to understand how research evaluation systems might be recontextualised away from the NPM paradigm and its associated problems, and also gives an indication of the role that an international research monitoring system could play in this. But at an operational level, there is an additional perspective, based once again on the waning popularity of NPM approaches, which allows for a clear theoretical framework for a system of this type.

Digital Era Governance

In their aptly titled article 'New Public Management is dead – Long live Digital Era Governance' or DEG (Dunleavy et al 2006), Dunleavy et al criticise NPM in similar ways to Dahler-Larsen and note that the advent of contemporary digital technology contains the possibility to reverse even some of the most central elements of NPM. Specifically, they note that the disaggregation of public management into multitudes of hierarchies and sub-departments, typical of NPM can now be reversed using digital and communication technology.

The transparency and public availability of information unthinkable in pre-NPM bureaucracies is a realistic possibility in the context of digital technologies (though not yet a reality, as the authors themselves note). Rather than public management having its key emphasis on a large middle-

managerial sector, lowered from the level of central governance but still largely publicly inaccessible, digital and communication technologies could allow for the setup of centralised initiatives and systems that can be drawn on by any potential set of users from the wider public or other organisations. In a subsequent publication, Margetts and Dunleavy note that the most recent developments in digital communication technology, specifically the ability to manage collection of and access to large amounts of data, has made the case for DEG ever more convincing (Margetts and Dunleavy 2013).

Through the lens of DEG, an international monitoring system is not necessarily an additional tool in the arsenal of a self-legitimising audit-culture to further standardise already problematic evaluation-systems. It can also be understood as a centrally organised resource of publically available information, which, without additional interference of several management bodies and hierarchies, could be drawn on by a large number of actors to suit a range of evaluative purposes. Precisely by focusing on the capacity of being able to collect unprecedentedly large amounts of data, the additional possibility is given here of a **'needs-based holism'** (Dunleavy et al 2006), providing those interested with a wide range of possible indicators to utilise in evaluative tasks.

Referring back to Dahler-Larsen's points discussed earlier, this in turn is of use for the notion of Evaluability Assessments and the task of tailoring evaluation systems more closely to the particularities of the institutions to be evaluated. Put simply, a greater number of available and feasible evaluation criteria allows for a broader range of possible evaluation approaches. In this context, the capacity of the system in question here to go far beyond collection of bibliometric data fits well with the demands for an evaluation culture that moves decisively beyond NPM.

2.2.2 Research governance in the context of the ERA

Since 2000, the European Union (EU) has taken steps to implement the European Research Area. However, while the ERA process has fostered stronger partnerships and research reforms across the EU, overall progress has been slow and uneven across the different ERA dimensions and Member-States (MS).

The new EC Framework Programme Horizon 2020 (2014-2020) constitutes a major effort to finalise the creation of the European Research Area, fostering an enhanced synergy in research policies and programme funding in Europe.

The EC also calls for direct actions from the Member States on their research systems, though. In 2011, and again in 2012, the European Council called for ERA to be completed by 2014: "Europe needs a unified research area to attract talent and investment. Remaining gaps must therefore be addressed rapidly and the European Research Area completed by 2014 to create a genuine single market for knowledge, research and innovation" (European Council Conclusions Feb 2011; European Council Conclusions Mar 2012).

We describe these two lines of EC policy actions and their influence on research governance in Europe further below.

Horizon 2020

The new EC Framework Programme marks a fundamental change in European policy-making due to its comprehensive and integrating approach to research and innovation, reflecting the developments in the ERA strategy described in Chapter 2.1.3, above.

It constitutes a paradigm shift in European research and innovation policy-making: addressing societal challenges, enhancing industrial competitiveness and supporting excellent basic research are its three fundamental pillars. Most important, the FP takes a challenging fully integrated and systemic approach to research and innovation: its policy toolbox covers almost the whole spectrum of public

policy measures in the field of research and innovation, including generic R&D measures for the public and private sector, thematic measures, fiscal measures, human resource support and demand-side actions to enhance large market uptake of innovations. Also a range of "linkage instruments" are developed such as forward-looking activities and foresight (including embedded foresight in e.g. joint programming or innovation partnerships), cross-sectoral networks and brokerage activities, innovation observatories and policy learning networks etc. These 'linkage' instruments gain additional relevance by supporting cross-cutting networks that can respond to the scope of societal challenges, e.g. encouraging collaboration between different disciplines and sectors, supporting links between established and emerging networks etc.

The rationale for implementation means that R&I policy at the EU level is driven not only by the existence of market and systemic failures but also by the European added value, i.e. the EU2020 agenda and the completion of the single market (ERA).

The historical justification for the Commission to pursue the Framework Programme has been the idea of 'European Added Value': the notion that together the Member States (MS) can achieve things that are impossible at the national level. Since the launch of ERA, European Added Value has increasingly shifted from networking MS-level activities to 'optimising' the European research and innovation system at the European level. Increasingly, the Commission aims to do this not only using European-level resources but also by coordinating or 'structuring' MS-level resources, in the form of both money and research performance. The Treaty now gives the Commission the right to legislate about research and technological development so this continent-wide influence will only increase, allowing the Commission to move beyond R&D funding to tackle framework conditions such as a proper common market in knowledge that are necessary in order to build the ERA and allow Europe's strengthened research actors to operate at the European scale.

While hitherto it has been possible to see European- and MS-level research R&D policies as largely independent, the European level increasingly influences the whole and will become a more important determinant of the continent-wide policy mix. A corollary of this increasingly European effort to optimise policy is the need for MS, singly and in variable-geometry groupings, to pursue specialised strategies in areas of comparative advantage. Many of the 'ERA instruments' innovated by the Commission in recent years support this specialisation and help empower stakeholders to develop and pursue variable-geometry strategies that serve the European interest by building larger, stronger, specialised, cross-border R&D communities.

Completing the European Research Area

In its 2012 Communication, the European Commission indicates a set of research governance practices that the European Member States are expected to undertake in order to complete the European Research Area. Exhibit 4, below, presents the drivers and problems identified to complete the ERA by 2014, as defined in the ERA ex-ante impact assessment (EC 2011b), which analysed the strengths and weaknesses of Europe's research systems.

Exhibit 4 Problem tree for completing the ERA by 2014
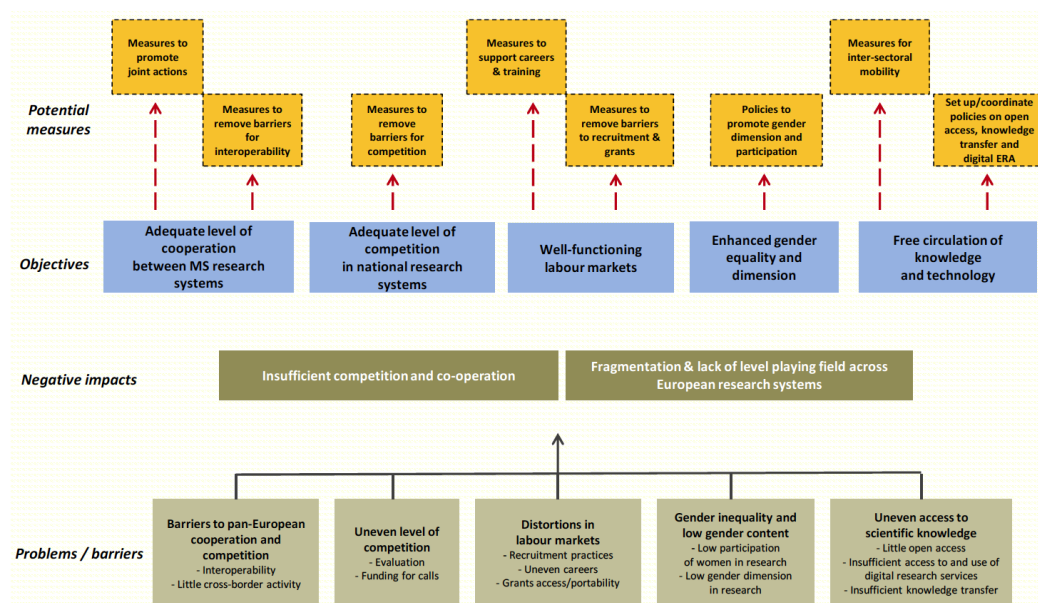
Source: ERA ex-ante impact assessment, 2012

The five ERA priorities that were retained as having the potential of inducing lasting step-changes in Europe's research performance and effectiveness by 2014 are the following:

- *Priority Area 1: More effective national research systems* – including increased competition within national borders and sustained or greater investment in research
- *Priority Area 2: Optimal transnational co-operation and competition* - defining and implementing common research agendas on grand-challenges, raising quality through Europe-wide open competition, and constructing and running effectively key research infrastructures on a pan-European basis
- *Priority Area 3: An open labour market for researchers* - to ensure the removal of barriers to researcher mobility, training and attractive careers
- *Priority Area 4: Gender equality and gender mainstreaming in research* – to end the waste of talent which we cannot afford and to diversify views and approaches in research and foster excellence
- *Priority Area 5: Optimal circulation, access to and transfer of scientific knowledge including via digital ERA* - to guarantee access to and uptake of knowledge by all

While national governments are called upon to make the necessary national reforms and put in place the conditions needed to complete ERA, the funding agencies are expected to take their responsibility. The Communication states:

> *"Relevant research stakeholder organisations will be invited to sign with the Commissioner a Joint Statement in general terms of their willingness to work towards completing ERA. They should also set out the specific ERA actions they will take in terms of timing, deliverables, public reporting on progress, etc. in a Memorandum of Understanding co-signed with the Commission or a unilateral declaration, informing their respective national authorities and the other Partners."*

The actions that Member States are expected to implement related to the priority areas 1 and 2 are of particular interest for the topics covered in this study:

- The intent of Priority Area 2 is to enable **transnational research and innovation** "by exploiting synergies between national and international programmes, strategically aligning different sources of national and other funds at EU level rather than cross-border funding per se." The Commission

envisages the definition of common priorities and joint research agendas, the implementation of joint research agendas, and the joint implementation and/or financing of calls and projects. For this purpose, Member States are invited to:

"Step up efforts to implement joint research agendas addressing grand challenges, sharing information about activities in agreed priority areas, ensuring that adequate national funding is committed and strategically aligned at European level in these areas and that common ex post evaluation is conducted

Ensure mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions

Remove legal and other barriers to the cross-border interoperability of national programmes to permit joint financing of actions including cooperation with non-EU countries where relevant"

- Priority Area 1 focuses on fostering **open national competition**, considered "crucial to deriving maximum value from public money invested in research". This includes open calls for proposals where peer reviewers include foreign experts, and institutional funding based on research performance assessments. The Commission paper argues, "While the balance between these two approaches may vary, they should be at the core of research funding decisions in all Member States in order to overcome divergences in performance across the EU."

These requirements can be expected having significant consequences for the research governance in the Member States, including strategy development, and the funding and performance assessments models:

- A higher level of standardisation in terms of focus of research funding programmes, funding and evaluation practices in the Member States can be expected as longer-term outcomes, which should facilitate the collection of detailed information for research assessment purposes at a European transnational level
- The intention to increase the joint funding of research programmes and the opening up of national programmes for researchers in other countries no doubt will accentuate the need for national policy makers to have access to data beyond the national borders, e.g. on participation in such programmes by the research actors in their countries and the related outputs and outcomes
- The EC report considered that performance-based research funding, i.e. "the assessment of the quality of research-performing organisations and teams and their outputs as a basis for institutional funding decisions", is part of 'best-practice performance' in this context – "which all Member States should attain". Thus, despite the misgivings of some members of the research community, there is a strong drive from the state (at both national and European levels) for performance-based funding and the information systems needed to support it.

3 CURRENT TRENDS IN RESEARCH PERFORMANCE ASSESSMENT – METHODS AND TOOLS

The analysis of the methods and tools that are currently applied for the collection of data and strategic information in the context of research performance assessments constituted a major focus in this study.

We start this chapter with an overview of the general trends in the approach taken, due to the changes in the policy contexts described in the previous chapters (Chapter 3.1).

In Chapter 3.2 we describe the sources for data and information that are currently available and their developments, reflecting also on the economics of knowledge and research and the role and position of the commercial information providers.

Chapter 3.3 reports on our analysis of the current research performance assessment practice at the various levels in the European research system, its use of sources, challenges and gaps.

In the final chapter we cover the efforts that have been made in recent years by the stakeholder communities to reach a standardisation of methods and tools used at the European level (Chapter 3.4).

3.1 Policy demands and needs

The trends in the landscape for research and research governance described in the preceding chapter generate new demands for the practice of evaluation, expanding its scope and use. Policymaking is increasingly required to be 'evidence-based' and evaluation becomes an integral component of the priority setting and strategy building processes at the level of national policy-makers as well as the research actors.

In international practice, evaluation has increasingly become an integral part of the policy and programme cycle. It has taken on a more pronounced *prospective and formative function*, in addition to the traditional *retrospective* one. Evaluation is expected to foster learning and improvement as well as to ensure accountability. It is expected to provide information to help design better policies and/or to assess performance in order to legitimise past initiatives (OECD 2012). Increasingly, evaluation is also being used at the level of whole national systems of innovation, for example through the OECD Innovation System studies and the 'policy mix' exercises promoted by the EU CREST and more recently ERAB committees.

Evaluation, then, can be seen to be developing in two directions.

- *Expansion of actors and needs*. Evaluations are conducted at increasing levels of aggregation. In the past, research and innovation evaluations have typically focused on the programme level – because programming was one of the major innovations adopted by the New Public Management. It is now increasingly being done at the level of research-performing organisations (such as universities and research institutes), research funders, national strategies and whole innovation systems

- *Expansion of breadth and focus*. There is increasing interest not only in the quality and immediate outputs of research processes but also in the resulting outcomes and impacts in society

A consequence of these developments is also the increased need for *data and information at the micro-level* in order to respond to the changing policy needs for strategic information and to enable the development of evaluation methodologies as such, based on an improved understanding of the dynamics leading to knowledge creation and innovation.

In the chapters below we cover these topics more in-depth.

3.1.1 Multiple actors and needs

A trend within research systems that is consistent with the drive of New Public Management is **increased institutional autonomy**. As the idea of setting broad objectives and steering through performance contracts and incentives takes hold, so universities and research funders become increasingly autonomous from their principals – at least in terms of their ability to decide what they do on a day to day level. The corollary of autonomy is increased exposure to external incentives and competition, which provide a different set of pressures towards conformity with the principals' objectives. This has an important implication for the traditional notion of academic freedom, which historically has been taken to include the right of every academic not only to write what she or he likes but also to research what she or he chooses. Individual academics now have to make decisions against the background of the specific incentives provided by external funders. The growth of institutional research management also means that such decisions are no longer wholly individual but that this academic freedom is increasingly exercised at the institutional level.

This increase in management autonomy implies that actors at all levels in the research system are in **greater need of strategic information** to understand their performance, define their priorities and design their strategies and policies. Actors actively involved in the production and use of research performance data also encompass government bodies at the EU, national and regional/local levels, government agencies in charge of research and innovation governance as well as research institutions and their management and governing bodies, research groups, and ultimately the researchers themselves. Exhibit 5 gives an overview of these actors' needs for and use of strategic information, further described below.

Exhibit 5 Use of research information by the different stakeholders

		Governments and government agencies			Research institutions management & governance		
		EU and National Governments	Ministries responsible for research/ innovation	Government Agencies	Governing Bodies/ Councils	Executives/ Management	Research Groups / departments & institutes
Inform policies & strategies	Determine competitiveness / strategic positioning	x	x	x	x	x	x
	Improve performance and quality		x	x		x	
	Improve system functionality		x	x			
	Aid resource allocation			x			
Assess per-formance	Quality, sustainability, relevance and impact of research activity		x	x			
Other	Investor confidence/value-for-money and efficiency	x	x	x	x		x
	Recruitment					x	x

Based upon: Expert Group on Assessment of University-Based Research, *Assessing Europe's University-Based Research*, European Commission, DG Research, 2010

Needs of the actors in the research system

Universities and research institutions have become more dependent on competitive and contract funding. Though some core funding is still historically determined, it is increasingly becoming performance-based, and responsibility for the quality of the research has substantially been delegated to the institutions' management and the researchers themselves.

The overall research context has changed considerably, characterised by growing competition and globalisation. It has provoked changes in the institutions' human resources policies, driving the institutions to develop strategies in order to raise their scientific profile and attract specific and/or foreign researchers and students (Veltri et al 2009).

In this context, universities and research institutions rely on performance assessments in order to understand their strengths and weaknesses and measure their competitiveness, at an aggregate level and at the level of their departments and research groups. Results of these analyses feed into institutional strategy making (and eventually internal fund allocations) and help the institutions in their monitoring and reporting on outputs and impacts. Institutions also use this information for publicity purposes, i.e. to help student and academic recruitment, aid research partnerships (with private enterprises or other research institutions), and initiate or sustain investments.

Government agencies and ministries responsible for research have seen an expansion of their responsibilities related to research governance. They are expected to exert their influence not only to ensure quality and relevance in research, including relevance from a socio-economic perspective; they are also to define and tackle systemic failures, ranging from the institutional set up and the creation of opportunities for improved interactions between the various actors in the system at national and international level, to ensuring the sustainability of competitiveness through the creation of critical mass in strategic areas. Their need for strategic intelligence is closely linked to accountability, i.e. to provide evidence of the efficiency of management processes and the effectiveness of programmes and policies in reaching the expected benefits for society.

A further driver is the growing importance of the grand 'societal challenges', such as those identified in Horizon 2020, in research and innovation policy and as channels for funding. These challenges tend to cut across the responsibilities of individual ministries, creating a need for policy coordination and a demand for more integrated and harmonised strategic intelligence across different ministry domains. Clearly, this is likely to increase the level of need and interest for the kinds of integrated research repositories, information systems and analytics discussed in this report.

The implementation of the ERA

Finally, changes in the **policy context in Europe** have imposed new demands on the monitoring and assessment of research and innovation at the European level. As mentioned in Chapter 2.2.2, above, the creation of the European Research Area, launched in the beginning of the 2000s, has led to a stronger collaboration and at times integration of national and European Commission research and innovation programmes and policies. National policies are therefore more firmly set within the European context, as are their outcomes and results. Evaluation at the European level now needs to consider the *European Innovation System.*

The function of performance assessment at European level has thus shifted from a mere aggregating of national performance data at the macro-level to a more fine-grained assessment of outputs, outcomes and impacts, taking a more comprehensive view and treating the EU as if it were a single national entity. An example of such a perspective is the European Competitiveness report where Europe's competitiveness is measured and benchmarked by means of aggregated European data rather than showing data at country levels.

The interest is now in a closer monitoring of national reforms and the integration of national programmes, policies and systems, as well as in an assessment of the Member States' contribution to the achievement of the overarching European innovation and research policy objectives. As a consequence, the 'silo' approach for the measurement of scientific performance that has been adopted so far – with analyses at national or European level having access to and analysing information only related to the respective national or European funding system and R&D policies – is no longer adequate to respond to policy needs. The 2011 decision of the Council to foster the completion of the ERA by 2014 stresses the urgency of such improvements (EC 2012a) (see also Chapter 2.2.2, above).

3.1.2 Expansion of breadth and focus

The higher one climbs in this hierarchy, the greater the need to span innovation and research issues. Performance assessments are now expected to identify economic and societal outcomes and impacts of research (including basic research) in addition to the monitoring and assessment of inputs and outputs. Quality of research, the creation of critical mass, international collaboration, input to innovation, and the creation of outcomes and impacts to the benefit of research, the economic sector and society as a whole are all items that are high on the evaluation agenda.

There is a general consensus among the authors of the studies consulted in the literature review for this study that the current need for improvement relates to *evaluation methodologies* as well as *data availability* and *indicators*.

The limited scope of current assessments

The challenge of adequately measuring the impacts of research is particularly problematic. A meta-evaluation of innovation policy assessments in Europe, conducted by the INNO-Appraisal project (Edler et al, 2010), confirmed the observation made by several researchers that indicators for the assessment of technological and economic impacts are more mature than those related to social impacts and impacts on the environment. It found that overall, impact assessments seemed to try and respond to the demand for quantified results, despite methodological limitations or data availability problems.

Assessment of technological and economic impact was most dominant, and the INNO-Appraisal project team noted the attempts made to cover also indirect economic impacts, i.e. the spill-over effects of the policy interventions. However, the project sees a need for evaluation to tackle "systematically and with methodological rigour" a broader range of impacts. The assessment of new impact types such as <u>social </u>impacts and impacts on <u>environment</u> still is rather uncommon, and more attention should be dedicated also to the analysis of <u>systemic effects</u> in terms of behavioural additionality, networking and science-industry interactions.

Also a recent IPTS report (Cuntz 2011) found that evidence on social impacts is currently limited – and more general experience in the assessment of such impacts is limited. This relates to impacts on minorities, gender issues, or the assessment of behavioural additionality, such as change in attitudes towards risks or a rise in entrepreneurial spirit. It also noted that direct or indirect economic impacts are covered more frequently in assessments of R&D programmes that specifically target industry clusters or networks than in programmes focusing on framework conditions or systemic effects such as improved science-industry links. The report sees a mix of *methodological complexity* and *measurability constraints* as reasons for this imbalance in the coverage of impacts.

The limits to current evaluation methodologies

The OECD Working Party on Innovation and Technology Policy (OECD 2009b) considered that major methodological constraints are related to the difficulty of attributing economic and social impacts to a particular research programme or policy. It also highlighted the limits of the national statistical frameworks in their ability to capture social impacts, as they are intangible and more difficult to measure and link to specific policies and programmes.

The Working Party concluded its report with a finding that was common to several studies consulted in this literature review, i.e. that methodological problems in the practice of evaluation are predominantly related to the complexity of innovation systems. Solutions for these methodological challenges are dependent on the availability of better definitions and an **improved understanding of innovation systems**. In several studies, researchers expressed the need for a radical improvement of our understanding on the <u>dynamics</u> of knowledge creation and adoption of innovation before adequate evaluation approaches can be developed. They stated that such improved understanding could be reached only through improved availability of data and information. There was a need for indicators that are "linked together so that they can tell the story of economic and social change". It is perhaps worth observing that there are significant theoretical gaps in this area, too, so improvement of theory and evidence need to move hand in hand.

3.1.3   The push for data at the micro-level

The literature review conducted for this study showed overall agreement among the experts on the need for the collection of data at the micro-level in order to satisfy the current challenges for evaluation.

The positioning indicators rationale

Lepori and colleagues (Lepori et al 2008) highlighted the need for more comprehensive data and information. They call for a paradigm shift in evaluation towards the adoption of a 'positioning indicators rationale' for the development of indicators, 'aiming to characterize the relative position and linkages between actors (conceived as autonomous strategic agents) in an innovation system'.

> "The position of the actors – their identity, relationships, complementarities and immaterial assets – are as important as formal inputs and outputs of their performance. The role of science, technology and innovation indicators is thus to describe each singular entity in terms of its specific characteristics, as of its competition and cooperation with other entities. In turn, this calls for a broader set of indicators including all kinds of measures of linkages and immaterial fluxes and stocks, alongside the classical input and output indicators. […]

The need for new data and indicators are in particular to allow for an adequate investigation of

- Efficiency, effectiveness and impact of different policy options
- The performance of actors and systems in Europe
- The choice of the funding instruments
- The governance and steering approaches
- Framing conditions (enablers) for excellence and innovation
- Determinants and constraints of economic growth

They are to provide information on processes and dynamics, setting the research within its context and providing information on the conditions in which the research took place.

Fine-grained data comparable at an international level

The European Commission Expert Group on the assessment of university-based research (Expert Group on Assessment of University-Based Research 2010) made similar considerations and identified in the lack of reliable, comparable and comprehensive data a major challenge for the current implementation of research assessments. The availability of more fine-grained information and data, comparable at an international level, was a topic that was high on the agenda and needs were expressed for

- Comprehensive data and information on the *context* in which knowledge and innovation is created, covering the full policy-mix, taking into account the roles of individuals, consumers and government in the innovation process and including the local and regional dimensions
- A more detailed coverage of *input data,* including funding and other intangible assets such as software, human capital and new organisational structures
- An improved description of policies and funding models related to different *typologies and focus areas of research,* including interdisciplinary research
- Improved data and information - at the micro-level - on interactions between the actors in the system and the *flow of knowledge and technologies,* at national and international level
- Data and new methods of analysis to *understand innovative behaviour,* its determinants and its impacts, such as, e.g., the birth and evolution of innovative firms
- Data allowing for the measurement of the *effects and impacts of research policies,* in particular those implemented at both national and European level, for example related to the grand challenges, and going beyond the limited time frame determined by the analysis and data collection related to projects and programmes
- The development of concepts and measures of innovation that reveal their impact on or contributions to achieving *social goals*

The Expert Group recommended the European Commission to 'invest in developing a shared information infrastructure for relevant data to be collected, maintained, analysed, and disseminated across the European Union.'

The OECD also made recommendations along the same lines. It took up the recommendations of the Blue Sky Forum in its 2010 Innovation Strategy (OECD 2010b) and recommended that evaluation and data collections should go beyond what is needed in order to answer the short-term evaluation questions, in order to develop a more fundamental understanding of the dynamics of innovation in firms. It also recommended investing in *high-quality and comprehensive data infrastructures*, linking different data sets in order to allow for the development of sound evidence-based policy advice. It indicated two challenges as key for future development:

- The redesign of surveys to address the relevant unit of analysis, and
- The restructuring of data collection to maximize data-linking opportunities for research and the analysis of impacts

Research information systems and metrics

The OECD and other experts and researchers also indicated the need for the development of a shared or integrated research information system at international level that would provide access to relevant comparable data at national and even institutional level. This is closely related to the need for improved indicators: improved interlinkages would allow for better data access and exploitation of 'distributed intelligence', i.e. strategic intelligence produced in different locations for different purposes (Kuhlmann et al 1999).

Rémi Barré and colleagues (Barré et al 2009) considered that the essential features of metrics and reporting systems required by ERA include the production of information that is

- Internationally comparable

- Actor-relevant as well as policy-relevant

- Metrics that can encompass all relevant activities, rather than a set that are limited towards certain assumptions about what constitutes research or how research will be used

We cover the topic of metrics in the next chapter.

3.2 Sources of data and information

In the last two decades, a wide range of data sources has become available to support research performance assessments and set the basis for the development of Science, Technology and Innovation (STI) indicators. These range from research information systems at the institutional level to bibliometric data at the global level.

Exhibit 6 provides a simple view of the different kinds of research-related information that is collected by the different actors and the systems and databases used. On the vertical axis, information on the higher levels is increasingly abstract and distant from the research process. On the horizontal axis, the scope and generality of systems or databases increases from left to right.

Exhibit 6 Sources for research information

Information type & entities	Research-performing institutions	National policy-makers & funders	European policy makers
Indicators *Research performance*	Institutional performance assessment datasets	Surveys	Aggregated statistics
	Commercial bibliometric databases		
Information about research *Input data (resources, etc)* *Data about papers, citations, etc* *CVs*	Institutional research information systems	Performance-Based research Funding datasets National / agency research information systems	Scoreboard datasets Commercial bibliometric databases
Research outputs *Papers and publications* *Patents* *Other innovation outputs*	Institutional repositories	National Open Access repositories	International Open Access repositories Publishers
Objects of research *Project data* *Intermediate outputs, reports* *Datasets, digital collections*	Institutional research information systems	National datasets National collections, eg museums	

In this chapter we describe the major sources for data and information on research, i.e. the sources related to research publications (and the metrics linked to them) and the research information systems.

An important topic in this context is the Open Data policy, strongly supported by the European Commission, and the phenomenon of the Open Access Repositories. In the last section of this chapter,

we set this topic in the context of the 'economics of knowledge and research', reflecting also on the positioning and role of the commercial information providers.

We look into how the different actors in the research system use these data sources in Chapter 3.3.

3.2.1 Sources for information on research publications and the issue of metrics

The bibliometric databases still constitute the major source for data and information related to research publications. Increasingly, however, alternative data sources and metrics are gaining in importance, based upon information available on the web. In the sections below, we therefore look into the current and potential value of Google Scholar and the altmetrics approach for research performance assessments.

This chapter needs to be set against the context of the ongoing discussion in the academic community on *how to define and measure quality in research,* with repeated criticism of the current predominant reliance on publication and/or citation data for the assessment of research and its impacts.

Ernø-Kjølhede and Hansson (Ernø-Kjølhede and Hansson 2011) especially questioned the dominant use of bibliometrics for the evaluation of research, arguing that indicators and data related to paper counts and citations do not adequately reflect the *features of Mode 2 research* (see also Chapter 2.1.1). They highlight that the objective of Mode 1 research is scientific excellence and theory-building; Mode 2 research, instead, intends to produce a socially relevant result – often in the form of a product, process, form of organization or marketing concept. These results are less likely to be published, and not necessarily in scientific journals. They also consider that even more than in Mode 1 research, the *context matters:* "quality assessments of Mode 2 research require markedly broader, more intangible and locally negotiated criteria, directed at the specific objective of the research and the individual preconditions for conducting research".

Bibliometric databases

Weaknesses of bibliometric databases are widely known (Seglen 1997; Cameron 2005; Reedijk 1998; Harzing and Van der Waal 2008a). There is a substantial body of academic literature stretching back several years that outlines several points of criticism and inadequacy of citational indicators alone, based on these databases (see eg MacRoberst and MacRoberts 1989; Seglen 1997; van Raan 2000).

- They are dominated by English language publications and authors, compared to other languages in general and to a large number of minority languages in particular. This produces a North American bias
- There is also a developed country bias, since most journal editors are from richer countries
- They handle much science and technology fairly well but do not do so well in covering other fields
  - Much of engineering communicates through conferences, which are not necessarily included in the databases and which have varying peer review standards
  - The humanities and many social sciences tend to publish to a greater extent in books and monographs, which are poorly covered by the databases
  - Some fields are in part shifting towards publication through electronic social media, rather than using traditional forms
- More broadly, publication traditions vary among disciplines, so that one discipline or sub-discipline cannot be compared with another. Bibliometricians cope with this through a variety of 'field normalisation' techniques, of varying degrees of ruggedness
- The number of people researching in different fields also varies, so raw citation numbers are poor guides to the influence of a publication and have to be considered in context

- Subject-specific limitations, including for instance poor aggregation of citations and minor variations of the same title in the Web of Knowledge Social Science Citation Index
- As bibliometric data become increasingly accessible, they are also increasingly used by people with little technical understanding of their strengths and limitations, so some uses of bibliometrics are misleading or misguided

One consequence of language and discipline bias in commercial bibliometric databases is that smaller countries such as Norway, Denmark and the Czech Republic have set up their own national publication databases for us in their PRFSs. These typically include national journals and forms of publication not necessarily admitted to the international databases.

Also the use of *citation data* is highly criticised in the academic community. Experts involved in a 2010 OECD workshop (OECD 2010a) highlighted, "Citation counts may relate as much to communication structures and professional networks as to quality, and deriving and interpreting citation data raises technical challenges".

The abuse of Journal Impact Factors, i.e. the average number of citations received by articles in a journal within a given time window, is a problem that is strongly felt in the research communities. Journal Impact Factors are often misused in research management and evaluation, as if they indicate the quality of particular articles or authors. The *San Francisco Declaration on Research Assessment*[1] of 2012 is a statement of opposition to such malpractices from the academic community.

Google Scholar

Measurements of academic impact based on citations have so far usually drawn on either Scopus, or more often on ISI Web of Knowledge as the data source. These are non-open access sources with relatively transparent algorithms geared in part towards the task of research evaluation.

Within the wider debate over the use and abuse of citational indicators and impact factors, there is therefore also the issue of which source citational indicators should be based on. As the largest available source with the additional distinction of being fully publicly accessible, Google Scholar has been viewed as a potential alternative, with several studies conducted to assess its comparative advantages as a data source for research evaluation. In relation to the <u>web-based publications databases</u> such as Google Scholar, Lepori and colleagues highlight that the usability of web-based publications databases for bibliometric analyses is often contested, as the procedures to include publications and citations are not public and the quality of data seems rather poor (Lepori et al 2008). However, in terms of coverage, Google Scholar has been shown to be superior to Web of Knowledge in all but a handful of disciplines (Sanderson 2008; Kousha and Thelwall 2007; 2008), thus substantiating the conclusion made by van der Waal and Harzing that Google Scholar is an alternative to Web of Knowledge worthwhile considering, particularly in those disciplines where coverage is considerably broader (2008b).

The most immediate effect of this is that sample studies conducted to determine impact factors based on Google Scholar have generally resulted in considerably higher values in comparison to equivalents based on Web of Knowledge. In part, this is genuinely attributable to the broader coverage. However, Google scholar also includes non-academic citations, resulting in a certain degree of blurring between academic and non-academic impact. Many writers regard this as an inherent flaw in Scholar Google. Whether or not this is viewed as a disadvantage is of course dependent on whether research

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[1] http://www.ascb.org/dora/

evaluations seek to have an exclusive focus on academic impact, or whether an understanding of wider research impact is sought.

Other, more unambiguously problematic elements of Google Scholar are double counting of citations, less frequent updating, uneven coverage across disciplines and less comprehensive coverage of older publications/citations (Harzing and van der Waal 2008b) and inability to filter out self-citations (Couto, Pesquita, Grego, & Veríssimo, 2009). Some of these may well be temporary issues that are easily solvable from a technical point of view. At the very least, these considerations highlight that the choice of source for impact factor measurement is hugely significant. Whether or not Google Scholar can genuinely be deemed superior to Web of Knowledge is, as shown, dependent on what exactly the impact factor will in turn be used for, and is furthermore discipline-specific in light of the differences in discipline coverage, which ranges from far superior in the social sciences to slightly inferior in a handful of hard science disciplines (ibid).

Altmetrics

'Altmetrics' – i.e. devising alternative or supplementary sets of metrics to the traditional bibliometric indicators to 'measure' research dissemination, visibility and impacts – is generating increasing attention. It has its own manifesto on the Web (www.altmetrics.org) and a significant number of research articles in the subject are hosted in the Altmetric Collection of the PLOS open-access journal at www.plos.org. Objects of study in altmetrics are continuously expanding, but include

- Social media like Twitter and Facebook
- Online reference managers like CiteULike, Zotero, and Mendeley
- Collaborative encyclopedias like Wikipedia
- Blogs, both scholarly and general audience
- Scholarly social networks, like Research-Gate or Academia.edu
- Conference organization sites like Lanyrd.com(Priem, Groth, & Taborelli, The Altmetrics Collection, 2012)

While the use of indicators for social media is relatively well established in advertising and marketing, now organisations like Altmetrics.com are starting to collect altmetrics on a commercial basis in relation to research publications. For research measurement purposes, relatively little is known about what individual altmetrics **mean**. CWTS at Leiden is among the pioneers trying to compare certain altmetrics with conventional bibliometric indicators and found that while the visibility of scientific publications via altmetrics ir growing very rapidly from a small base, there is little correlation between altmetrics and citation. Twitter and blog mentions have some weak correlation with citation rates while other altmetrics have as good as none (Costas, Zahedi, & Wouters, 2014) (Torres-Salinas, Cabezas-Clavio, & Jiménez-Contreras, 2013) Another issue is the **persistence** of the things measured by altmetrics. In the mainstream bibliometric databases, for example, a citation is for ever – while a Tweet is inherently part of a shorter-term discussion using a channel that may itself not persiste for an indefinite amount of time. For the moment we lack **theory** about the respective roles of publication, citation and the activities measured by altmetrics. We do not really know what we are measuring. This appears to provide a rich set of opportunities for research and further understanding – though we are probably some time away from being able to think in a precise way about concepts such as a 'field-normalised tweet'.

For the time being, it is clear that altmetrics do not provide alternatives to established bibliometric measures. Viewed as complements, however, they can tell us a lot about the sociology of knowledge production and dissemination – and they may be especially interesting in the field of understanding in more nuanced ways the nature and scope of impacts within research communities and with the 'users' of research. In the meantime, the significant problems of 'noise' in the data and the ease with which certain social media communication indicators can be 'gamed' coupled to the immaturity of the

field (Priem, Piwowar, & Hemminger, Altmetrics in the Wild: Using Social Media to Explore Scholarly Impact, 2012) suggest that altmetrics will complement rather than replace existing indicators.

3.2.2   Research information systems

Research information systems collect and aggregate data at the institutional, national, and international level. In most cases, they provide *descriptors* on inputs and outputs of research (the latter most often at the individual level) that allow for the development of *statistics*, i.e. numerical data related to an aggregate of individuals.

A Current Research Information System, commonly known as "CRIS", is any information tool dedicated to providing access to, and disseminating research information. A CRIS usually consists of a data model that describes the objects of interest to R&D and a tool or set of tools to manage the data.

CRIS systems have to satisfy multiple needs and stakeholder groups, so formalised and extensible standards to organise and access information are key to this effect. The European standard CERIF - Common European Research Information Format for Common Research and Information Systems fulfils this function in Europe (see also Chapter 5.1, below).

CERIF can be used in various ways. It can be used as:

- A model for implementation of a standalone CRIS that is ready for interoperation
- A model to define wrappers around legacy non-CERIF systems with the objective to allow homogeneous access to heterogeneous databases, thus acting as a middle-layer for different systems
- A definition of a data exchange format creating a common data warehouse from several CRIS.

User groups have different demands on CRIS systems. On the one hand, at the institutional level CRIS systems are regarded as a tool for policy-making, evaluation of research based on outputs, a way to document research activities and output, a formal log of research in progress and a way to assist project planning. At an individual level, a CRIS system might be used to evaluate opportunities for research funding, avoid duplication of research activity, analyse research trends (locally, regionally and internationally), find references and links to full text publications, locate new contacts and networks and identify new markets for the products of research.

CRIS systems assist users in their recording, reporting and decision-making concerning the research process. Stakeholder groups that use such systems include political decision-makers, funding organisations, entrepreneurs, researchers, innovators and even the media and the general public. The use cases of a CRIS range from developing programmes, allocating funding, assessing projects, executing projects, generating results, assessing results or transferring technology.

Relatively recent technological developments in the field of IT allow for a seamless interlinking of research information systems, overcoming aspects of interoperability among the different systems. In recent years an increasing number of initiatives have been launched in Europe that interlink research information and management systems, publication databases and (national) research evaluation datasets. Some of these initiatives integrate or interlink institutional or public agency information systems, eventually creating national information systems. The majority are initiatives that interlink research information systems with open access repositories. The common denominator for all these initiatives is the objective to *improve the availability of information* on research and its outputs (see also Chapter 3.3.2). They are therefore directly to be set against the context of the Open Data policies.

CERIF is currently used in more than about 200 institutional, disciplinary and national systems across Europe. The European Commission OpenAIRE Open Access Repository is CERIF-compliant (Case 1) as is the management system developed for the European Research Council – ERC (see Case 2 in Chapter 3.3.1, below).

Major commercial offers of CERIF-compatible CRIS are PURE, developed by Atira; CONVERIS, developed by Avedas; and Symplectic Elements.

Case 1 The OpenAire project (2013)

The European Commission has funded a series of projects aimed at fostering and enabling the development of integrated research information systems under the Research Infrastructures programme. One of them is the **OpenAIRE** project, which developed a research information system at the level of EC-funded research.

It interlinks data on research funding and on publications built upon the funded research, setting up a European integrated network of Open Access Repositories. Data on the EU funded projects are provided by the EC and are directly retrieved from the EC Cordis database. Data on peer-reviewed publications can be inserted by the researchers or harvested directly from external open access repositories, institutional or subject-based. The infrastructure entails a network of repositories with helpdesks functioning in 38 organisations operating in the different member states, in addition to an overarching electronic infrastructure.

The OpenAIRE Information Space portal enables users to search, browse and often access publications and project metadata on OpenAIRE and on other national, thematic and institutional repositories. For accessible publications, OpenAIRE displays metrics based on usage, besides traditional citation metrics.

The project was launched in December 2010 with participation from almost all European Union member states (but Luxembourg) and Norway. The ultimate long-term aim is to go beyond EC funding-related data and act as a European scientific information system.

The unique identification of researchers and publications is clearly a major issue for OpenAIRE, which deals with different repositories. The OpenAIRE approach is to use multiple IDs for researchers and publications. ORCID is one of the multiple IDs used for researchers, while publications' IDs are those used by the different repositories, plus the DOI identified by the bibliometric databases. The OpenAIRE data model is able to support multiple ID schemes at the same time.

3.2.3 Open Access Repositories & the economics of knowledge and research

Efforts to make academic research results widely available via the Internet have been growing in intensity since the early 1990s, when the power of the Internet to extend the existing practice of circulating draft results and scientific articles became clear. In earlier times, social networks as well as communications technology limitations tended to reinforce the creation of "invisible colleges" (Price, 1963). These were (and are) difficult 'clubs' of leading researchers that are difficult to enter. Those outside the charmed circle found themselves constantly behind the frontier, in part because they could not access work that had yet to be published. The pioneers of the open access movement saw the potential of the Internet to break this vicious circle, as well as more quickly and more widely to disseminate results.

The seed-crystal that solidified the open access movement in its modern form was the Budapest Open Access Initiative in 2001[2]. This argued that there were two routes to open access: creating reprint repositories, which – copyright issues notwithstanding – would hold and make accessible pre-prints and reprints of articles from peer-reviewed journals; or changing the economics of journals, so that they became freely accessible because the costs of reviewing and publishing articles were paid by a sponsor. By the time of the Initiative, the discussion about open access had moved from the immediate concerns of the research community for better internal communication to a wider, common sense claim, namely that taxpayer-funded research results should be available to the taxpayers who had paid for them – including, but not only, other researchers. The US National Institutes of Health were among the first research funding institutions to promote this idea, which has since been widely taken up and forms one of the key principles of Horizon 2020.

This common sense principle has roots in the economics of knowledge and research. The idea of 'market failure' leading to under-investment in research has been the principal rationale for state funding of R&D (Nelson, 1959) in the post-War period. Of course, governments had been funding research long before the economics profession produced a reason. Arrow is generally credited with describing the three major sources of market failure, which – from a neo-classical perspective – make it useful for government to fund research (Arrow, 1962)

- **Indivisibility**, because of the existence of minimum efficient scale. This applied to knowledge as much as it does to investments more widely
- **Inappropriability** of the profit stream from research, leading to a divergence between public and private returns on investment. This results from two essential (and economically efficient) freedoms that researchers have: namely to publish and to change jobs
- **Uncertainty**, namely divergences in the riskiness of research respectively for private and public actors

In economic terms, knowledge is a 'non-rival' good – meaning that many people can consume it at the same time without it being used up. Knowledge is also 'non-excludable' – it is hard to stop people getting access to it. Non-excludable, non-rival goods are 'public goods'. In economic theory, the results of public sector research are such public goods (though there are also other categories of public goods). The market cannot produce these, so since we need them the state must pay. And the point of the state paying is precisely to make the knowledge produced available to the whole of society. This maximises the spillovers and therefore the returns from society's investment in research. This concept constituted a driver for Europe's Open Data policy, considering open access to research vital for the creation of the knowledge economy (see Chapter 2.1.3, above).

There are at least two obstacles to spillover. One is that while the neoclassical economic model in its simple form assumes that knowledge (information) can be used without incurring costs. In practice, using research results – especially results from basic research – requires significant amounts of skill, knowledge and generally special kinds of investment (Callon, 1994). The second – and the more important from the perspective of this study – is that transferring or disseminating knowledge is not costless. That is especially important in scientific publishing, where peer-review quality-assurance is part of the transfer process.

Despite the fact that the scientific community does a lot of the work associated with editing and peer reviewing journal content without payment, significant costs remain, which create obstacles to dissemination. There is a range of ways to pay these costs

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[2] http://www.budapestopenaccessinitiative.org/read

- Community publishing, where an academic community published the journal without payment; usually there is an element of hidden subsidy by research-performing institutions
- Advertising or sponsorship, which typically works for high-circulation, high-status journals but not for those with small audiences
- Institutional subsidy, but such journals tend to become publication channels for people at the institution and their quality is often called into question
- Through hard-copy sales, which is the predominant model, supplemented by the electronic sale of individual articles
- By imposing article processing charges, so that authors pay to publish rather than readers paying to read
- Modifying the 'hard copy sales' model by bundling together large sets of journals and selling licenses to access collections of journals rather than individual ones

The last decade has seen a considerable consolidation in the commercial research publishing industry, with publishers such as Elsevier and Springer building large portfolios and bundling access by multi-year licences to institutions. This increased market power has been accompanied by real price increases and high margins in parts of the industry (Willinsky, 2009). Growing market power on one side and shrinking library budgets in the financial crisis on the other have only increased the pressures for open access.

The major ways in which open access is being implemented are via repositories on the one hand and by introducing article-processing charges on the other. Under pressure from authors and especially funders, publishers are increasingly tolerant of authors putting papers into repositories in parallel with their being published in the traditional manner through a journal. In many cases, the published version is embargoed for a period, so that it may not appear in a repository until sometime after its publication. Authors may be offered the choice of paying an article processing fee, in which case the article becomes open access on publication, or not paying, in which case the article is available only to journal subscribers for a period. Some funders appear to prefer the repository route, since it imposes no additional costs on them. Publishers appear to favour the subscription/article processing fee route because there is a substantial risk that as the proportion of the literature that is accessible via the repositories increases, the economic viability of the journals is undermined (Bernius, Hanauske, König, & Dugall, 2009). While researchers themselves seem reluctant to pay article processing charges (Solomon & Björk, 2012), they have other incentives to prefer open access publishing – in particular, that tends to encourage a higher volume of citations. Promoting research outputs through social media similarly affects the readership (Allen, Stanton, di Pietro, & Moseley, 2013).

Recent work sampling the scientific literature online in order to estimate the proportion of papers now available for free suggests that as much as half of the Scopus-listed articles published in 2008 could be read without payment by 2012. The hard sciences tend to have the highest proportion of open access articles while the humanities, social sciences and engineering have lower proportions. While historically repository-based articles have dominated, the share of articles available for free from the date of publication is growing quickly (Archambault, Amyot, Deschamps, Nicol, Rebout, & Roberge, 2013). The authors claim that open access has reached a 'tipping point', with the implication that academic publishing business models may now change rapidly.

Major publishing houses have already reacted to this possibility. In particular, Thomson-Reuters and Elsevier – who dominate the bibliometric database markets – have aggressively been diversifying their businesses into research information systems and open access repositories as well as increasing their product and service offerings for research managers. These services not only encompass the use of bibliometrics in gaining scientific intelligence and monitoring competitors – well-established industrial uses – but also increasingly helping university research managers monitor institutional and individual researcher performance with the aim of improving institutional rankings and maximising income from performance-based research funding systems.

The recent inclusion of the PURE research information system in Elsevier's SciVal services (2012) and of the COVERIS one in Thomson Reuter's InCites solution (2013), in both cases by means of acquisition of the production companies, needs to be set in this context. Another illustration is Elsevier's Snowball Metrics project, developing a system allowing for institutional benchmarking – see Case 11 in Chapter 3.3.3, below).

The understandable efforts of the traditional publishing and bibliometrics industry to protect its business by moving into these new areas means that control of RIS, repositories and the analysis that can be done based on these is contested. It is not clear that a completely business-driven outcome would serve the interests of researchers, funders or policymakers.

3.3   Current approaches to research performance assessments

This chapter sets out to describe the patterns and trends that we identified in the research performance assessment practice at the different hierarchical levels as well as countries. In the context of this study it serves to identify current strengths and weaknesses of the different models, with a particular attention to the approach taken at the national levels in Europe. It is based upon an in-depth analysis and a set of case studies, reported in our deliverables as mentioned in the Introduction to this report.

We have structured this chapter reflecting the hierarchical levels in the research system, covering in each section both the approach the models and methods for the assessment exercise and the use of research information systems.

We first cover the research performance assessment at the European level and then look into the approach taken at the national and the institutional levels. In each of these sections, we look into objectives and expected results, methods and indicators used, trends, benefits and challenges. Wherever relevant, we illustrate concepts or statements by means of concrete cases.

3.3.1   Research performance assessment at the European level

Research and innovation data collections at the European level have a triple function:

- They are to provide information and tools for the comparison and benchmarking of European research performance at a worldwide level
- They should inform the formulation of European policies and allow for its monitoring
- They are to provide strategic information for the definition and monitoring of research policy interventions at the European level, satisfying the need for accountability of the European Commission (EC)

The information collected is to provide a view on the performance of the European research and information system as well as support the assessment of the effects of European research policies and programmes. In the context of the ERA, a specific objective is in the field of the assessment of policy consistency in Europe (Exhibit 7).

Exhibit 7 Tools and objectives for data collection at the European level

	Performance of the European research system	Performance of the EU innovation system	Implementation & effects of EU policies	Effects of EC policies and programmes
Census / statistical surveys	√	√	√	√
External databases	√	√		√
Ad-hoc evidence collection	√	√	√	√
Research information systems				√

Notes: Sources of major importance for the different objectives are highlighted in orange

The picture emerging from the analyses conducted in this study is one of strong reliance on census and statistical surveys for the collection of the data related to the performance of the European system, complemented by the consultation of external databases such as the bibliometric ones and ad-hoc evidence collections (see also Exhibit 6, above).

National statistical offices, therefore, remain key actors for the collection of strategic information in the European context. They are increasingly charged also with the collection of data on the effects of policies at the micro-level. External experts involved in studies constituted the main source of information in that field, though.

Research information systems are used as sources only in relation to the effects of the EU research programmes.

In the sections below, we further describe the approach to the collection of strategic information on Europe's research performance and the challenges it poses in response to the policy needs. Seeing the importance of the subject in this study, we also cover the - currently limited - use of research information systems at the European level.

Data collection on European research performance

Research and innovation data collections at the international level build upon harmonised surveys, collecting data upon which aggregated indicators are built that allow for the needed comparability of the national data. Regularly updated manuals describe the internationally agreed definitions, classifications for compiling statistics and guidelines for the appropriate use of the indicators.

- The *Frascati Manual* has become the internationally recognised methodology for collecting and using R&D statistics, developing R&D indicators at the macro level
- The *Oslo Manual* is the foremost international source of guidelines for the collection and use of data on innovation
- The "*Patent Statistics Manual*". The latest edition of this manual (2009) provides the guiding principles for the use of patent data in the context of S&T measurement and includes recommendations for the compilation and interpretation of patent indicators
- Interest in indicators of human resources for science and technology (HRST) gave rise to the Canberra Manual.

As a response to the need to revise the indicators used for the collection of data on research and innovation at a European level, the European Commission consulted various expert panels and

working groups, in particular in relation to the European Research Area and the increasing integration of European research. A common concept that underpinned the work of these expert groups was the recognition of the heterogeneity of the research landscape in Europe.

Initiatives to improve the collection of data for indicators that have been launched in recent years at both worldwide and European level, include the global *Careers of Doctorate Holders - CDH* project focusing on the mobility and careers of researchers (Barré et al 2009) and the ongoing work to improve indicators on the *funding of research*, e.g. transnational funding of research and the characterisation of funding portfolios (van Steen 2012). Work on the improvement and expansion of the currently available indicators is ongoing also in relation to the mobility and careers of researchers holding PhD degrees, the funding of research, and more general framework conditions and policy mixes. As the indicators expand and policy makers recognise that innovation is context-dependent, more attention is being given also to the *framework conditions and the policy mix* that help the system to work better (Gault, 2011).

The collection of micro-data and the challenges encountered

In Chapter 3.1.3, above, we reported on the need for European data at the micro-level in order to satisfy the requirements for strategic information in the current European policy context.

Responding to these needs, the European Commission has funded various initiatives. Examples are the Industrial R&D Investment Scoreboard, the European Public Sector Innovation Scoreboard, the INNO policy trend chart collects information on policy measures and, together with data from ERAWATCH, since 2007 feeds into the European inventory of R&D policy measures, the Eco-Innovation Observatory (2010-12) implemented by DG Environment in the framework of the CIP's Europe Innova initiative, and the Cluster Observatory and the KETS Observatory, implemented by DG Enterprise. Many other studies have been funded in various Directorate Generals of the European Commission, aimed at covering perceived evidence collection gaps related to specific topics such as international collaborations for research.

The impression arising is that these efforts by the Commission are highly fragmented and an overall coordination seems to be lacking, with the risk of overlaps and duplications and an overall lack of efficiency. Some of the datasets resulting from these efforts are also fit for monitoring purposes only to a certain extent: the recent study setting the baseline for the ERA completion monitoring (Dinges 2013) pointed out that at times, assessments based on secondary sources are not standardised enough to provide the same level of information for all countries; an example of such an assessment is ERAWATCH.

Typically, sources for information in these studies are surveys implemented by the National Statistical Offices and/or the work of external experts.

Two studies that took a different approach were the EUMIDA feasibility study, looking into the possibility to collect micro-data on Higher Education Institutions at European level directly from the research institutions themselves (DG Research 2010b), and the JOREP project, focusing on the characteristics of Joint and Open Research Programmes and collecting information at programme-level from the funding agencies (Reale 2013).

Common issues that these two studies encountered were related to the *availability*, *comparability* and *confidentiality* of data. Specifically in relation to data availability and comparability:

- In both studies, issues related to availability and comparability particularly affected the *financial data*: in the case of EUMIDA the breakdown of the HEIs' expenditures as well as the breakdown of their funding sources

- Most problematic was data availability on activities where the *private sector* was involved - directly or indirectly: in the EUMIDA project collecting data on HEIs' 'innovation-related' activities,

private funding for R&D (contract research) and in particular data on private funding, patents and spin-offs were hard to obtain. In the JOREP project, few data on the loan repayments from private performers were available

- Major issues for comparability regarded the lack of common methodologies for data collection and common categorisations of the activities, as well as different recording of the data – influenced by the actors' needs. The JOREP project highlighted the high heterogeneity of funding configurations at national level, and the increasing importance of local funding agencies (at sub-national level), as two critical issues in this regard.

In both projects, it was felt that a critical step for the collection of micro-data at the European level was the definition of *conceptual frameworks* and *common methodologies for data collection.*

Also the study setting the baseline for the European Commission ERA monitoring mechanism (Dinges 2013), aiming at the completion of the ERA in 2014 (EC 2012a), reported on challenges regarding data availability for the collection of information for some specific indicators and sub-indicators:

Exhibit 8 Data availability for ERA monitoring

Data categories	Indicators
Quantitative information in fields where robust statistics do not exist	• Share of Institutional funding allocated on a competitive basis • Share of non-national researchers accessing RI of European Interest • Share of researchers who feel that recruitment procedures are transparent, merit-based and open • Share of women in assessment panels in funding agencies • Share of higher education institutions and public research organisations with rules and practices with regard to the female representation in recruitment, career progression
Lack of information / secondary source in a new field	Degree of implementation of Member States strategies for achieving electronic identity for researchers giving transnational access to digital research

Source: Analysis of the ERA state-of-play in Member States and Associated Countries: focus on priority areas - Final Report, 2013

The use of research information systems

At the time of this report writing, the use of research information systems by the European Commission in fields related to research performance assessments focuses exclusively on initiatives related to EC-funded research and its assessment: the OpenAire initiative, establishing a platform for information on research publications and the underlying datasets (see Case 1 in Chapter 3.2.2, above), and the Research Information System, developed by the executive agency of the European Research Council (Case 2, below).

It should be mentioned, though, that in the context of its policy initiative for Open Public Data, the European Commission has started operating a portal that will make the Commission's own data resources and those of other European institutions and agencies easily accessible and usable. This includes data on its research funding, European patent data etc. The Commission has also worked together with Member States, public sector has started operating in 2013. This pan-European portal will give direct access to a range of datasets from across the EU, including the data available through

the Commission portal. The initiative foresees also the interlinking of these data sets, setting the basis for a European Public Data information system.

Case 2 The ERC research information system (2013)

The long-term goal for the CERIF-compatible **ERC information system** is systematically to collect and link all the relevant data needed for the analysis of the impact of the Council's activities against various criteria. The system is primarily intended for monitoring and evaluation. Ensuring that it is sufficiently developed and works well internally for these purposes is the first priority of the ERC. It is planned that some of the information will be made available to the public.

Currently, the system focuses on the coverage of ERC funded activities. It collects information against four main categories of information: "Projects", "Results of projects", "Quality and impact of results" and "Information to the general public". The information on the projects includes data such as the abstract, the research field and the start and end dates, as well as all the related funding information. The "Projects" data is then complemented with the people and organisations involved. Then, the "Results of the project" entity documents the publications and patent applications that are direct consequences of a project (during the first implementation of the system only journal articles, conference proceedings and monographs are included). In addition, a "Quality and impact of results" entity provides traditional citation and journal-based metrics, as well as other qualitative information on the advances of the project results. Finally, "Information for the general public" includes anything that can give an idea of the relative importance of the results achieved in a project to a non-initiated audience.

For the information on projects, the system makes use of the ERC operational database. For the results of the projects the data on publications and conference proceedings is collected from both free services, such as PubMed or ArXIV (in implementation), as well as from commercial databases such as Scopus and the Web of Sciences. Besides these sources of information, the CRIS of the ERC is said to be extensible to other types of results and data sources in order to provide for the future. For example, the link to OpenAire is not yet implemented but it is a trivial connection to make once the DOI of all the publications are known. All this data is harvested automatically and the system integrates it with the final reports of the funded projects.

Drivers for the development were, on the one hand, budgetary pressures due to the recent economic crisis. This led to a need for an improved efficiency in complying with the requirements for accountability, i.e. the reporting on the use of public funding, the evaluation of the research programmes, and information to the general public. On the other hand, there was need for empirically stronger evidence on which to base policy decisions.

3.3.2 Research performance assessment at the national levels

At the national level research performance assessments have a dual function (Exhibit 9):

- The collection of information for the comparison and benchmarking of the national performance at an international level
- The collection of strategic information for the definition and monitoring of research policy strategies and interventions. In an increasing number of countries, this includes information on the performance of the research institutions, defining the allocation of the core institutional funding for research

There is a strong reliance on statistical surveys, external bibliometric databases and ad-hoc evidence collection for strategic information at the national level – similar to the approach at European level

A major difference is in the approach to the monitoring and assessment exercises of the national research policies and programmes. External bibliometric databases still play a dominant role, but there is an increasing use of the information stored in national Open Access Repositories and especially of research information systems. The latter serves in particular the assessment of the research institutions' performance and is closely related to an increased adoption of the performance-based research funding (PRF) model (see also Exhibit 6, above).

Exhibit 9 Tools and objectives for data collection at the national level

	Performance of the national research system	Performance of the national innovation system	Effects of national research policies & policy interventions	Performance of research institutions
Census / statistical surveys	√	√		
External databases	√	√	√	√
Ad-hoc evidence collection	√	√	√	√
Research information systems	√		√	√

Notes: Sources of major importance for the different objectives are highlighted in orange

Research performance assessment at the national level

National policymakers typically rely on the use and analysis of statistics and indicators collected at the international level (OECD or Eurostat) for the analysis of the country's positioning on the international research and innovation scene, in most cases complemented by indicators deriving from data in international bibliometrics and patents databases.

While these data sources give a view on the comparative performance of the national system, their lack of detail limits the possibilities for their use in the context of policy making at the national level.

Evaluations of innovation policies and programmes, for example, typically rely on descriptive statistics, based upon national data on indicators covered by the Frascati and Oslo manuals and complemented with stakeholder surveys and qualitative information deriving from case studies and interviews. A recent ESF-STOA report (ESF and STOA 2012) criticised the availability of evidence on the effects of innovation policy arguing evidence is "generally limited and widely dispersed […], the quality of the studies available is variable and is often lowered by de-contextualisation and by a quantification bias." The report concluded, "Innovation policy is often not really evidence-based, or based on distorted evidence. Available evidence from innovation research is fragmented, of variable quality, and hard to interpret."

Strategic information on which to build national policy making derives from ad-hoc evidence collections at the national level and/or information collected in research evaluation databases, i.e.

information systems often developed for the purpose of guiding research funding allocations (PRF – see also Chapter 2.2.1, above).

In the paragraphs below we first describe the different models used in the countries that were covered in this study. We then look further in-depth into the indicators that have been selected for the assessment of research performance and a major challenge common to all performance assessment models: the data quality.

The analysis in this study showed the <u>strong influence of the national context</u> on the research performance assessment exercises, how they are performed and which indicators are included. We illustrate this further in the paragraphs below.

The choice of model

Research performance assessments in the countries subject to this study differentiate in two major factors: the influence of the assessment on research funding and the choice of the methods used. These factors are interconnected: the level of funding that the assessment exercise governs typically influences also the level of pressure by the research communities for one method rather than another.

The national context is of importance here, including the policy decisions on the level of competition that is required or appropriate for the research system, the strength of the research communities' voice, and the more general culture of transparency and stakeholder consultation for policy decisions.

<u>Influence on research funding</u>

We covered the topic of research funding in the preceding Chapter 2.2.1. In that chapter we also reported that among the 12 countries included in this study, only the Netherlands does not directly link outcomes of the research performance assessment to institutional funding for research. In Belgium (Flanders) and Spain, the outcomes of the assessments govern research funding that is additional to the institutional core ones.

<u>The choice of method</u>

There are 3 different models for the assessment of research performance: purely metrics-based exercises, the involvement of peer review panels, and the mixed model, combining these two approaches.

Exhibit 10 shows that the current trend is towards the adoption of the mixed model.

The Scandinavian countries (with the exception of Denmark), the Czech Republic and Austria rely only on metrics. In this context one should consider, however, that in Finland, Norway and Austria, the evaluations considered here (the PRF systems) are complemented by other evaluations that are normally peer-review based. In Sweden and the Czech Republic, the model is being revised and it will become a mixed model in the years to come.

Exhibit 10 Models for performance assessment (2013)

	Metrics-based	Peer review / panels
Austria - BMWF	√	
Belgium (Fl) - EWI	√	√
Czech Republic – RDI Council	√	
Denmark - FI	√	√
Finland - MINEDU	√	

	Metrics-based	Peer review / panels
France - AERES		√
Italy - ANVUR	√	√
Netherlands – KNAW/NWO/VSNU		√
Norway – RCN	√	
Spain - CNEAI	√	√
Sweden - SRC	√	
UK - HEFCE	√	√

Notes: Models with mixed approaches are highlighted in orange

The choice between metrics or peer review is **contentious**. On the one hand, metrics-based systems typically encounter criticism in the research communities as an inadequate measure for their performance and the assessment of the quality of research (see also Chapter 3.2.1, above). On the other hand, however, peer reviews for nation-wide performance assessments are particularly cost-intensive and are liable to other biases (Martin and Whitley, 2010; Arnold, Good, Ohler, Tiefenthaler, 2012). Even in the context of the mixed model, though, the cost of the exercise – and in particular the cost/benefit balance – is a topic for discussion (Martin, B.R, 2011).

A historical analysis of the PRF systems also shows an ongoing search for the 'perfect' system, with ongoing changes in the models and methods chosen – partly due to pressure from the research communities, partly as a result of developments in the evaluation methodologies and concepts. The case of the PRF in the UK, described below, reflects a situation that can be found in most of the countries.

Case 3 History of the research performance assessment model in the UK (2013)

Public funding for research in English HE is administered under a 'dual support' system: the Higher Education Funding Council for England (HEFCE) provides block grant funding for institutions to support the research infrastructure and enable groundbreaking research in keeping up with their own mission, while the research councils, charities, the EU, and UK government provide grants for specific research projects and programmes (on a competitive basis).

HEFCE is a non-departmental public body, independent of government, but working within a policy framework set by the Secretary of State for Business, Innovation and Skills (BIS). It promotes and funds teaching and research in universities and colleges in England. Its main role is to distribute public money to these Higher Education Institutions (HEIs) in three priority areas: (i) learning, teaching and student choice, (ii) research, and (iii) strengthening links with businesses and the wider community.

The majority of HEFCE's funds for research are distributed on the basis of research quality, taking into account the volume and relative cost of research in different areas. This is called 'mainstream quality-related research funding'. For this reason, HEFCE (together with other UK HE funding bodies) runs a periodic assessment exercise, assessing the quality of research in UK HEIs. Until 2008 this was the Research Assessment Exercise (RAE), but from 2014 it is the Research Excellence Framework (REF). It will be completed for the first time by the end of 2014 and it will be undertaken every five or six years. The RAE model was based on expert-review only; the methodology for REF is based on bibliometric indicators, combined with expert-review. For the first time, the exercise looks also into impacts of research.

The first research performance assessment exercise that was run in the UK with the intent to inform institutional funding allocations was the Research Selectivity Exercise, launched in 1986 by the University Grants Committee (UGC). The method was peer-review, based on a short submission and a number of select 'best' publications per 'unit of analysis'. Fierce criticism to this model led to the launch of the RAE in 1989, which adopted a more rigorous but also more labour-intensive approach.

Ongoing criticisms from the research community led to an ever more refined but also burdensome and cost-intensive approach to the RAE. Estimates are that in the beginning of the 2000s, the total RAE exercise came to a cost of £100 million, including the time devoted by the universities and departments for the preparatory work and the costs of the peer-review panels. A debate started, recognising that the RAE had become too costly and too burdensome. The Treasury proposed to replace the RAE with a metrics-based system. Fierce opposition from the research community led to the final mixed model for the REF.

HEFCE considered that the REF should continue to focus on the most excellent research but in addition should include the quality of this research's contribution to the economy, public policy and the formation of public opinion as well as ensuring that the assessment system made it as easy as possible for researchers to move between universities and the private sector.

This was a clear political signal that the traditional model for assessing research quality based on a discipline-oriented Mode 1 perception of research, first and foremost in the form of publication in international journals, was no longer considered sufficient by the policy-makers. Henceforth, the social role of research, the build-up of strong research environments and the interaction between universities and private research must form part of the quality assessment; all evidence of a wider and more comprehensive conception of research quality than before

Consequently, HEFCE developed a model for a new and more comprehensive form of assessment of what may in total be considered excellent research. The new model is interesting because 'excellent research' is now defined in a broader manner. There are three important dimensions:

1. The quality of the research measured by publications, citations, and peer review;

2. The scope of economic and social influence produced by the research; and

3. An assessment of the quality and sustainability of the unit which has produced the research.

Source: partly based on Martin B.R. (2011) The Research Excellence Framework and the Impact Agenda: Are we creating a Frankenstein monster? Research Evaluation, 20(3), 247-254; and Erik Ernø-Kjølhede, Finn Hansson, Measuring research performance during a changing relationship between science and society, Research Evaluation, 20(2), June 2011, pages 131–143

The choice of indicators

A main factor influencing the choice of indicators for the assessment of research performance is the vision on research and its role in society, and in particular, the concept of the pathways for knowledge creation and innovation. In some countries, the linear model prevails, seeing direct links between the inputs (funding) and **outputs** of research.

In other countries, the concept of an innovation system has gained ground and the dynamics and interactions between the various elements of a research system (actors, context, infrastructures, etc) are considered to be of primary importance. We categorised the indicators used for the monitoring and assessment of these factors under the heading of '**systemic indicators**'. In PRF systems, these indicators have the function of steering research communities into certain changes of behaviour, depending on the national context and the perceived failures in the research system. **Outcome/impact indicators** are seldom included.

Exhibit 11 maps the PRF exercises in the countries covered in this study in terms of indicator categories used (horizontal axis) and the scope of the indicators (vertical axis). On the horizontal axis, the assessment has an increasingly broad coverage from left to right. On the vertical axis, the scope of the indicators increasingly takes into account also the role of research in the 'knowledge economy'.

The Czech Republic is the only country that limits the indicators used to the output of research, even though it is the PRF system that covers research and innovation-related outputs in the most detailed and comprehensive manner.

In a second grouping of countries, the PRFs include both output and systemic indicators; in Denmark, Finland and Norway this includes indicators related to innovation-oriented activities, such as research-industry interactions.

Only a few countries look also into impacts. While the PRFs in France and Belgium focus on effects in the spheres of research and innovation, the models in Italy and the UK consider also societal impacts.

It should be noted that both in Norway and Belgium, the PRF models and indicators used take account of the characteristics of the research conducted.

Exhibit 11 Indicator categories in the PRF models in Europe (2013)
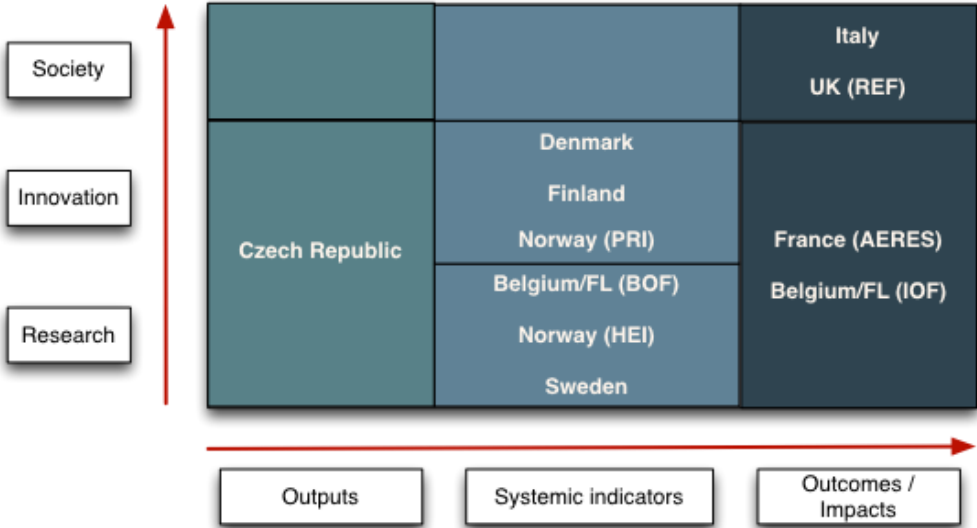
Indicators for the assessment of the quality of research

All assessment models show a strong reliance on bibliometrics as a measure of research quality - be it in the form of metrics or 'informed' peer review.

In several countries, however, the national research performance assessment models experiment with other measures for the **'indirect' assessment of the quality of research** – going beyond the use of bibliometrics and peer reviews. 'Indirect' quality indicators include in particular the amount of external research funding, standing for indications of 'excellence' or 'relevance' or both, and internationalisation indicators (Exhibit 12, below).

Funding agencies attribute a range of values to the data on the "external funding" indicators, predominantly related to the attainment of competitive funding. In some cases these indicators are considered an indication of the research organisations' level of *interaction with their environment* (e.g. research centres, collaborative research funding). When contract research funding is included under this category, it stands for an indication of *the relevance of the research for economic and societal purposes*.

At times, distinction is made between competitive funding from the research council and from the innovation agency.

The importance attributed to <u>internationalisation indicators</u>, grouped as international collaboration and international mobility indicators, is also interesting. In all cases, the value that is attributed to these data relates to the level of integration of the research organisation at the international level, interpreted also as recognition of the *quality of the research* performed by the organisation in the international community and its *level of competitiveness* in the international sphere. The line of thought is that international collaboration improves the quality of research

Exhibit 12 Indicators for the indirect assessment of the quality of research (2013)

	National competitive funding	Contract research	Int'l competitive funding	Int'l cooperation	Int'l mobility
Austria - BMWF	√	√	√		√
Belgium (Fl) - EWI		√	√		
Czech Republic – RDI Council					
Denmark - FI					
Finland - MINEDU	√		√		√
France - AERES		√	√	√	
Italy - ANVUR	√	√	√	√	√
Netherlands – KNAW/NWO/VSNU					
Norway – RCN	√		√	√	
Slovak republic					
Spain - CNEAI					√
Sweden - SRC					
UK - HEFCE					

Comparability of the PRF system outcomes

Specific metrics/indicators used to measure performance within these categories differ and have a **limited level of comparability**: research outputs, external funding, and knowledge transfer to education and industry were the only areas covered by most countries.

Most important, a more in-depth analysis of the research output indicators and what they cover reveals a diversity of output typologies that were included, in particular in relation to publications. The focus on refereed international publications is common to most, indicating the strong reliance on bibliometric databases as sources for assessment (Exhibit 13). However, in several countries also other scientific publications are taken into account.

Exhibit 13 Indicators related to research publications (2013)

	Belgium-Flanders (BOF & IOF)	Czech Republic	Denmark	Finland	Italy / VQR	Norway	Slovak republic	Sweden	UK – REF
Refereed international publications		√	√	√	√	√	√	√	√
Article in impact journals	√	√	√	√	√	√	√	√	√
Article in non-impact journals / international		√	√	√	√	√	√	√	√
Article in non-impact magazine/national		√	√	√			√	√	√
Scientific monographs (books)		√	√	√	√	√	√		√
In English		√	√	√	√	√	√		√
In other languages		√	√	√	√	√	√		√
Conference proceedings		√		√	√		√		
PhD theses			√				√		
Doctoral theses			√				√		
Other scientific publications				√	√		√		

The issue of data quality

A challenge that most of these research performance assessment models are struggling with regards the quality of the data, in particular related to the research outputs.

It led to various measures implemented in the countries covered in order to ensure and enhance the quality of the data entered. Extended control checks have been put in place especially in the Czech Republic and the UK, where the PRF systems attribute high importance to research outputs and more than 50% of the core funding is guided by the PRF model (Exhibit 14).

Exhibit 14 Quality control measures in PRF systems (2013)

Country	Quality control
Austria	Formal quality check and estimate of missing data
Belgium-Flanders	Close collaboration with the institutions (future harvesting)
Czech Republic	Compliance checks, duplication removal
Denmark	Responsibility of the institutions (harvesting)
Finland	Publication Data Collection Manual
France	Direct observation
Italy / VQR	Guaranteed by submitter
Norway	Responsibility of the institutions (harvesting)
Slovak republic	Compliance checks, duplication removal
Sweden	Current problems with quality and sufficient volume of data

Country	Quality control
UK - REF/RAE	Validation rules, REF audit team: Sample-based verification, Data comparisons, Panel instigated audit

The issue of data quality - and the reduction of data submission burden for the researchers and research performing institutions – is directly linked to the process for the data entry into the system. In most countries, this is a manual process, with the researcher or his/her institution inserting data directly on the interface of the research information system collecting the information. The experience is that this system is prone to mistakes, omissions and duplications. It causes a burden on the researchers or institutions required to enter the data as well as on the processing public agency in charge of the cleaning and checking of the data.

This topic constituted a major driver for the development of national research information systems, foreseeing a direct harvesting of the data from the institutional information systems and/or Open Access Repositories and therefore creating a higher level of efficiency as well as ensuring data quality.

We cover this topic further in the next paragraph.

The national research information systems

In Europe and at international levels, an increasing number of initiatives have been launched in recent years developing national research information systems (RIS). These information systems can take two forms:

- Research information systems set up by *funding agencies,* typically geared towards collecting information for accountability purposes to the benefit of a specific agency in the country. Examples are the VIPUNEN system created by the Finish Ministry of Education and the UK ROS system, capturing data for most of the UK Research Councils (see Case 5, below)

- *Fully national research information systems*, capturing information on all research and its outputs/impacts in the country from a variety of sources. These RIS are often intended to act as platforms for the creation of visibility on outputs and outcomes in society. Examples are the FRIS system in the Flanders/Belgium (Case 7, below) and the CRIStin in Norway (Case 8, below)

The trend is clearly towards the creation of **fully national research information systems**. Exhibit 15, below, maps the current developments in this context. Based upon current information, in the EU member states only Germany, Austria and 2 of the 3 Baltic States do not consider (yet) developing a fully national research information system.

All of these current and planned national research information systems are CERIF-compliant, and therefore interoperable – with the exception of the one in the Czech Republic. In several cases, the development of the CRIS at the national level was facilitated by the already existing level of interoperability between systems at institutional level; the same was true for the integration of the systems at the level of the agencies. Examples are the Netherlands, Belgium, and Norway; also the new Danish national system will build upon the institutional systems in the country, all CERIF compatible.

In most cases, information is collected at the individual researcher level, using national systems for the identification of the researchers – even though increasingly ORCID is used (see also Chapter 5.1, below).

Exhibit 15 Fully national research information systems in the European member states
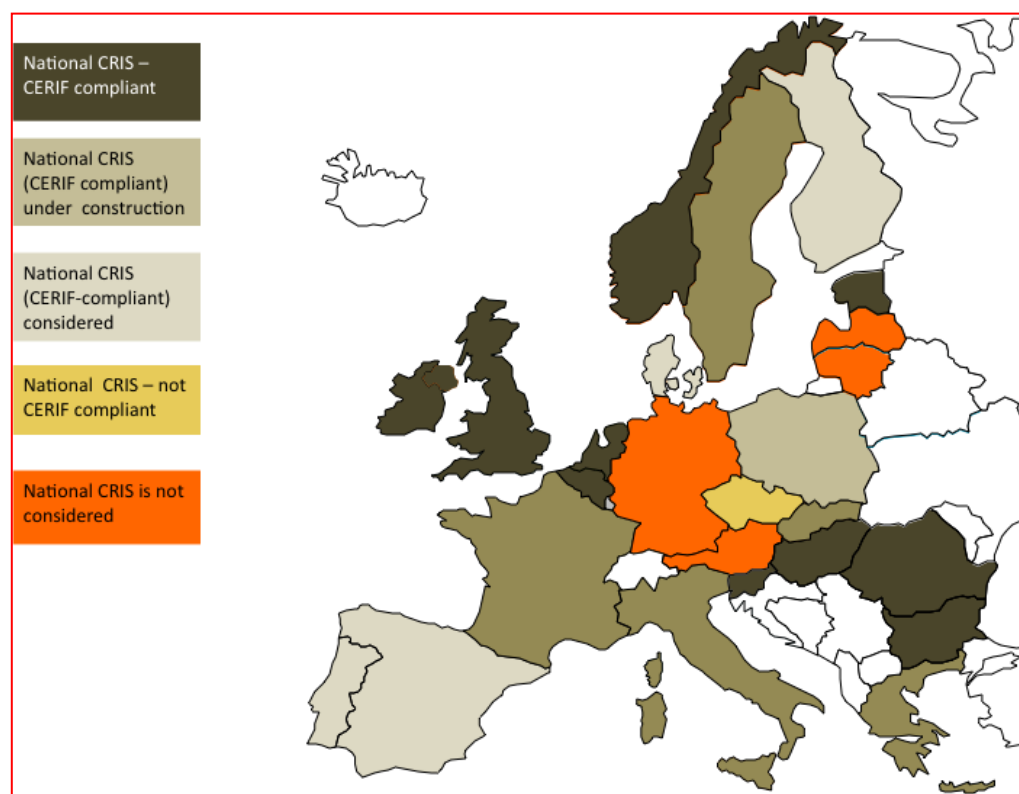
In the sections below, we cover some of the most relevant features of the national information systems in the context of this study, i.e. their use, objectives and expected benefits; the indicators against which information is collected; and the challenges that were encountered for their development and management.

Objectives and benefits

Typically, national information systems have both a strategic and operational function. A critical and typical feature of these systems is that **mutual benefits** are sought for both the research governance agencies and the research institutions and individual researchers, in an attempt to create a win-win situation and ensure the cc-operation in and acceptance of the initiative by the research communities. Such co-operation was considered a key factor for success of the initiative in several countries.

The systems are intended to provide access to information that may support strategy development to the benefit of both research institutions and policy-makers – at a broader and more detailed level than was previously the case, and especially of higher quality. Contemporaneously, they are expected to create efficiency gains in the reporting and collection of data.

An additional benefit for the national agencies is the collection of information for the allocation of institutional core funding (PRF); additional benefits for research communities are services that allow re-use of the data, e.g. in grant applications, direct access to repositories, once-only input of data thanks to linkages with eCV databases, etc.

Exhibit 16 shows that an enhanced efficiency and support for strategy development were key objectives for close to all systems. Only in half of the cases, the data collected inform also the PRF system. In Belgium, the Netherlands and Norway the RIS is intended as a portal that provides information also to the non-research community; in the UK the ROS inputs its information into the national research information portal, Gateway to Research.

The special characteristics of the Swedish system should be noted, rooted in its origins as a national system developed by the research institutions themselves, taken over only recently by the research funding agency.

Exhibit 16 Objectives of the national research information systems (2013)

	Belgium (Flanders)	Czech Republic	Finland	Netherlands	Norway	Slovak republic	Sweden	UK
Policy makers & funding agencies								
Efficiency in data collection	■			■	■			■
Strategy development	■		■	■	■		■	■
Allocation of core funding		■	■		■	■		
Research institutions & researchers								
Efficiency in reporting	■			■	■		■	■
Strategy development	■		■	■	■		■	■
Services to researchers	■		■	■	■		■	■
General public								
One-stop shop for information	■			■	■			▨

Note: Fully national research information systems are written in bold

As mentioned above, most of the systems attribute high importance also to providing services and information opportunities to the research communities. Exceptions to the rule are the RIS in the Czech Republic, the Slovak Republic and Finland (Exhibit 16, above). Reasons can be found in the characteristics of the RIS in Finland, intended as a research funding agency system rather than as a full international system; in the Czech and Slovak Republic, the original intent of the system was to act as a control tool rather than information one.

In the paragraphs below we describe the specific benefits that occurred – or are expected – from the adoption and use of a national RIS, for all stakeholder communities.

Case 4, below, reports on the outcomes of a survey conducted among the research communities in the UK on the benefits of an improved interoperability among and between the information systems at the different levels in the research system. It confirms the substantial benefits and importance of the national research information systems also for the research communities, in terms of efficiency and strategy development and the opportunities provided by an improved communication on research.

Case 4 Benefits of a standardised communication protocol at a national level – the viewpoint of the research communities in the UK

As part of its strand of work in Research Information Management, JISC funded a project in 2009 called Exchanging Research Information UK (EXRI-UK) to examine how research information is exchanged in the UK and to consider how those exchanges could be standardised and improved. One of the main outputs of the EXRI-UK project was the identification by the different stakeholder groups of a common set benefits and barriers.

Researchers and their institutions identified **benefits** of an improved research information exchange within and among research information systems at the different hierarchical levels in the UK in particular in terms of efficiency gains and a maximisation of the use of information on research. The former included cost savings for reporting requirements, including the internal institutional ones. Benefits seen in terms of the usage of data on research related to an improved strategy development at all levels, including individual researchers, but also an enhanced communication to the external environment – both in terms of the general public and at international levels, and the benefits that can derive from it for the research communities and the research governance institutions. Topics listed were: an improved information exchange across the research lifecycle; improved evidence-based decision-making at HEI, funder and national levels; wider opportunities for like-for-like data comparison at greater levels of granularity, improving benchmarking in the UK, EU and more widely internationally; more open access by third parties, the public and researchers; an improved understanding of research by the general public; increased promotion opportunities for UK research online, enhancing the profile of research projects, HEIs, Funding Councils and the UK government on an international scale; more consistent provision of research and funding opportunities to researchers.

Last but not least enhanced Virtual Research Environments (VREs) via standardised exchanges of information to support research collaborations and knowledge transfer in a more consistent way - within the UK and potentially in Europe and beyond.

An enhanced efficiency

Cost savings occur predominantly thanks to the direct harvesting of information from institutional research systems, in the most advanced systems including automated updates. Currently only a few national systems are sufficiently advanced fully to take advantage of the opportunities offered, though, and even those who have reached a certain level of maturity such as the CRIStin in Norway or the FRIS in the Flanders are still in development. It can be expected, however, that substantial cost savings will be mid-to-long term rather than short-term.

Concrete data on cost savings are therefore not (yet) available, apart of a general indication of time saving for the research institutions by the RCUK, which states, "submitting details to ROS takes 80% less time than previous methods". The Flemish FRIS claims that it enables saving time and resources spent on collecting, managing and transmitting identical information under different formats. The example of the University College Ghent is brought forward, which has built its own web portal based on information automatically provided through FRIS. The university's system is linked to the FRIS, enabling direct harvesting and automated updating, and the university estimates that over five years there will be a return on investment of over 500% in terms of time savings for the university, ensuring a more effective and efficient use of researcher time and science budget.

Improved strategy development

An important driver for the funding agencies was also the desire to improve the availability of information on research outputs, moving away from collecting information only at the termination of

funding agreements and recognising that outputs and outcomes from research often occur some time after funding has ended.

The use of web-based systems, an integration of the research information systems used across funding agencies and research organisations, and improved linkages with other systems and sources of information elsewhere allows for outputs to be reported and captured at any point within the funding agreement and, crucially, beyond.

A national research information system enables reaching a comprehensive view of the research activities and their outputs, at institutional level as well as across institutions and research sectors, providing a more comprehensive view on the research system for the national policy-makers. Gaining access to a larger set of data also allows research institutions to improve their strategic decision-making and/or facilitates benchmarking with other institutions in the country.

Evidence collected during our case studies confirms the significant benefits for the research institutions created by the national research information systems from this perspective. In Norway, these were needs that were explicitly voiced by the research communities; in Sweden, the development of the national CRIS was originally a 'bottom-up' initiative of the research performing organisations themselves, and was only subsequently taken over by the Research Council.

In the UK, the need for integrated research information systems was also set against the context of the increased fragmentation of data and information on research at national and international levels and the increased need for access to such information for reporting and accountability purposes (see Case 10, below)

The power of interlinking systems

The capacity of national research information systems to interlink with other systems that act as additional sources of information is an essential feature for the creation of the benefits mentioned above.

Exhibit 17 depicts the current and future linkages that are foreseen for the national CRIS. It shows the key focus on interlinking with the institutional systems and with systems to the specific interest of the research communities, such as bibliometrics databases and Open Access Repositories.

There is a strong focus on research-related information: only a few systems, especially the more mature ones, have started considering also innovation-related linkages.

This pattern confirms the importance attributed to creating benefits (also) for the research communities. The impression that this is mainly an issue of priority-setting for systems in ongoing development is confirmed by the fact that this limited focus on innovation for the linkages is not reflected in the indicators for which quantitative (and at times qualitative) data are collected – see the next section.

Exhibit 17 Current and future interlinking between National Research Information Systems and external databases/systems

	Belgium (Flanders)	Czech Republic	Finland	Netherlands	Norway	Slovak republic	Sweden	UK - ROS
Research								
Institutional systems	■		■	■	■	■	■	■
Bibliometrics databases	■	■		■				
Open Access Repositories (institutional, national)	■			■	■	■	■	
Innovation								
Other research organisations, e.g. companies	■							
Dtb on other research outputs, e.g. patents					■	■	■	
Funding								
Systems of national research funders		n.a.	n.a.		■	■	■	n.a.
EC funding database, including Structural Funds					■			
Other								
National database on researchers/ CV databases					■	■	■	
National portals for the public	n.a.				n.a.		■	■

Note: Fully national research information systems are written in bold

Case 5 The ROS information system in the UK

In the UK there are currently two online systems for researchers and/or institutions to submit information about their research: the **Research Outcomes Systems** (ROS) and the **ResearchFish** (formerly e-Val) system. The intention is that in the nearby future these two systems will be interlinked.

Five of the seven research councils (AHRC, BBSRC, EPSRC, NERC and ESRC) use the Research Outcomes System (ROS). It collects data on the outputs, outcomes and impacts of research, such as publications, other research outputs such as new materials, exhibitions and websites, staff development, collaborations and partnerships, communication and dissemination activities, and summaries of impact.

The ROS information system is interlinked with various other systems, including institutional repositories and the national research information and evaluation systems. The rule of thumb is that data and information should be uploaded only once, allowing for automatic updates also in connected information systems. The overall objective is to avoid the duplication of efforts and data entry, allowing also for better data quality.

Researchers or institutions can therefore insert the data directly in ROS, but existing information can also be uploaded directly from the institutional information systems. The ROS also takes into account and where possible accommodates the reporting requirements of other bodies such as the Research Excellence Framework (REF). The information that researchers or institutions upload to ROS and/or ResearchFish will also feed into Gateway to Research, the web-based portal that will provide access for the general public to Research Council funded research information and related data.

The goal of the Gateway is to allow the public access to information on the research funded by the UK's Research Councils and in particular information on who, what and where the Research Councils fund and the outcomes and outputs from Research Councils' funding, with direct links to already available open access repositories and/or data catalogues. It will especially target innovation intensive SMEs, who wish to understand the UK research base and it will provide a mechanism for non-researchers to identify potential partners in universities.

Use of the data in the national RIS

In the paragraphs above we have already mentioned the expectations and intended usage of the data collected by the national RIS by the various stakeholders involved.

The case studies conducted in the context of this study give a more detailed view on how the **national policy-makers** make use of the data collected in the national research information systems. We report on two cases: the Norwegian CRIStin and the UK ResearchFish, used by the Medical Research Council (Case 6).

Case 6 Use of the information collected in the national RIS by the policy-makers – Norway and the UK

The direct use of the information collected for policy purposes was a primary objective of the national research information system in **Norway** (CRIStin). Data on research outputs and research collaborations partially guide the allocation of institutional funding for higher education institutions and research institutes in the country (the PBRF system). In Norway, the system therefore provides strategic information to policy-makers for the ongoing monitoring of the value and effects of their decision-making, influencing policies. The data collected informed the policy makers on the positive changes in research publications that resulted from the introduction of the PBRF system. It also drew the attention to the low level of open access that was provided to scientific publications in the country, leading policy-makers to increase their efforts for the implementation of the open access policy.

In **the UK**, the use of the data collected for evaluation and policy-making purposes is a primary objective. Current practice is to ask the researchers to map the "pathways to impact" for their research. The intent is to create a dataset that would enable going beyond the immediate outputs of research and evaluate longer-term impacts. The Medical Research Council (MRC) extensively uses the data it collects in ResearchFisch for evaluation and strategy-building purposes. The MRC uses the data to examine the progress, productivity and quality of the research it funds. In particular data is used at the aggregate level to look at programmes and initiatives. At the project level, achievements and impact summaries allow case studies to be quickly compiled, contributing to the case for additional funding into the research base as well as to reach an enhanced efficiency of the research council in the fulfilment of its tasks.

Indicators used

In Exhibit 18, below, we list the indicators covered in the national CRIS. In this table we list 'input' and 'activity' indicators, i.e. the availability of information on funding, research actors and descriptions of projects and programmes funded. Data on funding is included in most of the systems – directly or indirectly, enabling their full use for state-of-the-art research performance assessments as well as for the collection of strategic information related to the value and outcomes of specific policy interventions. In most cases, data are collected on individual researchers.

Information related to systemic indicators is rarely collected explicitly, in contrast to the databases where information on PRFs and other research assessments is stored. This seems a missed opportunity, as is the lack of data for the process indicators (participation in conferences etc).

Finally, in relation to research outputs and outcomes, data on publications are included in close to all systems; interestingly, there is also a broad coverage of data on innovation-related research outputs, including patents and other innovation artefacts. Data on impacts are rarely collected (see also Appendix B).

In the exhibit below we took account of the current information collected as well as the future intentions, recognising that all of the national RIS are still systems in development. We illustrate the importance of taking future developments into consideration in Case 7, below, describing the FRIS system in the Flanders.

Exhibit 18 Data collected in the national research information systems - current & planned (2013)

	Belgium - Flanders	Czech republic	Finland	Netherlands	Norway	Slovak rep.	Sweden	UK / ROS
INPUT								
Research actors	■			■	■	■	■	■
Research performing institutions	■	■	■	■	■	■	■	■
Data on funding		■	n.a.		■	■		n.a.
ACTIVITY INDICATORS								
R&D projects	■	■		■	■	■	■	■
R&D programmes	■	■		■	■	■		
SYSTEMIC INDICATORS								
Research Infrastructures								
Partnerships								■
PROCESS INDICATORS (conferences etc)	■	■		■	■			
RESEARCH OUTPUTS								
Scientific Publications	■	■	■	■	■	■	■	■
Other scientific output		■		■				■
OTHER OUTPUTS								
Publications intended for professional communities			■	■	■			
Publications intended for the general public			■		■			■
Public artistic and design activities			■		■			■
Audiovisual material, ICT software		■	■		■			
Other innovation-related outputs		■						
Patents and innovation announcements	■	■	■	■	■	■		■
OUTCOMES/IMPACTS								■
Spinoffs (data on)	■				■			
Outgoing mobility								■
Impacts on research								■
Impacts on policy/delivery of public services								■

Note: Fully national research information systems are written in bold

Case 7 The FRIS research information system – Belgium/Flanders

FRIS is a follow-up to the Inventory of Scientific and Technological Research in Flanders (IWETO), which was set up in 1983 as an initiative of VLIR (Flemish University Council) with the aim of developing a "research and innovation clearing house" (Van Grootel and Poort (no date)). IWETO was the first research information system of its kind. However, as time went by, it became outdated and did not meet the standards expected from a modern research information platform. The main issue was the time and resources required for the ad hoc manual collection of information at intervals in Flemish research institutions. The information in IWETO was also limited in terms of scope and quality (core data such as publications, patents and doctorates were not included) and there was limited exchange of information with other information systems (Van Grootel et al 2008).

Needing a new system for managing research information, EWI launched the FRIS programme in 2007, whose objectives are like its predecessor to streamline the R&D value chain by collecting, centralising and giving public access to research information. While IWETO was essentially an operational initiative, FRIS is a more strategic programme with the core objective of managing the changes induced by FRIS in research organisations. FRIS' strategic goal is to create a simple, transparent and open research information space that contributes to the Flemish knowledge based economy and strengthens the international competitive position of Flanders. More specifically, the development of FRIS is based on **three strategic goals**:

- Speeding up the Flemish R&D value chain – by improving information flows and raising the international profile of Flemish research projects and institutions, increasing networking capacities and opportunities to find expertise, and improving and speeding knowledge transfer and exploitation

- Administrative simplification and better customer services (e-government) – by creating a highly efficient data environment, in which all desired information is entered once and can be reused instantly by all competent parties from researchers, universities to EWI, and by simplifying and streamlining the data collection processes to reduce induced administrative costs for institutions and researchers

- More efficient and effective policy-making through monitoring– by enhancing the government's strategic intelligence (e.g. benchmarking with other countries) and increasing the reactivity of the policy domain, by consolidating data to inform strategic orientations and use of resources in scientific institutions, and by enabling citizens to check where public R&D money has been spent.

FRIS is built upon technology developments that now enable the exchange of data between institutions (web services, service oriented architecture), and takes full advantage of the fact that all Flemish universities use the European research information standard CERIF, which makes it easy to collate data from various institutions and exchange data with other CERIF systems.

In contrast to IWETO, FRIS data are collected automatically and only once during the operational processes, which contributes to the better quality and accuracy of information. The process of data is automated and there is no need for a parallel data gathering at regular intervals as was the case with IWETO. This has helped to save costs and made the system of data gathering more efficient, complete and reliable.

FRIS is for use by a wide range of stakeholders:

- **Flemish policy-makers**: FRIS is used to develop information-based policy-making on research and innovation and compare Flemish research and innovation performance internationally. FRIS is a key asset for the monitoring of regional R&D and for a more agile research environment. It provides real-time and accurate data, while most countries across Europe use only retrospective and outdated information. More specifically, FRIS information feeds into answers submitted by

EWI to parliamentary questions, ad hoc analysis, business intelligence tools used by EWI, planning for funding programmes, etc. Subsets of FRIS data can also be supplied on request.

- **Federal policy-makers**: FRIS data are supplied annually to the federal Belgian government for inclusion in the federal RIS, which requires conversion to a different format. Information is used in federal strategic intelligence and reporting on R&D.

- **Research institutions**: organisations are able to generate a wide range of reports thanks to FRIS and this contributes to informing their strategic orientations and their internal use of resources.

- **Researchers**: thanks to FRIS, researchers are working on a single space where they can manage their research inputs and outputs, with benefits such as direct links between the update to their research outputs and central repositories. FRIS can also be used for automatic CVs updates and to generate reports on teams and projects that can then be used on personal, team or project websites.

- **Companies:** FRIS can be used as a tool to find partners for research and innovation projects and gain better access to research information and data. In its next development phase, FRIS will include more services for enterprises.

- **Citizens and media**: with FRIS the general public and media can check where public R&D money has been spent and gain better access to research information.

A new version of FRIS is currently under development and will be launched in 2014. In the new version there will be a real integration of data and output information will be expanded in content (patents, publications, etc.). In addition, the database will include information on a wider range of research units (e.g. companies) and new functionalities for partners search. The new version will also include new services for the identification of individual researchers. To make the service available to anyone, there will not be a common identifier but the service will be based on a range of different attributes used in the different organisations. Last but not least, EWI is planning to purchase a license to provide a regional service on journals and articles metadata. At the time, each research organisation has its own system and a central service will enable significant economies of scale and cost savings.

The challenges encountered

In most cases, the challenges encountered for the development of the research information systems. In most cases, these were not of a technological nature, but were related to the need for time and resources investments, i.e. the elevated costs, and the challenge to reach consensus among the stakeholders involved. There were also some legal issues to be solved, predominantly related to privacy concerns, but in all countries this did not constitute a major hurdle.

The information collected during this study points at different levels of challenges for the different national information systems, suggesting two main influencing factors: the **level of interoperability** between the information systems that were integrated into the national one - and in particular their compliance with the CERIF standard, and whether the national system was intended to substitute the existing systems, thus requiring a **full data aggregation**.

From this perspective we can identify two categories among the national research information systems covered in this study:

- A first group developed the national system by building upon existing CERIF-compliant research information systems; examples are the FRIS in the Flanders (Belgium) and NARCIS in the Netherlands. None of these systems had as objective also to aggregate the data.
- A second group is made out of those national systems that integrated existing not CERIF-compliant information systems such as the CRIStin in Norway, the ROS in the UK and SweCris in

Sweden. In the UK, the system also required the full aggregation in terms of content of the data stored in the systems of the different research councils, foreseeing the future use of one single RIS by all councils (see Case 5, above).

Considerable challenges for the development of the national research information system were reported in particular for the countries in the second group. For all national RIS, however, the involvement and commitment of decision makers at the higher hierarchical levels in the research governance system was of primary importance.

In Norway and the UK, the development of the national RIS posed the following issues:

- Lack of interoperability between the systems
- The need to agree upon, develop and communicate common routines
- The conversion of existing data into the new system's format

In the case of the UK, according to the interviewees, the major tumble stone was the need to reach consensus among the research councils on the *quality, depth, and definitions* of the data to collect. The representatives of the councils had difficulties agreeing on the standard to adopt for research outputs and outcomes.

In Norway, the development of the national system consisted in an integration of existing systems at the national level for the different research communities. In this case, consensus on the features of the integrated information system was reached through stakeholder involvement and careful attention to their needs, as described in Case 8, below.

These national research information systems – and in particular the UK – encountered challenges that are very similar to the ones the US Star Metrics programme was and is tackling. We describe this programme in Case 9, below.

Case 8 The Norwegian national RIS - CRIStin

The Norwegian national research information system **CRIStin** was set up with the primary objective to collect and make information on Norwegian research openly available. The starting point was the need to collect quality data for the calculation of the PBRF criteria, related to higher education institutions and research institutes. The Ministry of Education and Research, responsible for the research system in Norway, considered that for the information system to be sustainable and effective and to guarantee quality data, the system needed to be useful also to the research community and respond also to their needs.

The system covers researchers and research units, projects and research results (publications and research results other than scientific papers, such as conference contributions, scholarly presentations, reports/dissertations, translations, media contributions, artistic or exhibition-related presentations, artistic production, products, information materials and patents), and also has a reporting module. An additional feature that is currently planned relates to the research infrastructures. CRIStin is also to coordinate and promote Open Access development in Norway and act as National point of reference for implementation of EU commission recommendations on Open Access. CRIStin was launched in 2010 and collects information on about 160 institutions. It is based on the European CERIF-standard.

CRIStin builds upon a set of previously existing systems, the major ones being FRIDA and NORA. NORA (Norwegian Open Research Archives) is a service that procures all the Norwegian institutional repositories and open access journals in Norway. FRIDA (Research Results, Information and Documentation of Scientific Activities) was an information system developed for and owned by the main Norwegian universities. The system was developed to document research activities at the individual institutions and was specific to each institution. The institutions shared some code tables, such as the ones for countries and languages, periodicals, publishers and institutions. The back-end

for FRIDA was substituted for CRIStin to achieve a common unified logical database with the aim of simplifying registration for researchers affiliated with several different institutions. The new CRIStin system provides a better overview and presentation of Norwegian research and allows for the analysis of research data at a national level.

CRIStin leads to benefits also for the research community, i.e. less administrative burden thanks to the fact that information (e.g. on publications) needs to be registered only once in the system and data can be re-used by the researchers. It also allows researchers and institutions to look at competitors, collaborators etc. There are significant benefits also from a general efficiency perspective: several local systems could be discontinued and the workload for reporting was reduced thanks to the central access facilities. For policy-makers and the management of the research institutions, the system provides input for strategy development, providing overviews of the information at institutional level as well as across institutions and research sectors. Last but not least, the data quality of the reporting has improved.

The major issues that arose during CRIStin's development phase were the development of common routines, unique identifiers for researchers and the conversion of data from the previous systems, which in some cases implied significant investment of time and resources. Converting data from other systems with less structure and less quality, like the Forskdok system used in the university college sector, proved to be an even more demanding and time-consuming task, as some of the processing had to be done manually, requiring time and dedication at the institutional level.

A major lesson learnt from the transition to CRIStin is the importance of involving the users of the system during the first stages in order to ensure alignment with needs, steeper learning curves and buy-in of the change by the stakeholders affected. There was a strong focus on providing good documentation and description of the routines, processes for reporting information and user manuals. A group of super users of FRIDA made several visits to institutions during the start-up phase in order to provide guidance for the super users at new institutions. This was done in order to provide mentorship and to get in touch with the new user base. The involvement of the FRIDA super users during that phase was considered to be essential for the success of the rapid transition to the new system.

Case 9 The STAR METRICS research information system in the US

STAR METRICS is a multi-agency initiative, currently involving the National Institutes of Health (NIH), the National Science Foundation (NSF), the White House Office of Science and Technology Policy (OSTP), the United States Department of Agriculture (USDA), and the Environmental Protection Agency (EPA). The Department of Energy (DOE) has also signed a memorandum of understanding to participate but is not actively involved at this time.

It is a working initiative of the Science of Science Policy Interagency Group and was developed from a pilot project tested with the Federal Demonstration Partnership in 2009. The Office of Science and Technology Policy NSTC Committee on Science established the Science of Science Policy Interagency Group to develop an evidence-based framework for making policy investments in research and development.

The programme foresees two levels of activities:

- Level I relates to estimating employment resulting from research awards. The objective is to document the levels and trends in the scientific workforce supported by federal funding, thus measuring the *employment impacts* of the federal funding

- Level II is in development and concerns the creation of a multi-agency data infrastructure that will enable the documentation and analysis of inputs, outputs, and outcomes resulting from federal investments in science

Another initiative that will be of benefit to the STAR METRICS programme, with potential integration of the data, is the SciENCV project. This project intends to develop a national CV information system, possibly including publication and patent data.

A longer-term objective of STAR METRICS is to integrate the information collected in Levels I and II with other information systems such as the national datasets on employment and patent databases in order to measure the impact of science investment in four key areas:

- Scientific knowledge (e.g. publications and citations)
- Economic growth (e.g. patents and business start-ups)
- Workforce outcomes (e.g. student mobility into the workforce and employment)
- Social outcomes (e.g. health, environment, energy)

At Level I, the data elements cover expenditures on vendors, subcontractors, and the direct jobs that were created from award overhead funds, as well as data on individual employees supported by the public funding and the nature of the positions that they occupy. The latter are used to generate data on the actual (not estimated) number of individuals and the number of full time equivalent (FTE) jobs paid by grants. The current focus of the STAR METRICS team is on controlling the level of statistical representativeness of the current sample, the validation of the data in terms of the quality of the data submitted (which is beyond the control of the agencies), and the evaluation of the method applied for the job estimate calculations.

At the end of 2012, the programme entered its second phase (Level II), focused on the aggregation of information on public research funding information that is stored in the systems of the participating agencies, i.e. the NIH (National Institutes of Health), the USDA (United States Department of Agriculture), the EPA (Environmental Protection Agency) and the NSF (National Science Foundation). Features that are currently available in the pilot web-based data system concern the <u>basic project details</u> available for downloading. Further steps are the development of the text search facility and congressional district search features, to add information on the project details, and to include further agency information. The pilot version of the STAR METRICS system establishes a unique identifier for the researchers included in the system. However, it allows for multiple identifiers to be linked to the ID, including the ones used in the different agencies, e.g. ORCID.

Challenges encountered

The integration of research information from the various agencies presented some challenges from a <u>non-technical interoperability</u> perspective, in particular in relation to the different nominations of fields, overlapping classifications of disciplines, and different meanings attached to a singular field of research, such as nano-technologies.

The implementation of the <u>'topic modelling'</u> for the aggregated portfolio analyses also presents some issues. The 'topic modelling' software is based upon natural language processing techniques; using this tool for the keyword search in project titles and abstracts, it allows for the identification and clustering of related research and potential overlaps or gaps in research funding – within and across federal funding agency boundaries. While this is potentially a powerful tool for an improved inter-agency portfolio management, it presents some downfalls: manual checking of the outcomes is needed, leading to potentially significant resource investments, the use of keywords is evolving over time, and the difference in grants volume among the agencies implies the risk of out-crowding information on less frequently funded research topics.

From vision to reality: a question of priorities

In April 2012 the goals for the STAR METRICS programme were refined. The programme team took a pragmatic approach, taking into consideration the relatively limited budget for the programme ($1.5m) and its currently envisaged duration (five years, i.e. until 2014). The overall priority for the programme was set on ensuring the quality of the data collected, both for Level I and Level II. For the Level II part, the primary focus is on the collection and integration of the data. In the first instance, this will allow for cross-agency portfolio analyses, improving the portfolio management in the agencies. It is evident that more time and resources will be needed to realise the original vision of the STAR METRICS programme.

Currently, a difference to the originally envisaged STAR METRICS system for Level II is the unit of analysis, focusing on the funded project and the PI rather than the individual researcher. It should also be noted that the 'de-identification' of the individual information in Level I of the programme implies that at this stage, no linkage is possible at the individual level between the two datasets in the programme.

It is also uncertain to what extent the STAR METRICS system will include information on publications and patents. Major issues from this perspective are the *availability* of these data for all co-operating agencies, as well as the *quality* and reliability of these data.

3.3.3   Research information at the institutional level

Research-performing institutions are interested in all four levels of information types shown in Exhibit 6, above, and are building and connecting systems to tackle them.

Research information that is collected and stored at the level of research-performing institutions typically serves two main purposes: to facilitate and coordinate reporting to research funding providers and to support the development of institutional strategies. Exhibit 19, below, shows the predominant use of institutional research information systems for both of these functions, in the form of institutional research information systems and institutional repositories.

Increasing amounts of information about the operation of research projects are being shared by making project-related datasets, intermediate reports and other information available. That helps researchers do research. They are also interested in understanding their institutional performance and the performance of individuals and groups within the organisation, so they are tending to acquire and store information about research and innovation outputs – and to a growing extent also inputs, in order to allow normalised performance comparisons (such as cost to produce a scientific paper). Networks of institutions are forming in order to support these activities and to provide access to comparative data (see Case 11, below).

Exhibit 19 Tools and objectives for data collection at the institutional level

	Research performance	Effects of research	Institutional strategy development	Human Resources management
Census / statistical surveys	√		√	
External databases				
Ad-hoc evidence collection	√	√	√	
Research information systems	√	√	√	√

Notes: Sources of major importance are highlighted in orange

In research institutions, information systems typically have both an operational and strategic function. Information stored in these systems supports the day-to-day administration of research, informs an institution of its performance and competitiveness, fulfilling also the needs of external stakeholders (such as funding agencies) and allows it to take decisions based on that information (Imperial College London 2010). Especially in countries adopting performance-based research funding models, the information stored is most often geared towards satisfying reporting needs. Information is typically collected at the level of the individual researcher.

In most cases, these information systems are developed in isolation and there is little comparability in the data collected, even amongst research institutions in a single country. Also the technical interoperability of these systems is limited: only a few research institutions have developed systems that are compliant with CERIF. These are mostly concentrated in the UK, the Nordic countries, the Netherlands and Belgium.

The challenge that many institutions are currently approaching is therefore to set up meaningful and scalable links between research information systems and other information systems, and among the research information systems themselves, in a national but also international context.

The development of national research information systems constitutes a solution to this challenge (see for example the requests voiced from this perspective in Norway and Sweden).

Case 10, below, sets out the context for the development of institutional research information systems in the UK, the support provided, and an estimate of costs/benefits for the transition of institutional research system to a CERIF-compliant one.

Case 11 illustrates an approach taken by eight universities in the UK for an improved inter-institutional benchmarking of their research performance. Joining forces with Elsevier, they developed a system in the context of the Snowball Metrics programme making use of data in their institutional information system combined with bibliometrics.

Case 10 Policy drivers, support provided and cost/benefits for institutional research information systems in the UK

In the UK – as in most other countries - information about researchers, projects, outputs and funding is currently fragmented. All these data that arise from the management of research and from research itself are spread across different systems and in incompatible formats. We can find information related to research in operational systems inside institutions (human resources, finance, project management, etc.) as well as in external repositories and the different databases of the research funding organisations or the Higher Education Statistics Agency (HESA).

Higher education is undergoing a period of fast and, to an extent, unpredictable change. However, there is a sense of common direction in that the time to lay the foundations for *effective research management* is now. This pushes institutions, especially Universities to consider investments in research information systems, a market that is still not well developed but that it is growing fast. There is an opportunity, as well as a necessity, for institutions to review and consider different options that can help them meet long-term commitments in areas such as strategic management of research (especially mapping and benchmarking), providing funders with information about research outputs and outcomes, and presenting evidence for the research that they carry out, which is a requirement of the REF assessment.

Key actors for the integration and communication between the different systems are:

- JISC (formerly the Joint Information Systems Committee) works on behalf of UK higher education, further education and skills to champion the use of digital technologies. JISC is funded by all the UK post-16 and higher education funding bodies as well as the research councils and employs around 90 people based in Bristol and London. Together with HEFCE and the Research

Councils, JISC funds significant work to help the sector better manage information about research, covering institutional infrastructure (joining up institutional systems), national infrastructure (building services and interoperability to share research information), as well as providing guidance, support and opportunities to share experiences and work together

- UKOLN is a centre of expertise funded by JISC and the University of Bath (where it is based) which advises on digital infrastructure, information policy and data management. The Innovation Support Centre (ISC) at UKOLN is a service that delivers technical development, community support and technical advice to higher and further education. UKOLN and JISC infoNet provide programme support for all of the JISC projects funded as part of the JISC's Research Information Management activity. While JISC primarily focuses on the business requirements, UKOLN does so on data harmonisation needs including the European standards CERIF. UKOLN prepares briefing documents on CERIF, data harmonisation and other matters of interest to the sector. It also helps foster collaboration through focused meetings and workshops

In 2010, the **costs and savings** associated with implementing a common standard for research information exchange were analysed in a report (Bolton 2010) for the JISC Research Information Management Programme. Although it is noted that the needs and starting points are different for every institution, through several plausible assumptions the author arrived at a general expression to estimate the savings that an institution could achieve by transitioning to CERIF compliant systems.

The costs of a CERIF wrapper were estimated at £13,000 per year and the costs for a complete CERIF CRIS were believed to range from £10,450 to £20,880 per year, depending on the size of the institution. Savings were estimated in particular in the field of higher efficiencies in reporting to the REF system and grant applications to the funding agencies. The overall outcome was that the transition could be cost-effective even for small institutions, despite the learning curve and the complexity of using CERIF, which are pointed out as its main drawbacks (Russell 2011b). The break-even point of a big institution using a full CRIS system with no REF submissions (worst case) is just nine annual grant application submissions to the Research Councils.

It should be noted, though, that there is a lack of more up-to-date information on whether the real figures deviate from those estimates and of the present costs and benefits associated.

Case 11 The Snowball Metrics project

Eight UK universities adopted a different approach and defined 'bottom-up' a set of common metrics for research performance management and benchmarking at the institutional level, in collaboration with Elsevier. This work in the Snowball Metrics initiative has served as a basis for the development of a pilot software tool that allows universities to benchmark themselves against peer institutions, with a view to better assess research performance and support strategic decision-making.

The **Snowball Metrics** framework includes *research inputs, process and outputs* and distinguishes between those connected to research grants, postgraduate education and enterprise activities. It further defines a set of *common denominators* that are used both to "slice and dice" the metrics, and to normalise for differences in size across institutions, and through which data can be manipulated and interrogated to inform strategic decision making and cross-institutional benchmarking exercises. The Snowball framework is intended to lend itself to the entire spectrum of a university's research activities, including social sciences, arts and humanities (an area where there is resistance to the uptake of any metrics, due to difference in publications and referencing behaviour and the poor coverage of the major databases (Snowball Team 2011)).

The metrics draw on and combine university, proprietary and third party/ public data, including institutional systems, national statutory reports such as those produced by HESA, Google Scholar, Web of Science (owned by Thomson Reuters), and the Scopus database (owned by Elsevier).

All project partners have access to the benchmarking tool developed by Elsevier. Confidentiality was a major issue for the universities: partner universities share their metrics, but the data behind the metrics were provided to Elsevier as a spreadsheet whose standard format was agreed by each partner university and are not shared among the partnership. In order to ensure confidentiality, this tool ensures that only universities that have provided their own data for a specific metric have access to the same metrics for other universities ("*I'll show you mine if you show me yours*"). Despite these data sharing agreements between Elsevier and the universities, several institutions chose not to link funding data to researchers, while others did not report on commercially sensitive information such as patenting and licensing metrics. The data submitted by universities to Elsevier also includes minimal individual data on academics to enable them to be aggregated into disciplines, but these data are not featured in the benchmarking tool. Data can however be sliced by theme, type of funders, etc and normalised by size of research units, following a set of common denominators that were agreed as part of the project.

The main challenge at the start of the project was for the universities to agree on a set of *common metrics* as well as the *definition* behind the metrics and the related sources of information. Also in the case of Snowball Metrics, investments needed in terms of time and resources were considerable.

Elsevier has included Snowball Metrics in its service package, as part of the Pure CRIS (developed by Atira, which was purchased by Elsevier in 2012). The "Research Intelligence" module will allow universities to assess their progress towards targets that they set themselves. The tool will include eight of the ten Snowball Metrics in the first instance. It does not yet include any benchmarking options but allows universities an internal perspective on their research performance. Future work will ensure that the full complement of Snowball Metrics is available, and that using them for benchmarking is possible.

In addition to the service in the Pure CRIS, Elsevier also offers Snowball Metrics as a commercial service to universities that do not want to use the Recipe Book themselves – in the form of a Custom Report. Ultimately the openness of the Snowball Metrics will allow any data provider to calculate and use them. Another supplier has already adopted it, showing the interest of the supplier community.

3.4 The stakeholders' search for standardisation at the European level

Over the last decade, actors at the various levels of the research systems in Europe have been dedicating efforts into setting the basis for a standardisation at European level of the processes and tools for the collection of data on research and research performance. The ultimate aim of these efforts was to reach comparability of the data collected and the harmonisation of research information systems.

Major actors in this context at the European level are Science Europe and EuroCRIS.

- Science Europe is the association of European Research Funding Organisations - RFO and Research Performing Organisations - RPO, which is a 2011 merging of the European Science Foundation (representing the research communities) and EuroHORCS (representing the funding organisations).

- EuroCRIS is a not-for-profit organisation that is dedicated to the development of Research Information Systems and their interoperability. It currently manages the European standard CERIF and includes among its members the IT specialists in research institutions, funding agencies and research governance organisations from all over Europe and beyond.

An important development of the most recent years is the closer collaboration between these two organisations, more specifically the uptake and further development in the EuroCris of the outcomes from the ESF/EuroHorcs forum on internationalisation indicators.

In the chapters below we give a summary of the activities by these organisations in this context, i.e. the working groups organised by the ESF/EuroHorcs (Chapter 3.4.1) and the focus areas for the work in EuroCRIS (Chapter 3.4.2).

Finally, we mention a recent international forum on the standardisation of research information system, highlighting the interest and need in the communities involved for information transfer and a coordination that would allow for a future integration of the systems (Chapter 3.4.3).

3.4.1   The ESF/EuroHorcs working groups

An important input for this study is the work that has been done throughout the last decade in the joint ESF/euroHORCS member organisation (MO) fora in order to investigate and foster the interoperability and communalities of the research performance systems in Europe. MO Fora are venues for the Member Organisations of the ESF/EuroHORCS to explore and exchange information on specific ideas that are output-oriented, and to develop joint actions in science policy, according to the ESF strategy plan.

The work of these MO Fora needs to be set against the background of the Joint roadmap ESF/euroHORCS and its main objective to reduce fragmentation at an inter-agency level. The Road Map is perceived as an action plan through which the EuroHORCs and ESF Member Organisations can play an active primary role in the construction of the ERA.

The Fora on Evaluation of Publicly Funded Research and the group on Indicators of Internationalisation were the ones with special focus on Research Information Systems. The work of the first forum arrived at a state of the art of how research funders categorise their output data. It had the participation of research funders across Europe as well as some research performing organisations. The second forum set the basis and piloted a set of standard indicators to measure internationalisation, tailored to the needs of research-performing organisations and research funding agencies.

Forum on Evaluation of Publicly Funded Research

The ESF Member Organisation Forum on Evaluation of Publicly Funded Research intended to help implement activities concerning Action 6 of the Road Map (Develop common approaches to ex post evaluation of funding schemes and research programmes). The main objectives were to improve evaluation studies on funding schemes, to learn about best practices of impact assessment of research and research funding and to identify the challenges in conducting transnational comparative evaluation. In order to accomplish this, the forum facilitated networking, exchange and share of information on evaluation studies of funding schemes and practices. An inventory of current and past impact evaluation practices and methodologies across MOs was produced, identifying gaps and lessons learned. The forum also developed an analysis of research portfolios and research output.

In 2012 the Forum published an umbrella document and three working group reports: A Guide to Evaluation Activities in Funding Agencies; The Challenges of Impact Assessment; and Research Funders and Research Output Collection.

The findings of the working group on classification systems and categorisation of output data are of particular interest in the context of this study as they confirm several of the main drivers for the development of national research information systems.

- One of the first key points of this working group's document was the identification of a number of critical data collection processes, in particular those related to the quality assurance and validation of the data provided. The report advised putting in place a sanction and incentive system to users with regard to encouraging submission/collection of output data. We can regard this as an additional confirmation of the challenge that data entry poses to the various information systems.

- The group also recognised the value of direct harvesting and the importance of the information systems' linkages with other databases. It acknowledged that <u>data sourcing</u> from researchers should occur only once, that this data should be re-used where possible and that the rest of the necessary data should be obtained from research organisations or repositories. If data is available in research organisations or repositories it should be sourced from those places with the aim of minimising the administrative burden on the research community.

As for the <u>definition of outputs</u>, the group considered that there was no significant divergence in the information collected in the different countries. They found that in reality, very few funding organisations go beyond the collection of publication data, the main reason being that these data are readily available, thanks in part to publishers. As a result, this is where all organisations start when collecting information on outputs.

The group concluded that research outputs beyond papers and patents should be captured, and undertook the task of categorising and determining a core set of output types for science, technology, engineering and medicine (STEM) subjects. The following output categories were agreed and explored in more depth in some of the subsequent working reports (ESF – No Date):

- Publications (with discussion of issues like access to full texts, lag time, unresolved problems with unique author and institution identifiers, lack of coverage in SSH, etc.)
- Intellectual property and routes to commercialisation (with references to the EU Guidelines on Knowledge Transfer Metrics)
- Products and interventions
- Influence on policy
- Mobility, next destination and training
- Collaboration
- Dissemination of results to non-scientific audiences
- Use of research infrastructures and research resources

Forum on Indicators of Internationalisation

The forum on evaluation policies regarded the topic of indicators as being important enough to have its own group. To this end, the ESF MO Forum on Indicators of Internationalisation was formed in 2010. This MO Forum undertook a pilot study with the aim to design a set of indicators that could account for the internationalisation of European research activities and programmes. These indicators should be useful for <u>benchmarking and policy evaluation</u> and could help Member Organisations relate to each other and to the European Commission as well as to their governments.

The main objective of this forum was to provide a conceptual framework, by involving MOs in a collaborative project to develop indicators for their own needs at the organisational level. The set of indicators to be developed has to be adapted to the different types of MOs, their different missions and domains.

The group also took into account the work and expectations on indicators and internationalisation of the European Commission, since this topic is strongly related to the ERA objectives. As a result, the work of the group will be kept as the background for common actions within the ERA. The action plan of the forum included:

- An analysis of the literature to review current policies and practices in the MOs with respect to internationalisation in view of the ERA ambitions, and to identify best practices on internationalisation indicators
- The design of a common framework for internationalisation of research organisations
- A selection of a set of possible indicators (existing and newly designed) and operational recommendations to develop and maintain them

- A test phase where one or more indicators were collected in a number of selected MOs and at the European level

Main results

The output of the Forum was a set of research internationalisation indicators. To some selected indicators, different alternatives were considered. All indicators were discussed and approved by the experts and the organisations involved. The discussion allowed having a common understanding of the different points of view, based on a bottom-up approach.

The Forum identified indicators for the different activity dimensions in the two stakeholder communities, i.e. the funding agencies and the research performing organisations. As for future work, the Forum aims at expanding the indicators on research infrastructures, which are fundamental for research collaboration.

Another important point is the collection of data and feasibility checks for indicators in the development stage, as well as conceptual work and feasibility studies for the blue-sky indicators. Further, comparability issues and issues of transparency and independence of the data production have not been tackled by the Forum (not even for mature indicators), and require future work by experts and users. With this aim, common definition, classifications and data production methodologies should be defined.

3.4.2 The work in EuroCRIS

EuroCRIS manages the European standard for research information systems CERIF. Its core task is therefore to continue updating the standard in order to ensure ongoing interoperability of the CRIS in Europe.

EuroCRIS has also looked into ensuring **international interoperation**, though. It has set up strategic partnerships with CASRAI in Canada and VIVO in the US. These three organisations work together in order to be interoperable and exploit each other's strengths and are also advocating for standards and unique identifiers. In addition, they are also establishing arrangements for co-operation with the Lattes platform in Brazil.

The collaboration between euroCRIS and VIVO revolves around three aspects (Alpha Galileo 2011):

- Interoperation and convergence of semantics in the two systems
- Interoperation of the systems to allow homogeneous access over heterogeneous research information systems
- Exploring utility of the VIVO user interface for researchers as a 'front-end' to the CERIF research information storage environment

The partnership between euroCRIS and CASRAI also revolves around three main action points (CASRAI 2012):

- euroCRIS endorsing and promoting the CASRAI dictionary as a best practice for international vocabulary harmonisation
- CASRAI endorsing and promoting CERIF-CRIS as a best practice storage model implementation of its dictionary
- Both parties advancing full compatibility between CERIF and CASRAI models

In recent developments, euroCRIS is also trying to develop the CERIF standard so that it can handle better **metrics**. Members of EuroCRIS, predominantly IT specialists employed in national funding agencies, have set up an indicators workgroup, which will take further the work done in the ESF Fora. The expected result is CERIF-compliant software services that allow conducting evaluation of research

including commonly used national or international methods. As an example, the set of indicators proposed by the ESF groups can be expressed in CERIF.

One of the main activities of this working group will be mapping all the indicators used in bibliometrics and scientometrics and describing how they are used around Europe in terms of measuring outputs, outcomes and impacts. At present time, the countries that are more active in the group are the Netherlands, Germany, United Kingdom and Norway.

This euroCRIS group distinguishes between outputs, outcomes and impacts. The outputs are reasonably easy to measure while the outcomes are more complex and involve things like trained personnel, start-up companies, licence income, etc. The impacts come far downstream in most research fields, which is more difficult to track using CERIF-CRIS. However, euroCRIS believes this can be remedied partly by analysing narratives of impact in full text publications and partly by using backward chaining techniques from the newsfeeds. In this context the newsfeeds are seen as a much more interesting tool from the point of view of impact than for outputs.

In this context, EuroCRIS is also co-operating with **Elsevier** and **Thomson Reuters**.

- <u>Elsevier</u> has developed in collaboration with universities' Snowball Metrics, which is a whole range of metrics that can be used for research and characterising research and are agreed with all the stakeholders. Elsevier works with euroCRIS to ensure that these metrics can be implemented using CERIF

- <u>Thomson Reuters</u> is developing a feature called "backward chaining". Typically, to measure impact one starts from the research project and tries to trace what the outcomes from the outputs were and what the impacts from the outcomes were. Thomson is trying to reverse that process by finding new stories on the Reuters' newsfeeds (e.g. "wonderful cancer drug saves 10000 lives") and trace back to the research that caused the impact to occur, using intelligent text analytics.

3.4.3 The International Forum ""Standardisation of Research Information: International Experiences and Insights"

On 27 January 2014, the German Institute for Research Information and Quality Assurance (IFQ) hosted a forum with international experts to discuss perspectives on the implementation of national research information systems. The aim of the forum was to initiate an exchange of experience on the national and international level, sharing expertise in different approaches and strategies for the standardisation and harmonisation of research information. It illustrates the extent to which the more forward-looking organisations in the European research system start taking into account the future exchange of data on research at the international level.

The IFQ set this forum against the background of the high variety of systems – both from the perspective of content and level of sophistication - that research institutions have developed in recent years in Europe, in response to the various internal and external demands for data.

Specifically related to the situation in Germany, the IFQ informed, "The generation of comparable data over large numbers of institutions has become increasingly difficult due to the variety of local research information systems with different content, data definitions, legal standards, technical solutions, data formats, internal functions and data recipients." This situation triggered the launch of a project by the German Council of Science and Humanities in order to develop a standardised approach in the collection of data on research activities.

The project has as objective "to provide the foundations for a quality-assured data exchange between universities or research institutions and recipients of the information in the German research system". It is to identify and specify a future research core dataset, considering also which additional information should be included depending on the requirements on the local or institutional level. The

expectation is that on the basis of such standardised specification, institutions will be able to agree on an efficient process for data collection and storage to reduce the cost of future development and implementation of local research information systems.

The reasons for the organisation of the International Forum were in the consideration that such "research core dataset" was to be based on international standards in order to provide the basis for the future international exchange of research data.

4 THE DESIRABILITY OF A TRANSNATIONAL SYSTEM FOR RESEARCH PERFORMANCE ASSESSMENT

A core objective of this study was to investigate the desirability of a system enabling European-level analysis of research costs, performance and outcomes in order to support the development of research policies.

In this chapter we reach our conclusions based upon the findings of this study reported in the preceding chapters. We first summarise the needs for the different actors in the European research system and the challenges that the current assessment practices pose on them. Second, we consider to what extent a transnational system could respond to those needs and solve the issues the current approaches are struggling with.

4.1 Current needs and challenges

4.1.1 The needs of policy-makers at the European level

Current needs and challenges for the policy-makers at this level of the European research system relate to, on the one hand, the need for improved strategic information on which to base future European policy-making. On the other hand, it is also expected to monitor progress in the Member States in their alignment with and fulfilment of European policies and strategies.

In the context of the developments in the function of evaluation, with an expansion of the actors and needs as well as the breadth and focus of performance assessments in response to the enhanced role of science and research in society, there is an increased need for *data and information at the micro-level* in order to respond to the policy needs for strategic information.

These needs are sharpened also in the context of the current pressure for the effective completion of the European Research Area (ERA) and the increasing attention for an 'optimisation' of the European research and innovation system at the European level, not only by using European-level resources but also by coordinating or 'structuring' MS-level resources, in the form of both money and research performance.

Up to this moment, the European Commission heavily relies on metrics and the aggregation of statistical data, collected by the National Statistical Offices in the various member states. The inadequacy of these STI indicators in responding to the need for more fine-grained data has led to the investment of considerable resources in the collection of micro-data, by means of census and surveys implemented by national statistical offices and ad-hoc studies involving external experts.

These initiatives are many and diverse, and essentially fragmented; have a questionable sustainability and require ongoing investments of resources; an overall coordination seems to be lacking, with the risk of overlaps and duplications and an overall lack of efficiency; and often the quality of the data collected is insufficient for monitoring or evaluation purposes.

European Commission Expert Groups identified in the lack of reliable, comparable and comprehensive data a major challenge for the current implementation of research assessments and recommended the European Commission to 'invest in developing a shared information infrastructure for relevant data to be collected, maintained, analysed, and disseminated across the European Union'.

4.1.2   The needs of policy-makers at the national level

National policymakers typically rely on the use and analysis of statistics and indicators collected at the international level (OECD or Eurostat) for the analysis of the country's positioning on the international research and innovation scene, in most cases complemented by indicators deriving from data in international bibliometrics and patents databases.

While these data sources give a view on the comparative performance of the national system at a highly aggregated level, the lack of detail limits the possibilities for their use in the context of policy making at the national level as well as in the context of the European Research Area and its developments. National governments or ministries responsible for research policymaking need a comprehensive overview of strategies, research policies and policy interventions in other European countries and their effects on the research systems in order to define adequately the positioning of research in their country at the European level and develop research strategies, in synergy or complementary to the ones implemented in other countries or in the ERA. This is ever more important in the context of the current requirement for an active completion of the ERA and the pressure for transnational funding of research programmes.

In this context, national policy-makers rely on the strategic information developed at European level, with the limits to this information as described above.

National research funding agencies strive for improved efficiency and effectiveness in the collection of data for monitoring and assessment of research and research institutions funded. Reflecting the criticism of the research communities related to the strong reliance upon bibliometrics, these agencies increasingly face considerable costs for the implementation of peer reviews and look for alternative tools and mechanisms to measure quality of research. Major difficulties in current performance assessments also relate to the identification of methods and tools for the assessment of research outcomes and impacts, in particular in the economic, social and environmental spheres. Funding agencies are also increasingly concerned about the limits of performance assessments linked to programme or funding cycles, which limits the monitoring and assessment of the effectiveness of public research funding to the research outputs only. They are therefore striving for a longer-term collection of evidence, beyond the duration of the funding support.

These needs for more efficiency and effectiveness and the capacity to reach a more comprehensive view on the research system and research outputs and outcomes has led to an increasing use of national research information systems, linking data on input and output with data provided by other information systems and external databases.

Finally, also for these actors at the national level, the requirements set for the completion of the ERA and the current developments in European research funding, in particular the stronger emphasis on the transnational funding of research, accentuates the need for data and information at the European level. This relates especially to information on research funding programmes, funding and evaluation practices in the other Member States in order to satisfy the expectation of a higher level of standardisation, and data on the participation of research institutions in European and transnational-funded research programmes and the outcomes of this research.

The activities implemented by these actors in the national research systems in the context of the ESF/EuroHorcs MO fora as well as the latest International Forum for Standardisation illustrate the need that these communities feel for the development of standards and harmonised systems that would allow for a sharing of data and the development of relevant strategic information at the European level and beyond.

4.1.3   The needs of the research communities and their institutions

Research-performing institutions are in need of tools for an improved comparison and benchmarking of their performances, going beyond bibliometrics data and the eventually defined research performance criteria for funding allocations

Research information that is collected and stored at the level of research-performing institutions typically serves two main purposes: to facilitate and coordinate reporting to research funding providers and to support the development of institutional strategies. Increasing amounts of information about the operation of research projects are being shared by making project-related datasets, intermediate reports and other information available. That helps researchers do research. They are also interested in understanding their institutional performance and the performance of individuals and groups within the organisation, so they are tending to acquire and store information about research and innovation outputs – and to a growing extent also inputs, in order to allow normalised performance comparisons (such as cost to produce a scientific paper). Networks of institutions are forming in order to support these activities and to provide access to comparative data.

The challenge that many institutions are currently approaching is therefore to set up meaningful and scalable links between research information systems and other information systems, and among the research information systems themselves, in a national but also international context.

4.1.4   The needs of the evaluation communities

There is a general consensus among research assessment experts, research policy makers and research performers that the current methodological framework for the assessment of scientific performance in Europe is in urgent need for improvement. Methodological challenges are to be noted especially in the assessment of the quality of research as well as in the adequate measurement of its outcomes and impacts in the economic and social spheres. Taking into account the critical role of evaluation in providing input for policy priority setting and strategy development, these methodological failures directly impede the possibility for sound evidence-based research policymaking in Europe and the attainment of more effective research systems.

Solutions for these methodological challenges are dependent on an improved understanding of innovation systems. In several studies, researchers expressed the need for a radical improvement of our understanding on the dynamics of knowledge creation and adoption of innovation before adequate evaluation approaches can be developed. They stated that such improved understanding could be reached only through improved availability of data and information; improvement of theory and evidence need to move hand in hand.

4.1.5   Bibliometrics and the Open Access Repositories

The current strong reliance on bibliometrics for the assessment of quality in research is object to strong criticism in the research communities, leading to tensions with the national funding agencies in particular in relation to the use of bibliometric criteria in the performance-based research funding models.

The current Open Data movement and the rise in availability of Open Access Repositories, strongly endorsed by the European Commission in the context of the Knowledge Economy, clearly responds to the needs of most of the researchers. It has created an opportunity for an alternative to the use of bibliometrics databases that has been taken up also by several national RIS. Open Access seems now to have reached a 'tipping point', with the implication that academic publishing business models may now change rapidly.

4.2 Conclusions on the desirability of a transnational system

The needs and challenges for the collection of strategic information and the implementation of research performance assessments identified in this study lead to the conclusion that the actors at all levels in the European research system are in need of a joined-up view of scientific progress, productivity and quality at the European level.

This would allow also for the further development of the European Research Area and provide an opportunity for 'horizontal' connections (i.e. within and among the research communities) and cross-fertilisation, thanks to the opening up of access to data for and on research.

We note that national paths for developing such interconnections exist, thanks to the current development of national research information systems. What is missing is the interconnection at European level, which has to pass through the national systems.

Presuming that the transnational research performance assessment system collecting information at the micro-level will take the form of a research information system, the specific added values of these systems can be expected to occur also in a transnational system:

- The current experience with national research information systems shows the value of these systems in terms of an improvement of strategy development capacities for all stakeholders involved.
- The efficiency and effectiveness gains that the national research information systems produced at the national level can be expected to occur also in the case of a European system, in particular in relation to the costs currently covered by the European Commission for the collection of the needed micro-data.
- Finally, the centrality of the research actors in the national research information systems, the attention to their needs and the search for a win-win situation in relation to the potential use of the system, and the alignment with the policies of open access to data cannot but be a positive factor also for the system at European level.

More specifically, benefits provided by an integrated European research information infrastructure would include:

- For research institutions: the possibility directly to compare and benchmark research performance with other institutions in Europe, taking into consideration the different missions of the institutions, their research infrastructures and national environments, thus improving the awareness of the institution's positioning in the European research landscape – beyond the analysis of bibliometrics
- For national funding agencies and policy makers: a comprehensive view of the complementarities of national research strategies versus other countries and the European Commission; improved basis for comparisons and benchmarking of national research performance with other countries, in line with the proper needs
- For the European Commission: improved efficiency in the collection of micro-data, improving data availability, reducing duplicates and enhancing the sustainability of data collection efforts
- For the research performance assessment community at large: the basis for an improved understanding of knowledge exchange mechanisms in the European research system, providing a comprehensive view on input and outputs

We consider it desirable that policy-makers at the highest levels in the European system make use of the opportunities offered by the latest developments in communication and information technologies and exploit the momentum created by the current development of national research information systems.

This would also ensure avoidance of the risk for a completely business-driven approach to the use of research information systems; it is not clear that such an outcome would serve the interests of researchers, funders or policymakers.

European policy-makers should therefore start setting the basis for the development of a European integrated research information system that would enable sharing data on research across the European Research Area – and beyond.

5 THE FEASIBILITY OF A EUROPEAN INTEGRATED RESEARCH INFORMATION INFRASTRUCTURE

In this chapter we assess the feasibility of a European research information structure by looking into the two key components that will determine the successful development of such a system: the technical feasibility and the political framework.

In the preceding chapter on desirability, we have already covered the third component that would typically influence a positive outcome, i.e. the alignment with the needs of the relevant stakeholder communities and thus, their critical support to the initiative.

5.1 The technical feasibility of the infrastructure

We cover the technical feasibility from various perspectives that are relevant in the context of information collection and integration, i.e. the availability and comparability of the data, the potential legal constraints, the availability of persistent and unique identifiers, and the envisaged technical features of the system – closely linked to the costs for its development.

5.1.1 Availability and comparability of the data

In the preceding chapters we reported on attempts made by the European Commission to collect data at the micro-levels and the major challenges that they encountered in terms of the availability of data, its breadth and focus, and its comparability at the European level (see Chapter 3.3.1).

Availability of data

The issue of non-availability of data is linked to the way data are collected, and current practices in research performance assessments involve a dual approach: on the one hand, *aggregation* of data and on the other hand, *integration* of data. (Exhibit 20)

Exhibit 20 Approaches to data collection: aggregation versus integration
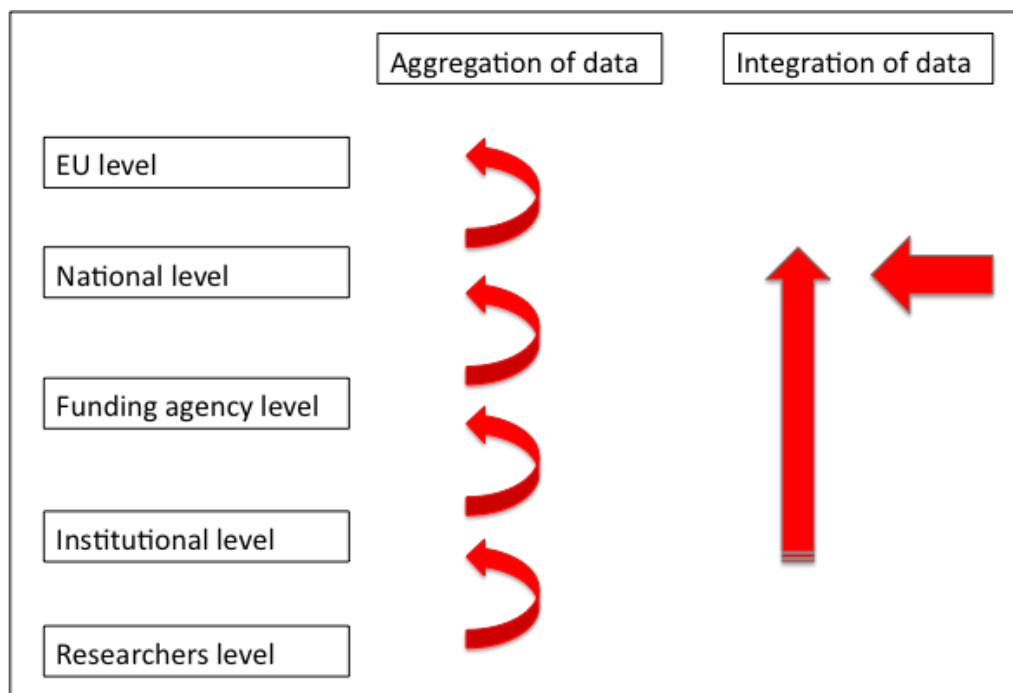
Aggregation of data refers to the current common practice of a hierarchical collection and analysis of information in the form of **metrics**, at increasingly aggregated and therefore less fine-grained levels. It is the approach that the European Commission is applying for its data collections at the European level against the STI indicators.

It was the approach that was taken also for the collection of the micro-data in the projects mentioned above. In these cases, the data was not available in a specific typology of institutions that constituted the target for the data collection across Europe; this does not mean that the data are not available in any institution in that country.

The **integration of data,** instead, makes use of currently available ICT solutions, i.e. **research information systems**, to collect and store information from various sources, essentially in the form of descriptors. A major advantage of these systems is that information can be automatically updated in and directly harvested from information systems at the lower hierarchical levels and/or other external information systems, <u>enriching the availability</u> of data for performance assessments.

More than an availability of the data as such, the issue is often a reluctance to provide data that is perceived as sensitive, for example the information on private funding received for the research institutions.

Two reflections can be made from that perspective: on the one hand, this seems to be predominantly an issue of the authoritative position of the entity requiring this type of information. In several PRF systems in the Member States, private funding received is part of the criteria against which information is collected (see Chapter 3.3.2, above)

On the other hand, a major advantage of research information systems is their high level of **flexibility** in terms of the access that is provided for certain functions.

The query function used in federated research information systems to retrieve such data also implies a <u>possibility for control</u> over the level of access that is provided to data for certain indicators. Some data may be made "query-able" to everybody, others only to a restricted set of registered users.

Comparability, breadth and focus of the data

The lack of comparability of data across countries is a long-lasting problem for national policy-makers that seek information on the performance of their research system in comparison to other countries.

The technological developments provide a solution to this issue in the context of **research information systems.** Technically, the harmonisation of data is no longer a major problem thanks to the capacity for 'semantic crosswalking", allowing for a correct mapping of the terms used in different systems.

Semantic ontologies that can provide comparability at the international level constitute a key focus for the cooperation between EuroCRIS and CASRAI in Canada and VIVO in the US (see Chapter 3.4.2, above).

This approach to the collection of information on data allows for a high level of **flexibility** and the possibility for the national research information systems to keep on maintaining the national character and reflecting the 'local' needs. Standardisation of indicators in this context implies only the precise definition of the indicator in order to allow its correct 'interpretation' and categorisation.

Experts consulted in the context of this study felt that there was a strong argument for the identification of a **standard approach** to the definition of outputs and other indicators, following up on the work that has already been done in the context of the ESF/EuroHorcs MO fora and other studies and projects (see Chapter 3.4, above).

Such standard approach would also allow the use of the data collected in the transnational information system for the creation of 'aggregated' indicators, thus combining the strengths of both an integrated system and an aggregated framework.

In other words, in this context standardisation does not imply that Member States would need to agree upon a *standard set of indicators* against which to collect information, possibly disregarding their 'local' needs. Experience in information systems where this was the intent, such as the UK ROS and the US STAR METRICS, showed the difficulty of such an approach and the lengthy process and negotiation it entails.

5.1.2 Unique and persistent identifiers

A critical factor for the utility of interlinked information systems and infrastructures is the development and widespread use of unique and persistent identifiers for the different variables used in the systems - be it researchers, institutions, projects or publications.

Having reliable unique identifiers for individuals involved in research is very important in order to enable disambiguation of authors (assigning publications to a specific individual on a national and global scale), career tracking of researchers (from post-graduate research to emeritus professor, across institutions) and reduce the burden on researchers by enabling easier entry on forms for funding and appraisal. In addition, clarification of staff institutional affiliations can bring further benefits, for example by using this data to confirm eligibility for access to international facilities.

The problem of author-name ambiguity has frequently been acknowledged (e.g. Haak et al 2010; Foley and Kochalko 2012). A solution to this lies in moving beyond the standard approach of simply noting all authors' names on every research publication, to a system of unique researcher identifiers. Following consultations with several stakeholders in 2009 (Foley and Kochalko 2010), the Open Researcher and Contributor identification system (ORCID) was designed to fulfil this capacity. The ORCID system allows researchers to make a profile, giving them a unique identification in the ORCID database, whilst ORCID itself is designed to link up with existing science databases, potentially linking all publications and contributions of an author to their unique researcher ID.

However, whilst this puts in place the technology to create more comprehensive research systems with respect to unambiguous author identification, its success strongly depends on uptake of the ORCID system, both by the providers of research publications, as well as by researchers themselves. So far, there is evidence that this uptake is taking place: in late 2012 two of the largest research publication databases, Thomson Reuters and Elsevier, announced integration of the ORCID database into their systems (Thomson Reuters 2012; Elsevier 2012), enabling all publications of ORCID-registered researchers to be linked to their unique identifier. This step has been especially important in terms of heightening researchers' incentive to make use of ORCID. Between October 2012 and July 2013 ORCID issued nearly 200,000 user identifications (Taylor 2013).

Though uptake is not yet sufficiently widespread fully to solve the problem of author ambiguity, and though the ORCID system's ability to do so additionally depends on several more science databases and a range of activities beyond formal academic publications to be integrated and linked to it, the current state-of-play in unique researcher identification strongly suggests technical feasibility in this regard.

In fact, in contrast to the expectations, this topic seems not to have been a major issue in the countries covered. The following solutions were adopted:

- In the Netherlands all researchers were given a Digital Author Identifier (DAI), deriving from the OCLC library system which is an international cooperation between scientific libraries
- In Norway the adoption of the ORCID system was planned but due to time pressure, the option of using Norwegian social security numbers was preferred as this also solved some legal issues
- After due discussions, the UK committed itself to the success of the ORCID system and decided to overcome the relative immaturity of the ORCID system by 'seeding' it with data on UK researchers

It should be noted also that several currently existing research information systems, including OpenAire and the pilot version of STAR METRICS allow for multiple identifiers to be linked to the ID defined in the system itself, including the ones used in the different agencies, e.g. ORCID.

5.1.3   Potential legal constraints

Possible legal constraints for the collection of data regard in particular the unit of analysis that is adopted, i.e. the level at which the information is collected.

Publication of information at the individual (researcher) level is, in fact, a matter of national legislation. As the EUMIDA project experienced, in some European member States the statistical law explicitly forbids the publication of data at the individual level (see also Chapter 3.3.1). The US STAR METRICS project encountered similar issues and went over to a 'de-identification' of individual information (see Case 9 in Chapter 3.3.3, above).

It cannot be disregarded that legal constraints will occur in the development of the transnational research information system.

Three factors may facilitate the development process of the European system from this perspective, though:

- The policy framework in Europe calling for open access to information and the possibility to re-use Public Sector Information (even though for the moment a restricted interpretation is given to this concept)
- The flexibility of the research information system's query-ing function, as described above
- The fact that a transnational research information system would create benefits also to the individual researcher, similar to the win-win situation that is created in the context of the national research information systems. We should mention here that in fact, close to all national research information systems collect the information at the level of individual researchers (see Exhibit 18 in Chapter 3.3.2)

5.1.4   Technical features and costs of the integrated system

The current technical features of the CERIF standard and its maturity allow for a seamless interlinking of datasets and/or research information systems, in different formats and including non-CERIF systems. In its current version 1.5 XML, CERIF has proven to be a data model that can ensure the integration of information from diverse sources and act as the basis for the generation of Linked Open Data, i.e. web-accessible interlinked information systems. It is able to capture the semantic relationships of data sets with each other and with other entities (e.g. persons, organisations, documents, activities/projects, funding sources and research outputs) as well as data set classifications. It has built-in support for multi-lingual metadata and handles geo-location information.

In other words, not withstanding the fact that close to all currently existing national research information systems -– as well as those under construction and planned – are CERIF-compliant (see Chapter 3.2.2, above), a lack of compatibility with the European standard should not constitute a barrier.

The **integrated European research information infrastructure** should not be considered as a substitution of the existing national research information systems, but essentially as an additional layer on top of them (see Exhibit 21, below).

It should take the features of a distributed infrastructure, inter-connecting the existing national research information systems, thus allowing for querying depending on the needs as well as for the eventual exploitation of the data in terms of indicators and/or metrics.

In this context, the cost for the development of such a system should be relatively limited.

Exhibit 21 The CERIF-based federation of research information at the European level
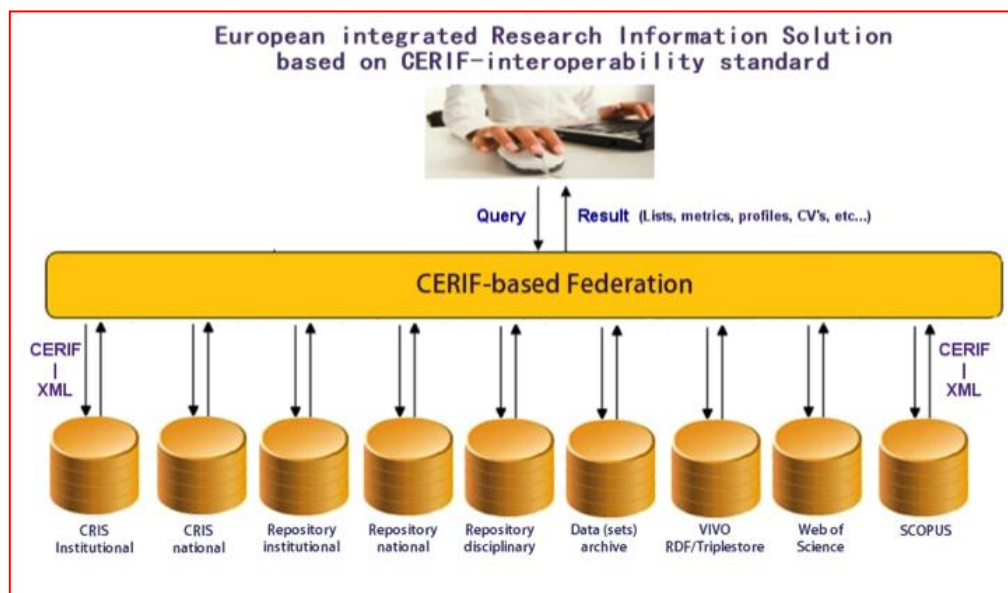
Source: Keith Jeffery, STOA Science Metrics workshop, 2013

5.2   The policy framework

The most straightforward European policy framework under which an initiative for the development of a European research information infrastructure would fall is the **ERA 2020** (see Chapter 2.1.3, above).

The ERA context seems relevant especially in the context of the 2011 and 2012 Council decisions requiring the completion of the ERA by 2014, including the development of common European approaches to research assessments and ex-post evaluations. Any eventual political or cultural resistance to the development of a transnational research performance assessment system needs to be set against this policy context.

Also the Europe 2020 Digital Agenda flagship entails two initiatives that upon first sight seem relevant in this context, i.e. the Open Data and the Open Government ones. The Open Data initiative regards information for researchers (open access policies); the Open Government initiative focuses on the re-use of Public Sector Information.

5.3   Conclusions on feasibility

The findings in this study lead to the conclusion that a European Integrated Research Information e-Infrastructure is technically feasible and in full alignment with the current policy context in the European Union.

It will require a **joint effort** from all Member States, in particular for the identification of a standard approach to the definition of outputs and other indicators.

The 2012 European Commission communication on a reinforced ERA partnership (EC 2012a) set "a reinforced ERA partnership - deeper, wider and more efficient than to date – between Member States, the Commission and research stakeholder organisations" as context for the activities that need to be implemented for the completion of the ERA by 2014. It indicated the need and appropriateness to systematically involved stakeholder organisations such as Science Europe in the activities. The Communication stated that the involvement of stakeholder organisations such as Science Europe (previously ESF/EUROHORCS) was in line with the wishes of this organisation, its previous activities in the context, and "repeated calls by the Council".

All our interviewees, however, considered that the achievement of a common system or approach to the measurement of research performance was not manageable only through bottom-up initiatives. **Early-stage steering of the process** towards integration at the European level was considered to be fundamental in this context and from that perspective there is a need for coordination at the European policy level, hence by the European Commission.

Such coordination at the European level would ensure the inclusiveness of the process, involving all EU Member States and relevant stakeholder communities in the European research system, as well as facilitate an acceleration of the development of national research information systems.

Ownership of the monitoring activities in relation to the fulfilment of the ERA and current active support to the development of research e-infrastructures such as OpenAire in the field of Open Access Repositories and Eudat in the Public Sector Information sphere makes the European Commission the most plausible lead actor and coordinator.

6 POLICY OPTIONS

In recent years, Europe saw a considerable increase in the development of national research information systems, exploiting current technological developments. These information systems yield significant opportunities for all stakeholders in the national research systems and have the capacity to respond to the multiple needs of researchers, research institutions and research policymakers.

It created a momentum for the development of a pan-European comprehensive research information system, geared to supporting science management as well as serving scientists. Currently, however, these initiatives are taken in isolation, highlighting a policy deficit at the European level.

To support and encourage the development of an integrated European research information infrastructure, the policy options are:

- To recognise the need to overcome the current methodological challenges for science performance assessments and commit support to improvements both in theoretical concepts and the practice
- To support and coordinate the development of national research information systems in the European member states, ensuring interoperability and facilitating the acceleration of the implementation of these systems in Europe
- To support and coordinate the development of a standard approach to the definition of outputs and other indicators, recognising the need for its social construction in respect of the national needs
- To support and commit to the technical development of an integrated European research information infrastructure

Policy Option A. To support and commit to an improved methodological framework for science performance assessments

The need

Current trends in the landscape for research and research governance generate new demands for the practice of evaluation, expanding its scope and use. Policymaking is increasingly required to be 'evidence-based' and evaluation becomes an integral component of the priority setting and strategy building processes at the level of national policy-makers as well as the research actors.

In international practice, evaluation has become an integral part of the policy and programme cycle. It has taken on a more pronounced *prospective and formative function*, in addition to the traditional *retrospective* one. Evaluation is expected to foster learning and improvement as well as to ensure accountability.

The pressures set upon the evaluation practice and the broadening of its scope and function due to the changes in the current policy landscape implies the need for evaluation methodologies to renew and update. The most challenging task for the evaluation community in this context is to reach an improved understanding of the dynamics leading to knowledge creation and innovation and the possibilities and opportunities to assess the economic and societal returns of public investment in research.

The context

Recognising the increased methodological complexity of the evaluation practice in the context of Horizon 2020, the European Commission (DG Research and Innovation) announced its intentions to develop a European Research and Innovation Evaluation Network, setting up a platform for discussion with the evaluation constituencies in Europe. It intends to respond to the challenges that are posed for the Horizon 2020 evaluation system, which go beyond the collection of data and

evidence: analytical skills need to be improved and there is a need to explore also new methodologies for the evaluation of research and innovation activities.

The policy option

This framework constitutes an ideal context for the creation of an evaluation network that would expand the focus for discussion from analyses geared towards H2020 (i.e. EC funded research) to evaluation methodologies in the context of knowledge and innovation systems in general.

Such network should be 'interdisciplinary', i.e. involving indicator development experts, policy evaluation experts, and IT experts in information systems. These three communities currently work in relative isolation from each other; considerable benefits could be attained from the integration of their different perspectives on the possible roads towards an improved methodological framework, The focus of the network should be on the transfer of knowledge on needs, challenges, and existing or emerging opportunities.

Activities to be implemented should encompass the stocktaking of current practices at the national, European and worldwide levels; discussion forums with the wider constituencies – including European and national policymakers; and pilot exercises tackling exploratory methods.

Policy Option B. To support and coordinate the development of national research information systems in the European Member States

The need

In recent years, Europe saw a considerable increase in the development of national research information systems, exploiting current technological developments for an improved strategy development at the national and institutional levels. These information systems yield significant opportunities for all stakeholders in the national research systems and have the capacity to respond to the multiple needs of researchers, research institutions and research policymakers. It created a momentum for the development of a pan-European comprehensive research information system, geared to supporting science management as well as serving scientists.

The current wave in Europe towards the development of national research information systems, interconnecting the systems existing at agency and institutional levels – often also to external datasets, needs to be set against the context of a growing pressure for monitoring and measurement of research in Europe. The need for accessible information and 'strategic intelligence' has grown across all parts of the research system, requiring a much higher level of data availability and analysis across multiple domains and countries than has previously been the case.

The context

The majority of the currently existing national research information systems as well as those under construction are fully interoperable. Experiences at the national level have shown that the already existing level of interoperability between systems at institutional or agency level considerably facilitated the development of the integrated system. The same can be envisaged to be the case for the development of the European research infrastructure.

Experiences at the national level show that political commitment at the highest levels is key for the authoritative decision-making and the successful completion of the research information system.

The policy option

Early-stage steering of this trend is critical in order to ensure inclusiveness of the process as well as to foster the acceleration of the current development of national research information systems.

Such policy actions require the commitment and involvement of a 'neutral' policy agency at the European level. Support at the level of the European Parliament and Council may be needed in particular in relation to the decision-making on the need and relevance of the development of national research information systems in all member states and their interoperability. A potential issue is also the budgeting for the development of such information systems.

Involvement of relevant stakeholder communities, including Science Europe as the association of the European funding agencies, seems appropriate.

Specific actions that could be implemented in this context include in particular the raising of awareness on the benefits of national research information systems for all actors in the research system and the sharing of best practices.

Policy Option C. To support and coordinate the development of a standard approach to the definition of outputs and other indicators

The need

The literature review in this study showed a growing need for an integrated – rather than aggregated – European view on research performance and impacts. This is to be seen in the context of the increasing consistency between European and national research policies as well as the fostering of transnational research collaborations, in both European and national research policies.

Key for the development of integrated systems is the correct understanding and mapping of the terms used in different systems. Technically this constitutes no longer an issue thanks to the capacity for 'semantic cross-walking' of research information systems. Experts consulted in this study considered that nevertheless, a *standard approach to the definition of outputs and other indicators* should be defined. This would also ensure the possible use of the data collected in the transnational information system for the creation of 'aggregated' indicators, thus combining the strengths of both an integrated system and an aggregated framework.

A second line of action needed in this context is the selection of key indicators for which availability is required in all national research information systems. This implies *agreement on the focus, quality, and depth* of the minimal set of data to collect.

The context

The technical developments imply that standardisation in this context does not require Member States to agree upon a *standard set of indicators* against which to collect information, possibly disregarding their 'local' needs.

Experts as well as current experience in the national systems highlight the researcher and the research communities as central for the development and identification of indicators. In the case of a system at the European level, this also affects national research policymakers and funding agencies. In fact, experts stress the importance of the <u>social construction</u> of the micro-data indicators and data selection model at the European level, which should take into account the different national cultures and approaches.

The policy option

A set of workshops and working groups should be launched in order to agree on the common definition of a key set of indicators as well as on the minimum set of indicators for which data should be available in all Member States.

Organisations to be invited to these activities include representatives of the various stakeholder communities, i.e. indicator development and policy analysis experts, IT experts, Science Europe as

representative organisation of national funding agencies and the researcher communities, Eurostat as key actor in the field of European STI indicators, and the European Commission, and more specifically DG Research and Innovation and DG CONNECT as key actors in the development and implementation of the infrastructure and therefore taking up the overall coordination of the initiative.

Policy Option D. Support and commitment to the technical development of an integrated European research information infrastructure

The need

The integrated European research information infrastructure should not be considered as a substitution of the existing national research information systems, but essentially as an additional layer on top of them. It should take the features of a distributed infrastructure, inter-connecting the existing national research information systems, thus allowing for querying depending on the needs as well as for the eventual exploitation of the data in terms of indicators and/or metrics. In this context, the cost for the development of such a system should be relatively limited.

The context

The development of a European integrated research information infrastructure should not constitute a major technical endeavour. This is due to the recent technological developments and especially the maturity of the European CERIF standard, which allows for a seamless interlinking of datasets and/or research information systems, in different formats and including non-CERIF systems.

The policy option

There is a clear drive among the stakeholder communities towards an improved harmonisation and interconnection of strategic information and information systems. However, the achievement of a common system or approach to the measurement of research performance is not manageable only through bottom-up initiatives. *Early-stage steering at the European level and coordination* of the process towards integration is critical. It would ensure the inclusiveness of the process, involving all EU Member States and relevant stakeholder communities, as well as facilitate an acceleration of the development of national research information systems.

Ownership of the monitoring activities in relation to the fulfilment of the ERA and current active support to the development of European research e-infrastructures make the European Commission the most plausible lead actor and coordinator.

Organisations to be involved include representatives of the various stakeholder communities, i.e. indicator development and policy analysis experts, IT experts, Science Europe as representative organisation of national funding agencies and the researcher communities, and managers of the national research information systems in the different Member States.

Appendix A – Key indicators for performance assessments at the national levels

The information listed below relates to research performance assessments conducted at the full national level. It therefore focuses in particular on institutional assessments and the eventual PRF systems and does not include information on scientific field-specific exercises.

	Austria	Belgium-Flanders (BOF & IOF)	Czech Republic	Denmark	Finland	France	Italy / VQR	Netherlands (SEP with ERiC)	Norway / HEI	Norway / RI	Slovak republic	Spain	Sweden	UK - REF
Operational characteristics														
Purpose														
Core funding allocation	part		x	x	x	x	x		x		x		x	x
Performance contracts	x			x	x	x	x				x			
Additional funding		x										x		
Level of assessment														
Institution	x	x	x	x	x		x		x		x		x	
Department/institute				x	x			x	x					
Research group						x		x						
Individual researcher											x	x	x	Sel ect
Modality for information collection														
Data collection in IS		x	x	x	x				x		x	x		
Peer review		x				x	x	x				x		x
Annual reports	x	x											x	
Surveys/questionnaires														
Benchmarking modality														
Points			x	x					x					x
Shares					x							x		
Internal to the organisation						x	x	x						
Allocation internally in institutions														
Internal competition		x			x				x					
PRF criteria are key	x	x	x	x	x	x	x				x			?
Input criteria														

	Austria	Belgium-Flanders (BOF & IOF)	Czech Republic	Denmark	Finland	France	Italy / VQR	Netherlands (SEP with ERiC)	Norway / HEI	Norway / RI	Slovak republic	Spain	Sweden	UK - REF
Third-party funding	X	X			X	X	X		X	X				
National competitive funding	X				X		X		X	X				
International competitive funding	X	X			X	X	X		X	X				
Contract research	X	X				X	X							
Non competitive funding	x			x	x		x	x	x	x			x	
Research staff		x					x	x		x			x	
Systemic indicators														
International cooperation						X	X							
Within research community						X	X							
Research-education										X				
Science-industry						X	X							
General						X								
International mobility	X				X		X					X		
National cooperation						X	X			X				
Within research community						X	X							
Research-education										X				
National mobility							X							
Personnel/Recruitment		X			X		X				X			
Process indicators	X	X		X	X	X			X	X		X		X
Infrastructural work for the research system						x								
editorship in journals			x								x	x		
conferences etc			x						x		x	x		x
intra-research collaboration						x		x	x				x	
Graduate teaching		x												
PhDs / postdocs		x		x	x	x	x		x				x	
collaboraton with education						x		x						
Knowledge transfer to enterprises & society	x													

	Austria	Belgium-Flanders (BOF & IOF)	Czech Republic	Denmark	Finland	France	Italy / VQR	Netherlands (SEP with ERiC)	Norway / HEI	Norway / RI	Slovak republic	Spain	Sweden	UK - REF
collaboration						x	x	x						
Research outputs														
Types of Publications (nr)														
refereed international publications			X	**X**	X		X	X	X	X	X	X	X	X
article in impact journals		X	X	X	X		X	X	X	X	X	X	X	X
article in non-impact journals / international			X	X	X		X	X	X	X	X	X	X	X
article in non-impact magazine/national			X	X	X			X			X	X	X	X
scientific monographs (books)			X	**X**	X		X	X	X	X	X	X		X
in English			X	X	X		X	X	X	X	X	X		X
in other languages			X	X	X		X	X	X	X	X	X		X
article in **conference** proceedings			X		X		X	X			X	X		X
PhD theses				X				X			X	X		X
Doctoral theses				X				X			X	X		X
other scientific publications					X		X	X			X	X		X
Quantity of Publications (nr)														
Number		X	X	X	X			X	X	X	X	X	X	
Quality of publications														
Classification in quality levels (national)				X					X	X	x			
Classification in quality levels (international)			X	X					X	X				
reviewed publications only				X									X	
Nr of citations		X					X				X	X	X	
Impact factor			X				X					X		
Publications		X	X	X	X		X	X	X	X	X	X	X	
Other research outputs			X											
Sources for comparison														
National identification		X	X	X	X				X	X	X			

	Austria	Belgium-Flanders (BOF & IOF)	Czech Republic	Denmark	Finland	France	Italy / VQR	Netherlands (SEP with ERiC)	Norway / HEI	Norway / RI	Slovak republic	Spain	Sweden	UK - REF
list of journals/ publishers														
International database		X	X	X	X		X		X	X	X		X	
Scopus			X				X							
WoS		X	X										X	
Bibliometrics used				x										
Nr of publications		x	x	x	x		x		x	x	x	x	x	x
Citations		x					x				x	x	x	x
Innovation outputs														
IPR		X	X	X			X				X	X		
Other innovation outputs			X											
Outcomes/impacts														
Research (cultural)							X							
Innovation (spinoff, incubators)		X				X	X							
Societal	X						X							X

Appendix B – Indicators in the research information systems

It should be noted that the list below covers all research information systems at research governance level. Only some of these can be considered 'national' systems and not all of them make their information public. The indications related to data for which information is collected, is based on information that was available to us in 2013.

	Austria	Belgium (FL)	Czech rep.	Denmark	Finland	France	Italy	Netherlands	Norway	Slovak rep.	Spain	Sweden	UK
Users (intended / real)													
Policy-makers	x	X	X	X	X	X	X		X	X	X	X	X
Research institutions	x		X	X	X	X	X	X	X	X	X	X	X
Researchers	x		X				X	X	X	X	X		X
Industry								X	X			X	
General public								X	X	X		X	
Usage (intended / real)													
Access to publication data			X	X	X			X	X			X	
Access to publications			X	X	X			X					
Allocation of research funding						X	X		X		X	X	
Accountability for research funding			X	X		X	X		X	X	X	X	X
Monitoring of research performance	x		X	X		X	X	X	X	X		X	X
Public R&D strategy development	x	X		X		X		X		X	X		X
Input to research institutions strategies					X	X			X			X	
Information to industry & citizens		X				X	X	X	X				
Level of data collection													
Individual researcher	x	X		X	X	X	X	X	X	X	X		X
Research group					X								
Institution	x		?	X		X	X	X	X	X		X	X
Institute	x					X	X	X	X	X			X
Funded project / PI			X	X				X	X		X		
Funding agency			X				X			X		X	X
Level of coverage													
National	X	X	X	X	X			X	X			X	X
Sample							X				X		

INPUT												
RESEARCH ACTORS												
Individual researcher												
Name		X		X		X		X	X	X	X	
Gender	X					X				X	X	
Date of birth	X					X			X	X		
Position	X	X				X		X		X	X	
Affiliation institution		X		X		X		X	X	X	X	
Research Field		X		X		X		X	X	X		
Arrival in unit		X				X						
Departure from unit		X				X						
Ttile of most important publications						X		X	X	X	X	
Full profile / CV				X				X	X	X	X	
PhD candidate							X					
Name				X		X		X				
Gender	X					X						
Date of birth	X					X						
Master's institution				X		X						
PhD supervisor						X						
Starting date PhD						X						
Ending date PhD						X						
Funding institution						X						
Ttile of main publications						X						
Principal investigator												
Name								X				
Gender												
Date of birth												
Position								X				
Affiliation institution								X				
Research Field								X				
Title of most important publications								X				
Full profile / CV								X				
Research group				X		X			X			
DEPARTMENT / LAB				X					X			
Name and type of organisation by legal status		X										
Country of origin		X										
Address		X							X			
Name of organisational unit such as faculty etc		X							X			

	1	2	3	4	5	6	7	8	9	10	11	12
Number of participations of normalised partner	X											
Projects information	X											
Other:	X											
UNIVERSITY / RESEARCH INSTITUTE		X	X			X	X	X				
Name and type of organisation by legal status	X	X				X		X		X		
Identification number		X						X		X		
Country of origin	X	X										
Address	X	X				X	X	X		X		
Name of organisational unit such as faculty etc	X	X					X					
Number of participations of normalised partner	X	X										
Projects information	X	X				X		X				
Other:	X	X				X						
R&D projects					X							
Description												
Type of activity	X	X						X		X		
Branch of research	X	X						X		X		
Keywords		X						X		X		
Administrative details												
Project name	X	X				X	X	X		X		
Contract number		X				X		X		X		
Start and end dates	X	X				X	X	X		X		
Start and end date of national support being provided	X	X								X		
Type of tender	X	X						X		X		
Input (funding)					X			X	X			X
Code of the funding provider		X										
Total approved costs for the whole execution period of the project		X								X		
State contribution during this time period		X						X		X		
Number of receivers	X	X										
Name of the primary receiver		X						X				
Outputs									X			
Evaluation of the result		X										
Number of resulting outcomes		X						X	X			X
R&D programmes												
Description												
Type of activity	X	X				X	X	X				
Aim of activity		X				X	X	X				

Programme type			X							X		
Administrative details												
Funding provider			X							X		
Activity name		X	X					X		X		
Start and end year		X	X					X	X	X		
Government resolution number										X		
Research Infrastructures												
Size of the research infrastructures						X						
Partnerships							**X**					**X**
European partnerships (projects / networks)						X						
Name of the partnership						X						X
Number of European and foreign institutions involved						X						X
Name of the leading institution						X						X
Name of the project manager						X						X
Starting date						X						X
Ending date						X						X
Funding received by the team						X						
ERC Grants						X						
Name of the researcher						X						
Type of grant						X						
Starting date						X						
Ending date						X						
Funding received by the team						X						
International partnership (projects/networks)							X					
Name of the partnership						X						X
Number of European and foreign institutions involved						X						X
Name of the leading institution						X						X
Name of the project manager						X						X
Starting date						X						X
Ending date						X						X
Funding received by the team						X						
Public-private partnership (e.g. cluster projects)						X	X					
Name of the project						X						X
Number of partner institutions						X						
Starting date						X						X
Ending date						X						X

Funding received by the team						X						
PROCESS INDICATORS												
Participation in conferences			x	x			X	X		X		X
Proceedings papers that are not part of special issues of journals or edited books			x									X
Nr of people attending			x									
Exhibition catalogues				x				X				
Lectures				x								
Lecture notes				x								
RESEARCH OUTPUTS												
Scientific Publications										X		
Peer-reviewed publications	X						X				X	X
Bookmark and identification number in the database		x	X	X			X					
General description												
Field of science			X					X				
Language of publication			X					X				
Nature of publication												
Approved by dtb/agency						x						
in WoS						x						
Information on publication												
Publication title												
Original language		x	X	X	X		X	X	X			X
English			X	X								
Publication type			X	X	X							
Articles in journals		x	X	X			X	X				X
Books as author		x	X	X			X	X				X
Articles or chapters in books			X	X			X	X				
PhD theses				X			X	X				X
Doctoral theses				X			X	X				X
Pages				X								
Nr starting page		x	X	X	X			X	X			X
Nr ending page		x	X	X	X			X	X			X
Number of pages of the result and of the book			X					X				X
Article reference number				X								X
Information on authors												
Nr of authors												
In total		x	X		X		X	X	X			
Only national			X									
Author(s) name(s)												X

All	x	X	X	X			X	X	X			
Foreign co-publishers												
National co-publisher		X										
Affiliation of author	X	X					X	X				X
Department/institute			X	X			X					
Institution			X				X	X)				
Information on publisher												
ISBN/ISSN		X	X		X		X	X	X			X
Year of publication		X	X	X	X		X	X	X			X
Name of the edition/journal	x	X	X	X			X	X				X
Name of publisher/editor			X		X		X	X				X
Country of publisher/editor			X		x		X					X
Access to publication												
Abstract		X	X	X			X	X	X			
Open Access			X	X			X					
Theses										X		X
Polytechnic thesis, Bachelor's thesis				X			X	x				
Master's thesis, Polytechnic Master's thesis			x	X			X	x				
Licentiate thesis				X			X	x				
Doctoral dissertation (monograph)			x	X			X	x				
Doctoral dissertation (article)			x	X			X	x				
Other scientific output												X
New methods		x										
Certified methodology & procedures		x										
Specialised maps		x										
Research reports containing classified information		x										
Datasets		x					X	X				X
Publications intended for professional communities												
Article in a trade journal				X				x				
Article in a professional book				X				x				
Professional conference proceedings				X								
Published development or research report or study				X				x		X		
Textbook, professional manual or guide				X			X	x		X		
Publications intended for the general public												X
Popularised article, newspaper article			x	X				x				
Popularised monograph				X				x				

Public artistic and design activities	X					X		X		X	X
Published independent work of art					X						
Published partial realisation of a work of art					X						
Artistic part of a non-artistic publication					X						
Audiovisual material, ICT software						X		X			X
Audiovisual material		X	x	X							X
ICT Software		x	X	X	X						
Date of deposit					X						
Owners			X		X						
Finality					X						X
Royalties					X						
Other											X
New technologies		X									
New materials		X									
New products		X									X
New systems		X									X
New services		X									X
Prototype, functional sample		X									X
Usable sample		X									
Industrial sample		X									
Trials, Verified technologies, prototypes etc.		X									X
Pilot plant, confirmed technology, species, breed		X			X						X
Patents and innovation announcements										X	
IPR											
Patents		X	X	X		X	X	X	X		X
Title		X	X		X		X	X			X
Type					X		X	X			X
Number		X	X		X			X	X		
Place of issue		X	X					X			X
Year of application					X						X
Year of publication		X			X		X	X			
Owners		X	X		X		X	X			X
Inventors		X			X						X
Royalties		X			X						X
Use		X									X
Granted patent				X							
Invention announcement				X							
References to patents			x								X

Utility models granted												
Other copyrights						X						
OUTCOMES/IMPACTS												
Spinoffs						**X**	**X**		**X**			
Name of the company						X			X			
Date of creation						X			X			
Scope and nature of activity						X			X			
Number of employees						X						
Outgoing mobility						**X**	**X**				**X**	
Name of the research						X						
Period						X						
Programme						X						
Host institution						X						
Host country						X						

Appendix C - List of Interviewees

This study has built upon the input from the following interviewees:

Organisation	Interviewee
Academy of Sciences of the Czech republic	Jiri Rakosnik, Director, Institute of Mathematics
CNR CERIS, IT	Emanuela Reale, senior researcher in science policy and law; Expert and National contact point for the EUMIDA project; coordinator of the JOREP project; expert for the ESF focus group on research internationalisation indicators
Elsevier, Netherlands	Lisa Colledge Project Director
	Nick Fowler, Elsevier (Director of Strategy)
ERC Executive Agency, Belgium	Alexis Michel Mugabushaka, Policy Analyst, ERC.A.1 - Support to the Scientific Council
European Commission, DG CONNECT	Richard Swetenham, Adviser Open Data
Finnish Ministry of Education and Culture	Jukka Haapamäki, Senior Adviser
Flemish Department for Economics, Science and Innovation (EWI), Department of Knowledge Management	Geert Van Grootel, senior researcher, member of the standardisation body at euroCRIS
Flemish Department for Economics, Science and Innovation (EWI), Research Division	Karen Haegemans, Senior Researcher
Library at Technical University of Denmark	Mikael Karstensen Elbæk, Project manager Danish National Research Database
Medical Research Council, UK	Ian Viney, Head of strategic evaluation
National Agency for the evaluation of the university and research system (ANVUR)	Roberto Torrini, Director
National Commission for the Evaluation of Research Activity (CNEAI)	Dr. Narciso Garcia, Director-General
	Prof. Dr. Juan Carranza Almansa, Member
National Institutes of Health (NIH), US	George Chacko, Director, Office of Planning, Analysis, and Evaluation Center for Scientific Review, STAR METRICS programme manager
Radboud University Nijmegen	Ed Simons, International IT project Manager & project manager for METIS; current president of euroCRIS
Science and Technology Facilities Council (STFC), UK	Keith Jeffery, former Director of International IT Strategy; former president of euroCRIS
Slovak Centre of Scientific and Technical Information (SCSTI)	Danica Zendulková, manager SK CRIS
Slovak Centre of Scientific and Technical Information (SCSTI)	Juraj Noge, Head of section of Information Systems Development
Swedish Research Council	Torulf Lind, ICT strategist

Organisation	Interviewee
Technology Centre ASCR	RNDr. Tomáš Vondrák CSc., Department of strategic studies
UKOLN – Innovation Support Centre (ISC)	Rosemary Russell, Research Officer
University of Athens, Greece	Natalia Manola, project manager of OpenAIRE
University of Cambridge, UK	John Green, Chair of the Snowball Metrics Steering Committee
	Malcom Edwards Project partner - Head of Planning and resource allocation office
University of Oslo	Katrine Weisteen Bjerde, manager of CRIStin
Uppsala University	Åke Johansson, IT strategist

Appendix D - List of main references

The study also built upon the outcomes of an extensive desk research. We list our main references:

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The evaluation of research has become more important as expectations for research to support social and economic improvements have risen. However, there are currently a wide variety of measures to measure the impact of research, with some disagreements between policy makers and the research community about the aims and methods of evaluation. This study considers the possible options for improving the monitoring of research performance by researchers, research institutions and funding bodies. In particular, the feasibility of developing a transnational European system to monitor the inputs, outputs and productivity of research is considered.