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OECD CASE STUDY OF NORWAY'S DIGITAL SCIENCE AND INNOVATION POLICY AND GOVERNANCE LANDSCAPE

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Abstract

This report describes Norway's landscape for Digital Science and Innovation Policy (DSIP) - the overarching framework through which governments make intensive use of digital technologies and data resources to support the formulation, delivery and administration of STI policy. The report describes how Norway's DSIP landscape is shaped by its broader digital government framework and agenda, introduces the main actors in the DSIP system and discusses their main features in relation to their key objectives and the generic purposes of DSIP approaches. Special attention is paid to the role of STI statistics. It concludes by drawing out key findings and potential implications to help the Norwegian government identify opportunities that promote the system's further development in line with its strategic objectives. This study also provides an indication of the potential opportunities and challenges that other countries might face when developing, implementing and maintaining digital systems for STI policy and administration.

Keywords: digitalisation, science and technology, innovation, policy governance, statistics

JEL codes: D8, O3; I28; L86; L88

Foreword

This report is one result of work conducted under the OECD Committee for Scientific and Technological Policy (CSTP) on the digitalisation of science and innovation policy (DSIP), conducted jointly with its Working Party of National Experts on Science and Technology Indicators (NESTI), in the framework of the OECD horizontal "Going Digital" project.

This in-depth case study of Norway's DSIP system has been carried out with financial voluntary contribution support from Norway's Ministry of Education and Research. This report has been prepared by the OECD DSIP project team, comprising Fernando Galindo-Rueda, Michael Keenan, Daniel Ker and Dmitry Plekhanov, from the OECD Directorate for Science, Technology and Innovation.

This report is part of a series of documents prepared in the course of the DSIP project. Some have already been published (OECD, 2020; OECD, 2018a) and others are forthcoming in this policy paper series. This is also the first of its kinds among a potential future series of custom-prepared, case studies and country reports on how policy makers and agencies and institutions with science and innovation policy design and implementation responsibilities use and could use data and digital tools to fulfil their responsibilities and achieve their desired objectives.

The authors are very grateful to all participants in meetings held virtually and on site in Oslo for their hospitality, their time, the valuable information provided and the experiences shared. Special gratitude is owed to Sigve Berge Hofland and Christine Mee Lie, as well as Geir Arnulf, Ingvild Marheim Larsen and Svein Olav Nås, who facilitated the conduct of this study and provided detailed feedback on an earlier draft.

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Executive summary

This report **describes the Norwegian landscape for Digital Science and Innovation Policy** (DSIP), the overarching framework through which the public sector makes intensive use of digital technologies and data resources to support the formulation and delivery of STI policy. In 2018, the Norwegian Ministry of Education and Research sponsored the OECD to conduct a **case study of its DSIP landscape** with a view to better understand its strengths and to identify opportunities that would promote the system's development in line with strategic objectives.

Norway possesses several **benign conditions** for digitalising STI policy, governance and administration. It benefits from a strong legacy of comprehensive administrative records built on a trust-based societal consensus - citizens and organisations benefit from services based on their data. Use of individual and organisational IDs managed by the Norwegian government enable substantial database interoperability within Norway. A strong accountability and evaluation culture implies that STI policy instruments undergo rigorous periodical evaluations. Despite these tailwinds for digitalisation in STI, there is a wide appreciation of opportunities to **address inefficiencies, often arising as the result of fragmentation and limited scale.**

Norway's **sectoral approach** to policy is a marked feature that results in some unavoidable fragmentation that authorities and actors involved actively manage. This calls for review of co-ordination mechanisms among STI actors in designing and maintaining digital infrastructures to avoid fragmentation of resources and creation of isolated solutions with limited interoperability and functionality. Some form of **inter-agency digital co-ordination working group** for STI policy could discuss and consider in a more holistic fashion the generation and use of data about STI activity in Norway, helping overcome resistance to data sharing.

There are opportunities for strengthening the **compatibility of standards** and to develop a **framework for experimentation in advanced digital technologies** to meet user needs. There is significant scope to adopt identifiers, ontologies, protocols and common formats to match datasets from different public and private databases. Readiness for deploying semantic technologies seems yet to be fully demonstrated across many organisations, while **Big Data analysis capabilities** and support decision tools are not yet commonplace among those involved in STI policy, administration and analysis.

Access to data describing the functioning of Norway's STI system is a major issue. It is recommended to assess the access regime to data *about* STI generated in the system (administrative, statistical, commercial, etc.) according to data types, purposes and actors, and communicating it to potential users. These arrangements could be considered in parallel to decisions on access to data *from and for* research.

Norway has recently undergone a process of transformation in the **provision of digital support services to the research and higher education sector** by reforming the key agencies. UNIT, the services agency for the public research sector, following consolidation, has the challenge of adapting the Cristin platform to enable a wider range of possible functionalities and integrating this system with the broader range of infrastructures under its responsibility, all while deepening links with other external platforms.

Norway's **official statistical system** and its leading agency, Statistics Norway, is a **key pillar of its DSIP landscape**. Its role goes beyond the production of descriptive statistics about the state of the STI system. Its data clearinghouse model can be attractive for other countries to consider implementing to address problems raised by different data silos. Its high degree of involvement in evaluation of government policy, a rather unique feature enshrined by recent legislation, may prove complicated if not impossible to adopt in other countries. In the case of the other major actor in STI statistical data and pioneer in this area, the NIFU research institute, research and statistical roles are also combined to some extent. In this context, it is important that the authorities help **level the playing field** for bidding for new analytical/research work between data holders and external parties with relevant expertise but not necessarily equal access to data.

Norway's key DSIP actors are reassessing the **data resources and skills portfolio** for IT and data management, as well as the **balance between maintenance and development** activities. The abundance and connectedness of administrative and survey data in Norway have reduced pressures for exploring **alternative data sources** for statistical and policy analysis. Wider exploratory efforts could consider the potential application of unconventional data sources for the study of Norway's STI system and its role in the global arena. Having deep analytical expertise and rich digital capabilities is instrumental. IT project management emerges as a salient issue, calling for further development of competences within organisations active in implementing new digital solutions.

An effective and efficient use of human and financial resources in DSIP initiatives is dependent on the ability of policy makers to provide **governance frameworks** in which actors in the national science and innovation system are able to apply data-based practices to planning, delivery and review of their activities. Although Norway has robust frameworks in place, it would be useful to consider a more formal application of **impact assessment methodologies** and options analysis in the planning and evaluation of new DSIP initiatives, at all stages of implementation.

Norway's tendency to "make" its own solutions as opposed to sourcing them "off the shelf" has obvious customisation and learning advantages but can be inefficient given the country's size. Norway's DSIP landscape may benefit from the **input of "outsiders"** to the IT departments in the public sector and/or the subject field of STI. The **business private sector** plays a relatively limited role in Norwegian DSIP landscape.

This study presents **some valuable lessons for the international community**. Norway exhibits a strong drive to promote **international co-operation** to ensure more effective use of data resources, especially capturing cross boundary STI phenomena, at the Nordic, European and OECD levels. Its DSIP system demonstrates a range of approaches for possible emulation and adaption to circumstances, as well as exemplifying the potential challenges encountered when developing, implementing and maintaining digital systems in support of science and innovation policy and administration, even under almost ideal resource and governance framework conditions as in the case of Norway.

Extended summary

Digitalisation is on course to profoundly affect the public sector and the evidence base on which it formulates, implements, monitors and evaluates public policy. The science, technology and innovation (STI) policy field should be no exception if it wishes to be at the forefront of this transformation. Digital technologies offer opportunities to increase the access, reach and quality of public services, and to improve policymaking and public services design. Under the right conditions, the application of digital tools to the domain of science, research and innovation can provide policy makers, officials in charge of policy delivery and other stakeholders in this area with an extended range of tools to achieve their objectives.

This report **describes the Norwegian landscape for Digital Science and Innovation Policy** (DSIP), namely the overarching framework through which the public sector makes intensive use of digital technologies and data resources to support the formulation, delivery and administration of STI policy. In 2018, the Norwegian Ministry of Education and Research formally requested the OECD to conduct a **case study of the DSIP landscape in Norway** with a view to better understand its strengths and limits, and to identify opportunities that would promote the system's further development in line with its strategic objectives.

Norway possesses a **number of rather optimal and unique conditions** that are conducive to the effective development and implementation of digital practices into STI policy, governance and administration. It benefits from a strong legacy of comprehensive administrative records built on a trust-based societal consensus in which citizens and organisations based in Norway directly perceive benefits from having data about them used by public authorities to provide a significant portfolio of services over their lifetime. Use of individual and organisational IDs managed and protected by the Norwegian government enable substantial database interoperability within Norway. There is a strong accountability and evaluation culture, as STI policy instruments in Norway undergo rigorous periodical evaluations. Despite these tailwinds for digitalisation in STI, there is a wide appreciation of opportunities to **address inefficiencies, often arising as the result of fragmentation and limited scale.** Norway's tendency to "make" its own solutions as opposed to sourcing them "off the shelf" has obvious customisation and learning advantages but can be inefficient given the country's size. Compared to some of its closest neighbours, Norway has taken some time to coordinate digitalisation efforts across different parts of its publicly funded science system.

The Norwegian DSIP landscape shares several features with its broader digital government landscape and would benefit to some extent from greater alignment with horizontal policies in this area. There is broad understanding, even among proponents of a horizontal agenda, that domain-specific approaches are needed and should be maintained and further developed in the case of Norway, owing to technology, knowledge and process specificities in this policy area, including a legacy of relative data scarcity as compared to other areas. Norway's **sectoral approach** to policy making and delivery is a marked feature of its DSIP landscape. This results in some unavoidable fragmentation that authorities and all actors involved actively manage through fluid communication, facilitated by the proximity of the main actors, as well considerable institutional stability and collegiality. This calls for regular review of co-ordination mechanisms among science and innovation actors in

designing and maintaining digital infrastructures to avoid fragmentation of resources and creation of isolated solutions with limited interoperability and functionality.

The national science and innovation policy agenda in Norway is co-shaped by a number of government ministries and agencies, supported by government-controlled organisations linked through a **complex network of hierarchical data reporting arrangements and procedures**, often related to R&D and innovation funding and support more generally. While these relationships are well defined and anchored in related policy documents and regulations, data flows resulting from these interactions are often fragmented and exhibit some weak linkages at times. This might prevent identification of policy gaps and opportunities for positive synergies across government agencies.

The governance of DSIP activity in the Norwegian system is currently operationalised in separate silos often dealing with one initiative at a time (e.g. specific indicator reports, evaluations, infrastructures, etc.). While there is no fundamental reason why these should all feature under a **common governance framework**, it may be still useful to formulate some form of **inter-agency digital co-ordination working group** for STI policy that meets with a certain frequency to discuss and consider in a more holistic fashion the generation and use of data about STI activity in Norway, while helping to overcome resistance to data sharing. Norway's DSIP governance would greatly benefit from identifying all potential uses and users and providers of relevant digital systems. Agencies tasked with addressing such needs could demonstrate greater attention to user expectations by laying out more explicitly approaches to improve experience design and feedback gathering.

There are significant opportunities in Norway for strengthening the **compatibility of standards** and identifiers across domestic actors and internationally; as well as to develop a **framework for experimentation in the adoption of advanced digital technologies** to meet demonstrable user needs. Existing capacities of DSIP systems and DSIP-related digital infrastructures in Norway to collect STI data could be expanded through increased interoperability with digital solutions managed by a variety of domestic actors. Increasing interoperability between elements of the national DSIP ecosystem is a priority for near and medium-term development. While there has been rapid progress in using APIs across government databases, there is significant further scope to adopt identifiers, ontologies, protocols and common formats to match datasets from different public and private databases. Readiness for deploying semantic technologies seems yet to be fully demonstrated across many organisations, while **Big Data analysis capabilities** and support decision tools are not yet commonplace among those involved in STI policy, administration and analysis.

Access to data describing the functioning of Norway's STI system is a major preoccupation of key actors in its DSIP landscape. It is therefore recommended to assess the access regime to data *about* STI generated in the system (administrative, statistical, commercial, etc.) according to data types, purposes and actors, and communicating it to potential users. These arrangements could be considered in parallel to decisions on access to data *from and for* research, bearing also in mind that data about STI systems is in considerable demand for researchers in STI and related topics.

Norway has recently undergone a process of transformation in the **provision of digital support services to the research and higher education sector** by reforming the key agencies. The expanded role of UNIT, the services agency for the public research sector, following several rounds of consolidation, has the challenge of adapting the Cristin platform to enable a wider range of possible functionalities and integrating this system with

the broader range of infrastructures under its responsibility, all while deepening links with other external platforms.

Norway's **official statistical system** and its leading agency, Statistics Norway (SSB), is a **key pillar of its DSIP landscape**. Its role has evolved over time and is not limited to the production of descriptive statistics about the state of the STI system that policy makers and users can take note of. In the case of SSB, this role extends to providing the function of a macro- and microdata clearinghouse as well as source of expertise in research and evaluation. The SSB model as data clearinghouse, facilitated by the combination of multiple statistical powers that address confidentiality issues, can be an attractive model for other countries to consider implementing to address problems raised by different data silos. Its high degree of involvement in evaluation of government policy, a rather unique Norwegian feature enshrined by recent legislation, may prove complicated if not impossible to adopt in other countries.In the case of the other major actor in STI statistical data and pioneer in this area, the NIFU research institute, research and statistical roles are also combined to some extent.

The combination of multiple objectives (statistical, research and evaluation, for example) under the same organisation, while allowing for several synergies to be exploited, can also be a source of potential conflicts of interest (or at least perceptions of them) and a challenge for long-term and sustained collaboration for these organisatiosn if not adequately managed, for example, by **levelling the playing field** for bidding for new analytical/research work between data holders and external parties with relevant expertise but not necessarily equal access to data.

Norway's key DSIP actors are reassessing the **data resources and skills portfolio** for IT and data management, as well as the **balance between maintenance and development** activities. The abundance and connectedness of administrative and survey data in Norway have traditionally reduced the pressure for exploring **alternative data sources** for statistical and policy analysis. It is advisable that exploratory efforts in other statistical areas take into consideration the potential application of unconventional data sources for the study of Norway's STI system and its role in the global arena. In a context in which there will be growing pressure to consider hitherto unexplored dimensions (e.g. innovation networks and assessment of content and directionality of research and innovation efforts) that current data struggle to address, the current leading actors in the STI statistical system can help independently evaluate the relevance, feasibility and expected impact of using statistical data from other sources or applying different tools to existing ones.

Such a role requires the development of **analytical capacities and digital competences** in order to keep up with the pace of new approaches and methods in producing data and analyses leveraging advanced computational power and unconventional data sources. Having deep analytical expertise and rich digital capabilities is instrumental for maintaining the relevance of traditional providers of statistical data for science and innovation policy. Through the case study interviews, aspects relating to IT project management have proved to be rather salient, calling for further development of competences in this area within the organisations active in implementing new digital solutions for the management of STI information.

An effective and efficient use of human and financial resources in DSIP initiatives is dependent on the ability of policy makers to provide **governance frameworks** in which actors in the national science and innovation system are able to apply data-based practices to planning, delivery and review of their activities. Norway has robust frameworks in place although it would be potentially useful to consider a more formal application of **impact**

assessment methodologies for demonstrating value for money and options analysis in the planning and evaluation of new DSIP initiatives, at all stages of implementation.

A potential limitation of current arrangements is a marked degree of reliance on incumbent providers of solutions to various challenges. The further development of Norway's DSIP landscape may benefit from the **input of "outsiders"** to the IT departments in the public sector and/or the subject field of STI as well as outsiders to the core group of research organisations and consultants that have so far provided highly valuable services. The funding agencies have mechanisms in place and the possibility to develop new knowledge acquisition strategies (e.g. hackathons) to allow them to reach out for relevant pockets of expertise once the key needs and priorities are identified.

The **business private sector** has a relatively limited role in Norwegian DSIP landscape. Commercial solutions are used as functional elements in publicly owned digital systems to provide data access, data aggregation, visualisation and disambiguation. Whether this balance of public-private relations in DSIP will remain depends on the future IT procurement frameworks and the ability of the Norwegian government to develop necessary competences on its own to extract actionable intelligence from datasets leveraging recent technological advancements and making the most of available open source solutions.

There is a strong drive within Norway to promote **international co-operation** to ensure more effective and frictionless use of data resources, in particular for capturing cross boundary STI phenomena. There are several attempts to pursue initiatives at the Nordic, European and OECD levels, notwithstanding significant differences even with respect to its closest neighbours (for example in the way that Research Information Systems are organised).

The evidence collected through this case study confirms the increasingly held view that capacities to implement new digital solutions in STI policy and administration **allow for incremental rather than radical transformations in the short term**. As shown in the case of Norway, they will be most likely successful if conceived as complements and enhancements to existing demonstrated needs and approaches. This may require focusing on concrete application domains where the number of transactions and decisions that can benefit from DSIP solutions is sufficiently large to justify automation, provided that the underlying quality of the data is unlikely to be compromised as a result. This makes it particularly important to start from a sound and stable baseline of good governance as well as adequate skills and other resources. Data resources will be more abundant in instances where the incentives are in place for such data to exist, but this in turns requires appropriate management of uncertainty about the integrity of the data and its usage in the system.

The Norwegian landscape presented in this report, despite its many idiosyncratic features that may be impossible to reproduce in other contexts, presents **several valuable lessons for the international community**. Its DSIP system demonstrates a range of possible systems and approaches that many countries may be willing and able to emulate and adapt to their own circumstances. The examples also provide an indicator of the potential challenges that countries might encounter when developing, implementing and maintaining digital systems in support of science and innovation policy and administration, even under almost ideal resource and governance framework conditions as in the case of Norway.

Chapter 1. Introduction and background to the study

This case study, like the broader project it is part of, is motivated by the considerable transformational potential of advances in digital technologies and an exponential growth of data, which can contribute to science and innovation policy making and delivery. Digital technologies offer opportunities to increase the access, reach and quality of public services, and to improve policymaking and service design (OECD, 2018; OECD, 2014; Ubaldi, 2013). The application of digital tools to the domain of science, research and innovation can provide policy makers, officials in charge of policy delivery and other stakeholders in this area with an extended range of tools to assist them in their work.

Digital Science and Innovation Policy and governance (DSIP) initiatives refer to the adoption or implementation by public administrations, with responsibilities for science and innovation, of practices characterised by an intensive use of digital technologies and data resources, with the aim of supporting the formulation or delivery of science and innovation policy. One major point is that DSIP initiatives are focused on the activity of the public sector – their primary goal is to support some aspect of the public STI policy process – though the provision of functionalities can come from any actor, including the private sector. Furthermore, the practices referred to can include new or re-used procedures and infrastructures (OECD, 2018a).

The OECD Committee for Scientific and Technological Policy's DSIP project is a first attempt to map the landscape of DSIP initiatives in member and partner countries, addressing the very specific nature of digital government in the area of science and innovation policy. This is set within broader OECD efforts – as part of the cross-cutting Going Digital project – to help policy makers better understand the transformation that is taking place and develop and implement a resilient policy framework that fosters a positive and inclusive digital economy and society.

The scoping of the DSIP project in 2017 combined a series of horizontal or cross-cutting issues, with the possibility for countries to volunteer for conducting in-depth case studies of their national DSIP landscape. In 2018, the Norwegian Ministry of Education and Research formally requested the OECD to conduct a case study of the DSIP landscape in Norway with a view to better understand its strengths and limits and to identify opportunities that would promote the system's further development in line with its strategic objectives.

The full terms of reference for this study are available in Annex A. It should be clearly noted at the outset that this is not an official OECD review of a component of the Norwegian innovation system. As a result, no formal recommendations are provided. The main purpose of this case study is to obtain a comprehensive understanding of the key elements, relationships and dynamics that define and shape the functioning of the Norwegian DSIP landscape, identifying from this foundation opportunities to increase its efficacy and efficiency through government policy. In addition, this study set out to provide a number of potentially relevant pointers for other countries by relating the findings to their own national experience and frameworks. Being a first of its kind, this study also provided an opportunity to develop and test a model type of country case study that other countries may find of interest to pursue in the near future, which would also enhance comparative learning opportunities.

This report lays out the approach and main findings of the Norway DSIP case study. It is structured as follows:

- Section 2 presents the conceptual framework and methodological approach of the case study for Norway.
- Section 3 describes the context in which Norway's DSIP landscape is shaped by its broader digital government framework and agenda.
- Section 4 introduces the main actors in the Norwegian DSIP system and discusses their main features in relation to their main objectives and the purposes of DSIP approaches.
- Section 5 discusses specifically the role of STI statistics in Norway's DSIP landscape.
- Section 6 concludes by drawing out the findings of the case study and potential implications.

Chapter 2. Conceptual framework and methodological approach

The case study of Norway's DSIP landscape is informed by the conceptual framework underpinning the broader DSIP project and its components (OECD, 2018a). This framework is in the first instance defined by the definition of the DSIP concept introduced in the previous section, which focuses on the application of digital and data-driven policy making and administration to the science, research and innovation policy domain.

The case study has looked at ways in which the Norwegian DSIP system operates to meet a number of potential science and innovation policy and administration objectives, namely:

- *Optimise administrative workflows*: streamlining potentially burdensome administrative procedures and delivering significant efficiency gains within agencies while improving the quality of services provided to their users.
- *Support the general discovery of information relevant to the management of science and innovation policy*: DSIP systems often include data on a wide range of inputs, outputs and activities, which policy makers and delivery agencies can use to retrieve relevant resources, e.g. to identify leading experts when looking for relevant reviewers or looking for prior art before granting IP protection.
- *Assist in furthering the overall understanding of the scientific, research and innovation enterprise*, as general resource for researchers with an interest in science and innovation as a subject matter.
- *Support performance monitoring and management*: DSIP systems offer the possibility to collate real time policy output data, which can enable more agile short-term policy adjustments and provide improved insights into the policy process for accountability and learning in the mid-to-long-term.
- *Support policy formulation, design and ex-ante and ex-post evaluation*: e.g. through more granular, connected and timely data analysis to support STI policy, which should improve the allocation of research and innovation funding.
- *Provide anticipatory intelligence*: e.g. to detect patterns of emerging research areas, technologies, industries, innovation policy issues, etc., which can support short-term forecasting of issues of policy concern and contribute to strategic policy planning.
- *Promote inclusiveness and collective intelligence processes in science and innovation agenda-setting*: DSIP systems can support the process of debating policy options with stakeholders by providing detailed information about the policy problem at hand in an accessible way. This can also increase effectiveness by capitalising on multiple sources of intelligence.

These functions are analysed by assessing a series of potential enablers or moderating factors that are closely related to the principles laid out in the OECD Recommendation on Digital Government Strategies that act as strategic levers for digital government policies. Particular attention has been paid to aspects relating to:

- Data integrity and usability, including discoverability, availability and access to data, interoperability and reusability.

- Domestic and international co-ordination, including the extent and nature of interplay between ministries and delivery agencies, as well as the degree of international engagement with the private sector.
- Capabilities, including skills and organisational capabilities, funding, value for money and sustainability, as well as evidence of understanding and responsible use of data.

The DSIP work and this case study have looked out for specificities of the science, research and innovation policy domain relative to other policy areas. These can call out for specific DSIP solutions that differ from those applied more widely.

The case study has taken a broad approach, covering data providers and regulators, the managers of DSIP infrastructures, and their users. In its preparatory phase, it has drawn upon earlier findings of the DSIP project and a literature review. This allowed the OECD DSIP team to prepare an initial mapping of Norway's DSIP institutional landscape and identify, with the assistance of Norway's Ministry of Higher Education and Research, a series of potential candidates for more in-depth personal interviews.

In April 2018, the OECD DSIP project team visited Norway to conduct interviews and to deliver a workshop to sharpen initial findings and hypotheses. Over the course of 4 days in Oslo, the team conducted 22 interviews with 39 different individuals affiliated to 15 different organisations, which include ministries and a number of their most relevant executive agencies – including those in charge of research and innovation funding, and the management of the most relevant data resources in the science and research ecosystem, including the production of official statistics. The OECD team also met with representatives of the higher education sector providing and using DSIP systems, research institutes and private companies. More details on the mission schedule are available in Annex B. The interviews sought to retrieve evidence and insights on a range of issues, ranging from the organisational structures, the legal framework, and the interrelationships with other stakeholders, to examples of use of data technologies, tools and methods along the full data cycle (collection, storage and processing, analysis, reporting, visualisation and use in decision making).

The preliminary findings arising from the mission were presented to a number of stakeholders on the fifth and final day of the mission in the form of an interactive seminar at the Ministry of Higher Education and Research. This allowed to further refine the main hypotheses and conclusions.

Additional interviews were arranged by telephone or video conference after the OECD mission to Norway to fill some of the gaps and address some outstanding questions. This led to the preparation of the report which was submitted for feedback from the Norwegian authorities by the end of 2018. After further checks, the revised and updated draft, incorporating key changes (new legislation and strategies) following the production of the first draft, was presented to the CSTP at its meeting in October 2019 for final feedback and approval, contributing to the final DSIP report. This report will be published in the form of separate but inter-connected STI policy papers covering the different topics captured in the project.

Chapter 3. Science and innovation policy in Norway's broader digital government

3.1. General context

There are several contextual factors that help interpret Norway's DSIP landscape. Norway is an affluent, highly developed economy. Business dynamism and sound management of natural resources wealth has helped propel Norway among the highest levels of GDP per capita in the world (OECD, 2017a). Combined with its "Nordic model" ensuring inclusiveness and low inequality, Norway exhibits impressive levels of well-being in many dimensions. Its society has an egalitarian approach to income distribution and has prioritised reducing gender discrimination. Comprehensive provision of education, healthcare and family support has been a key driver. This is in large part associated with high levels of citizen trust in government and the latter's ability to leverage on rich data resources to provide public services.

Norway – a constitutional monarchy with a parliamentary democracy – can be described as a centralised state, where the bulk of policy and budgets are governed at the central government level. As a member of the European Economic Area, Norway is also required to follow EU rules, including those concerning personal data, statistics, State Aid for R&D, etc. Public R&D spending almost exclusively comes from central government budgets. The government, led by the prime minister, includes 15 ministries, and each is quite independent in terms of policy formulation and execution. One of its main structuring elements is the *sector* principle, with the consensus principle as an underlying approach to policy making. The sector principle is a governance principle that by convention gives each ministry a great deal of independence in terms of policy formulation and execution within its policy portfolio, including for matters relating to research and innovation and digitalisation. Consensus-based co-ordination is a defining feature of the system's functioning. Geographic inclusiveness is a major horizontal policy driver. This explains the distribution of government agencies responsible for digitalisation across different locations in the country.

Digitalisation promises to affect all actors of the Norwegian system of research and innovation by introducing new ways to support strategic intelligence, promoting organisational innovations through automation of workflows, and intensifying and reshaping data flows. This section explores the main drivers shaping the digitalisation of Norway's science and innovation policy, governance and administration. In particular, it covers:

- The overarching digital government framework and agenda within which STI policies need to operate.
- The framework for statistical data governance that set standards for data quality and rules for collection and processing of STI data in Norway.
- The specific STI policy drivers behind domain-specific solutions in the area of science, research and innovation.

3.2. Norway's overarching digital government framework and agenda

As noted in the OECD Digital Government Review of Norway (OECD, 2017c), Norway is well placed on the path to digital transformation, together with other Nordic countries. The creation of an electronic identification system (eID), citizens' digital mailboxes, one-stop-shop portals for citizens and businesses, and the development of inclusive digital strategies and services are all results of the government's commitment to improving and simplifying the relationship between the public sector and the Norwegian population. A system of fundamental data registries, as well as the adoption of digital government principles, such as the aim to avoid asking users to provide the same data more than once, have also made it easier for public institutions to share data and become more closely integrated. As explained below, there are a number of cross-cutting elements in place that enable a wide range of DSIP solutions to be implemented in Norway.

3.2.1. Digital government priorities in Norway

The Digital Agenda for Norway (2015-16) identifies as key priorities the adoption of a user-centric focus in public administration, the digitisation of a number of public operations, the strengthening of digital competence and inclusion across different population groups, as well as the protection of personal data.

Dissemination of public data and effective digitisation of the public sector were laid out as key priorities in the Digital Agenda for Norway (Ministry of Local Government and Modernisation, 2016). The agenda set out a course on introducing digital innovations in the heart of the public sector through adapting data management regulations, alleviating hurdles on the use of digital technologies, and facilitating the development of digital infrastructures. Special emphasis was put on creating domestically and internationally interoperable digital solutions across government agencies, and on ensuring a streamlined process for citizens to communicate with public authorities. A set of measures proposed by the Digital Agenda to strengthen digitalisation of the public sector includes, but is not limited to:

- across all government agencies, identifying data resources, potential areas of application of data analysis, and levels of accessibility to datasets by different groups of users;
- studies of how cross-government data exchange can be improved;
- establishing a common framework for integrated data management at the national level; and
- establishing a co-financing scheme for government digitalisation projects.

In 2015, the Productivity Commission, a government-appointed ad hoc committee tasked with proposing measures to strengthen productivity and growth of the Norwegian economy argued for the need to facilitate co-ordination between the central government and municipalities in data management (Productivity Commission, 2015). The commission also called for the creation of common technological architectures of public databases and strengthening of public-private co-operation in development of digital tools. Collaboration with commercial providers on matters related to digitalisation of the public sector was further emphasised in the 2017 Prospective Report to the Norwegian Parliament as one of the key measures to optimise workflows of government agencies (Ministry of Local Government and Modernisation, 2016).

3.2.2. Responsibilities for digital government and its regulatory framework

The use of digital technologies and the collection and analysis of large datasets have the potential to radically transform the design, implementation, enforcement, monitoring and evaluation of policies across a number of policy domains. Within Norway, the lead for issues concerning government Digital Agenda sits with the **Ministry of Local Government and Modernisation (MLGM).**

The **Department of ICT Policy and Public sector reform** of the **MLGM** has responsibility for the **Agency for Public Management and eGovernment (Difi)**, the public sector agency responsible for the executive management and implementation of digital government policies in Norway. Difi (www.difi.no) primarily serves central government and the municipalities. Difi developed the Framework for the National IT Architecture, which places information management and the basic registries as one of its priority areas and provides an Information Governance (IG) model. One of the main tools of the IG model is a set of rules for agencies to govern their data value chain, comprising guidance on standards, metadata and publication of open government data – a key priority for both MLGM and Difi.

The 2017 OECD Digital Government Review of Norway pointed to untapped potential of open government data within its Digital Agenda. The Freedom of Information Act of 2006 is the main legal instrument supporting the publication of government data, driven by the need to implement EU directives in this area. This was updated to include requirements for the publication of public sector information in digital formats.

Difi chairs the **Strategic Cooperation Council for Management and coordination of eGovernment services (SKATE)**, a strategic collaborative council and advisory body tasked with ensuring co-ordination of the digitalisation of the public sector. SKATE comprises senior managers from 12 public sector agencies and various sectors of government, including representatives from the Directorate for ICT and Joint Services in Higher Education and Research and the Brønnøysund Register Centre (described in sections below).

Difi also chairs the Digital Council, a multi-stakeholder group responsible for evaluating ICT projects between NOK 10 Million and NOK 600 million, providing advice and supporting agencies in the definition, development and implementation of ICT projects. Table 3.1 provides the list of projects managed by the Digital Council in 2017, highlighting those with closest potential relevance to the introduction of DSIP initiatives. Although the Ministry of Research and Higher Education is not a lead participant in any of these projects, it is possible to note initiatives in relevant domains for research and innovation policy.

The government also established a co-financing scheme managed by Difi aimed at supporting digitalisation projects in SMEs and to which state enterprises, including state-owned higher education institutions (HEIs), can apply for funding worth up to 50% of the project costs. It is unclear to what extent STI-focused organisations within the public sector are making use of these funds.

The Digitalisation Council identified three challenges impeding successful digitalisation of government agencies: a lack of co-operation; a limited ability to exploit and document benefits from developed solutions; and a limited ability to innovate (Digitaliseringsrådet, 2017). Co-operation with internal and external users is found to be particularly important at the early stages of digitalisation projects, allowing agencies to better understand users' demands and expectations and provide tailored services.

One general conclusion is that government agencies should be better informed on the possible scope of co-operation with the private sector. Currently, a limited understanding of procurement frameworks prevents them from deeper engagement with external suppliers for digitalisation (Digitaliseringsrådet, 2017).

One particularly relevant area of work within the Digital Agenda concerns the public administration's use of digital information and tools for managing digital contact information and authorisations, as a condition for safe and efficient digital communication, both within public administration and between the administration and business enterprises. The project on **digital contact information and authorisation** (KoFuVi) aims to create a common solution for collecting and making available information, contributing to the government's goal of public administration being able to communicate digitally with all enterprises.

Table 3.1. Projects managed by the Digitisation Council

Project	Responsible organisation	Sector
E-archive/ MAVOD	National Archival Services of Norway	Ministry of Culture
National Data Directory*	**Brønnøysund Register Centre**	**Ministry of Trade, Industry and Fisheries**
Digital Courts	Norwegian Courts Administration	Ministry of Justice and Public Security
SIKT	Norwegian State Housing Bank	Ministry of Local Government and Modernisation
NIS/NOR Directory	Norwegian Maritime Authority	Ministry of Trade, Industry and Fisheries
Online Application Service	Ministry of Foreign Affairs	Ministry of Foreign Affairs
Incremental Modernisation	Norwegian Directorate of Immigration	Ministry of Justice and Public Security
Strengthened ID	Norwegian Directorate of Immigration & National Police Directorate	Ministry of Justice and Public Security
ICT Security	National Police Directorate	Ministry of Justice and Public Security
Analytical System	Norwegian Police Security Service	Ministry of Justice and Public Security
Underground Programme	Geological Survey of Norway	Ministry of Trade, Industry and Fisheries
Online public disclosure	Agency for Public Management and eGovernment	Ministry of Local Government and Modernisation
National Resource Directory	Norwegian Coastal Administration	Ministry of Transport and Communications
My IPR page*	**Norwegian Industrial Property Office**	**Ministry of Trade, Industry and Fisheries**
Electronic health card for pregnant women	Norwegian Directorate of eHealth	Ministry of Health and Care Services
Digital University 1.0*	**Oslo Metropolitan University**	**Ministry of Education and Research**
Modernisation Programme	Norwegian Directorate of Immigration	Ministry of Justice and Public Security
Trade System for Milk Quotas	Norwegian Agriculture Agency	Ministry of Agriculture and Food
National Core Solution for Toll Collection	Norwegian Public Roads Administration	Ministry of Transport and Communications
Appeal Procedures for the Future	Immigration Appeals Board	Ministry of Justice and Public Security
Modernisation Programme*	**Statistics Norway**	**Ministry of Finance**
Artificial Intelligence*	**Norwegian Tax Administration**	**Ministry of Finance**
Minerals for all	Directorate of Mining	Ministry of Trade, Industry and Fisheries
Health Analysis Platform*	**Norwegian Directorate of eHealth**	**Ministry of Health and Care Services**
Digitalisation of Clearance Process	Norwegian Defence Material Agency	Ministry of Defence
The pension program - PRO25 first phase	Norwegian Public Service Pension Fund	Ministry of Labour and Social Affairs

Note: Entries in bold and with asterisks represent projects with potential direct relevance to DSIP initiatives.
Source: Digitaliseringsrådet (2017). Erfaringsrapport 2017. Gordiske knuter i digitaliseringsprosjekter – hvordan kan vi løse dem? Retrieved 20 September 2018, from https://www.difi.no/sites/difino/files/digitaliseringsradets_erfaringsrapport_2017_0.pdf

3.2.3. Administrative registers – A key strength

Registers are a key component of Norway's digital government and DSIP landscape. Norway was one of the first countries to establish registers for both individuals and businesses. Since their establishment, the registers have been used by a cross section of sectors and have been perceived as trustworthy by society as a whole. The basic data registries are regulated by specific laws and regulations that set the rules on who collects and produces these data (data ownership), what public sector institutions can access it and under which conditions (e.g. data anonymisation and data protection). The 1970 Census Act (Folkeregisterloven) regulates the confidentiality of, and public sector institutions' access (e.g. health authorities) to, the data registered in the National Population Registry (managed by the Norwegian Tax Authority). The Census Act also regulates the provision of these data for research activity (within the limits of confidentiality and private protection).

The organisational registers are the responsibility of the **Brønnøysund Register Centre (BRC)**, an agency of the Ministry of Trade, Industry and Fisheries, that administers 17 of the most important registers in the country with 560 employees, most of them based in Brønnøysund. The Central Coordinating Register for legal entities (CCR) was established in 1995 following the 1994 Act on Legal Entities (Enhetsregisterloven) and coordinates basic information about commercial entities and entities in the public sector found in various public registries. To prevent multiple requests from different agencies, the CCR coordinates and collects all necessary information in one single location.[1] The nine-digit organisation number identifies an entity, enabling easier collaboration and information exchange between government agencies.

The Register of Business Enterprises (RBE) was established in 1988, acquiring the previous function of more than 100 various local trade registers. A registration in the Register of Business Enterprises gives the business a number of rights, e.g. to conduct business activity as well as a means to identify itself to government. The main public benefit is to clarify the relevant form of liability in a registered business.

BRC also has responsibility for operating and further developing the **Altinn platform,** a digital infrastructure that maintains the channel for digital communication of both private individuals and business with the public sector (www.altinn.no) (see Box 3.1). Altinn was at its origin an alternative reporting channel (in Norwegian ALTernativ INNrapportering) for economic and financial data. Increasingly, Altinn assists the public sector through its use for simplification and streamlining.

The overall policy direction is at present towards implementing a comprehensive update of the diverse IT systems that supported the appearance of separate registers decades ago and that are currently outdated. The work on renewing the registers infrastructure includes all support systems and other functionality belonging to the various registers, such as customer registration, the system for handling orders, subscription services, searching and statistics. A more modern architecture and platform for case processing will also make it easier to achieve 100 per cent digital reception of information to the registers and 100 per cent digital availability from the registers.

Box 3.1. The Altinn Platform and its use

The digital platform Altinn was launched in 2003 by Brønnøysund Register Centre to facilitate data exchange and to support the development of public digital services through a common technological architecture (KMD, 2016). The project's origins date back to 2002, when the Brønnøysund Register Centre, Statistics Norway and the Tax Administration began their co-operation. All Norwegian adults and enterprises have a user account in Altinn (OECD, 2017c). The platform plays a role of an intermediary facilitating interaction of the central government with municipalities, the business community and private individuals.

In March 2018, there were 46 co-owners of Altinn represented by ministries, municipalities, financial institutions and government agencies with the Tax Administration being the largest user.[2] The Tax Administration uses the platform for several purposes including automatic exchange of data on loan applications with financial institutions to improve credit risk assessments and streamline administrative workflows (Reimsbach-Kounatze & Ronchi, 2018). The Ministry of Trade, Industry and Fisheries retrieves firm-level data from Altinn and match it with information on grantees from relevant agencies to analyse the profile of recipients of financial support for innovation.

The extent of Altinn's use among ministries and government agencies varies significantly. There are several sectoral digital service delivery platforms, including in the STI area, that make incomplete use of central ICT key enablers such as Altinn. As noted in OECD (2017c) and confirmed in the DSIP case study interviews, agencies note as reasons the limited adaptability of the mentioned enablers to the specific requisites and needs of a sectoral area.

Metadata is another important dimension of the digital government environment, as it allows to make sense of available data sources and better understand their true potential. The **National Data Directory**[3] serves SKATE's first level ambition for government information management to provide a common overview of data and a shared understanding of information, and to fulfil Open government data objectives. The directory currently provides an overview showing which data have been registered by the various public agencies, how they are connected and what they mean, and indicating availability and accessibility for interested users.

3.2.4. General outlook for the government digital strategy

Norway boasts relatively well-developed public data infrastructures represented by versatile open public databases, business registries and data sources on research and innovation activities. The Digital Agenda sets ambitious goals towards realising the promise of a so called "data-native" public sector, requiring strategic actions to enable the systemic and coherent digital transformation of the public sector. Norway enjoys a consensus-based public sector where decision making is the result of collaborative processes among ministries and agencies. However, this vertical administrative culture relies on the role and capacities agencies have to implement digital government policies, resulting in fragmented efforts of sector-specific solutions to systemic policy challenges (OECD, 2017c). This implies some possible trade-offs between securing the benefits from centralising and homogenising practices for increased efficiency and addressing the specific needs of thematic policy areas, such as the domain of research and innovation policy.

Box 3.2. Recommendations in the OECD Digital Government Review of Norway

- Consider developing a **dedicated and integrated digital government strategy** –including a comprehensive impact assessment instrument.
- Develop a clearer and more structured **governance framework** for digital government, strengthening leadership, reinforcing the mandate of the Agency for Public Management and eGovernment (Difi) and defining clearer roles.
- Sustain efforts to ensure the **legal and regulatory framework** favours the achievement of the Digital Agenda and better responds to changing citizens' and businesses' needs.
- Strengthen **co-ordination** with local government through more regular and stable mechanisms. Reinforce the role of the Digitisation Council, strengthening its position as a recognised collective body guaranteeing a sound and agile evaluation of all proposed projects or investments in the digital arena.
- Reinforce the applicability of **general digital standards and guidelines** – to provide a more coherent, interoperable and resilient digital government infrastructure – through ICT project evaluation and establishing a standard business case model for ICT projects for mandatory use across sectors and levels of government.
- Leverage the use of **Difi's project management platform** – the Project Wizard – for implementing inter-institutional, standardised and comparable practices.
- Increase the priority assigned to the development of **digital and data-related leadership and skills across the public** sector through a dedicated ICT human resources policy, regularly mapping needs across the administration, and improving the attractiveness of civil service roles in digital government.
- Develop a specific **strategy for the commissioning of digital technologies in the public sector**, expanding demand-aggregation processes to the procurement of digital goods and services, exploring synergies and increasing the public sector's negotiating capacities with private suppliers, reinforcing the adoption of existing common standards, and enhancing the transparency, tracking and accountability of public ICT expenditures.
- Establish an **integrated service delivery policy** within the new Digital Government Strategy to reinforce the effectiveness and sustainability of the public sector's efforts to deliver high-quality services.
- Consider prioritising the development of Norway's role as **promoter of cross-border services** among Nordic and Baltic countries, through the country's active support for the development of a common area for cross-border digital services in the public sector.
- Define a formal **open government data strategy** (part of the data governance and management strategy) in collaboration with private, public and third-sector actors.
- Simplify and streamline **data sharing practices** across the public sector to break down data silos and enable further efficiency within the public sector as well as

data re-use by external actors. Data needs to be easily found, understood and used by all systems.

- Define a **roadmap for the development of a data-driven public sector**. This should include the development of skills as core element of the Digital Government Strategy and backbone of the overall public data governance and management strategy, exploiting the use of data science and big data and opportunities identified by public sector institutions for the development of data-driven services and foresight activities.

Source: OECD (2017c).

As will be discussed later, the case study team was able to recognise the direct relevance of several of the OECD generic recommendations (see Box 3.2) in the research and innovation policy domain. Whether the application of such recommendations is best served at a central, whole of government level, or through domain and subdomain specific solutions remains an open question. All official and stakeholders the OECD case study team met with, including those from Difi, coincided in arguing for the need of a mix of both approaches, suitably well integrated, in most cases.

3.3. The framework for statistical data in Norway

A country's statistical system is another major component, both as an enabler and user, of its DSIP landscape. Statistical data inform policy decisions and rely in part on administrative systems and procedures. The latter is particularly the case of Norway, a country in which administrative data play a key enabling role for its official statistics and one in which the statistical agency plays a marked role as clearing house for microdata linking and through its active engagement in research and evaluation activities.

3.3.1. Legal framework

The Act of 1989 relating to official statistics sets out Statistics Norway (SSB) as the central body responsible for covering the need for statistics on Norwegian society (https://www.ssb.no/en/). SSB is a professionally autonomous institution but is subject to the guidelines and financial framework determined by the Norwegian Government and Parliament. It has overall national responsibility for Norwegian official statistics. SSB accounts for approximately 85-90% of all official statistics produced in Norway.

The Statistics Act provides SSB with a high degree of autonomy and strong powers to demand data from public and private entities in cases where statutory confidentiality protection does not prevent it. It therefore allows SSB to make use of national administrative data registers. Because the registers use national identity numbers, company registration numbers or addresses, they enable SSB to easily combine information from them into statistics that portray how various aspects of Norwegian society interrelate. This is performed in a way that safeguards data confidentiality and safety.

Under the Act, SSB has a particular obligation to identify and prioritise the need for official statistics; coordinate comprehensive statistics produced by administrative agencies; develop statistical methods and apply statistics to analysis and research; provide data for statistical use for research purposes and for public planning; and bear the main responsibility for international statistical co-operation.

Approximately two-thirds of SSB's funding is directly allocated from the state budget, while one-third is formed by project-based funding coming from analytical reports commissioned mainly by government authorities. As a result, SSB combines two roles: statistics production and data analytics.

SSB has a duty to comply with the Personal Data Act and the rules set out by the Norwegian Data Protection Authority with regard to the processing of personal data. Neither companies nor individuals must find that their information has gone astray, and people must be able to rely on the fact that the information they give to SSB is used only for the agreed purposes. SSB complies with the security requirements of the Norwegian Data Protection Authority on the processing of sensitive personal data, and its privacy protection officer monitors that this processing complies with applicable regulations. All SSB employees have a duty of confidentiality.

3.3.2. Internationalisation

Being a part of the European Statistical System (ESS) through the European Economic Area (EEA) Agreement, Norway produces approximately 60% of its official statistics using frameworks of European statistical co-operation (principally the EU Regulation on European statistics that forms the legal framework for the development, preparation and dissemination of European statistics). The European Statistics Code of Practice sets standards for autonomy of national statistical offices and strengthens their position in national contexts by granting them a right to serve as national coordinators of the ESS. Operating under the guidelines set out by the OECD's 2015 Council Recommendations on Good Statistical Practice, Norway is an active participant in the OECD Committee for Statistics and Statistical Policy, and participates in the statistical working parties of other OECD policy committees, such as NESTI.

In 2015, and following a feasibility study[4], Nordic National Statistical Institutions (NSI) launched NordMAN – Nordic Microdata Access Network to improve overall co-operation in statistics among Norway, Sweden, Finland, Denmark and Iceland and facilitate access to statistical datasets for research purposes in Nordic countries. While these can be seen as positive developments strengthening data quality and maximising the added value of datasets, internationalisation also brings a number of challenges for national statistics. Since socio-economic phenomena have become more multinational, it is increasingly more difficult to define those using national statistical data. Internationalisation calls for increased co-operation with foreign statistical offices on collecting and sharing microdata and developing new methods for data analysis.

3.3.3. Microdata

SSB has an API (Application Programming Interface) for users to quickly and easily retrieve and integrate its published aggregated data with their own systems. SSB also has relatively advanced procedures for providing microdata for research projects, and has data relating to persons, establishments and enterprises. Approximately 20 people support this function that is greatly enhanced by the availability of register data for the full population. The legislation covering microdata in Norway was described as complex to the OECD DSIP project team. The main purpose of microdata held by SSB is to support statistics production.

The procedures for applying for microdata use for research purposes are explained online in considerable detail.[5] It was however reported to the OECD team that the pricing structure

is not always clear and that the approval process can take up to several months, generating considerable uncertainty on the part of researchers and their funders.

In order to make it easier to analyse registry microdata, the microdata.no interface has been developed in co-operation between NSD and SSB through the register data infrastructure project funded by the Research Council of Norway. Resources available include data from the Population Register, National Educational Database (NUDB), the tax return database and FD-Trygd, a longitudinal database based principally on administrative social security records. Researchers and students can, through their own institutions (contracted institutions manage their users), process and analyse all available registry variables. The concept in microdata.no is to allow the use of non-anonymised data through a confidentiality-proof platform, where researchers are only in indirect contact with personal data, where data does not leave SSB, and where the platform ensures that all output is anonymous.

The definition of researcher for the purpose of accessing and using the data is subject of ongoing debate, as it appears to preclude in the first instance access by firms that may be engaged in contract research, including for public administrations. Access has to be constrained in order to prevent potential abuses or misuses of microdata for non-research purposes. It appears that special waivers can be granted in specific cases for the use of microdata, but this requires considerable additional burdens.

Access to the interface allows use of all variables that are made available in the system. The analysis environment offers a number of data processing functionalities, including descriptive analysis, aggregation, linear regression analysis, logistic regression, etc. However, access to survey-based data is constrained under this platform. Limitations apply for security and privacy reasons as researchers cannot view or download data, use their own statistics packages or libraries or connect to their own data. Hence, the possibilities for research design are restricted to the data and methods covered by the system, which are mostly descriptive in nature. The main use for this platform may be among master's level students and early stage researchers seeking to obtain basic population statistics. However, not being able to look at the data, e.g. to detect outliers, and restrictions on the ability to implement own computer codes, means that researchers still need to apply for access to the original data sources in order to undertake more sophisticated analysis. While all output is subject to confidentiality security checks and disclosure controls, there is a considerable degree of trust in appropriate use of the results by the researchers. The solution developed by NSD and SSB won the Norwegian Data Protection Authority's (DPA) competition in 2018 for built-in personal data protection in digital applications.[6]

3.3.4. Research and policy evaluation in SSB

A rather distinctive feature of SSB is its involvement in analytical work, particularly through its research department, which employs close to 60 individuals. SSB research aims to contribute new knowledge about "economic behaviour and the economic impact of, inter alia, political measures"[7] supporting the research community and improving the quality of statistics. The aim is to operate as an analytical service provider furnishing findings that can be utilised by government agencies and the public. A potential challenge with this system is that SSB's preferential access to data might in some instances provide them with a competitive edge over other research or analysis units wishing to engage in similar types of analytical work. In addition to this, since analytical evaluation work requires the implicit definition of counterfactuals that cannot be observed, the engagement of SSB in the evaluation of government policy may have some impact on the perception of the

organisation as an independent body and the core statistical outputs of a more descriptive nature.

In this context, an international panel of experts involved in the evaluation of the Norwegian national statistical system concluded in 2014 that SSB should continue to function as a central statistical authority performing statistical data collection and conducting research. The panel emphasised that research activity should be organised in a manner that it does not distort analysis of statistical microdata performed by other organisations.

3.3.5. Data-driven modernisation at SSB

The department for data collection and methods within SSB has the lead for data and ICT-based modernisation efforts. The organisation has modernisation targets for 2022. Technological modernisation is carried out in accordance with the IT sourcing strategy 2017-2022 that sets frameworks for developing digital solutions internally or outsourcing them to external providers. By 2022, SSB will have an overarching IT platform for statistical production that will consist of the following building blocks: information security, working environment; service platform; information platform; technical infrastructure; development, operation and management. For preparation and analysis of statistical data, the IT platform will use an international Validation and Transformation Language (VTL) in combination with data models based on the outcomes of two previous projects: the Remote Access Infrastructure for Register Data (RAIRD) and the Municipality-State reporting (KOSTRA). Under the modernisation programme SSB will launch a database for financial enterprises, ADABAS, in co-operation with the Financial Supervisory Authority of Norway and Norges Bank. Interoperable with several other government digital systems including data collection system InnFin, the database aims to provide SSB and its customers with high-quality data (Statistics Norway, 2018).

The modernisation programme aims at minimising costs of statistical data production and analysis, developing new analytical tools and methods and streamlining administrative workflows through automatisation. SSB's modernisation programme is partly funded by the Digitalisation Council (Digitaliseringsrådet, 2017). The programme focuses on streamlining statistics production and advancing analytical capabilities through application of new digital tools and data sources. The aim is to ensure that Statistics Norway has necessary competences and skills to provide statistical data and analyses that correspond with society's expectations and needs. Digitalisation of operations takes place in a broader context of strategic organisational restructuring. One of the main objectives of the reforms is to shift a focus of organisational tasks towards production of advanced statistics and increase the share of analytical tasks (Digitaliseringsrådet, 2017). That requires application of digital tools to process, analyse and visualise data; development of necessary digital capabilities among employees of SSB; and improved management of already available data sources. The success of re-organisation and modernisation efforts of SSB depend on its ability to secure sufficient external funding. Given the existing level of annual allocation from the state budget, it will be challenging to achieve all goals within the scheduled timeframe set out in the modernisation strategy of SSB (Statistics Norway, 2018).

In 2018, Statistics Norway started a new project cycle RAIRD II. The project is oriented to integrating data from third parties with data sources of Statistics Norway in a single solution that will provide necessary information for external users for research purposes while ensuring confidentiality, privacy and safety of data (Statistics Norway, 2018).

SSB is in the process of considering extending the range of data sources it draws upon to conduct its mission. SSB operates under the firm principle of not paying for data and it was reported to the OECD team that the legislation confers SSB powers to request data from all types of organisations – including private firms – to meet its statistical objectives. These powers are used very sparingly and data requests cannot be "gold-plated" for more speculative statistical research purposes. The 2018 action plan on the use of unconventional data sources in production of official statistics includes the development of national and international partnerships to provide sound methodology and acquire necessary instruments to exploit such sources.

The use of alternative sources and methods at SSB is still in its early stages, partly explained by the abundance of administrative data. SSB has for instance recently started using web-scraping technology to develop the Consumer Price Index (CPI) in Norway based on information from product barcodes. Although barcode data containing valuable product and price information is stored on privately owned websites, SSB has powers to impose disclosure obligations to access such private datasets for statistical purposes. This opens up an opportunity for supporting official statistics in an area where administrative data does not provide an effective substitute or complement to surveys.

SSB is involved in exploratory partnerships with the Norwegian Computing Centre (NR) – a private, independent, non-profit research foundation that carries out contract R&D in the areas of computing and quantitative methods for a broad range of organisations. Based within NR, BigInsight is a centre for research-based innovation, started in 2015 and funded by the Research Council of Norway and by 15 partners and will operate until 2023. BigInsight aims to produce solutions – developing analytical tools to extract knowledge from complex data for insights – for key data-driven challenges faced by its consortium of private, public and research partners, by developing original statistical and machine learning methodologies. SSB brings its own business challenges in search of solutions to its own needs. There is recognition that the SSB has limited scale for tackling some of these challenges, a reason why it looks to develop external partnerships in addition to building internal analytical capabilities.

In a recent report *on the statistics law by a government-appointed commission,* new data sources and digital tools were noted to contribute not only to the decentralisation of the national statistical system but also raise concerns over the quality of statistical information. As the number of registers owned by various public and private authorities has been on the rise, there is a growing tension among SSB and other statistical producers on the division of labour in preparing official statistics in certain areas. In this regard, the commission has argued that SSB should play a greater role in governance and co-ordination of a national statistical system ensuring that high data quality standards are applied among all statistical producers. It also noted that a national multi-annual programme for official statistics may contribute to resolving potential conflicts among statistical producers by setting priorities and establishing clearer responsibilities among the various stakeholders.

The Norwegian government reacted by submitting proposals in April 2019[8] for a new law on official statistics and SSB, and passed the legal act in June 2019, that reaffirms a series of existing principles:

- A national, multi-annual programme will provide the framework for official statistics. This programme will define official statistics, and which authorities that will be responsible for the different official statistics.

- The bill also provides SSB with the legal basis to collect the data necessary to produce official statistics, including privately held data, both for development, production and dissemination of official statistics. Development comprises experimenting with data to check if they can be used for new official statistics.
- Research institutes and public authorities can apply for access to data from SSB for statistical purposes, research and analysis.
- SSB will continue to perform a dual official task – producing statistics and conducting research and analysis. It will continue to perform the task of providing research and analysis for the parliament, the government and the social partners in the labour markets.
- SSB will maintain its professional independence and the existing board will be replaced by an advisory committee, leaving professional matters as the sole responsibility of the head of the SSB.

3.4. Science and innovation policy drivers for DSIP initiatives in Norway

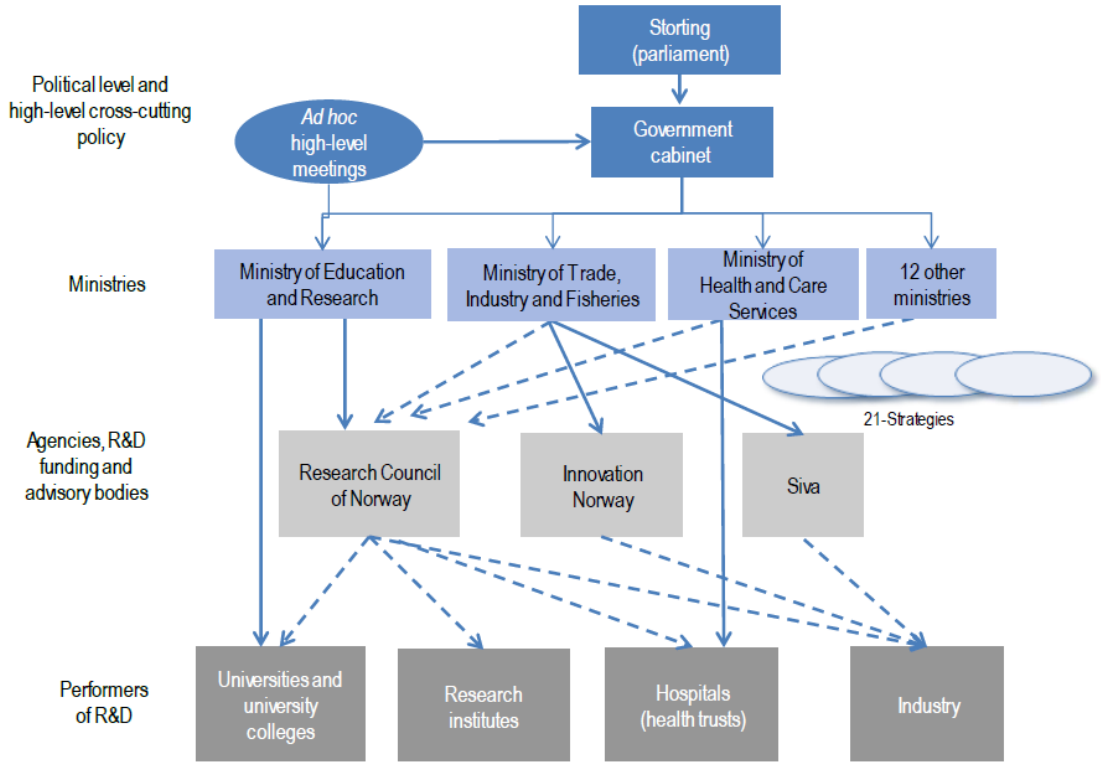
3.4.1. General perspective

A description of Norway's DSIP landscape requires understanding the primary drivers of STI policy. The OECD Review of Innovation Policy in Norway (OECD, 2017b) noted three main drivers of Norwegian STI policy that reflect a multiple transitions imperative. These relate to the intention to move towards a more diversified and robust economy (one less dependent on key natural resources and less vulnerable to variations in their prices); ensure a more competitive, effective and efficient innovation system; and develop and implement solutions to confront an array of pressing societal challenges.

It is beyond the scope of this case study to reflect in detail the full STI Norway policy STI landscape – already described at length in OECD (2017a) – hence only a general description is provided before turning the focus on those initiatives that shape the drive for digitalisation in research and innovation policy, governance and administration.

Actors of the Norwegian system of education, research and innovation are engaged in regular interactions through hierarchical reporting lines anchored in government regulations, as well as procedures related to R&D and innovation funding (Figure 3.1). The roles of many of these actors in the national DSIP landscape will be examined in the next section. External linkages are equally important. Being a member of the European Economic Area and part of the broader global context, Norway actively collaborates with international actors on research and innovation that consequently contribute to creating data flows beyond national borders.

Figure 3.1. Main science, technology and innovation policy actors and governance relations



Source: Ministry of Education and Research (2016), "Background report: OECD Innovation Policy Review of Norway".

Following the general sectoral policy model previously alluded to, it is worth noting that the horizontal STI policy domain is also significantly organised to address the needs of strategic industries. On the **business side** of the research and innovation system, it is important to recognise the extent to which the Norwegian economy strongly relies on the exploitation of abundant natural resources of which the most important is oil and gas. Other natural resources are of great importance, including fish stocks, timber, non-ferrous metals and water resources (particularly for hydropower). These sectors are, on an OECD-wide basis, traditionally low R&D-intensive sectors. In Norway, however, they have been long-standing drivers of business innovation and are, as in many other countries, not at all low-tech or innovation-light.[9]

Resource intensive industries continue to feature prominently in Norway's innovation policy strategy, albeit in a more complex way. Hydropower availability is for instance a key factor in the government's current strategy to become a magnet for data centres.[10]

The **public sector** has an important role in industrial issues, and hence in large-scale programmes of public investment and general support, including through public enterprises, public procurement and financial investments.[11] The high level of public sector engagement demands in principle a considerable amount of information to support decision making. This study did not however examine the procedures used by public or semi-public investment entities such as Norges Bank to scan for innovations and related market opportunities.

In the area of knowledge creation, a significant role for government concerns its support for a large sector of **technological institutes** to carry out both strategic R&D and applied contract R&D for firms. Norway has a comparatively young but sizeable public research sector consisting of public research institutes (PRIs), universities, university colleges and hospitals. These are the main target of Norway's Long-Term Plan for Research and Higher Education 2015-2024, which is built around three overarching government objectives for STI policy that focus on the pursuit of excellence in research (owing to long-standing concerns over the insufficient excellence of research and the quality of higher education), increasing competitiveness and innovation, and addressing social challenges (as reflected in the triple transition imperative).

A number of policy documents highlight the Government's intention to pursue excellence and demonstrating it by tracking Norway's performance in *global rankings*[12] at different levels of analysis. This monitoring and assessment activity requires data-based solutions not only for Norway but also for units outside Norway for benchmarking purposes. The emphasis on quality in a DSIP context is also reflected in the government's view that digitalisation offers significant opportunities for improving the quality and efficiency of research. This is the context for the introduction of a number organisational reforms in the HE and research sectors, as explained in the subsection below.

3.4.2. Digitalisation strategies for Norway's research base

A sectoral digital strategy: Digitalisation of research and innovation in higher education

The government's "Digitalisation strategy for the HE sector 2017-2021"[13] provides a good indication of Norway's main aspirations to realise the opportunities of digitalisation for research and innovation. It defines "digitalisation" as the "use of technology to innovate, simplify, and improve" and "offering new and better services that are easy to use, efficient, and reliable". The strategy acknowledges that Norway's higher education system is complex and has many actors playing complementary roles. It recognises academic freedom when it comes to education, research and innovation, and argues that HEIs have been given more administrative and organisational autonomy than other state bodies. While the strategy covers several key dimensions of digitalisation with regards to the teaching component of HEIs,[14] it highlights several elements of relevance to helping the sector meet its research and third mission objectives. These are presented in Box 3.3 and refer to implications for researchers, managers, infrastructure and administrators.

Box 3.3. Objectives for Norway's digitalisation of the higher education sector of relevance to research and innovation

Objectives for researchers

- Digital skills for the optimal utilisation of ICT in research in order to carry out their tasks efficiently and exploit the opportunities that digitalisation provides for developing the discipline and processing research data effectively and appropriately.
- Access to relevant scientific publications, a good overview of relevant researchers, and access to research data for their discipline.
- Access to a well presented range of applications and services with sufficient resources for storage, calculations, and advanced user support.
- Access to user-friendly ICT support functions that meet the needs of day-to-day work in terms of both academic and administrative tasks.
- Access to infrastructure and tools that enable effective interaction with other researchers across sectors, nationally and internationally.
- Use of tools for digital interaction in order to work efficiently on projects and in networks, both internally and externally.

Objectives for management

- Leverage the opportunities provided by digitalisation in order to achieve their institutions' goals by including digitalisation in planning and in specific processes.
- Management is aware of their managerial responsibilities and have the skills to lead, motivate, and support the change processes necessary to drive digitalisation.
- Management leverages the potential of digitalisation to streamline administrative support functions and ensure effective governance.
- Management maintains their institutions' values and interests and follow national policies through systematic efforts to improve information security.
- Management puts in place formal systems for the documentation of and remuneration of work relating to the development of teaching.
- Management sets goals at a level that makes it possible for academia as a whole, and not just enthusiasts, to embrace the potential of digitalisation for raising the quality of education.
- Management ensures that the systems chosen facilitate interaction internally within the higher education sector, as well as with stakeholders outside the sector.
- Management has easy access to information and decision-making support.

Data and infrastructure

- Data is stored once and made available from a single source.
- Data is retrievable, available, interoperable, and reusable in accordance with the FAIR principles.
- Infrastructure is flexible and facilitates mobility and development.

- Cohesive governance and management of information security are fundamental to digitalisation and strategic efforts to achieve the sector's goals.

Administrative systems

- All services, information, and communication are digitally available as far as possible.
- Needs, ease of use, and the user experience are key criteria in realising new solutions.
- Administrative workflows and user interfaces are improved and streamlined through standardisation and digitalisation.
- A shared system portfolio has been established to address transversal administrative needs (budget, accounting, payroll, procurement, etc.).
- The potential for automation and self-service is well utilised so that services are perceived as being simple, effective, and user-friendly.

Note: The strategy also contains objectives for teachers and students in the HE system, including an objective relating to the enabling of student participation in and contribution to research.
Source:https://www.regjeringen.no/contentassets/779c0783ffee461b88451b9ab71d5f51/en-gb/pdfs/digitaliseringsstrategi-for-uh-sektoren-engelsk-ve.pdf

These objectives highlight the application of generic digitalisation principles to the domain of higher education. From the HE researcher perspective, the objectives are principally presented in terms of facilitating skills development and securing access to data and tools to facilitate the conduct of their work. However, there is no explicit mention of practices and policies that apply to researchers and that are required to realise objectives laid out at other levels, such as those relating to features of data and infrastructure that researchers themselves contribute to develop. From the perspective of the DSIP project, objectives for management and administrative systems are of particular relevance, as they confirm the prioritisation of outcome-driven approaches and the relevance of skills, responsibility allocation, practices and standards when implementing DSIP solutions. In this regard, it is worth noting that automation is not an objective in its own right but the appropriate utilisation of its potential. The implementation of this agenda will be considered in the section on the use of DSIP solution and the role of different actors.

Promotion of open access and open science policies in research

Digital solutions are key to fulfilling the high priority assigned by the Norwegian authorities to securing open access to research publications. Furthermore, facilitating access to research data more broadly is high on the policy agenda. The Research Council of Norway's guidelines stipulate that "research data should be made accessible to all relevant users, on equal terms, as long as there are no legal, ethical or security-related reasons to preclude this" (Open Access to Research Data: Policy for the Research Council of Norway, 2014). In 2017, the government extended the ambition by setting the goal that all publicly funded Norwegian research articles should be made openly available by 2024. Accordingly, the Ministry of Education and Research has established in 2017 guidelines and measures for open access to research articles, including the development of supporting digital infrastructures and reconsideration of research evaluation practices.[15]

3.4.3. Digitalisation for innovation in the public sector

Digitalisation and innovation in the public sector

As noted in the Oslo Manual (OECD and Eurostat, 2018), innovation takes place in all sectors. In light of the large presence of the public sector in the Norwegian economy, the innovation imperative for innovation in the public sector can be an important driver of productivity and societal well-being. Public sector innovation is high in Norway's policy agenda and there is significant awareness of the importance of evidence to map it out and analyse its impacts.[16]

Digital capabilities are core to the efficiency and effectiveness of innovations in the public sector, where a large part of process innovations entail some form of digital-enabled or driven initiative. The OECD Review of Innovation Policy in Norway's noted that digitisation might be absorbing a disproportionate share of efforts to drive innovation in the public sector, arguing that complementary activities should not be neglected. These relate to organisational capabilities and processes, regulatory changes (for example, regarding public procurement), incentives and disincentives for innovation and the diffusion of innovation, experimentation and learning, public-private partnerships, leadership, and other activities crucial for increasing the efficiency and effectiveness of the public sector (OECD, 2017b).

Throughout this case study, it has been possible to note a considerably fast pace of institutional re-organisation, often in the form of mergers, across many areas. However, it was not always apparent the extent to which the reorganisations were fundamentally changing the strategy and nature of the work carried out by the institutions in relation to the implementation of digital-based solutions for policy design and administration, other than on an incremental basis.

Research for public sector innovation

The Research Council of Norway has developed its own strategy for supporting public sector innovation. The Research Council, which has responsibility for promoting research-based innovation within the public sector, aims to strengthen research on the digitalisation challenges for privacy and social security, stimulate research support for innovation projects that exploit big data, artificial intelligence and automation where public enterprises are partners, stimulate projects that strengthens the implementation of digital solutions in the development of smart cities and places, and collaborate with the Agency for Public Management and eGovernment (Difi) and public organisations about access to, link and share data for research and innovation purposes.[17]

The public sector as a user of innovations

The public sector spends about NOK 500 billion a year on procurement. Public agencies can save a great deal by streamlining procurement processes. Procurement for innovation has been a long-standing priority of various Norwegian governments (OECD, 2017d). However, there is no standalone procurement for innovation action plan. Difi and the National Programme for Supplier Development have developed a national method for procurement of innovation, which gives public purchasers a systematic approach when conducting procurement for innovations, encouraging dialogue with the market.

It is the government's policy that it should not do what the market can do better and more efficiently. In 2016, the government put forward a cloud computing strategy for Norway.[18]

The strategy states that government agencies must consider cloud services when procuring new ICT solutions. When there are no special obstacles to using cloud computing, and when such services are the most appropriate and cost-effective solution, it goes on to state that these should be adopted. The government intends all agencies to make a conscious choice about whether or not to outsource IT services and to optimise its procedures for doing so.

Box 3.4. Key principles guiding digital government activity

The following principles for the use of IT in the public sector have been distilled by the Directorate for ICT and shared services in higher education and research (UNIT), based on multiple strategy and governance documents issued by the Norwegian government:

- User-centric approach.
- Think big, start small through flexible development. Prototyping and testing rather than reports. Use interdisciplinary teams if possible.
- Data once-only: Store data just once and make it accessible for re-use.
- Privacy by design and security by design.
- Ensure access management to data and resources.
- Cloud first: Where there are no impediments to adopting cloud services, and such services offer the most practical, cost-efficient solution, the public sector should opt for cloud services.
- Active use of markets, which can do better and more efficiently than the public sector.

Source: UNIT (2019). https://www.unit.no/sites/default/files/media/filer/2019/07/The-Action-Plan-for-digitalisation.pdf.

Innovation and competitiveness

One of the government's main ICT policy priorities is for the authorities to facilitate digital innovation. The government's stated policy aim is to help Norway make the most of data-driven value creation, so the country can reap the benefits and manage the challenges.[19] The "International cyber strategy for Norway 2017"[20] sets out Norway's governing principles and strategic priorities for this area, considering its effects on innovation and the economy. The strategy sets out a commitment to:

- Promote global openness on the internet, working with other countries to ensure that the internet remains an open and non-discriminatory communication platform that fosters consumer confidence in digital markets.
- Facilitate digital innovation in the private and public sectors in the European Economic Area, giving priority to improving digital expertise and digital skills to meet future employment market needs.
- Protect intellectual property, helping to protect copyrighted works and sensitive information against theft and reproduction, and encouraging actors in the

Norwegian information security sector to join the European Cyber Security Organisation (ECSO).

- Promote Norwegian research globally to ensure that Norwegian researchers are at the forefront of information and communications security developments, facilitating close collaboration with leading international researchers and knowledge centres.
- Support growth of the digital economy in international co-operation, prioritising improving access to digital services globally, reducing barriers to investment in and use of digital technologies, promoting commonly agreed global standards, supporting the development of national and international strategies for privacy and data protection, developing and applying technology-neutral regulations that foster infrastructure competition, reducing obstacles to global ecommerce development – with an emphasis on increased consumer confidence – and improving education and training systems to meet demand for ICT expertise.

Chapter 4. The use of DSIP solutions in Norway

This section explores the role of a number of major actors in Norway's DSIP landscape and their involvement in selected initiatives and processes with the government and the broader public sector. Within the government sector, the section is structured by different levels of operation, namely the strategy and policy definition roles attributed to the government ministries, the allocation and management of resources for research and innovation delegated by government to the major funding agencies, and the administrative enabling and support functions carried out by a number of other government agencies. This section also examines the use of digital solutions in the governance and administration of other public organisations in the Norwegian DSIP system, discussing a number of relevant interactions among them and with other actors in the system.

4.1. Defining and steering science and innovation policy

4.1.1. The Ministry of Education and Research

The areas of responsibility of the Ministry of Education and Research (MER) encompass the entire education and research sector. MER is responsible for ensuring that digitalisation strategies are aligned with the other strategies under its responsibility, as outlined in the previous section.

MER has a significant impact on the DSIP landscape through its role setting regulations for research data management, monitoring and evaluating research funding, and investing in the development of digital infrastructures. MER has supported the establishment of centres for research of the impact of science in Norway that contribute to informing policy makers on developments in science and innovation through the FORINNPOL programme at the Research Council Norway (RCN). This programme funds the R-Quest centre at the Nordic Institute for Studies in Innovation, Research and Education (NIFU), and the OSIRIS Institute at the University of Oslo. The influence of the ministry is further extended through its responsibility over two subordinate institutions: RCN, the government agency responsible for awarding grants and advising the government on science policy; and UNIT, an agency in charge of digital infrastructures supporting research and education in Norway.

Within the DSIP space, MER is in charge of setting the strategy for governing the access to research data and publications, which involves data management plans and standards, as well as funding and access models; and providing resources that enable Norwegian research communities to participate actively in frontline international research. The ministry is also responsible for promoting greater administrative efficiency and use of shared services within agencies and organisations under its portfolio.

4.1.2. The Ministry of Health and Care Services

Norway's health sector accounts for a sizeable proportion of R&D expenditures. Most of it under public control, it is also a key driver of innovation in the public sector and a source of major data resources relevant to various DSIP systems. The Ministry of Health owns a number of digital infrastructures collecting and sharing data on patients and clinical trials: patient journals, central health registers, national medical quality registers, biobanks and databases of public health studies. Some of these are long-standing infrastructures, e.g. the National Health Net, a digital system for healthcare specialists. Others, like the common

patient record platform Helsedata, are still being under development. In 2016, the Ministry launched a project aimed at the development of an integrated digital healthcare system serving multiple stakeholders by supporting healthcare research, improving financial management and governance at relevant public institutions and stimulating innovation and commercial application of research in life sciences (Vestli, 2018; Oderkirk, 2016). The project will include a set of measures covering among others the establishment of a national service provider responsible for the framework for developing digital tools for the healthcare sector. The report of the Directorate of eHealth (2017) calls for outsourcing tasks on the national service provider to private vendors and a greater degree of co-operation with public and private organisations in digitalisation of healthcare.

The Ministry of Health and Care Services currently cooperates with several Norwegian government agencies on interoperability issues and the development of digital infrastructures. A joint project with the RCN targets the development of Health&Care21 Monitor which collects data on the funding and impact of research and innovation activities related to health and care in the Norwegian research system. This information can be further used by researchers and policy makers to map trends in research and innovation and apply this knowledge to strategic planning. One of the objectives of the Health&Care21 Monitor is to improve the health research classification system (HRCS) to be able to relate research activities to diseases and health categories in a more precise manner. To support this work, RCN launched a project to develop algorithms that analyse keywords in research abstracts and based on the results of this analysis organise research publications into thematic areas. The Ministry is also expanding co-operation with UNIT to incorporate data on clinical trials and to strengthen the interoperability of biobanks and registers of ethical committees with the Cristin system (see subsection 4.3.3 below).

The creation of new national digital systems for healthcare goes in hand with governance changes in the Ministry of Health and Care Services. In the Action Plan for Implementation of the Health&Care21 Strategy (2015), the Government set an objective to increase innovation in the healthcare sector through the adoption of new technologies, changes in governance, and amendments to regulations. A greater emphasis was put on monitoring and evaluation of subordinate institutions. In co-operation with NIFU (see section 5) the Ministry is working on improving R&D statistics for the hospitals and the development of a system for measuring innovation activities. It promises to improve the design of statistical indicators through modern techniques for data collection and analysis. The application of digital technologies are expected to streamline workflows and provide timelier insights on the granular impacts of research and innovation activities.

4.1.3. The Ministry of Trade, Industry and Fisheries

The Ministry of Trade, Industry and Fisheries (MTIF) is responsible for industrial and fisheries-related policy. The ministry develops and oversees the administration of the framework for policy regarding Norwegian business activities. The ministry promotes trade, research, innovation and entrepreneurialism, coordinating efforts across various ministries with a stake in industrial policy. Some of these areas of responsibility imply an interest in the overseas activities of Norwegian companies, highlighting the importance of data beyond the jurisdictional boundaries of the country. Information on the framework conditions faced by Norwegian businesses is another key driver of data and information needs.

The ministry commands the third largest R&D budget after MER and the health ministry. It also provides a quarter of RCN's funding and is responsible for the technical-industrial

public research institute (PRI) sector (OECD, 2017b). Major STI-related agencies that depend on MTIF include Innovation Norway (alongside county authorities), the Norwegian Industrial Property Office and the Norwegian Export Credit Guarantee Agency.

As previously noted, MTIF plays a central role not only within the DSIP landscape but on the overall digitalisation of Norway's public sector since one of its responsibilities concerns the oversight of the BRC and its organisational and business registers.

4.1.4. Common aspects across ministries

Information for policy making

Access to interpretable, granular and timely data is a common interest of ministries. Data feed into several processes within ministries, including briefings for senior officials and ministers, costing of policies, and as input to international negotiations, to cite a few examples. Some intended applications may require a considerable level of detail, for example, being able to identify how much government funding a given company has received from different public sources for the purpose of research and innovation.

MTIF has been investing in the development of a database on grants for business. The Government Aid Register is a national register of public aid grants created in 2016 to help Norway comply with rules on public support set out in its EEA Agreement. The register seeks to provide greater transparency around public support, making it easier for public authorities considering granting public support to obtain information about a business' pre-existing use of other public support that might be relevant to the assessment of further support. Furthermore, information in the register could inform policy formulation, and provide Norwegian authorities and the EFTA Surveillance Authority (ESA) with an overview and control of public support given in Norway. The registration obligation applies only to public support within the scope of the EEA Agreement, i.e. single grants of EUR 500 000 or more. However, donor agencies have the option to declare in the register support below this amount and make effective use of it.[21]

Norway's statistics bureau currently manages a database and produces on behalf of MTIF a series of statistics to monitor public support to national R&D and innovation activity in the business sector and provide information about the providers and recipients of public support.[22] This type of statistical information (see Table 4.1) would be relevant for other countries to produce under rules that allowed for international comparability in an OECD context.

A major usability challenge for this type of information identified by Norwegian officials relates to the ability to map pass-through funding and outsourcing, e.g. when funds go to public research institutions as primary recipients and businesses carry out part of the work, or the converse, when business are beneficiaries but they outsource some of the work to public research or higher education institutions. Being able to trace these relationships is of great importance when assessing the true extent of private sector engagement by the publicly funded research base. One additional potential area for development is to ensure that all types of transactions between government and business other than grants can be documented and captured in an integrated system. Being able to map payments for goods and services provided to public sector organisations would allow innovation activities to be better captured and the impacts of different types of government support and exchange to be identified.

Table 4.1. Government support for business in Norway, 2018

Public support for business R&D figures reported by Statistics Norway using administrative register data

	Largest agency / scheme	Second largest	Third largest	Total support (NOK million)
Subsidy category	Skatefunn (R&D tax incentive)	Research Council of Norway	Innovation Norway	13 086
Loans and guarantees	The Norwegian Export Credit Guarantee Agency	Innovation Norway	Export Credit Norway	20 315
Equity investments	Investinor			561
Services	SIVA	Innovation Norway	County municipalities	114
Network development	Innovation Norway	County municipalities	SIVA	253
Promotion	County municipalities	n/a	n/a	55
Total support	Skatefunn (R&D tax incentive)			34 384

Note: Amounts are as reported by SSB. No metadata available on the quantification of support methods used. Figures are provisional.
Source: Statistics Norway, 13 June 2019. https://www.ssb.no/en/statbank/table/12639/tableViewLayout2/

Evaluation

Ex-ante and ex-post policy evaluation are common major ministerial interests that require the adoption of digital sources and methods. In the interviews carried out by the OECD case study team, Norwegian officials highlighted this as their main direct point of contact with data on STI and DSIP solutions. Their understanding of the possibilities and challenges of using microdata for such purposes is very good, revealing actual experience into commissioning and using related work. Two main challenges were identified: a) securing access to the data for the analysis; and b) procuring the services of teams with sufficiently good analytical skills to carry out the necessary work in support of the assessment.

The evaluation assessment work requires bringing together different sources that are not under the direct control of the ministries themselves. This therefore requires inter-institutional agreements that can be sometimes hard to reach, while technical considerations may complicate the task of data linking owing to lack of common identifiers in some instances. Such agreements have to take a view of access and potential charging policies that recognise the requirements of the various underlying databases.

A common question is how to address in a coherent fashion a specific set of questions to inform a policy question at a point in time while ensuring that the databases brought together to that end can be used more widely and remain up to date for other internal or external uses. Effort duplication is a key concern.

4.2. Funding and promoting research and innovation

Research and innovation funding agencies occupy a key place in the DSIP landscape because of the combination of strategic and operational roles in the pursuit of their funding and support missions. This also allows them to become major repositories of information about the Norwegian system. Data about their operations is also crucial for demonstrating to their parent ministries how they acquit themselves in fulfilling their tasks as institutions and on a programme or project basis.

4.2.1. The Research Council of Norway

The Research Council of Norway (RCN) serves as the chief advisory body for government ministries on research policy issues, and distributes roughly NOK 9 billion to research and innovation activities each year. It has ca 460 employees, mostly based in Oslo with regional offices in various parts of Norway, as well as a liaison office in Brussels. At the time of conducting the fieldwork for this case study, the RCN was undergoing a process of re-organisation.

As part of its mandate for funding and coordinating research and promoting Norwegian participation in international research and innovation activities, the RCN has a key position in Norway's science and innovation system. In pursuing its functions, it collects large volumes of data on research and innovation activities. The RCN Project Databank contains statistics and information related to research projects funded by the Research Council since 2004. Users can retrieve information about funded projects that meet their search criteria as well as generate customised statistics to fit their needs for information.[23] However, large volumes of valuable data collected and stored by the Council remain undiscoverable, both for external and internal users, owing to database fragmentation, data access regulations, and the lack of common data formats.

RCN has a strong evaluation culture covering multiple dimensions and encompassing in some instances ground that is not covered by its counterparts in other countries:

- Evaluation of RCN`s own activities (i.e. own programmes, activities and other funding instruments) is conducted on the initiative of the Council's governing bodies, and in fulfilment of reporting obligations to government and parliament.
- Institute evaluations cover research institutes that receive their core funding from RCN.
- Evaluation of political reforms. RCN also administers a number of research-based evaluations of political initiatives and social reforms, often commissioned by the various ministries. This dimension is rather unique to the Norwegian case.
- Subject-specific evaluations provide a critical review of the Norwegian research system in different domains from an international perspective. This requires internationally comparable data for benchmarking purposes.

There is significant awareness of the need to have in place a data infrastructure for facilitating analysis of the RCN's impact and supporting evaluation and monitoring of funded activities. Internal data integration and interoperability with databases managed by other Norwegian government agencies is being extended, as discussed elsewhere in this report. Two types of data needs are particularly salient. Firstly, a more systematic reporting and use of information about the decision-making and resource allocation processes within RCN (including projects ultimately not funded at the margin) could be usefully applied to analysis of its efficiency and impact. Secondly, access to data on linkages about project collaborators and participants (as opposed to focusing on the lead partner) should be improved for conducting in-depth studies on policy impacts and increasing governance efficiency of the RCN. Results of such data analyses can inform policy makers on academia-industry linkages and identify potential synergies between national and international funding.

RCN's latest annual report succinctly points out efforts to render work processes more efficient through digital solutions. In mid-2017, it launched an initiative to use robot process automatisation technology (RPA) in regulated work processes and a pilot project

was launched with help from the University of Oslo to implement procedures to allow simplified notification of changes in projects receiving support from RCN to simplify project follow-up.

From the interviews with the OECD case study team, RCN also alluded to potential interest in extending also the range of methods and solutions applied to its data resources. There had been experimental studies on topic modelling for its projects with the aim of informing the monitoring of challenge driven initiatives, pointing out the relevance of carrying out international comparisons in this area. It was noted that RCN should consider more actively the potential application of AI tools developed within its projects to improving its own efficiency and efficacy. This would enable, for example, to develop better anticipatory intelligence (new trends in R&D performance), improve the identification of potential reviewers, and so on.

4.2.2. Innovation Norway

Innovation Norway (IN) (https://www.innovasjonnorge.no/en/start-page) is the Norwegian Government's leading agency for promoting business innovation and the development of Norwegian enterprises and industry. IN provides Norwegian enterprises with access to a broad business support system as well as financial means. This includes advisory, promotional and network services.

The spatial dimension of knowledge and service delivery is particularly important for IN and, as a result, so is the relevance of mapping local and international networks. Combining local presence throughout the country and outposts abroad is one of Innovation Norway's unique features. Local industry knowledge is a key part of its product offering to help firms grow and find new markets, with local authorities (counties) being the main sponsors alongside MTIF. IN's activities also extend beyond Norwegian boundaries, as it also acts as the Norwegian government's official trade and investment representative abroad, with presence in more than 30 countries. Intelligence on global locations is key for managing the processes of selecting which markets to be active in. Running an extended geographic network is, however, costly. The recent mergers of IN offices under joint management teams with a larger base of customers and partners was intended to bring together cutting-edge expertise and resources, making greater use of possibilities from electronic communication.

A goal-oriented collaboration between IN, RCN and the Industrial Development Corporation of Norway (SIVA) is intended to ensure that Norwegian businesses are offered more comprehensive and expert services. The Norwegian Innovation Clusters programme is one such collaboration. Export Credit Norway (GIEK), GIEK Credit Insurance, and IN have collaborative arrangements for helping Norwegian companies abroad. Collaboration requires the fluid exchange of information across organisational boundaries.

IN is engaged in a process of digitalising its work, internally and together with partners. Matching business customers to advisors and ensuring a uniform level of service quality across offices calls for sophisticated monitoring systems. The OECD DSIP case study team heard about activities to re-assess and redesign the tools that staff use to evaluate projects and the information offered to their sponsor organisations (owners) and society for accountability and as insights. User experience is a key component, as IN is also rethinking its digital platforms and redesigning them, including the self-service tools offered to customers. IN also tracks its ability to attract and retain talent, priding itself to have been named as Norway's most attractive employer by economics graduates in a recent survey.

IN is an active data resource acquirer and developer. It works together with the RCN and MTIF on shared data resources. This is a natural step as they share a number of responsibilities in delivering several public support programmes, for example, Norway's tax relief for R&D in firms (Skattefunn, see Box 4.1). IN is working to secure information on firms with Norwegian banks to better target investments and provision of loans. It has recently embarked on exploring the value of its own and external datasets (such as those provided by companies like vainu.io that accumulate information about companies through web-crawling), and developing algorithms for aiding decision-making and optimising search and retrieval in databases.

Box 4.1. Cross agency collaboration for assigning support for business R&D – the administration of tax relief for R&D (Skattefunn)

The Skattefunn scheme provides tax-based support for companies conducting R&D projects in Norway and is open to all branches. To be eligible for a tax deduction, companies must be subject to taxation in Norway, even if not currently liable for taxation. The tax relief scheme is administered jointly by the Research Council of Norway, Innovation Norway and the Norwegian Tax Administration. Companies must submit their applications electronically via the online service at www.skattefunn.no.

The Research Council is responsible for approval or rejection of the project's R&D content. Then, the Norwegian Tax Administration assesses the costs of approved projects based on auditor-verified documentation before determining the tax deduction to be applied in the annual tax assessment, which in cases of insufficient tax liability by the firm for a deduction to be applied in full, can result in amounts being directly paid to it.

This process generates a trail of administrative processes and data that could be subject in principle to further modernisation in order to deliver greater efficiencies. Potential areas of enhanced efficiency relate to the assessment of R&D content, for which a number of AI-powered computational procedures might help assess the novelty and other attributes of the projects by comparison with previous applications and external corpora (e.g. patent abstracts).

Source: OECD database on R&D tax incentives. http://oe.cd/rdtax

4.2.3. The Industrial Development Corporation of Norway

The Industrial Development Corporation of Norway (SIVA) is part of the public support system for innovation, and owns and develops infrastructure for industry, start-ups and research environments.[24] Founded in 1968, it is a public enterprise fully publicly owned (under MTIF control) whose goal is to improve the national infrastructure for innovation. SIVA operates within four main areas:

- As a professional property developer, SIVA develops ways in which industrial premises can be adapted to regional needs, seeking to reduce the risks faced by new companies;
- Through its engagement in multiple-use premises, it develops activities that aim to facilitate synergy among companies;
- It owns and establishes incubators together with industrial companies, and runs a national programme for incubators;

- It operates as a shareholder in a number of strategic investment and development organisations. SIVA has ownership in 150 companies in total, including subsidiaries.

The OECD case study team did not meet with SIVA representatives. SIVA has several elements in common with the other two organisations described above. Its most recent evaluation took place in 2015, carried out by Menon Consultants.[25] Its 2017 annual report[26] refers to the imperative of professionalising its work process, through digitalisation and automation of various procedures, with the goal to save time and resources on routine tasks. The organisation aims to have access to updated, safe and effective decision support and management indicators. A review of IT structure was undertaken and the intention is to implement a new data warehouse to make information more readily accessible and role-driven to support decision makers in SIVA.

4.2.4. Common issues across providers of support for R&D and innovation

Agencies in charge of providing financial and in-kind substantive support for R&D and innovation are in constant need to reinvent themselves because of the inherently changing nature of their "customers" and the environment in which they operate. This requires a capacity to re-assess their products as well as their processes, to keep them on top of rapidly evolving requirements. DSIP initiatives are at the core of many of the reforms reported but also need to go hand in hand with the appropriate governance and skills to define and implement them.

The drive for greater efficiency from the sponsoring ministries manifests itself in pressures to deliver more with the same or less resources, and to benchmark their performance not only against their own past record but also vis-à-vis other similar agencies in other countries. The case study team heard about difficulties to undertake evaluations of these organisations and the challenges for them to demonstrate their impact under alternative scenarios. Membership of international networks of similar agencies was noted as highly important in this regard.

As part of their interaction with customers, these agencies also have to consider whether they are exploiting to the full the potential of general platforms such as Altinn or at least some of their functionalities (e.g. for authentication purposes).

The governance of databases developed to bring together different administrative sources is a common challenge, as it requires managing the risk of potential data misuse. Reliance on Statistics Norway (SSB) for linking together different forms of data is in some instances necessary but can represent a potential challenge for some types of data uses if access to the newly linked administrative data is subject to additional constraints that are not intrinsic to the access and use safeguards in the contributing databases. Issues such as the branding and ownership of the merged administrative datasets should be clarified, crediting all relevant contributors.

4.3. Policy delivery and implementation – the role of specialised service executive agencies

4.3.1. The Norwegian Industrial Property Office

The Norwegian Industrial Property Office (NIPO) is a government agency under MTIF that handles applications for patent protection, and for trademark and design registration. It promotes awareness of intellectual property rights, providing also a variety of

preliminary search services. NIPO provides its customers with information on technological developments within specific technical fields, and gives prior assessments of ideas for patenting, trademarks and designs. NIPO joined the EPO in 2008 and is a partner in the Nordic Patent Institute, and as such acts as International Searching Authority for patent applications within the international system, PCT. The Nordic Patent Institute also carries out various patent searches and analyses for foreign companies.

NIPO is highly reliant on data-driven capabilities and services, combining internal and external interfaces. In 2003 it introduced a series of digital tools for processing applications. E-filing and correspondence management is possible via the Altinn platform.

International standards in the intellectual property (IP) area keep to a minimum the reporting obligations by applicants and as a result the amount of information that data-driven systems can feed on. There are some areas where the application of DSIP solutions appears to be most promising:

- The streamlining of processes aimed at verifying the identity of applicants and monitoring ownership over IP could deliver considerable efficiencies. Organisational IDs are not formally required and it was also noted that domestic IDs are not relevant for entities submitting applications from overseas.
- The use of AI-related, data-driven solutions to support discovery and help assess patentability and novelty for inventions is also taking place under EPO leadership. The use of new tools to analyse data (e.g. machine learning, natural language processing) promises to increase the value of services provided by NIPO.
- There is ongoing collaborative work driven by analytical considerations, matching NIPO's data with data from RCN and MTIF to inform econometric evaluations of government support for business R&D and innovation.

An area where NIPO recognised potential for extending the use of digital solutions concerns the in-house digital solutions for analysis and visualisation of IP data through relevant, customisable dashboards.[27]

4.3.2. Norwegian Centre for Research Data

Established as a Limited Company owned by the Ministry of Education and Research, the Norwegian Centre for Research Data (NSD) is one of the largest archives for research data of its kind and provides data to researchers and students in Norway and abroad. RCN provides resources for developing NSD as a national infrastructure facility for access to data for research. NSD catalogues all kinds of quantitative and qualitative research data in the social sciences, humanities, medicine and health, the environment and development research.

As a resource centre that assists researchers in issues relating to data gathering, data analysis, methodology, privacy and research ethics, its main objective is to improve possibilities and working conditions for empirical research that is primarily dependent on the access to data. Statistics Norway uses NSD as a channel for data dissemination for research purposes. NSD also manages a database for statistics on higher education on behalf of the Ministry of Education and Research.

NSD also plays an important role in the DSIP landscape through its joint operational responsibility for managing the Norwegian Register for Scientific Journals, Series and Publishers, in collaboration with the National Board of Scholarly Publishing (NPU) (see Box 4.2).

Box 4.2. The Norwegian Register for Scientific Journals, Series and Publishers

The Norwegian Register for Scientific Journals, Series and Publishers is operated jointly by the National Board of Scholarly Publishing (NPU) and NSD on behalf of MER. NSD has operational responsibility. NPU has approval authority of journals, series and publishers. The register shows which publications are recognised in the funding model.

Use of the register (index) for promoting research excellence

Norway's incentive system/funding model for promoting excellence relies on a view of the merits of institutions based on which journals or publishers publish their work. The register or index assigns journals (ca 25 000) and publishers (ca 1 400) considered to meet scientific quality criteria into groups named "Level 1" and "Level 2". "Level 2" is the highest and aims to capture the journals and publishers that are considered to have the highest degree of international prestige, as decided by the thematic panels convened by the NPU, covering 20% at most of all publication channels in a given discipline. The index gives out publication points according to the Level which are then translated to funding.

The work of the thematic panels is partly informed by bibliometric citation indicators such as the SNIP (source normalised impact per paper) journal indicator published by the Centre for Science and Technology Studies (CWTS) at the University of Leiden. This practice differs from recommendations voiced in different fora to abandon journal level metrics (e.g. the DORA declaration),[28] which argue that these would represent inappropriate surrogate indicators. The argument made by Norwegian authorities is that article level citation metrics also present challenges, for example, not being sufficiently comprehensive nor timely, while arguing that the panels are able to examine in detail the extent to which a certain journal or publishers applies the required quality standard, so the assessment is not fully based on journal metrics. One example presented relates to efforts to support open access publishing. When an editorial board decides to leave a publisher and start up a brand new journal under open access principles and identical quality standards, it was reported to the OECD case study team that a panel may assign the same credentials to the new journal so that it is not penalised for lack of historical metrics.

Internationalisation

Since 2015 the Nordic countries have been collaborating to develop a common registry of authorised research publication channels with bibliographic data on journals, series and publishers. Denmark, Finland and Norway have joined their national lists of authorised research publication channels, used for indicators in the national performance-based research funding systems (OECD, 2010). The Nordic List application and database are hosted in a cloud solution and available via a log in solution. Access is restricted to the contributing stakeholders. The data model for the Nordic List is complete and supports publishers, series, journals and conferences, with associated data fields. The list supports metadata, both from the individual lists, and unique to the Nordic List (registration dates, modification dates, history, comments etc.). OECD fields of R&D (OECD, 2015) are added and the connections to fields from the stakeholders are matched. There has been much work in resolving duplicate information in the list.

Source: https://dbh.nsd.uib.no/publiseringskanaler/Forside?request_locale=en

To fulfil its objectives, NSD works to reduce financial, technical, legal and administrative barriers between users and data resources. The Norwegian Data Protection Authority works with NSD for implementing the statutory data privacy requirements in the research community.

4.3.3. UNIT - Directorate for ICT and joint services in HE and research

Created in January 2018 as a grant-maintained public company following the merger of CERES (the National Center for Systems and Services for Research and Studies), BIBSYS, and parts of UNINETT[29], UNIT directly serves MER to develop and maintain digital infrastructures for research and education (https://www.unit.no/).

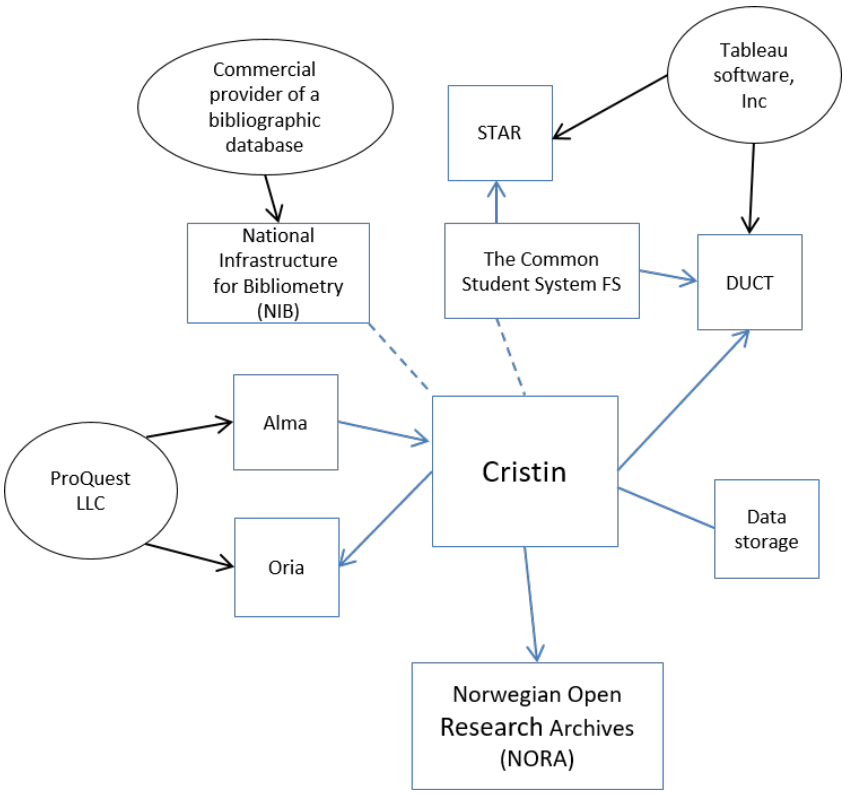
UNIT is tasked with implementing the strategies and guidelines set by MER in areas relating to the higher education sector and other relevant actors, principally the research institute sector and the health sector. Its main tasks relate to:

- portfolio management for the co-ordination and follow-up of national development projects and shared services, developing and managing a common ICT architecture for the harmonisation and standardisation of processes, data and technical interfaces in the university and college sector, and contributing to co-ordination with other relevant actors;
- providing library-related community services for all sectors related to higher education or research;
- providing common administrative systems and services to the university and college sector; and
- providing a database for the reporting of scientific publications to MER and the Ministry of Health and Care.

Currently, UNIT manages a number of databases and digital systems that are parts of the broad DSIP landscape. These include (see Figure 4.1):

- Norway's current research information system – 'Cristin' (described in the subsection below);
- the student administrative system FS;
- a customised version of a library administration system Alma owned by ProQuest LLC;
- a discovery tool named Oria, developed atop of commercial tool Primo Ex Libris (owned by ProQuest LLC);
- Norway's National Research and Education Network (NREN);
- the National Bibliometric Infrastructure (NIB);
- data visualisation and aggregation platforms DUCT and STAR; and
- the Norwegian Open Research Archives (NORA).

Figure 4.1. Solutions managed by UNIT connected to research



Source: OECD, based on information provided by UNIT staff.

UNIT's Digitalisation Board

The purpose of the Digitalisation Board at UNIT is to strengthen the digitalisation of Norway's higher education and research sector through national governance and co-ordination. It also has a steering role for the development of joint services and an advisory function that contributes towards UNIT's role of authority. The Digitalisation Board is expected to contribute to a) the sector's adoption of relevant, stretching and realistic digitalisation strategies and goals; (b) improved goal attainment and faster realisation of digitalisation benefits through faster development and introduction of new joint services, as well as faster reform of existing joint services; (c) better utilisation of resources and new technology.

Its tasks and responsibilities cover the following areas:

- Strategic processes: Recommend digitalisation strategy and action plans, including policies to ensure implementation (management and finance models, organisation).
- Portfolio management: Recommend priorities in the national digitalisation portfolio, including delivery plans; decide scope and financing; and determine prioritisation criteria for the joint portfolio. The board is also tasked with considering major ICT investment proposals.
- Architecture management: Recommend standardisation or changes in law/regulation, organisation, work processes, solution architecture, technical and computer-related standards where this is necessary for the realisation of strategies.

- Management of common services: Decide management model; designate governing bodies for joint solutions.

UNIT appoints the chair of the Board, which includes senior management representatives from universities and colleges (11), research institutes (2), RCN, the regional health authorities' strategy group for research, the state loan fund for education, and the Norwegian student organisation.

The Cristin system

A unique type of Current Research Information System

Norway's Current Research Information System (CRIS) is well known internationally and has to some extent inspired other countries to develop their own national systems. The origin of Cristin can be traced back to 2003, when the Centre for Information Technology at the University of Oslo, in co-operation with several partners (University of Bergen, the Norwegian University of Science and Technology, and University of Tromsø), launched a digital system named Frida to facilitate the registration of research activities for reporting to funders (Lingjærde and Sjøgren, 2008). Frida was used by a limited group of Norwegian HEIs for annual reporting purposes, but after a transition to a new technological infrastructure in 2011 and new governance arrangements, the number of users increased to 158 organisations comprising HEIs, research hospitals and public research institutions. That year, the Frida system was renamed as 'Cristin' and a new body bearing that same name (initially part of the University of Oslo for administrative purposes) was established by the Ministry of Education and Research in co-operation with the Ministry of Health and Care Services to maintain the national CRIS, promote open access and negotiate national licences for digital resources (Karlstrøm & Wenaas, 2014). In 2011, 158 institutional users adopted Cristin to report data on research outputs to relevant ministries. This is an essential component of Norway's research assessment system, for it provides a comprehensive list of publication outputs produced within the publicly funded science and research system outlined in Box 4.2. [30] Cristin also provides policy makers and researchers with an opportunity to link various datasets for statistical purposes to support evidence-informed policy making in Norway (Klausen, 2016).

The Cristin.no site currently allows users to retrieve information on about 18 thousand projects, a million and a half results (principally publications)[31] and 85 thousand personal profiles linked to Norwegian institutions and "sectors". The information reported is considered to be open data and not subject to confidentiality restrictions. Unlike in other European countries where national CRIS harvest data from institutional digital systems, Cristin can be directly used by Norwegian research organisations for reporting purposes reducing – at least in principle – a need to develop in-house solutions. This is believed to save financial resources and streamline administrative workflows of Norwegian R&D performing organisations. Data on research activities submitted to Cristin can be exchanged with other systems reducing manual input of information (Figure 4.1).

Box 4.3. Standards for Current Research Information Systems

CRIS national systems like CRISTIN differ significantly as they prioritise serving specific needs. Other examples of national CRIS systems include the Netherlands National Academic Research and Collaborations Information System, the Lattes Platform in Brazil and Sweden's SweCRIS. In light of these differences, there have been attempts to standardise their development and facilitate greater interoperability across them.

According to a 2018 global survey of research information management systems (Bryant et al, 2018), one of the most widely referenced standards in this area is CERIF, a standard maintained by euroCRIS and promoted by the European Union. CERIF attempts to standardise the data manipulated and exchanged in CRIS systems, using XML to provide a common format that proposes a formal data model, including entities, attributes and relationships between entities, as well as controlled vocabularies.

While participating in CERIF, the managers of Cristin pointed out that the detail and scope of CERIF made its implementation particularly challenging. This was the main reason why its exact adoption was not foreseen in the near future. As standard development cuts across governments, policies and countries, this remains a difficult area of co-ordination in which policy makers need to ensure that there is consistency with related policy and statistical standard setting activities.

As an institutional repository and single point of entry for all Norwegian research, Cristin is a key element in the government's policy to promote open science and open access. It enables the delivery of full text for comprehensive archiving of publication material generated within Norwegian research institutions. Cristin is interoperable with several external digital systems managed by Norwegian government agencies: the project database of RCN; institutional repositories of Norwegian HEIs based on Brage software (an extension of DSpace); an archive Norart of the Norwegian library; and the Norwegian Register for Scientific Journals, Series and Publishers of NSD.

Extending the scope of scientific outputs covered within Cristin

To serve its purpose, Cristin needs to cover Norway's scientific scholarly production comprehensively. To obtain better coverage in the social sciences and humanities, it avoids relying solely on commercial repositories and indexes. This makes Crisitn a particularly interesting model for other countries, in particular those where publishing is principally focused on books and the use of English for titles and abstracts is not the norm. As noted in a previous section, the scope of the reporting system was also recently extended to include a number of scientific outputs in the health domain. However, the mapping of other outputs remains incomplete and will remain so as long as the quality assurance system remains focused on selected items such as publications.[32] The incentive system described in the previous section allocates part of the funding for research institutions on the basis of how many research units are in Tier 1 or Tier 2 publication channels or journals. This is the mechanism that drives reporting of publication outputs.

Pursuing policy objectives that are shaped by comparative performance with scientists worldwide requires global information. Currently, Norwegian government agencies do not have access to world level data on research outputs and impacts that they could use for a range of administrative and statistical purposes. UNIT was commissioned by MER to acquire a national licence to a commercial bibliographic database, so that international bibliographic data can be linked to national datasets for research purposes, statistics and programme evaluations. Given the rapid change in bibliometric resources available for

different purposes, this can be an important and complex procurement exercise that UNIT should conduct with extreme care to avoid potential lock-in into solutions that may turn out to be less than optimal. In light of Norway's policy line on open access and open science, UNIT may also wish to consider the potential use of open data sources.

Towards a more comprehensive mapping of research activities in Norway

Efforts to achieve a more comprehensive capture of scientific research outputs go hand in hand with the mandate to collect data on all research projects in the HE and institute research base. Data on grants from the funding agencies, principally RCN, provide the basis for this. Norway is attempting to go one step further by promoting the reporting of research activity and projects not covered by dedicated grants. This is of particular importance in a research system characterised by a high share of institutional funding, in which general university funds play an important role in funding research. However, current incentives for reporting projects outside the project grant system are limited. Given difficulties in capturing such projects, putting such a system in place will require a considerable change of procedures and incentives, but would have the benefit of providing an even more comprehensive mapping of research activity and ultimately support a better assessment of the funding and incentive system.

Connecting various elements across the STI system

The National strategy on access to and sharing of research data (2018) emphasises the need to improve the quality of data on research outputs as well as its searchability and retrievability through proper metadata curation and publishing of licences with clear rules on how data can be used. In order to facilitate data disambiguation and improve data exchange, Digital Objects Identifiers (DOI) and Open Researcher and Contributor IDs (ORCID) are planned to be issued for all related datasets in the near future. According to the strategy, it is desirable that all categories of users have equal rights to access data at the lowest cost.

Managing transformation in UNIT

The recent strategy for the digitalisation of higher education and multiple demands from other ministries put UNIT at the centre of a large part of Norway's DSIP landscape to which it has already contributed much. Despite several achievements, progress towards fulfilling the objectives set for Cristin has been hindered in the past by challenges to scalability from its previous technological infrastructure. This problem was in part alleviated by the introduction of a REST API in Cristin in 2016. While this rendered data from Cristin more easily interoperable with other digital systems and databases in Norway, relying on an old web server did not allow developers to realise its full potential. In 2018, Cristin migrated to a new technological infrastructure, which provides new features and greater interoperability. This improved flexibility on the part of Cristin to address the needs and constraints of users (including the individuals and organisations providing data) has been especially important in the light of the merger of several government agencies into UNIT in January 2018.

Still, further integration of digital systems for research and education managed by UNIT would deliver greater value.[33] Further work is envisaged to improve the interoperability of systems and to stimulate positive synergies among UNIT's digital tools, which were developed separately by government agencies, research institutions and HEIs. As

previously noted, the rigidity of legacy technological architectures has challenged the transition to a more integrated digital environment.

Improvement of data quality and the introduction of add-on analytical modules can represent a new stage of Cristin's evolution, opening a new chapter in evidence-informed science and innovation policy making in Norway. Through various iterations, there has been significant progress in introducing new tools to support and enhance the use of Cristin's data resources. Examples include the development of algorithms to improve search in the discovery tool Oria, and the introduction of a solution based on a commercial product, Tableau, to visualise information in Cristin.

There appears to be considerable potential for UNIT to make more use of the opportunities provided by cross-government schemes in support of digitalisation, both financially and in terms of best practice guidance, as well as peer support from other parts of public administration – including economic assessment of alternative options and evaluation. Greater involvement of data users and providers in the governance of Cristin can also promote greater buy-in from key stakeholders. Data quality is one of the principal issues raised by users as requiring attention by Cristin managers, but at the same time, Cristin relies on good reporting practices by individuals and institutions.

The Cristin system has become a key feature of the Norwegian DSIP system. The system is still in the process of demonstrating its full potential and fulfilling its vision. As past experience shows, this process faces rapidly emerging demands that may sometimes call into question past decisions, calling for some degree of flexibility in order to avoid overreach and slicing resources too thinly across too many projects. Sustainability questions are bound to arise that call for some stark prioritisation. The long-term strategy may also need to consider whether the Cristin system can itself become a product that Norwegian authorities make use of in the broader context of international co-operation, for instance, in providing services in a more integrated Nordic STI monitoring system or in the context of Norway's active stance in providing development assistance overseas (ODA) in the area of science and research.

4.4. Administration and support to research within the publicly funded Norwegian research base

Operating in a highly regulated arena assigns a significant number of data management responsibilities to the institutions active in Norway's DSIP system. Reducing the burden faced by these organisations and their staff while fulfilling the ultimate reporting objectives is a primary driver for the development and adoption of DSIP solutions. Much of this responsibility is vested in the newly created agency UNIT and the Digitalisation Board. This report has examined the services and infrastructures developed by policy makers and agencies under their responsibility.

Norway's strategy for the digitalisation of the HE sector [34] points out a series of responsibilities for HE institutions in two main areas, which to a large extent also apply to the public research institute and health sector:[35]

4.4.1. Digitalisation for research

Responsibilities in this area include the fulfilment of obligations in relation to open access to research data (including its monitoring); facilities for data usage that allow participation in frontline international research projects; as well as reporting and depositing of relevant material via the Cristin system.

4.4.2. Improving conditions for research through digital-based administration, management and infrastructure

The strategy expects HEIs to make greater use of shared ICT solutions and data sharing, with procedures that allow for data to be reported and stored once and subsequently re-used. The strategy also encourages HEIs to harmonise and streamline work processes, exploring when they can be suitably automatised. The "robotisation" of administrative tasks is explicitly alluded to, but so far all examples found by the OECD team relate to the education dimension of HEI work (for example projects on digital student counselling and use of robots in exam administration).

4.4.3. Skills development

HEIs are identified as principally responsible for ensuring that researchers have the necessary skills to make optimal use of ICTs in their research. The strategy highlights the research dimension of STI work on HEIs. The MER may wish to consider the alignment between its digitalisation strategy for HEIs with their third mission objectives.

Representatives of HEIs that met with the OECD case study team reported challenges in navigating the number of different data infrastructures available and the number of checks required. Training and guidance to manoeuvre within the research data space are perceived as very important and something the authorities should promote further.

Norwegian HEIs are differently equipped to deal with the challenges of digitalisation, by virtue of size, resources and experience, to acquire external solutions or develop their own. The example presented in Box 4.4 highlights the approach adopted by one university (NTNU) to rise up to the challenge of digitalisation. The emphasis placed on attracting and training young personnel to address skills shortages is noteworthy. Norwegian universities also react to the digital challenge by organising themselves into groups within which joint solutions are developed and implemented, seeking to achieve necessary scale.

Despite initial user frustration at handling aspects of the reporting system, it is broadly perceived that the new systems, as they stabilise, are giving way to a new normal in which benefits and efficiencies will be more easily demonstrated.

Box 4.4. An example of IT transformation in Norway's HE sector – the experience at the Norwegian University of Science and Technology (NTNU)

As a result of the merger between NTNU and 3 university colleges in 2016, all IT functions at NTNU were reorganised. All common services were transferred to a central IT department. Following the government's efficiency program for the public sector, with an associated annual decline of 1% in budgets, NTNU reacted to the changing landscape by adopting in 2018 a digitalisation program leading up to 2025 at an annual cost of approximately NOK 100 million.

As part of this programme, in 2019, the equivalent of ca 50 person-years (over 20% of the IT department internal and external human resources) are being redeployed from IT operations to transformational digitalisation tasks. The shortage of a qualified work force with the right skills needed for the digitalisation programme has inspired the NTNU IT department to come up with several new recruitment and competency development approaches. One example is the hiring of a group of junior project managers, combined with a newly established in-house targeted training program including traditional project management using NTNU's resources outside the IT department, and the highly focused and agile Project Administration Method (PAM) developed internally by the IT department, inspired by such diverse sources as Prince 2, ITIL and Togaf.

In addition to this, external partnership development has been an important component of changes in culture and working methods. A fast track was introduced for routine activities with potential for major business improvements. Architecture as well as transformational digital competencies help to select good fast track candidates, and guide them to a successful completion. To be able to use fast track more often, the underlying architecture must allow this, by more easily getting APIs of fast track systems to exchange data with existing systems. APIs are integrated via a Service Integrated Architecture, a relatively low-cost and flexible solution where all new systems connect and exchange data. To ensure better engagement, involvement and understanding of the university's needs, the IT department has established so called Key Account Managers, which are listening posts throughout the university. The Key Account Managers typically work in close relationship with faculty and department management as strategic IT advisors.

Source: Alstad et al (2019). Paper presented at the 2019 European University Information Sytems (EUNIS) conference held in Trondheim.

Public-private co-operation in the DSIP landscape

Participation of the private business sector in maintaining and designing digital infrastructures for science and innovation policy making can be instrumental in ensuring long-term sustainability and functionality of associated digital services. The public sector may lack expertise in digital technologies or may not have access to datasets covering an international dimension of research or innovation activities (e.g. world citation data, research outputs created in other countries). Additionally, the fragmented nature of public datasets and an insufficient proliferation of common data formats in Norwegian government agencies may impede exploitation of data for science and innovation policy to the fullest extent possible. Commercial data brokers and providers of analytical solutions

may help the Norwegian government extract a greater value in cases where it is not able to benefit from its own data sources or where key complementary datasets are missing.

The government's Digital Agenda requires government agencies to outsource IT-related tasks, where relevant. At the same time, the Agenda emphasises the need to streamline procurement activities in order to stimulate innovations and decrease the costs of deployment of digital tools. In 2016, the government published a cloud computing strategy for Norway aimed, among others, at the proliferation of cloud technology in the public sector in cases where it is the most appropriate and cost-effective tool (Ministry of Local Government and Modernisation, 2016). Detailed strategies on the use of other types of commercial technologies and digital infrastructures may contribute to further advancing digitalisation of government activities related to science and innovation policy.

Proprietary digital products are spread over the whole Norwegian DSIP landscape, providing services in data collection, linking, disambiguation, analysis and visualisation. The scope of involved firms is very versatile: technology companies, consulting companies, research information analytics companies, not-for-profit organisations, multinational corporations and technology start-ups. The involvement of the private sector may be justified if the quality of services is higher compared to those delivered by the public sector on its own. In order to strengthen positive effects from the participation of firms in maintenance and design of elements of the DSIP infrastructure, certain actions can be taken. Long-term procurement contracts with large funding may fail to stimulate competition in the market of DSIP solutions and to address evolving needs of versatile groups of users to digitalisation of science and innovation policy making. Therefore, short and medium-term procurement arrangements might in cases be preferable. Contracts with the private sector should ensure that government agencies will maintain control over public datasets and that data privacy is properly secured. It has been noted that imprecise specification may have resulted in unintended loss of control over public data in Norway. This is a major concern not only in Norway but also globally as government and public administrations sometimes find themselves charged, at least in part, for accessing data that was originally theirs. [36] Understanding the importance of such arrangements, the Norwegian government was preparing a white paper to the Storting on public procurement. The white paper on procurement seeks to accelerate innovation and competition in the private sector and to improve the efficiency and effectiveness of public services. An assessment of Norway's public procurement system by the Norwegian Agency for Public Management and eGovernment (Difi) and the OECD highlights challenges for the systematic collection and use of public procurement data (MAPS, 2018), recommending investment in data gathering and performance monitoring.

In order to unleash the innovative potential of the private sector in DSIP area, several further actions can be taken. Although data is perceived by the Norwegian government as a valuable resource and an important input factor that may contribute to diversification of the Norwegian economy (MTIF, 2018), existing data regulations and practices may not be fully stimulating data-driven innovations including the development of IT solutions for DSIP systems.

4.5. UNIT's action plan for digitalisation in Norway's science and research base

Following the Digitalisation Strategy for Higher Education and Research of 2017, UNIT has developed an action plan for digitalisation in higher education and research that covers the entire sector of knowledge, with goals also applying to the health sector and the research institutes. This new plan covers the period 2019-2022, laying out targets and initiatives (see

Box 4.5) oriented towards strategic priorities on a) a learning process for the future; b) open science; c) improved insight and decision support; d) foundations for mobility and sharing; and e) information security and data protection.

In the area of research, the key guiding political initiatives used for prioritising concrete measures are threefold: the drive for open science, the drive for bureaucratic simplification, and the compliance with annual efficiency requirements.

Research administration simplification measures include a general roadmap for delivering shared services for researchers across different institutions; the delivery of continuous support services for research and administrative tasks through the entire research cycle; the facilitation of automated information retrieval and re-use, to avoid multiple registration efforts, through authoritative IDs (individuals, organisational units and projects); as well as guidance and training on the use of shared services.

Box 4.5. Research-related targets in the Action Plan for Digitalisation in Higher Education and Research, 2019-2021

The Action Plan sets targets for researchers and research managers in higher education, health, and at research institutes as follows:

Researchers should:

- have access to research publications, research data and public data as the basis for their work
- make research results (publications, data, etc.) easily retrievable and make them as available for re-use, as possible
- have access to a clear, user-friendly set of services that supports both academic and administrative tasks
- have access to services that make it possible to effectively interact with other researchers across disciplines and sectors, nationally and internationally
- have access to instruction that leads to the expertise needed to exploit the services optimally.

Research managers at all levels should:

- have good access to information and to the information needed for making decisions.

Source: UNIT, https://www.unit.no/sites/default/files/media/filer/2019/07/The-Action-Plan-for-digitalisation.pdf (Accessed August 2019).

Open science measures include the provision of services for storage and management of research data; the facilitation of access to public data for research purposes; services for database collaboration; scientific publishing agreement models retaining copyright vis-à-vis publishers; solutions for the completion of data plans; and simplified access to the publications repository.

Among these measures, it is possible to note a marked preference for developing services based on open source solutions. For example, DataverseNO is an archive service for open research data, owned by the Arctic University of Norway (UiT) and operated by its IT

department and library. The platform is based on the open source application Dataverse, which has been developed at Harvard University.[37]

Also of relevance to research activities, the plan includes initiatives under the headings of management and support services; infrastructure, middleware and data; and information security and data protection. An interesting feature of the overall governance model is the approach to examine whether local solutions can be generalised into shared services, thus achieving greater scale and efficiency. Another is the approach for combining seed funding for development with usage fees to replenish investment funds.

Given the generality with which actions are described, the UNIT Action Plan can be probably best considered as an overarching guiding framework, setting out among other thing the basis for bottom-up initiatives and top down priorities to connect with each other and into funding streams. One example is BOTT partnership, a collaboration between the universities of Bergen, Oslo, Tromsø and Trondheim on common, standardised administrative and technical services and processes to support the organisations' primary activities. In the MER's Digitalisation Strategy previously discussed, BOTT has been given the responsibility to assess common solutions that can be used by the entire university and college sector. The collaboration will release resources for implementing core tasks at these universities and eventually across the entire system. BOTT focuses on deploying co-operation, standardisation, acquisition and organisation processes for administrative data joint ventures, applied to areas such as access control, case management and archive, HR, finance and payroll.

Overall, as it transpires from presentations at the recent UNIT conference on Digital Transformation Conference for Higher Education and Research,[38] it is possible to conclude that Norway's higher education and research sector has made significant progress in terms of data management and making data more amenable to use by decision makers. However, there is rising awareness that the adoption of increasingly sophisticated digital solutions is insufficient without further consideration of how to reorganise practices, culture and competences to attain knowledge-driven organisations.

Chapter 5. The role of STI statistics and statistical data in Norway's DSIP landscape

Earlier on, this report discussed the role of the statistical system in the overall digital and data landscape, highlighting the very distinctive role of Norway's national statistical office, SSB. This section turns to the role of Norway's statistical system in helping policy makers, researchers and the society at large, including the international community, develop a good understanding of Norway's STI system. It also considers the role of the STI statistical system as a possible instrument for data-based STI policy formulation, implementation and ex-post assessment, while potentially contributing to other governance and administrative dimensions of the DSIP landscape.

5.1. STI statistics and statistical data in Norway

The production of STI statistics is distributed across different parts of Norway's statistical system. This is quite common across OECD countries and partner economies. The current allocation of responsibilities reflects a number of factors including historical considerations as well as data availability features that are rather unique to Norway. As noted in previous sections, the availability of administrative data resources, especially in some government-controlled sectors, provides for significant opportunities to collect data, minimising the need for ad hoc inquiries addressed to STI actors. This influences the allocation of responsibility for data collection and statistical reporting.

5.1.1. The production of R&D statistics

Statistics on research and experimental development (R&D) for Norway are based on the OECD Frascati Manual and draw both on data from administrative registers and questionnaires sent to the R&D performing units in each sector.

- The survey on R&D activity in the business sector is conducted by SSB[39] and covers all companies with 50 or more employees and a sample of companies with at least 10 employees. The coverage of micro-companies is therefore an issue subject to periodical investigation to ensure that important pockets of R&D performance in very small firms and start-ups are not missed out.
- In the higher education sector each individual department or corresponding equivalent unit is surveyed by the Nordic Institute for Studies in Innovation, Research and Education (NIFU, see Box 3.1) every second year. These data are supplemented by information from other surveys on staff time distribution, administrative data on personnel and expenditures from the institution's central administration, as well as data from RCN and the medical foundations.
- The institute sector is fully covered by surveys also conducted by NIFU following similar procedures to those highlighted for HEIs. R&D in museums is estimated.
- Statistics on R&D resources in university hospitals and other health institutions (the health "sector") are collected through a separate reporting system recently integrated in the national statistics system. Health trusts and research institutes are the only government institutions surveyed for the purpose of compiling performer-based R&D statistics.

The distribution of production roles for R&D statistics between research centres and national statistical offices has followed a similar path to many other European countries. SSB took over the production of R&D statistics for the business enterprise sector in 1991 from the former Royal Norwegian Council for Scientific and Industrial Research (NTNF), a research funding agency focused on the technical and natural sciences and industrial research, which went on to be integrated into the current RCN. As STI statistics have become mainstream, it has been perceived as necessary to make full use of the statistical powers of national statistical office to collect data from businesses.

NIFU is responsible for compiling the information for different sectors into annual national totals for Norway. These statistics[40] are updated typically shortly after the release of provisional statistics for the business enterprise sector. NIFU's R&D statistics bank[41] comprises indicators on the following dimensions.

- National R&D statistics (expenditures and personnel (FTE and head counts)).
- Government budget appropriations of outlays for R&D. Statistics on government budget allocations for R&D are produced by NIFU and reported broken down by ministry, primary recipient and socio-economic objectives, based on an assessment of the annual state budget.
- Norwegian funding of R&D abroad. This is a dimension of R&D statistics that is often neglected in many other countries and that provides useful information on international collaboration from a domestic and international perspective. Nordic R&D statistics (expenditures and FTE) and international R&D statistics and indicators (expenditures and FTE), drawing on data from Eurostat and OECD (although not explicitly sourced within the data).
- Key figures for research institutes (income, annual results, FTE, publication points, indicators).[42]

Box 5.1. The Nordic Institute for Studies in Innovation, Research and Education (NIFU)

The Nordic Institute for Studies in Innovation, Research and Education (NIFU) is an independent social science research institute, organised as a non-profit foundation. Its roles combine statistical and research work. Formally created in 1961 as a Research Division of the Norwegian Research Council for the Sciences and Humanities, it became in 1969 the Institute for Studies in Research and Education and then the NIFU foundation in 1996. In 2004, NIFU merged with the STEP group (Studies in Technology, innovation, and Economic Policy) to make the most of the synergies between these organisations and their complementary areas of expertise. STEP was a research and policy centre stemming from the NTNF research program on Future-Oriented Technology Policy, initially set up as a research group within the Norwegian Computing Center.

The consolidated NIFU is funded through multiple sources. MER, via the RCN, provides the largest share of funding. Its research work is structured into the areas of higher education; research and innovation; and primary and secondary education. This research mission implies that NIFU is subject to the reporting and performance requirements laid out in previous sections. A fourth research area devoted to statistics translates into national responsibility for collecting, processing, interpreting and disseminating national R&D statistics and indicators for the overall Norwegian R&D system. Tasks include the preparation of R&D statistics and development of new indicators, managing the register of research personnel, as well as facilitating and analysing patent data and data on scientific publications (bibliometrics). NIFU aims to contribute to the development of indicators for the purpose of informing research and innovation policy in Norway as well as internationally. It is an active participant in statistical co-operation at European and international levels, including the OECD. Through its history, NIFU has contributed to the development and implementation of a number of STI measurement standards and databases. The R&D statistics work at NIFU is funded by MER via the RCN under special agreements subject to periodic review.

Statistical production and research work are closely intertwined at NIFU. This provides a number of positive synergies based on enhanced understanding of the subject matter and the application of data. On the other hand, this requires NIFU and other government organisations that procure services from it to ensure that other potential bidders to carry out statistical, research or evaluation work are not discriminated against while NIFU is allowed to pursue its own scientific publication and related objectives for which it is also held accountable. Biennial bidding requirements for its statistical responsibilities imply a certain degree of uncertainty for planning infrastructure-based operations over the long-term operations.

As an organisation, NIFU is also facing the challenges and opportunities from digitalisation. NIFU might also benefit from some of the generic support possibilities on offer within the general government digitalisation agenda and the research sector in order to fulfil its research and statistical functions within a rapidly changing environment. Co-operation with other similar research groups abroad and with HEIs for skills development may also be of considerable utility when grappling with new phenomena and challenges.

5.1.2. Other STI statistics

Statistics on human resources and STI

Norway does not have specific data collection activities in the area of human resources for STI. It uses its rich administrative data and data from generic surveys to fulfil general requests for information in this area. This limits to some extent the ability to probe in some detail the nature of the STI activities of the population, as general administrative and statistical sources do not contain information for example on whether an individual is engaged in research or other innovation related activities except for individuals within specific communities (e.g. academia). For example, new indicators on companies with researcher involvement are based on information on data about whether a start-up employs HEI personnel with a minimum qualification attainment level. On the other hand, administrative data enable very good quality longitudinal data. Graduate surveys could be potentially used more actively to serve the needs of research policy – especially in the area of doctorate education. It is expected that a new doctorate recruitment monitor tool will facilitate the production of statistical information in this domain, complementing existing surveys for master's level candidates *(Kandidatundersøkelsene)*.

Innovation and technology statistics

Through its involvement in the production of the first edition of the Oslo Manual in the early 1990s, Norway has been at the centre of developments to promote the measurement of innovation. Norway's STEP group (see Box 5.1) had placed a strong emphasis on empirical work, and on using statistical sources with an economy-wide basis. Their strong criticism of the available data sources at the time prompted them to develop new approaches to measuring innovation inputs and outputs. They trial-tested them with support from NTNF and in collaboration with other groups and researchers working along the same lines in other countries. Workshops were held, in Oslo and at the OECD, and in 1992 a draft manual was written by STEP on how to collect and analyse business innovation data, which provided the basis for the OECD's *Oslo Manual* that was formally adopted and published in that year.[43]

Responsibility for the production of statistics on business innovation evolved along similar lines to R&D statistics and have now been produced for several years by SSB through a regular, dedicated business survey which until recently used to be carried out in combination with the business R&D survey. The survey is conducted in alignment with the CIS every two years and results are published at the end of the year after the reference year.

SSB has used in the recent past quasi experimental methods to collect evidence on the framing effects of asking questions on R&D when collecting data on innovation, as well as the role of mandatory versus optional surveys. This work was influential in the decision to move away from a single combined survey, providing an important contribution to the revision of the Oslo Manual and the release of its fourth edition in 2018.

SSB is also involved in the production of statistics in collaboration with NIPO. A very succinct data release[44] reports number of applications for patents, design and trade marks to NIPO in 2017 and the growth rate with respect the previous year. This report comes with hardly any supporting information about the data presented. It also lacks references to alternative sources of IPR statistics, domestic or international sources that capture registration behaviour by Norwegian residents. The combined report on R&D, innovation, and IPR statistics for the Norwegian business enterprise sector appears to have more background and detailed information.[45]

Norway's statistical system does not produce data or indicators on technology use other than for ICT surveys, which are outside the scope of this study. Information on biotechnology or nanotechnology use in firms is currently lacking for Norway.[46] The new standalone business innovation survey might be a suitable platform for collecting information on the use of technologies of interest to STI policy makers.

5.1.3. Statistical reporting and dissemination

The main consolidated reporting of STI statistics in Norway takes place through the Report of Science and Technology Indicators for Norway ("The Indicator Report").[47] This is produced by NIFU in collaboration with SSB and RCN, which funds and publishes the report. The abridged English version is published biannually. The latest edition was published in December 2017. An editorial committee includes representatives of these organisations as well as Innovation Norway, SIVA and the University of Oslo.

Published since the late 1990s, the report is based upon the results from the national R&D and Innovation surveys as well as other statistics and studies. Time series and international data are also included. The purpose of the English version of the report is to present an overall description for non-Norwegian readers of the status of Norwegian activity in research and experimental development, higher education, science and technology. The Indicator Report has a parallel web publication that has recently become the main channel for publication and dissemination.

In addition to this report, MER has since 2011 published on an annual basis the Forskningsbarometeret (i.e."Research barometer"),[48] a website and a report fully dedicated to statistics and indicators for research and innovation. The 2018 report seeks to shed light on R&D efforts in areas within the priorities in the long-term plan. Since the plan is relatively recent, the indicators are effectively intended as a benchmark. The interest in special thematic areas relating to government priorities is common across the two publications.

The OECD case study team heard alternative views about how the two STI indicators publications complement each other. The Research barometers contains no policy statements other than those contained in the foreword by the responsible minister. Drawing on the same or very similar sources and presenting also very similar findings, the publications may be found to compete for user attention although the timing of publication is sufficiently separate within the year to allow drawing attention to different elements in their fairly consistent description of the research and innovation system. It was noted that the Research barometer serves as a gateway to statistics on research and innovation for those approaching the issues from a policy perspective through the Ministry's webpage, and its development provides an opportunity for internal discussion and professional development among policy officials. Since the OECD team is unaware of similar arrangements in other countries, it may be advisable for the various actors involved in these two publications to come to an agreement on how to differentiate them to help them achieve their shared objectives in a most cost-effective possible fashion.

5.2. Statistics-based research on STI issues

The role of statistics is not only to generate indicators. Much of the value of statistical data stems from its secondary use for research and related analytical purposes. This section presents two examples that highlight some of the features of the role of statistical data in Norway's DSIP system.

5.2.1. Oslo Institute for Research on the Impact of Science

The Oslo Institute for Research on the Impact of Science (OSIRIS), funded by RCN's Forinnpol programme, is hosted and led by TIK Centre for Technology, Innovation and Culture at the University of Oslo. It principally partners with SSB domestically and with two organisations abroad.[49] OSIRIS has a sister centre called R-QUEST, hosted by NIFU. This centre is dedicated to state-of-the art studies of quality in research.

The institute has a strong interest in the use of multidisciplinary methods and use of qualitative data. It has, for example, used impact case studies based on the UK Research Excellence Framework template for the evaluation of social science institutes, emphasising different types of impact and highlighting various grand challenges (peace, social welfare etc.).[50] Digitalisation opens avenues for the quantitative study of qualitative information.

5.2.2. Evaluation of STI programmes involving SSB

As noted earlier, there is a strong culture of data-informed evaluation activity in Norway. SSB is a rather distinct central NSO given its active involvement in undertaking evaluations of government policies and programmes. Such a status has been confirmed in the recently passed statistical legislation, as noted in section 3.3.

This Norwegian specificity is indeed apparent in the area of STI policy analysis, where it is feasible to link together different databases that contain information relevant to one or more elements of the impact model underpinning STI policy evaluation requirements. This means that it is possible to combine information on the exposure of individuals or organisations to policies (from administrative data) to data on research and innovation activities (e.g. survey data reported to SSB or administrative data reported to authorities in fulfilment of obligations) and then to data on outcomes of potential interest (e.g. financial data). These linkages are enabled by the widespread use of common identifiers in a majority of cases (as well as ad hoc work that renders then interoperable) and the availability of "safe" spaces where such linkage can take place in compliance with the legal arrangements that apply to each database separately. SSB thus play an important role as data clearing house.

For example, SSB has published reports on the input additionality[51] of the Skattefunn R&D tax credit scheme in 2007 and on the relationship with other innovation policy instruments.[52] This was followed by work on the effects on patenting and innovation. In 2015-16, SSB carried out an evaluation of the effects of Innovation Norway's public policies to support R&D and innovation activities in the business sector. The evaluation was carried out on behalf of the MTIF and is documented in Cappelen et al. (2015).[53] In 2018, SSB published an econometric-based evaluation of SIVA's services to Norwegian firms following in the earlier evaluation work.[54]

SSB has also supported evaluations carried out by third parties. The Ministry of Finance commissioned the private consultancy "Samfunnsøkonomisk analyse AS" to conduct a full evaluation of the Skattefunn programme, including its interaction with other innovation support instruments. Its results were published in June 2018.[55] As Box 5.2 shows, several SSB and administrative databases were used in support of the evaluation.

Box 5.2. Types of data used in the evaluation of Skattefunn – making the most of data linking opportunities in Norway

The Skattefunn evaluation makes uses of an impressive array of different data sources combined to address a wide range of incidence and impact questions. These include:

Company accounts statistics: The accounts statistics contain information obtained from the income statements and balance sheets of joint stock firms, including information on operating revenues, operating costs and operating profit/loss, labour costs, and the book value of the firm's tangible fixed assets, their depreciation and write-downs.

R&D (and innovation) statistics: The R&D statistics are survey data collected by SSB every second year up to 2001, and annually after that. These data comprise detailed information about firms' R&D activities, i.e. total R&D expenses divided between own R&D and purchased R&D services, the number of employees engaged in R&D activities and the number of full-time equivalents working in R&D. The 2001, 2004, 2006, 2008, 2010 and 2012 editions are combined with the Community Innovation Survey (CIS) and contain information on whether firms have introduced different types of innovation over the three-year period preceding each survey. Information on several types of innovation protection including patent applications, trademarks, design and copyright is also available from the CIS and used in the analysis.

The Register of Employers and Employees (REE): This register from Statistics Norway contains information about each individual employee's contract start and end, wages and contract working hours. Since both the firm identification number and the personal identification number are included, these data can easily be aggregated to the firm level.

The National Education Database: This database from Statistics Norway includes individual-based statistics on education and contains information on the level of attainment of the person. This allows building an estimate of education levels within each firm.

Skattefunn project database: This is RCN's database with information on all Skattefunn projects' applications, i.e. who is the project leader (with firm identification number), the budgeted cost by item (personal cost, purchased R&D from an approved R&D institution, equipment, other costs), start and the end of the project, collaborative partners, description of the main goal, etc. Both approved and not approved projects are registered in this database, allowing comparisons by treatment status among applicants.

Tax register: The Norwegian Tax Administration's database contains information on all Skattefunn beneficiaries, such as the amount of R&D expenditures eligible for the tax credit in the given year, the applied deduction rate (i.e. 18 or 20 per cent), the total amount of tax credit obtained and the amount ultimately paid in cash or remitted from due taxes.

Database for public support schemes: This is Samfunnsøkonomisk analyse AS's database established for MTIF. The database is a compilation of project data from 16 public funding agencies. All observations are categorised according to the type of support provided (grant, loan, equity investment, etc.) and the kind of activity supported. This allows for comparisons across funding agencies.

Source: Samfunnsøkonomisk analyse AS (2018). Accessed from: https://www.regjeringen.no/contentassets/b8f109e6ae9c4809b21773f9b5168f00/evaluation-of-skattefunn.pdf

SSB is able to put in place secondment-like arrangements that allow staff experienced in microdata use to contribute to evaluations commissioned from private enterprises while temporarily working for the company in charge of conducting the evaluation. It would be useful for other countries to better understand how such arrangements can be put in place if this is something they consider relevant implementing within their own systems. The overarching impression of the OECD case study team is that such arrangements are only possible under conditions of considerable institutional stability and high trust among participating organisations.

5.3. Outlook for STI statistics in Norway

A major finding of this case study of relevance for other countries is the centrality of the statistical system and the components that deal with STI-related phenomena to the national DSIP landscape. The Norwegian model presents a clear example of an NSO playing a central role as STI data clearing house, an aspiration for several other countries.

This role is in large part enabled by SSB's powers to provide data services of relevance to policy makers that require previous sensitive data handling operations. Data linking is also a more sensitive operation when using IDs that are not in the public domain – once a link is done and identifying information is removed data are less sensitive. In small economies and when dealing with organisational data, it is virtually impossible to ensure full confidentiality. Lack of legal clarity even in instances that may appear straightforward may result in there being no option but for analysis to be carried out within SSB. In the case of Norway, it is a significant achievement that the leading NSO is willing and capable of undertaking such a task. A potential downside is that this might in turn reduce the opportunities for other parties to engage in research and provide derived analytical services. As Box 5.3 highlights, data development requires collaborations whose long-term governance can raise a number of challenges given the multiple linkages between upstream and downstream data-based operations.

It is important to build trust-based relationships to facilitate and accelerate collaborations. Over time, staff mobility may pose challenges to a number of trust-based collaborations while publication incentives and legal constraints may accentuate competitive pressures.

A principles-based system that works in full alignment with the legal system may help practitioners plan with greater certainty future collaborations and provide a firmer base for developing sustainable data infrastructures. This requires a clear understanding of confidentiality and privacy provisions applying to individual databases; agreement on possible uses and accessibility that will apply to resulting outputs; delimiting use for descriptive statistics, research and evaluation purposes; consensus on a mechanism for recognising / giving credit for the input of contributing parties; and considering third party requests for the use of the databases developed. Potential conflicts of interest should be considered actively at all levels of governance. Trust and integrity are fundamental assets for the Norwegian DSIP system that all parties involved should strive to preserve and make more resilient as the topics it deals with attain greater levels of political and social importance. Lessons from the experience in other highly exposed areas should be taken into account.

Box 5.3. Challenges managing data resources across organisations and over time

As noted elsewhere in this report, the OECD case study team witnessed several instances of long-standing inter-institutional collaborations in which parties invest in data development and analysis for multiple purposes, which may include not only indicators but also research and possibly evaluation.

As the relatively most efficient mechanism for new data development, data linking is one of the key activities within the scope of inter-institutional collaboration. For example, NIFU, SSB, and NIPO have collaborated to ensure a single common version of the linked IPR and company database called FlipdOPEN[56] (Iversen et al, 2016). FlipdOPEN is based on cumulative work dating back to the late 1990s carried out by NIFU with sponsorship from the World Intellectual Property Organization and RCN. Currently, NIPO takes responsibility for most of the update work in collaboration with SSB, and NIFU on quality-checks and other aspects requiring co-ordination. There are concerns within the community that this database containing purely open administrative data is not openly accessible and the database has not been released after it was effectively launched in 2016. The data has been made available to the research community via NIPO rather than SSB.

As reported to the OECD, there are outstanding issues of attribution, data ownership and appropriate confidentiality regime in this and related cases. In the FlipdOPEN collaboration, SSB is in charge of linking the verified firm IDs with industrial categories, size-classes etc. using public administrative data (see https://www.brreg.no/home/). Access to this information is however challenging for research organisations, suggesting that the access regime should be based on fundamental confidentiality features of the data rather than on the general confidentiality regime of the organisation responsible for data linking.

The new law on official statistics should enable use of statistical data by public and private entities and the public at large to the greatest possible extent, taking into account privacy and confidentiality requirements as well as intellectual property rights. These needs are ever present in the domain of STI statistics and analysis. This study perceives a widespread demand for procedures related to STI data access that are transparent and cost-effective. Legal frameworks for data access and use should be accompanied by technological solutions ensuring sufficient levels of data safety and security, while providing necessary means for users to extract value from datasets.

Chapter 6. Main conclusions

6.1. Using digital technologies to improve the design and implementation of STI policies in Norway

The statement in Norway's digitalisation strategy for the research sector that "digitalisation can be as much of a game changer as it has been in other sectors" reveals considerable opportunities for the digital upgrade of Norway's science and innovation policy and administration. Understanding Norway's readiness for this transformation has been the key motivation for this case study of its DSIP landscape. Government authorities with responsibilities for science and innovation are expected to promote the core principles of science and innovation activity in applying evidence-based decision making to their own areas of responsibility. Based on the observations of the OECD case study team, there are a number of areas for potential future reflection for the Norwegian authorities and other key actors in the DSIP landscape.

Build on unique strengths around digital public administration, interconnected registers and a culture of evaluation.

Norway possesses a number of rather optimal and unique conditions that are demonstrably conducive to the development and implementation of digital practices into its science and innovation policy, governance and administration. It benefits from a strong legacy of comprehensive databases comprising administrative records built on a trust-based societal consensus in which citizens and organisations based in Norway directly perceive benefits from having data about them used by public authorities to provide an extensive portfolio of services over their lifetime. Use of individual and organisational IDs managed and protected by the Norwegian government enable substantial database interoperability within the country. Norway has a strong accountability and evaluation culture, and science, research and innovation policy instruments in Norway undergo rigorous periodical evaluations (OECD, 2017a). Norway also has a long-standing interest in the study of innovation policy and has invested considerably in this area over the past decades.

Review horizontal co-ordination with broader government digital initiatives, while allowing for the necessary flexibility to adopt solutions better suited to the management of science and innovation policies.

Despite these tailwinds for digitalisation in STI, there is a wide appreciation within Norway of the need and opportunity to address inefficiencies, often arising as a result of fragmentation and limited scale. The HE and Research digitalisation strategy reflects Norway's intention to emulate neighbouring countries's early adoption of coordinated digitalisation measures in this area. The Norwegian DSIP landscape shares several features with the broader digital government landscape and would benefit to some extent from greater alignment with horizontal policies. Having said that, there is broad consensus even among the Norwegian custodians of a horizontal agenda that domain-specific approaches are needed and should be maintained and further developed, owing to technology, knowledge and process specificities of this policy area (OECD, 2018a,b). Norway has developed a single digitalisation strategy for its higher education and research sector. It is desirable that specific sector strategies and the government's overarching digitalisation strategy recognise the specificities of science and innovation policy and administration and allow for the necessary flexibility to address them.

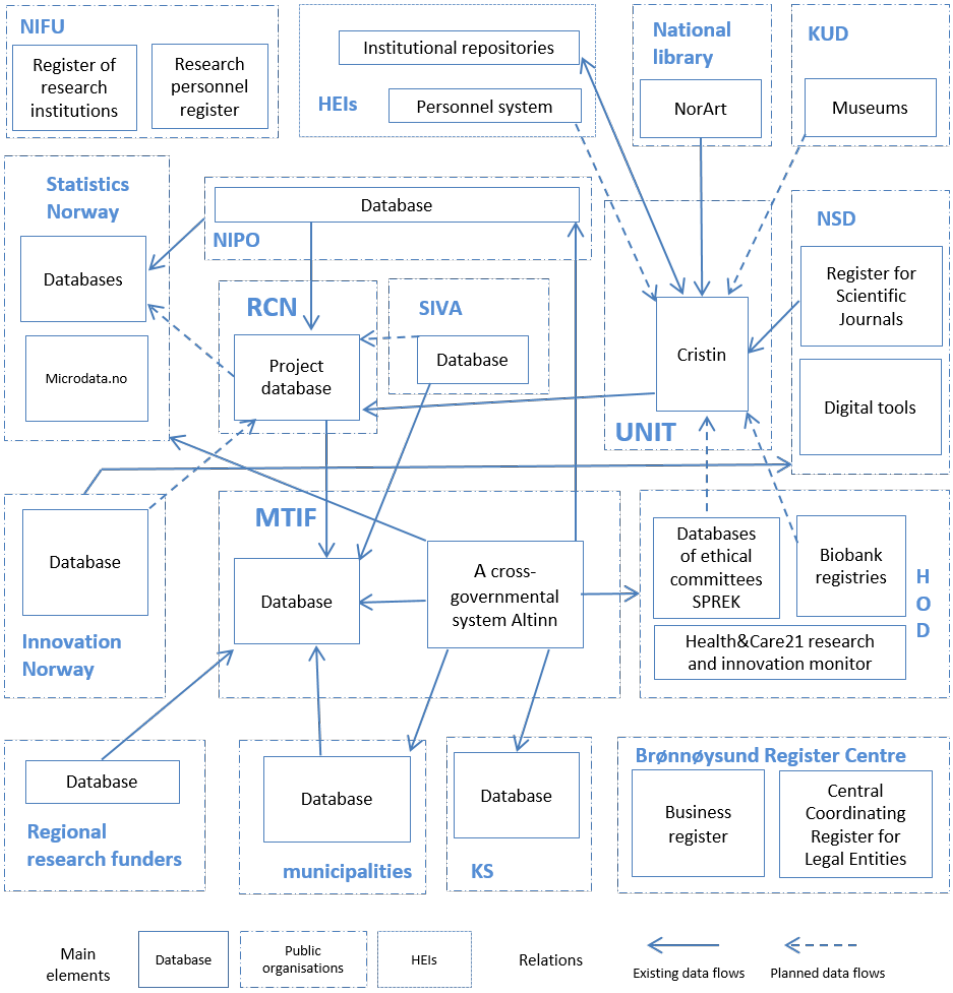
Review the co-ordination among science and innovation actors in designing and maintaining digital infrastructures to avoid fragmentation of resources and creation of isolated solutions with limited interoperability and functionality.

The sectoral approach to policy making and delivery that characterises the Norwegian public sector is a marked feature of its DSIP landscape. This results in some unavoidable fragmentation, which authorities and all actors involved actively manage through fluid communication, facilitated by the proximity of the main actors as well some considerable institutional stability and collegiality. A recent wave of re-organisation across several organisations, affecting the way in which data-driven processes are decided and implemented in the Norwegian administration, reflects a marked degree of non-complacency with the status quo and shows acute interest in exploring more cost-effective arrangements.

The national science and innovation policy agenda in Norway is co-shaped by a select number of government ministries and agencies, supported by government-controlled organisations linked through a complex network of hierarchical data reporting arrangements and procedures, often related to R&D and innovation funding and support more generally. This is reflected in the DSIP landscape examined in this case study. While these relationships are well defined and anchored in related policy documents and regulations, data flows resulting from these interactions are often fragmented and exhibit some weak linkages at times. This might prevent identification of policy gaps and opportunities for positive synergies across government agencies. This governance could also be productively extended to other ministries and agencies with an active role in facilitating innovation policy society-wide, and not only on research policy.

The governance of DSIP activity in the Norwegian system is currently operationalised in separate silos often dealing with one initiative at a time (e.g. specific indicator reports, evaluations, infrastructures, etc.). While there is no fundamental reason for them to be brought under a common governance framework, it may be still useful to formulate some form of inter-agency digital co-ordination working group for STI policy that meets with a certain frequency to discuss and consider in a more holistic fashion the generation and use of data about STI activity in Norway, while helping to overcome resistance to data sharing. The governance of Norway's DSIP system would greatly benefit from identifying all potential uses as well as users and providers of DSIP solutions. Agencies tasked with addressing such needs could demonstrate greater attention to user expectations by laying out more explicitly approaches to improve experience design and engage in more active feedback gathering. These considerations often appear to be absent from annual reports seen by the case study team.

Figure 6.1. A stylised representation of Norway's DSIP landscape[57]



Explore further opportunities for strengthening the compatibility of standards and identifiers across domestic actors, and internationally; and develop a framework for experimentation in the adoption of advanced digital technologies to meet actual user needs.

Existing capacities of DSIP systems and DSIP-related digital infrastructures in Norway to collect STI data should be further expanded through increased interoperability with digital solutions managed by a variety of domestic actors. Currently, the DSIP landscape of databases and digital systems in Norway shows some fragmentation and a number of missing linkages. Public databases on research on one side and databases on innovation activities on the other are not fully connected. Increasing interoperability between elements of the national DSIP ecosystem is a priority for near and medium-term development. In that regard, a recommendation of the OECD Digital Government Review of Norway (OECD, 2017c) on using APIs across all government databases remains relevant. Significant work still needs to be done to design and implement identifiers, ontologies, protocols and common formats in order to match datasets from different public and private databases.

Since research and innovation cuts across several policy areas, integration of DSIP systems with other elements of the overarching digital government infrastructure may contribute to increasing efficiency and efficacy at all levels. A number of DSIP solutions include linkages and shared functionalities with other generic platforms including Altinn. Altinn can be seen as a cornerstone technological infrastructure for digital government in Norway and it should be possible to explore additional opportunities of using Altinn for science and innovation policy and administration.

Readiness for deploying semantic technologies seems yet to be fully demonstrated across many organisations, while Big Data analysis capabilities are not yet commonplace among those involved in STI policy, administration and analysis.

Re-assess the access regime to data about STI generated in the system according to data types, purposes and actors, and communicating it to potential users.

This study has examined in some detail the role of the various government agencies that populate the STI policy delivery system and the provision of support services. The active role of funding agencies has been noted, highlighting pathways for further collaboration from an already high level. The expanded role of UNIT, following several rounds of consolidation, is addressing the challenge of adapting the Cristin research information system to enable a wider range of possible functionalities. This includes integrating Cristin with the broader range of infrastructures under UNIT's responsibility, while deepening links with other external platforms. Cristin is, indeed, a core element of Norway's DSIP landscape, and a focus of international attention as it is used to serve a growing range of policy objectives.

Norway's official statistical system and its leading agency, the SSB, is a key pillar of its DSIP landscape. Its role has evolved over time and is not limited to the production of descriptive statistics about the state of the STI system that policy makers and users can take note of. Its role extends to providing the function of a macro and microdata clearinghouse as well as source of expertise in research and evaluation. The SSB model as data clearinghouse, facilitated by the combination of multiple statistical powers that address confidentiality issues, can be an attractive model for other countries to consider implementing to address problems raised by different data silos. Its high degree of involvement in evaluation of government policy, a rather unique Norwegian feature enshrined by recent legislation, may prove complicated if not impossible to adopt in other countries.

In the case of the other major actor in STI statistical data, the NIFU research institute, research and statistical roles are also combined to some extent. The combination of multiple objectives (statistical, research and evaluation, for example) under the same organisation, while allowing for several synergies to be exploited, can also be a source of potential conflicts of interest (or at least perceptions of them) and a challenge for long-term and sustained collaboration if not adequately managed, for example, by levelling the playing field for bidding for new analytical/research work between data holders and external parties with relevant expertise.

Re-assess the data resources and skills portfolio for IT and data management in STI government agencies, as well as the balance between maintenance and development activities.

The abundance and connectedness of administrative and survey data in Norway have traditionally reduced the pressure for exploring alternative data sources for statistical and policy analysis. It is advisable that exploratory efforts in other statistical areas take into

consideration the potential application of unconventional data sources for the study of Norway's STI system and its role in the global arena. In a context in which there will be growing pressure to consider hitherto unexplored dimensions (e.g. innovation networks and assessment of content and directionality of research and innovation efforts) that current data struggle to address, the current leading actors in the STI statistical system can help independently evaluate the relevance, feasibility and expected impact of using statistical data from other sources or applying different tools to existing ones.

Such a role requires developing analytical capacities and digital competences to keep up with the pace of new approaches and methods in producing data and analyses leveraging advanced computational power and unconventional data sources. Having deep analytical expertise and rich digital capabilities is instrumental for maintaining the relevance of traditional providers of statistical data for science and innovation policy. Through the case study interviews, aspects relating to IT project management have proved to be rather salient, calling for further development of competences in this area within the organisations active in implementing new digital solutions for the management of STI information.

An effective and efficient use of human and financial resources in DSIP initiatives is dependent on the ability of policy makers to provide governance frameworks in which actors in the national science and innovation system are able to apply data-based practices to planning, delivery and review of their activities. This case study has highlighted the importance of co-"ownership" of risks and rewards, communication and trust. Likewise, it would be potentially useful to consider a more formal application of impact assessment methodologies for demonstrating value for money and options analysis in the planning and evaluation of new DSIP initiatives, at all stages of implementation.

Examine procedures for the public procurement of IT solutions in the STI area, considering potential lock-in effects and interoperability issues.

A potential limitation of current arrangements is a marked degree of reliance on incumbent providers of solutions to various challenges. The further development of Norway's DSIP landscape may benefit from the input of "outsiders" to the IT departments in the public sector and/or the subject field of STI, as well as outsiders to the core group of research organisations and consultants that have so far provided highly valuable services. The funding agencies have mechanisms in place and the possibility to introduce new mechanisms (e.g. hackathons) that should allow them to reach out for relevant pockets of expertise once the key needs and priorities are identified. For a number of reasons, the business private sector has a relatively limited role in the Norwegian DSIP landscape. Commercial solutions are used as functional elements in publicly owned digital systems to provide data access, data aggregation, visualisation and disambiguation. Whether this balance of public-private relations in DSIP will remain depends on the future IT procurement frameworks and the ability of the Norwegian government to develop necessary competences on its own to extract actionable intelligence from datasets leveraging recent technological advancements and making the most of available open source solutions.

Promote international co-operation to ensure more effective and frictionless use of data resources, in particular, for capturing cross boundary STI phenomena.

As an open economy and society, the main actors in Norway's DSIP landscape are looking at the broader global picture (see Box 6.1). This case study presents a model that can be in principle adapted to other countries to offer a comparable in-depth picture.

Box 6.1. Implications of the international dimension of Norway's DSIP system

Norway's DSIP landscape is influenced by international rules by virtue of its membership of the Nordic Council, the European Economic Area, the European Statistical System and the OECD, to cite a few examples. Norway is an active participant in such fora. There is also a growing realisation that in light of the high degree of interconnectedness of Norway's STI system with the rest of world (e.g. internationally mobile scientists, multinational enterprises, participation in global value chains and global innovation networks, etc.), many policy decisions can no longer rest entirely on information collected within its jurisdictional boundaries.

Cross-border data management and sharing are limited by legislation restricting cross-border data storage (such as the Archives Act and the Accounting Act). This obstructs the possibility to further develop cloud-based services that may require storing data in servers outside Norwegian borders; limits Nordic and further international co-operation on this subject; and prevents putting the recommendations on cloud computing of the 2016 Digitalisation Memorandum into action.

This case study has highlighted a number of instances in which international collaboration by governments can help deliver significant efficiencies, for example, dealing with the aggregation of separate administrative data produced by individual countries that ultimately becomes a proprietary resource that countries themselves have to pay for to consult. The challenge in many such cases is that there is limited basis upon which to test the extent such aggregated administrative resources are suitable for the intended purposes (i.e. statistical, administrative, etc.).

Standard setting and adoption provides another instance where international co-ordination may still be inadequate, resulting in suboptimal outcomes from a taxpayer perspective. International co-ordination may also allow to achieve the necessary scale to justify the development of custom digital solutions in support of science policy and administration.

International arrangements on data exchange and access already exist among statistical agencies and government authorities with responsibilities for science and innovation. However, the scope of this co-operation could be further expanded to ensure an effective and frictionless use of data resources, which is currently burdened by technical, legislative and organisational challenges, as well as the use of different, non-interoperable standards in many instances. Norway is in the process of trialling several cross boundary initiatives in the context of the Nordic Council that might be effectively exported to other countries.

6.2. Broader implications from this case study

Incremental approaches to the digital transformation of science and innovation policy for mid to long-term radical change

The evidence collected through this case study confirms the increasingly held view that capacities to implement new digital solutions in science and innovation policy and administration allow for incremental rather than radical transformations in the short term (OECD, 2018a). As shown in the case of Norway, they will be most likely successful if conceived as complements and enhancements to existing demonstrated needs and approaches. This may require focusing on concrete application domains where the number of transactions and decisions that can benefit from DSIP solutions is sufficiently large to

justify automation, provided that the underlying quality of the data is unlikely to be compromised as a result. This makes it particularly important to start from a sound and stable baseline of good governance, as well as adequate skills and other resources. Data resources will be more abundant in instances where the incentives are in place for such data to exist, but this in turns requires appropriate management of uncertainty about the integrity of the data and its usage in the system.

Caution in extrapolating from Norway's experience

In conclusion, the Norwegian landscape presented in this report, despite its many idiosyncratic features that may be impossible to reproduce in other contexts, presents several valuable lessons for the international community. Its DSIP system demonstrates a range of possible systems and approaches that many countries may be willing and able to emulate and adapt to their own circumstances. The examples also provide an indicator of the potential challenges that countries might encounter when developing, implementing and maintaining digital systems in support of science and innovation policy and administration, even under almost ideal resource and governance framework conditions as in the case of Norway.

Potential lessons from this case study for related OECD work

As the first of its kind, this case study has faced the challenge of having to define a basic reference framework. By making it public, the aim is to gain additional feedback on what are the key relevant dimensions for this type of study to focus on. Additionally, opportunities for learning about a given country would be therefore greatly increased if it were ultimately possible to compare the DSIP landscapes of different countries. This would help identify which are the major framework conditions that shape the functioning of DSIP systems (for example, highly centralised versus federal countries), and whether countries face fundamental trade-offs when it comes to making the most of digital systems to support decision making.

This case study has also helped demonstrate that even highly sophisticated systems such as Norway's are still working to develop a holistic vision about the usefulness for policy of data about science, technology and innovation and how to realise that value, exploiting potential synergies across a disparate range of governmental activities. Grasping the full data cycle in STI systems is a key challenge as identified in the latest OECD Blue Sky agenda (OECD, 2018b). While many have already been realised, the opportunities for data re-purposing are considerable in the case of Norway, but this requires governance mechanisms that ensure fitness for purpose and efficient division of labour.

The speed of technical change in terms of digital tools also renders traditionally held views about what solutions are possible. Authorities can proactively engage in promoting the development of digital resources that can help serve their needs, as opposed to taking data "as given". This can call for future OECD work on both realising the value of administrative data on STI, and policy decisions to influence the types of data that private actors in the system generate for their own and broader social benefit.

Case studies such as this have the potential to become mainstreamed into well-established OECD activities such as the OECD Reviews of Innovation Policy. These reviews offer a comprehensive assessment of the innovation system of individual OECD member and partner countries, focusing on the role of government, and providing concrete recommendations on how to improve innovation policies. As each review identifies good practices from which other countries can learn, it is potentially relevant that these also advice on how countries can make the most of digital opportunities to inform their policies.

The mapping of DSIP initiatives and their governance could also play a salient role in the context of reviews conducted by other OECD committees, for example, by informing how the science and innovation policy area compares to others in terms of digital maturity.

Notes

[1] The CCR contains basic data about entities with reporting obligations to the NAV Register Management, the Value Added Tax Register, the Register of Business Enterprises, the Business Register of Statistics Norway, the Corporate Taxation Data Register, Norwegian Foundation Register and the Register of Bankruptcies. Others may register voluntarily with the CCR.

[2] Retrieved May 3, 2018, from www.altinn.no/en/about-altinn/the-altinn-co-operation/.

[3] See https://fellesdatakatalog.brreg.no/?lang=en.

[4] See https://simsam.nu/wp-content/uploads/2016/08/Feasibility-study-regarding-research-access-to-nordic-microdata.pdf

[5] See https://www.ssb.no/en/omssb/tjenester-og-verktoy/data-til-forskning

[6] See https://nsd.no/nsd/english/microdatano-won-data-protection-award

[7] See https://www.ssb.no/en/forskning/forskning-i-ssb

[8] See https://www.regjeringen.no/en/aktuelt/a-new-law-on-statistics-to-meet-current-needs/id2640436/

[9] For instance, Fagerberg et al (2009) argue that the rise of the large-scale, capital intensive path of economic development in the early 20th century can be traced back to innovations such as those associated with developments in the hydroelectric industry through a 'new combination' of knowledge, capabilities and resources; new technological and organisational solutions to problems faced by the oil and gas industry in extracting oil and gas under conditions of unprecedented complexity and hazardousness; as well as a stream of important innovations in fish farming, processing, and disease control within the fish-farming industry.

[10] Ministry of Trade, Industry and Fisheries (2018). "Powered by Nature - Norway as a data centre nation". https://www.regjeringen.no/en/dokumenter/datasenterstrategien/id2590685/

[11] For example, the USD 1 trillion worth Government Pension Fund Global is part of the Government Pension Fund of Norway was set up in 1990 to underpin long-term considerations when phasing petroleum revenues into the Norwegian economy. The fund invests in international equity and fixed-income markets and real estate. Managed by the Norges Bank Investment Management on behalf of the Ministry of Finance, it is invested to achieve broad exposure to global economic growth. For example, the fund owns half a percent of Tesla according to the latest available data from the fund (Reuters, 2018).

[12] See MER(2017). References to world-class research groups and to climbing global rankings can be found in this and other related documents.

[13] See https://www.regjeringen.no/contentassets/779c0783ffee461b88451b9ab71d5f51/en-gb/pdfs/digitaliseringsstrategi-for-uh-sektoren-engelsk-ve.pdf

[14] The Norwegian Strategy for Skills Policy 2017-2021 noted that the various data sources developed in Norway are not used, maintained, and disseminated jointly, and they are not easily accessible and useful. The website www.utdanning.no provides prospective HE students with interactive information about the average scores required to enter a certain field of study at different HEIs. The website also lists the types of jobs in which graduates from a certain field of study typically work, the number of people working in those occupations, the anticipated number of jobs in the future (based on projections by SSB), and median earnings for a given occupation. However, the site does not provide any labour market outcome information at the institution level, nor on anticipated skills needs (OECD, 2018c). The White Paper on Quality Culture in Higher Education argued for better labour market information to make informed career choices, leading to plans to develop a single web portal (OECD, 2018c).

[15] See https://www.regjeringen.no/en/dokumenter/national-strategy-on-access-to-and-sharing-of-research-data/id2582412/.

[16] For example, Norway was one of the partners in the Nordic research project "Measuring public sector innovation in the Nordic countries (MEPIN)", which included a large scale pilot survey conducted in all five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) with the aim to develop a measurement framework for collecting internationally comparable data on innovation in the public sector. This project sought to provide evidence on how public sector organisations innovate and to develop indicators for use in promoting public sector innovation (Bloch 2011).

[17] See (Norwegian page) https://www.forskningsradet.no/servlet/Satellite?cid=1254032722408&pagename=VedleggPointer&target=_blank

[18] https://www.regjeringen.no/en/dokumenter/cloud-computing-strategy-for-norway/id2484403/

[19] See https://www.regjeringen.no/en/dokumenter/datasenterstrategien/id2590685/.

[20] See https://www.regjeringen.no/globalassets/departementene/ud/dokumenter/sikpol/cyberstrategy_2017.pdf.

[21] See https://www.brreg.no/om-oss/oppgavene-vare/alle-registrene-vare/om-registeret-for-offentlig-stotte/

[22] See https://www.ssb.no/en/naringvirk

[23] See https://www.forskningsradet.no/prosjektbanken/#/Sprak=en.

[24] See http://www.siva.no/

[25] See https://siva.no/wp-content/uploads/2015/03/evaluering-av-eiendomsvirksomheten.pdf (in Norwegian).

[26] See http://www.nsd.uib.no/polsys/data/filer/aarsmeldinger/AN_2017_52959.pdf

[27] See https://statistics.patentstyret.no/.

[28] See https://sfdora.org/read/

[29] Uninett transferred a number of services and 31 employees to UNIT in January 2018. Uninett remains responsible for networking support to HEIs and related ancillary services.

[30] For a comparison of the Norwegian and Swedish publication databases roles in their respective assessment systems, see Eriksson (2013).

[31] The list of outputs includes a wide range of categories, in declining order of incidence: Academic articles (304K); Academic chapters/articles/conference papers (110K); Interviews (100K); Popular scientific lectures (81K) ; Reports (78K); Posters (64K); Lectures (56K); Divulgation papers (43K); Academic anthology/Conference proceedings (42K); Feature articles (38K); Scientific books (22K). The categories also include articles in business/trade/industry journals; article and book reviews, editorials, opinion pieces, dissertations, films, musical compositions and performances, websites, documentaries, exhibitions, digital learning tools; brochures, briefs, software, databases, patents, etc. A majority of these categories are reported on a voluntary basis, and therefore, coverage is rather uneven compared to the categories that contribute directly to performance assessment.

[32] Cristin collects data on funders, projects, employees at member institutions, research performing organisations, approved clinical trials, publications and presentations. Information on patents and start-ups used to be incorporated into the system, however, due to a tepid response from Cristin's users, this information is no longer available. There are additional plans to improve data exchange

between Cristin and external databases, e.g. biobank registries of the Ministry of Health and Care Services and databases of private funders.

[33] For example, it appears possible to achieve better integration with teaching-related HE data.

[34] See https://www.regjeringen.no/en/dokumenter/digitalisation-strategy-for-the-higher-education-sector-2017-2021/id2571085/

[35] HEIs are viewed by government in the HE digitalisation strategy, notwithstanding their academic autonomy, as subject to MER's "authority and instruction". Because of limited time availability and the limited scope of the study, it was not possible for the OECD case study team to meet with a broad group of representatives from the various sectors.

[36] It is important to be able to identify the added value services that justify the additional charging in such cases.

[37] See https://site.uit.no/dataverseno/about/.

[38] See https://www.unit.no/en/arrangement/digital-transformation-conference-higher-education-and-research.

[39] See https://www.ssb.no/en/teknologi-og-innovasjon/statistikker/foun. Preliminary figures for research and development in the business enterprise sector for a given year are published in October of the following year and final figures follow in February the year after.

[40] Available at https://www.nifu.no/en/statistics-indicators/nokkeltall/hovedtall/.

[41] See http://www.foustatistikkbanken.no/nifu/?language=en.

[42] The R&D statistics bank also includes data on awarded doctoral degrees in Norway (institution, type, gender and fields of sciences) and PhD degrees and students in the Nordic and Baltic countries.

[43] See https://www.fpol.no/keithsmith/.

[44] https://www.ssb.no/en/teknologi-og-innovasjon/statistikker/patent/aar

[45] https://www.ssb.no/en/teknologi-og-innovasjon/artikler-og-publikasjoner/r-d-innovation-and-ipr-statistics-for-the-norwegian-business-enterprise-sector-2016

[46] Information on R&D in those areas is collected and reported to the OECD.

[47] https://www.forskningsradet.no/prognett-indikatorrapporten/Home_page/1224698172612

[48] https://www.regjeringen.no/no/tema/forskning/innsiktsartikler/forskningsbarometeret/id635788/

[49] These are INGENIO at the Polytechnic University of Valencia and the Manchester Institute of Innovation Research at the University of Manchester.

[50] See https://www.sv.uio.no/tik/english/research/projects/osiris/presentations/osiris-presentation-general-english.pdf

[51] See https://www.ssb.no/en/virksomheter-foretak-og-regnskap/artikler-og-publikasjoner/input-additionality-in-the-norwegian-r-d-tax-credit-scheme

[52] See https://www.ssb.no/en/virksomheter-foretak-og-regnskap/artikler-og-publikasjoner/the-relationship-between-the-norwegian-r-d-tax-credit-scheme-and-other-innovation-policy-instruments

[53] https://www.ssb.no/en/virksomheter-foretak-og-regnskap/artikler-og-publikasjoner/innovasjons-og-verdiskapingseffekter-av-utvalgte-naeringspolitiske-virkemidler

[54] https://www.ssb.no/en/virksomheter-foretak-og-regnskap/artikler-og-publikasjoner/he-effect-on-firm-performance-of-facilitating-services-from-siva

[55] https://www.regjeringen.no/contentassets/b8f109e6ae9c4809b21773f9b5168f00/evaluation-of-skattefunn.pdf

[56] Firm-linked patent dataset OPEN: Opening access to linked patent-data for indicator development.

[57] HEI – Higher Education Institutions. HOD – Ministry of Health and Care Services. KS – Norwegian Association of Local and Regional Authorities. KUD – Ministry of Culture. MTIF – Ministry of Trade, Industry and Fisheries. NIFU – Nordic Institute for Studies in Innovation, Research and Education. NIPO – Norwegian Industrial Property Office. NSD – Norwegian Centre for Research Data. RCN – Research Council Norway. SIVA – Industrial Development Corporation of Norway

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Annex A. Terms of reference for the case study

I. Introduction

Recent advances in digital technologies and an exponential growth of data can contribute to more evidence-informed policy making. The application of digital tools to disambiguate and analyse data on research and innovation activities can provide policy makers, officials in charge of policy delivery and other stakeholders with more granular information on research and technology trends and policy impacts. National and regional governments, public funders, for-profit and not-for-profit organisations cooperate with each other on Digital Science and Innovation Policy (DSIP) initiatives, which involve designing digital tools and infrastructures for formulating, implementing, monitoring, and evaluating science and innovation policy.

In the context of the OECD Committee for Scientific and Technological Policy's ongoing DSIP project, the Royal Norwegian Ministry of Education and Research has asked the OECD Secretariat to carry out a case study of the DSIP landscape in Norway with a view to better understand its strengths and limits and to identify opportunities that would promote its positive development.

This document sets out the case study's goals, scope, and activities, as jointly agreed by the OECD Secretariat and the Royal Norwegian Ministry of Education and Research. It also highlights the key issues the case study will address and outlines a timetable for completing the work.

II. Goals, scope, and activities

The purpose of this case study is to obtain a comprehensive understanding of the key elements, relationships and dynamics which drive and impact upon the Norwegian DSIP landscape and from this foundation identify opportunities to increase its efficacy and efficiency through government policy. In addition, this study will provide an example that other OECD members may learn from by relating to their own national situations.

On the study's scope, DSIP landscapes typically contain several actors performing a mix of roles. The case study will take a broad approach, covering data providers and regulators, the managers of DSIP infrastructures and their users. The key issues covered are outlined in the section that follows. The case study will also draw upon the emerging findings of the ongoing OECD DSIP project, in particular on lessons that can be drawn from the experiences of DSIP initiatives in other countries.

More specifically, the case study will:

- Conduct in-depth interviews with all key actors across the Norwegian DSIP landscape
- Deliver a half-day workshop to discuss the OECD team's hypotheses and initial findings with the key actors
- Produce a systematic and thorough description of the DSIP landscape in terms of actors, data, regulations, etc.

- Identify where improvements might be made in order to develop a stronger DSIP landscape

The case study will provide an independent assessment of the Norwegian DSIP landscape, which will contain information based on an analysis of existing reports and policy documents and will draw on the expertise of the OECD combined with the knowledge and experience of the key stakeholders involved in developing and maintaining the DSIP landscape in Norway.

III. Key issues to be addressed

The shape and dynamics of DSIP landscapes are influenced by a mix of factors, including emerging technologies, the changing needs and expectations of policy makers for policy-relevant data, legacy data infrastructures, national and international standards, as well as the growing availability of commercial platforms that offer services in managing and analysing data on research and innovation activities. This case study will take these factors into account as part of a comprehensive analysis of the DSIP landscape in Norway.

The case study will devote special attention to the following issues:

Describing the system - initiatives, actors and scope

1. *Mapping DSIP initiatives in Norway:* Besides the well known CRIStin initiative, what other DSIP initiatives exist in Norway and for what purpose(s)? How have these developed over time and how do they relate to one another?
2. *Mapping the actors in the Norwegian DSIP landscape:* Who are the main actors engaged in DSIP and what roles do they play? This includes operators of DSIP systems, e.g. CRIStin, as well as data providers, regulators, and data users. Are there actors who could play more or different roles?
3. *Data coverage of DSIP:* What types of data are currently captured in DSIP systems in Norway and how is this done? What would be desirable to include and how could this be done? What barriers, if any, need to be overcome?
4. *The interoperability challenge:* What challenges have arisen when matching data? How can data matching be made sufficiently robust? What measures could be undertaken to improve the interoperability of digital systems and databases in Norway?
5. *International dimension of DSIP*: How does the Norwegian DSIP landscape use and align with international standards? In what international DSIP-related fora does Norway already participate and to what benefit? What further international learning and co-ordination opportunities would be desirable from a Norwegian DSIP landscape perspective?

Objectives and outcomes

6. *Expectations of DSIP:* What expectations do policy makers, funders, universities and other actors (such as individual researchers and entrepreneurs) have of the DSIP landscape in Norway? How are these expectations driving developments in the field?
7. *Outputs, use and impacts:* What sorts of policy-related outputs and services are provided in the Norwegian DSIP landscape? How are these used in the policy

cycle? How are the use and impacts of DSIP initiatives, like CRIStin, monitored and evaluated? What about other non-policy actors – how do they use the outputs and services of DSIP initiatives and at what cost and benefits?

Resources

8. *Resources in the DSIP landscape:* How is the DSIP landscape funded in Norway? What business models are the various DSIP initiatives adopting to ensure the sustainability of their operations?
9. *Technology choices:* What technologies are commonly used in the DSIP landscape in Norway? How have technological choices been made and by whom? How are emerging technological developments, e.g. around machine learning, semantic web, visual analytics, etc. shaping developments in the Norwegian DSIP landscape?
10. *Skills and capabilities:* Are there sufficient skills to develop, implement and utilise DSIP infrastructures in Norway? What further measures would contribute to the accumulation of skills and capabilities among DSIP infrastructure developers, managers and users?
11. *Involvement of the commercial sector*: What roles, if any, does the commercial sector play in providing data, software and services in the Norwegian DSIP landscape? What are the main factors driving its likely development in the coming years?

Looking forward

12. *What does the future DSIP landscape look like in Norway?* Building on insights from the other issue points here, what might the future DSIP landscape look like in Norway in, say, five years? What actions would need to be taken now to realise a desirable DSIP landscape?

Annex B. List of interviews and meetings held

Ministries

- Ministry of Education and Research
  - Geir Arnulf, Deputy Director General
  - Ingvild Marheim Larsen, Specialist Director/Head of Policy Analysis
  - Sigve Berge Hofland, Senior Adviser

- Ministry of Trade, Industry and Fisheries
  - Carl Gjersem, Senior Research and Innovation Policy Adviser
  - Tone Evje, Deputy Director

- Ministry of Health and Care Services
  - Hjørdis Møller Sandborg, Senior Research Policy Adviser
  - Marianne van der Wel, Senior Adviser

- Ministry of Local Government and Modernisation
  - Espen Dennis Kristoffersen, Head of Unit (video conference after mission)

Government funding organisations

- Research Council of Norway
  - Randi Søgnen, Director, Chief Executive's staff
  - Frode Georgsen, Department Director, Department for Strategic Development and Analysis
  - Stig Slipersæter, Special Adviser
  - Svein Olav Nås, Special Adviser

- Innovation Norway
  - Sigrid Gåseidnes, Head of Analysis
  - Pål Aslak Hungnes, Special Adviser
  - Kristian Bysheim, Analyst

Other government agencies

- UNIT - Directorate for ICT and joint services in HE and research
  - Katrine Weisteen Bjerde, Director of Research Services
  - Marit Henningsen, Senior Adviser
  - Tanja Høvin, Senior Adviser
  - Yamuna Vallipuram, Senior Engineer
  - Tore Vatnan, Senior Engineer
  - Lars Wenaas, Senior Adviser

- Agency for Public Management and eGovernment (Difi)
  - Heather Broomfield, Digital Strategy and Co-ordination (video conference during case study visit)

- Norwegian Industrial Property Office
  - Bjarne J. Kvam, Senior Adviser, Strategic Analysis

- Norwegian Centre for Research Data (NSD) (video conference after case study visit)
  - Kristin Gåsemyr, Head of Division
  - Knut Kalgraff Skjåk, Director of the Department for Survey and Data Services
  - Bjarne Mundal, Senior Adviser

Higher education institutions

- UHR (Universities Norway)
  - Vidar Røeggen, Senior Adviser

- OsloMet – Oslo Metropolitan University
  - Tanja Strøm, Senior Adviser

- BI Norwegian Business School
  - Amir Sasson, Professor

- University of Oslo
  - Magnus Gulbrandsen, Professor and OSIRIS Director, Head of Research team TIK
  - Herman Strøm, Senior Advisor (video conference after case study visit)

Organisations within the National Statistical System

- Statistics Norway (SSB)
  - Frank Foyn, Senior Adviser
  - Brita Bye, Research Director
  - Terje Skjerpen, Researcher
  - Elisabetta Vassenden, Head of UNIT
  - Marianne Aamodt, Senior Adviser

- Nordic Institute for Studies in Innovation, Research and Education (NIFU)
  - Susanne Sundnes, Head of Research, Statistics and Indicators
  - Espen Solberg, Head of Research, Research and Innovation Studies
  - Kaja Wendt, Senior Adviser
  - Eric Iversen, Senior Researcher
  - Marco Capasso, Senior Researcher

Private companies

- Menon Economics AS
  - Leo Grünfeld, Partner and Chairman

- Economics Norway (Samfunnsøkonomisk analyse AS)
  - Rolf Røtnes, Managing Director (video conference after case study visit)