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Atlas of Open Science and Research in Finland 2019

Evaluation of openness in the activities of higher education institutions, research institutes, research-funding organisations, Finnish academic and cultural institutes abroad and learned societies and academies

Final report

Publications of the Ministry of Education and Culture, Finland 2019:45

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Abstract

This evaluation of the openness of Finnish research organisations, research-funding organisations, academic and cultural institutes abroad and learned societies and academies was completed by the Ministry of Education and Culture to assess the openness of operational cultures and to evaluate progress for the organisations evaluated in previous years. This evaluation covers the activities of Finnish higher education institutions, research institutes, research-funding organisations, the Academic and Cultural Institutes abroad and Learned Societies and Academies in 2019.

This evaluation examines the key indicators chosen to assess the performance on openness. Key indicators are used to provide some insights on the competences and capacity of the research system in supporting progress towards openness. Barriers and development needs are discussed, with suggestions for improvement.

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Tiivistelmä

Arvioinnissa tarkastellaan suomalaisten tutkimuslaitosten, tutkimusrahoitusorganisaatioiden, ulkomaisten akateemisten ja kulttuurilaitosten sekä tieteellisten seurojen ja akatemioiden toimintakulttuurien avoimuutta sekä edistymistä edellisvuotisiin arviointeihin verrattuna. Arviointi kattaa suomalaisten korkeakoulujen, tutkimuslaitosten, tutkimusrahoitusorganisaatioiden, ulkomailla sijaitsevien akateemisten ja kulttuurilaitosten sekä tieteellisten seurojen ja akatemioiden toiminnan vuonna 2019.

Loppuraportissa tarkastellaan keskeisiä indikaattoreita, joilla avoimuuden tuloksellisuutta on arvioitu. Keskeisten indikaattoreiden perusteella esitetään näkemyksiä tutkimusjärjestelmän valmiudesta ja kyvystä tukea avoimuuden edistämistä. Loppuraportissa puututaan myös esteisiin ja kehitystarpeisiin sekä esitetään parannusehdotuksia.

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I denna utvärdering granskar undervisnings- och kulturministeriet öppenheten i verksamhetskulturerna vid finländska högskolor, forskningsinstitut, forskningsfinansieringsorganisationer, akademiska institut och kulturinstitut utomlands och vetenskapliga samfund och akademier samt utvärderar utvecklingen jämfört med undersökningar från tidigare år. Utvärderingen gäller verksamheten 2019 vid finländska högskolor, forskningsinstitut, forskningsfinansieringsorganisationer, akademiska institut och kulturinstitut utomlands och vetenskapliga samfund och akademier.

I utvärderingen granskas nyckelindikatorer som använts för att bedöma öppenheten. På basis av nyckelindikatorerna beskrivs forskningssystemets förmåga att stöda främjandet av öppenhet. I rapporten behandlas även hinder och utvecklingsbehov samt presenteras förbättringsförslag.

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OPEN SCIENCE AND RESEARCH IS FOR RESEARCHERS AND BY RESEARCHERS

It is time to congratulate the Finnish higher education institutions, research institutes and public research funders on the impressive results achieved in the openness evaluation! This means that many practical steps have been taken by the organisations since the previous evaluation. It is tempting to think that one factor behind this development is the open science and research initiative by Ministry of Education and Culture that was started nearly six years ago.

Finland was one of the first countries to start promoting the Open Science approach and to define the concept of Open Operational Culture and thus the variety of open science activities is wide. Finland is ready to be at the forefront of open science and research activities with dedicated competent personnel, up-to-date research infrastructures and policy support.

These evaluations were started in 2015 to track how organisations adapt and embrace openness using the roadmap, guidelines and framework constructed and provided. The Ministry of Education and Culture has used the results in the steering processes of higher education institutions and the Academy of Finland. Going forward, the Finnish researcher community with the help of the Federation of Finnish Learned Societies is excellently fostering and drive openness to new heights. Determined work and collaboration cultivates the change needed.

Even though the ball is now in the hands of the researcher community and the organisations, the Ministry of Education and Culture continues to promote openness at all fronts, national and international.

Erja Heikkinen

Summary

This final evaluation of the openness of Finnish research organisations, research-funding organisations, Finnish academic and cultural institutes abroad and learned societies and academies was completed to assess the openness of operational cultures and to evaluate progress made by organisations evaluated in previous years.

The Open Science and Research Roadmap (OSR Roadmap) was published in 2014 to support research organisations in making progress towards openness. The OSR Roadmap defined certain objectives and actions, as well as the responsibilities of different stakeholders in policy implementation. The openness of activities were first evaluated in 2015, when universities, universities of applied sciences and research institutes were assessed with respect to their open science policies on and practices. In 2016, the evaluation was repeated and extended to cover university hospitals and research-funding organisations. The evaluation of research-funding organisations included a comparison with selected European research-funding organisations. The evaluation in 2017 covered the activities of Finnish research organisations and research-funding organisations. This was complemented by an evaluation of Opening Academic Publishing. This evaluation covers the activities of Finnish higher education institutions, research institutes, research-funding organisations, Finnish academic and cultural institutes abroad and learned societies and academies in 2019.

The purpose of these evaluations is to highlight best practices and areas of development. Evaluation is by no means directed at the quality of work done by research organisations and research-funding organisations. In addition, the ranking has no direct impact on the activities of organisations concerned, but merely visualises their scores. As such, it should be interpreted with caution and by no means treated as a ranking table.

This evaluation examines the key indicators chosen to assess openness performance. Key indicators are used to provide some insights into the competences and capacity of the research system in supporting progress towards openness.

1 Introduction

Since the Open operational culture evaluations in 2016 and 2017, the Open Science landscape has changed. European Commission launched a policy vision of European Research Area involving Open Innovation, Open Science, and Open to the World in May 2016[1]. The vision shows that Open Science will help Europe benefit from digitization and support new ways of doing research and innovation (R&I). This includes opening up access to R&I data, results and collaborative tools. European Open Science Cloud (EOSC) is seen to become the primary enabler to realize open policy initiatives in Europe[2]. The initiative to create EOSC has been strongly supported by European Council in conclusions (May 2018), the European Parliament in a resolution (January 2017), and the European research community with the EOSC declaration (June 2017). To realize and steer the vision of EOSC, the European Commission is assisted by the Governance Board of EOSC and an expert group (Executive Board of EOSC) in the first phase of development from 2018-2020.

Advancement of Open Science is about fostering the best use of all research resources. In 2018, a group of national research funding organisations, with the support of the European Commission and the European Research Council (ERC), announced the launch of an initiative to make full and immediate Open Access to research publications a reality. It is built around Plan S, which consists of one target and 10 principles[3].

The development of EOSC has made FAIR-principles visible. The FAIR data principles[4] propose that all scholarly output should be findable, accessible, interoperable and reusable. Mostly all open science policy papers nowadays refer to these principles. The

1 https://ec.europe.eu/digital-single-market/en/news/open-innovation-open-science-open-world-vision-europe

2 COM(2016) 178 final of 19 April 2016.

3 https://www.coalition-s.org/about/

4 M.D.Wilkinson, M. Dumontier, I.J. Aalbersberg, G. Appleton, M. Axton, A. Baak et al., The FAIR guiding principles for scientific data management and stewardship. Scientific Data [Internet] 3 (2016), 160018. Available at http://www.nature.com/articles/sdata201618.

updated and revised Commission Recommendations[5] encourages Member States to set and implement clear policies for openness (as detailed in national action plans), and most importantly for the necessary skills and competences of researchers and personnel of academic institutions regarding scientific information. Those policies and action plans should provide concrete objectives and indicators to measure progress in the future.

Open Science is more and more understood as a process. Support to the transition to Open Science has come for example from Lindau Nobel Laureate Meeting, expected to publish a declaration on Sustainable, Cooperative Open Science by June 2020[6]. Open Science is exceedingly about how we do research, and thus the actions should take a holistic view on the research process. Open science is a living thing – now it is transforming to emerge as responsible research.

In Finland, Open Science and Research Initiative (ATT), defined the Open Science and Research Roadmap 2014–2017[7]. The OSR Roadmap identified a set of actions and measures to ensure the openness and reproducibility of research, and to enable the opportunities afforded by open science to be developed and used extensively in Finnish society. The ATT initiative is now in the past, and the Federation of Finnish Learned Societies (TSV) coordinates Open Science in Finland. However, to ensure comparability with the previous reports, the framework of the evaluation is based on the earlier Roadmap.

The OSR Roadmap's four sub-objectives are still relevant: reinforcing the intrinsic nature of science and research, strengthening openness-related expertise, ensuring a stable foundation for the research process, and increasing the societal impact of research.

Open science and research requires a good, open method for managing research processes and results. This can be achieved if those responsible for research systems are motivated and trained to put the related principles into practice. Various stakeholders have responsibility for implementing such principles, based on the objectives listed on the OSR Roadmap. Development responsibilities are paired with measures on the OSR Roadmap. Success in achieving the related targets is evaluated by measuring the key factors underlying individual criteria, in order to form a set of indicators.

5 Commission Recommendation (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information C/2018/2375OJ L 134, 31.5.2018, p. 12–18 (BG, ES, CS, DA, DE, ET, EL, EN, FR, HR, IT, LV, LT, HU, MT, NL, PL, PT, RO, SK, SL, FI, SV) ELI: http://data.europa.eu/eli/reco/2018/790/oj

6 http://www.lindaudeclaration.org

7 The Open Science and Research Roadmap 2014–2017, http://openscience.fi/open-science-and-research-roadmap-2014-2017

Being responsible for the activities and culture of research environments, research organisations play a vital role in steering development towards the objectives in hand. The following responsibilities listed in the OSR Roadmap can be considered key actions for promoting openness within the activities of research organisations:

- including openness within the organisation's strategy
- supporting and facilitating a collaborative culture
- well-defined policies for publication, research data and other research outputs, licensing, copyright and proprietary rights
- a clear description of researchers' rights and obligations with regard to openness
- developing and maintaining competences
- promoting the use of shared services and research infrastructures
- systematic use of quality systems
- ppromoting interoperability
- exemplary management of research results and methods
- promoting openness, availability, visibility and usability, and introducing support services for the measurement of such factors

An organisation's operational culture should be apparent in its strategies, values and quality systems. It is therefore important for organisations to provide clear guidelines and support services for researchers, and to communicate their research results openly online. Openness also requires organisations to adhere to and support national and international shared and general guidelines, policies, and principles, where these exist.

1.1 Framework for Evaluation

The OECD Science, Technology and Industry Outlook document states that: *"As Open Science progresses, new policy approaches will be needed to determine how public research is funded, research is undertaken, research outputs are exploited, research results are accessed and protected, and to shape how science and society interact."*

In order to develop policies that support open science and research in the appropriate manner, we need a better understanding of several critical aspects - such as the policies and guidelines that apply to research funding - of the openness of research activities. For this purpose, we need to provide indicators for benchmarking national performance in open science. We believe that the indicators selected reflect openness-related management and support activities.

The purpose of this evaluation is to highlight best practices and areas of development at national level in order to encourage national collaboration and to initiate discussions on open science and research at international level. This evaluation is by no means directed at the quality of work of the organisations concerned and has no direct impact on the activities of organisations as such. It merely visualises maturity scores in facilitating and advancing open science and should be interpreted with caution: it should by no means be treated as a ranking table.

This evaluation examines the key indicators selected to gauge performance in terms of strategic steering, management and support of openness. Such indicators are used to provide insights on the competences and capacity of the research system to progress towards openness. However, since Open Science and openness are interpreted differently depending on the country and organisation concerned , the overall comparison has limitations. This report is one in a series of studies on the open science and metrics[8] [9], a fact that highlights the importance of debates on the topic. For example, an earlier survey on Open Access Publishing Policies from Science Europe also examined research-funding organisations, but from a different angle.[10]

1.2 Purpose of Evaluation

The evaluation covers 38 higher education institutions and 12 Finnish research institutes, three major Finnish research-funding organisations, four Finnish academic and cultural institutes abroad and seven organisations of learned societies and academies.

Valuating the organisations aims to:

- assess the openness of operational cultures and establish a clear picture of the current level of maturity in promoting openness
- identify strengths and weaknesses in promoting openness
- identify areas in which support and cooperation are needed
- evaluate progress, when previous evaluation data is available
- identify barriers and development needs in promoting openness

8 https://ec.europa.eu/research/openscience/index.cfm?pg=altmetrics_eg

9 https://ec.europa.eu/research/openscience/pdf/report.pdf

10 http://scieur.org/oa-survey

2 The Approach

The key objectives, against which the assessments are made, are defined in the Open Science and Research Roadmap. Using the objectives listed in this Roadmap, various stakeholders are responsible for putting openness policies into practice. The development objectives are implemented through actions, which are defined as responsibilities in the OSR Roadmap. Key indicators reflect the objectives to be assessed. Success in achieving the objectives is scored against the key criteria that form the indicators. Figure 1 shows the relation of the OSR Roadmap to the indicators, criteria and scores of this analysis.

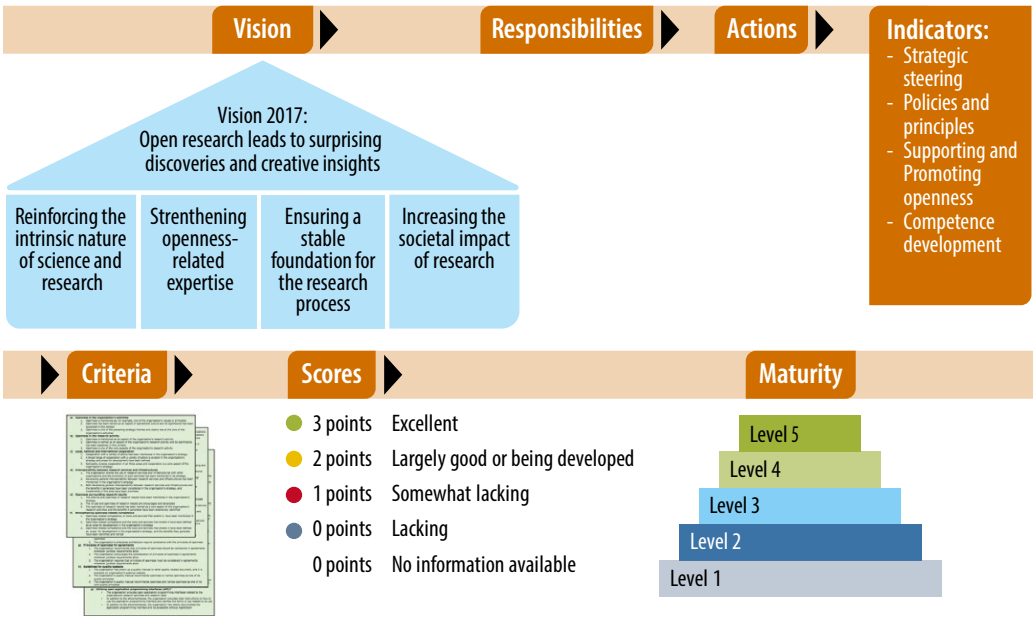

Figure 1: Relation of this evaluation and its indicators and measures to the Open Science and Research Roadmap 2014–2017.

The criteria have been fine-tuned and updated for the 2019 analysis by collaborative efforts. The fine-tuned criteria were tested, and further re-defined to make it possible to see differences in the data. The key indicators are used, as earlier, to define the maturity of

openness activities. Maturity in turn is described in levels, the so-called maturity hierarchy. Each organisation is ranked at the final phase within this maturity hierarchy, based on the scores given for each criterion.

The evaluation consisted of the following steps:

1) **Preliminary data collection:** Data used in preliminary analysis consists of information available on each organisation's external website: its publicly accessible strategies, policies and principles, and its guidelines for supporting openness. Preliminary data collection covers only parts of the final data.
2) **Preliminary analysis:** Based on this information, the preliminary level of openness for the organisations was scored with in a number of criteria. Scoring was based on indicators derived from the responsibilities for promoting openness assigned to each organisation within the Open Science and Research Roadmap.
3) **Preliminary report:** Preliminary evaluation based on the preliminary analysis.
4) **Complementary Data Collection:** Data collected via a request for information was sent to organisations of interest by the Ministry of Education and Culture, together with the preliminary analysis. In the request for information, the organisations can make additions and correct mistakes or misinformation in the preliminary data and analysis, and provide further insights on the activities undertaken within the organisation. Their research heads can also provide information on the existing barriers and development needs for openness.
5) **Final Analysis:** Based on preliminary and complementary data collection, the final level of openness for the organisations was scored. The barriers and development needs were analysed.
6) **Final Report:** This report. The final evaluation based on the combined data.

2.1 Preliminary Data Collection

As the preliminary data, information was collected from the organisations' external websites. During data collection, a specific set of data was used in the analysis performed for each key indicator. For all indicators, data was limited to each organisation's external (public) website. No information available on internal (e.g. intranet) pages was included. If the organisation's website had links to external guidelines, the website had to mention

that the organisation either adhered to those guidelines or recommended their use. A simple link to external guidelines did not suffice.

All of the organisations' strategies were collected from public websites for analysis. If no bespoke strategy document was available for downloading, strategy-related web pages, or comparable documents (such as values and visions), were used instead. Performance agreements were not solely considered as sufficient strategic level documents for steering the organisation in question towards openness.

Other information was acquired from external websites, both by browsing and via searches using terms derived from the indicator's criteria. All of the available relevant information was included in the analysis.

The preliminary data was collected in May-June 2019.

2.2 Complementary Data Collection

During complementary data collection, the preliminary data, preliminary report and a request for information were sent to all organisations for a review and additions. The organisations were able to provide further insights into the activities conducted within each organisation. Research heads in organisations were also able provide information on the existing barriers and development needs for openness.

Complementary data was requested to reach the Ministry of Education and Culture on 16th September 16th 2019 at the latest.

The complementary and reviewed data were combined to form the final data for the final evaluation. The data gathered for this analysis is available in Appendices 6-20.

2.3 Indicators and Scoring Principles

In the analysis, selected indicators were used to evaluate Finnish organisations' openness.

The indicators for higher education institutions and research institutes were:

1) Strategic Steering
2) Policies and Principles
3) Supporting Openness
4) Competence Development

The indicators for research-funding organisations were:

1) Strategic Steering and Principles of Openness
2) Openness in Research Funding
3) Supporting and Promoting Openness

The indicators for academic and cultural institutes working abroad were:

1) Strategic Steering
2) Policies and Principles
3) Supporting and Promoting Openness

The indicators for learned societies and academies were:

1) Strategic Steering
2) Policies and Principles
3) Supporting and Promoting Openness

Each indicator has a number of individual criteria that were scored using the data, based on the score category (see below). All indicators and criteria can be found in Appendices 1, 2, 3 and 4.

Openness was evaluated separately for each measure, using a four-tiered scoring system:

- 3 points Excellent
- 2 points Largely good or being developed
- 1 points Somewhat lacking
- 0 points Lacking / No information available

For each criterion, each organisation was given a score between zero and three on the basis of the available information. Evaluation of the scores for each criterion was performed by at least two individuals. If no information was available or information was lacking, zero points were awarded.

To achieve the overall score for openness, an aggregate score was calculated covering all criteria and across all indicators for each organisation. This was calculated as the aggregate of points received for all criteria across all indicators.

2.4 Maturity levels

Based on the analysis scores, the higher education institutes, the research institutes, the research-funding organisations, the a Finnish cademic and cultural institutes abroad and the learned societies and academies were placed within a hierarchy of maturity levels. A five-level maturity model was employed. A figure depicting the overall maturity level is shown in Table 1. The scores required for each maturity level are given alongside the maturity levels in question. Table 1 provides an interpretation of these maturity levels from the perspective of open science and research.

Table 1: An interpretation of maturity levels from the perspective of open science and research.

LEVEL 5 STRATEGIC
An open operational culture is publicly encouraged throughout the organisational level and openness has been defined as a core value in the organisation's strategy and policies. Activities are open and developed in accordance with the principles of openness and in cooperation with other actors. Openness has also been linked to the long-term planning and management of activities. The organisation is always able to ensure that it is moving towards its goals, and is learning and adapting. Key benchmarks are in comprehensive use and are continually reviewed. Personnel are aware of their targets and the organisation's progress towards openness.
LEVEL 4 MANAGED
The organisation is actively working towards an open operational culture, and principles of openness have been publicly set as one of its objectives. Activities are largely open and adhere to the principles of openness. Openness is managed and regularly measured. Measurements are analysed and corrective measures are proactively taken. The organisation is mature in terms of its utilisation of open information, which is also taking on increased significance.
LEVEL 3 DEFINED
At this level, decisions are increasingly made with the aid of data based on openness measurements. Management supports the planning and implementation of an already more effective openness strategy. The organisation has done a great deal of work towards breaking down information silos, in order to establish an extensive organisation-wide technology management and architecture. Although progress has been made towards an open operational culture, this has yet to be completely achieved due to deficiencies in policies and principles. Openness is not to be found as a core steering value in the organisation's strategy. Activities are in many respects open and based on documented descriptions.
LEVEL 2 PARTLY MANAGED
The organisational culture will begin to change at the next level. Understanding the benefits of openness and its impact on activities is key. However, support for openness is limited and the organisation still has unlinked data warehouses. The first steps have been taken towards an open operational culture, but this is not publicly encouraged. Openness does not appear as a core value in the organisation's strategy. Activities are open to some extent. The organisation has begun efforts to develop competencies and create a systematic approach to openness. Performance measurement is largely the measurement of financial performance.
LEVEL 1 UNMANAGED
No steps have yet been publicly taken towards an open operational culture and the organisation lacks guiding principles and policies. Processes have not been clearly defined. Openness is not included in the organisation's strategy. Openness-related activities are not encouraged at organisational level. Indicates a situation in which openness is not consciously managed. At worst, the organisation may be an information silo. The term 'information silo' denotes informal point solutions. Although systems are in use, data for reports and benchmarks is often manually collated from a variety of information systems and other sources.

3 Promoting openness in higher education institutions

The collected data supports the identification of best practices and areas of development. Against this background, the results show that organisations with resolute strategic steering and clear policies and principles are able to manage change towards openness.

Higher education institutions (HEIs) are compared only in relation to the results of their previous evaluation performed in 2016.

3.1 Strategic Steering

An organisation's strategy reveals both its long-term and short-term visions, and the organisation's strategic choices and commitment to the implementation of various measures needed to advance open science. An organisation uses its strategy to communicate its objectives not only to its own personnel but also to others. The openness of an organisation's operating culture should therefore be evident in its strategy. Transparency is at least as important as concrete actions. Table 2 shows the measures considered for the evaluation of activities in this indicator. Table 3 shows the scoring of each organisation for each criterion in this indicator.

Table 2: Criteria for the Strategic Steering indicator

Strategic Steering

a) Openness in the organisation's strategy
b) Openness in the research activity
c) Local, national and international cooperation
d) Managing interoperability
e) Openness of research results
f) Strengthening openness-related competencies

See Appendix 1 for more details on scoring in relation to these measures.

Based on the score results, higher education institutions have actively included openness to their strategies. At the same time, a bit less commitment to openness in research activity is indicated by the strategic documents and shown as scores 1b.

Local, national, and international cooperation is strongly noted in the higher education institutions' strategies, and ten of them mention cooperation as the core aspect of their strategies. More than two-thirds of the universities and half of the universities of applied sciences have mentioned the promotion of interoperability in their strategic steering. Nine out of thirteen universities and more than 60 % of the universities of applied sciences mention openness of research results in the strategy-level. Strengthening openness-related competencies has clearly intensified in the strategic documents since the previous evaluation and five of the higher education institutions have mentioned it as a focus area for resourcing.

Table 3: Scoring for higher education institutions for the Strategic Steering indicator.

Organisation	Strategy						Total points
	a	b	c	d	e	f	
AYO	🔴	🔵	🔴	🔴	🔴	🔵	4
HY	🟡	🟢	🟡	🔴	🔴	🟡	11
ISYO	🟢	🟡	🟡	🟡	🟢	🟢	15
JY	🟢	🟢	🟢	🟢	🟢	🟢	18
LY	🔴	🔴	🔴	🔴	🔵	🟡	6
LTY	🔴	🔴	🟡	🔴	🔴	🔴	7
MPKK	🔵	🔵	🔵	🔵	🔵	🔵	0
OY	🟡	🟡	🔴	🟡	🔴	🔴	9
SHH	🔵	🔵	🔵	🔵	🔵	🔵	0
TaiY	🔴	🔴	🟡	🔵	🔵	🔵	4
TAU	🟢	🟢	🟢	🟢	🟢	🟢	18
TYO	🟢	🟢	🟢	🟢	🟢	🟢	18
VY	🔵	🔵	🟢	🔵	🔵	🔴	4
ÅA	🟢	🟢	🟢	🟡	🟡	🟡	15
ARCADA	🔴	🔴	🔵	🔴	🔴	🔴	0
CENTRIA	🔴	🔵	🟡	🔵	🔵	🔵	3
DIAK	🔵	🔵	🔴	🔵	🔵	🔵	1
HAAGA-HELIA	🔵	🔵	🔴	🔵	🔵	🔴	1
HAMK	🟡	🔵	🔴	🔵	🔴	🔵	4
HUMAK	🟡	🟡	🟡	🟡	🟡	🟡	12
HÅ	🔵	🔵	🔵	🔵	🔵	🔵	0
JAMK	🔴	🔴	🟡	🔴	🔴	🔴	7
KAMK	🔴	🔴	🟡	🔵	🔴	🔴	6
Karelia-AMK	🟢	🔴	🟡	🔴	🔴	🔴	9
XAMK	🔴	🔴	🟡	🔴	🔴	🔴	7
LAMK	🟡	🟡	🔴	🔵	🔴	🔵	6
Lapin AMK	🔴	🔴	🔴	🔴	🔴	🔴	6
LAUREA	🟢	🟢	🟢	🟡	🟡	🟢	16
METROPOLIA	🟢	🟢	🟢	🟡	🟢	🟡	16
NOVIA	🔴	🔴	🟡	🔴	🟡	🔴	8
OAMK	🔵	🔵	🔴	🔵	🔵	🔵	1
Polamk	🔵	🔵	🟡	🔵	🔵	🔵	2
SAIMAA	🟢	🔴	🟢	🔵	🟢	🔵	10
SAMK	🔴	🔵	🔴	🔴	🔵	🔵	3
Savonia-AMK	🔵	🔵	🟢	🔴	🔴	🔴	6
SeAMK	🟡	🔴	🟢	🔴	🟢	🔴	11
TURUN AMK	🔵	🔵	🟡	🟡	🔵	🔵	4
VAMK	🔵	🔵	🟡	🔵	🔵	🔵	2

3.2 Policies and Principles

The organisations implement their strategies in practice by defining and executing policies and principles that encourage openness. These include defining policies on the openness of data, methods, publications and collaboration, writing clear instructions for support services and aiming at establishing open research enterprise architecture, and including openness within an organisation's quality systems. Their various policies and principles describe openness as part of the organisation's activities and help actors to embrace openness. Table 4 shows the criteria considered for the evaluation of activities in this indicator. Table 5 shows the scoring of each organisation for each criterion in this indicator.

Table 4: Criteria for the Policies and Principles Indicator.

Policies and Principles

a) Principles of openness for scientific publications
b) Principles of self-archiving for scientific publications
c) Principles of openness relating to research methods
d) Principles of openness relating to the availability, use and licensing of research data
e) Service principles supporting openness
f) Guiding principles from Open Science framework
g) Principles of openness in cooperation
h) Principles of openness in agreements
i) Guidelines for quality systems

See Appendix 1 for more details on scoring in relation to these measures.

Based on the data, higher education institutions have actively set policies and principles to promote and clarify their stand in openness. Most of the HEIs have been able to achieve remarkable progress since 2016 in developing especially principles of openness for scientific publications, self-archiving, to research methods and to the availability, use and licensing of research data.

About 80 % of the higher education institutions have principles which recommend or encourage the use of open-access channels for publishing and more than 60 % require the use of open-access channels. Nearly all (93 %) of the universities and 88 % of the universities of applied sciences have recommendations on self-archiving publications in institutional or other repositories. Of the HEIs, 60 % require self-archiving research publications and has a support process place for it.

Compared to the previous evaluation, there has been significant improvements in developing the principles for the openness of research methods (including algorithms and code). Openness of research methods is surprisingly well managed in policies and almost all of the universities and more than 70 % of the universities of applied sciences have policies and principles for this. Almost half of the universities and about 40 % of the universities of applied sciences require openness of research methods.

The availability, use and licensing of research data is also very well managed. Every university has a data policy and implementation plan recommending openness of research data, whereas eight universities of applied sciences have not yet set principles for open research data. Ten out of thirteen universities and almost half of the universities of applied sciences require open licensing of research data and use of agreed open repositories.

Table 5: Scoring for thePolicies and Principles indicator for higher education institutions.

Organisation	Policies and Principles									Total Points
	a	b	c	d	e	f	g	h	i	
AYO	🟢	🟢	🔴	🟢	🟢	🟢	🟡	🟢	🟡	23
HY	🟢	🟢	🟡	🟢	🟢	🟢	🟡	🟢	🔴	24
ISYO	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	25
JY	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔵	24
LY	🔴	🔴	🔵	🟢	🟡	🔴	🟡	🟡	🟡	14
LTY	🟢	🟡	🟢	🟢	🟢	🔴	🟡	🟡	🔵	19
MPKK	🔵	🔵	🔵	🔵	🔵	🔵	🟡	🔵	🔵	2
OY	🟡	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🔴	23
SHH	🟢	🟢	🟡	🟡	🔵	🔵	🟡	🔵	🔵	12
TaiY	🔴	🟡	🟡	🟢	🔵	🟡	🟡	🟢	🔴	16
TAU	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	25
TYO	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	27
VY	🔴	🟢	🔴	🟡	🟡	🔴	🟡	🔴	🔴	14
ÅA	🟢	🟢	🟡	🔴	🟢	🟡	🟡	🔴	🔵	17
ARCADA	🟡	🟡	🔵	🔵	🔴	🔵	🔴	🔴	🔵	7
CENTRIA	🟢	🟢	🟡	🔵	🟡	🔵	🔵	🔴	🔵	11
DIAK	🟢	🟢	🔴	🟡	🟢	🔴	🟢	🟢	🔵	19
HAAGA-HELIA	🟢	🟢	🟡	🟢	🔴	🟢	🟡	🔴	🔴	19
HAMK	🟡	🟡	🟢	🟢	🟢	🟢	🟡	🟡	🟢	23
HUMAK	🟢	🔴	🔴	🔴	🔵	🔴	🟡	🟡	🔵	11
HÅ	🔵	🔵	🔵	🔵	🔵	🔵	🔴	🔵	🔴	2
JAMK	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	26
KAMK	🔴	🔴	🟢	🔴	🔴	🔴	🟡	🟡	🔴	13
Karelia-AMK	🟢	🟢	🔴	🟢	🟢	🟢	🟢	🟢	🟢	25
XAMK	🟢	🟢	🟢	🟡	🟡	🔴	🟢	🟢	🟡	22
LAMK	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🔴	🟡	23
Lapin AMK	🟢	🟢	🟢	🟢	🔴	🟡	🟡	🟡	🔴	20
LAUREA	🟡	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🔵	22
METROPOLIA	🟢	🟡	🟢	🔴	🟡	🔴	🟡	🔴	🔵	15
NOVIA	🟢	🟡	🔵	🔵	🔴	🔵	🟡	🔵	🔴	9
OAMK	🟢	🟢	🔴	🔵	🟡	🔵	🟡	🔴	🔴	12
Polamk	🔵	🔵	🔵	🔵	🔴	🔵	🟡	🔵	🔴	4
SAIMAA	🟡	🟡	🟢	🟢	🟢	🟡	🟡	🔴	🔵	18
SAMK	🟢	🟢	🟡	🟢	🟢	🔴	🟡	🔵	🔵	17
Savonia-AMK	🟢	🟢	🔵	🔵	🟡	🔵	🟡	🟢	🔵	13
SeAMK	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🔵	23
TURUN AMK	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	24
VAMK	🔵	🔵	🔵	🔵	🟡	🔵	🟡	🔵	🔵	4

Of the HEIS, 87 % have recommendations for open service principles, and can give access to the resources it administers to users from other organisations. The data shows that nine out of thirteen universities' enterprise architecture encourages or requires compliance

with the principles of Open Science framework. More than 60 % of the universities of applied sciences have at least considered principles of the framework, and implemented these in relevant policies. All but three HEIs are committed to collaboration and described collaboration activities openly. All but one university and almost 80 % of the universities of applied sciences recommend that principles of openness should be considered in agreements. Quite surprisingly, the public guidelines for quality systems are lacking from 16 HEIs and only four of the total 38 HEIs' quality manual recommends openness and names openness as one of its core quality principles.

3.3 Supporting Openness

The indicators refer to concrete actions in organisations, with which openness can be promoted and encouraged. Well-defined guidelines for the research community enable the entire organisation to harness the benefits of openness. A common understanding of the benefits of openness coupled with competences facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 6 shows the criteria considered for the evaluation of activities in this indicator. Table 7 shows the scoring of each organisation for each criterion in this indicator.

Table 6: Criteria for the Supporting Openness indicator.

Supporting Openness

a) Monitoring the openness of publishing (Open Access, self-archiving)
b) Monitoring the openness of research data (making data available, utilisation)
c) Monitoring the visibility of research (impact; scientific and social media)
d) Services for catalogueing and creating metadata for research materials
e) Services for documenting research publications and materials

See Appendix 1 for more details about scoring in these measures.

Compared to the 2016 evaluation, the higher education institutions have developed their operational culture in supporting openness notably in every area. Gratifyingly, many receive the highest possible scores in monitoring the openness of research outputs and visibility and in providing support services.

The data shows that most of the HE institutions monitor the openness of publishing activities. Fewer of them monitor the openness of research data and only three of the HEI actively collect data and metadata and use the information in decision-making. Monitoring the visibility of research activities is the most developed area in supporting openness and over 60 % of the HEIs and all but one university collects actively data and distinguishes scientific and other media hits.

Most of the HEIs use services for cataloguing and creating metadata for research materials to some extent and are developing metadata management. Of the HEIs, 10 % provide self-help guidelines for storing research publications and information about parallel publishing, 16 % provide also some support personnel helping on storage and metadata for research materials, and 50 % has sufficient amount of personnel guiding documentation, suitable storage sites for research materials and metadata, and explaining what must be considered when storing them. This means that only half of the HEIs have extensively covered the topic of services for documenting research publications and materials and explained the benefits for researchers.

Table 7: Scoring for higher education institutions for the Supporting Openness indicator.

Organisation	Supporting Openness					Total Points
	a	b	c	d	e	
AYO	●	●	●	●	●	13
HY	●	●	●	●	●	12
ISYO	●	●	●	●	●	13
JY	●	●	●	●	●	13
LY	●	●	●	●	●	6
LTY	●	●	●	●	●	13
MPKK	●	●	●	●		0
OY	●	●	●	●	●	14
SHH	●	●	●	●	●	8
TaiY	●	●	●	●	●	9
TAU	●	●	●	●	●	15
TYO	●	●	●	●	●	15
VY	●	●	●	●	●	13
ÅA	●	●	●	●	●	13
ARCADA	●	●	●	●	●	4
CENTRIA	●	●	●	●	●	5
DIAK	●	●	●	●	●	11
HAAGA-HELIA	●	●	●	●	●	10
HAMK	●	●	●	●	●	10
HUMAK	●	●	●	●	●	12
HÅ	●	●	●	●	●	0
JAMK	●	●	●	●	●	14
KAMK	●	●	●	●	●	3
Karelia-AMK	●	●	●	●	●	12
XAMK	●	●	●	●	●	10
LAMK	●	●	●	●	●	11
Lapin AMK	●	●	●	●	●	10
LAUREA	●	●	●	●	●	11
METROPOLIA	●	●	●	●	●	10
NOVIA	●	●	●	●	●	11
OAMK	●	●	●	●	●	5
Polamk	●	●	●	●	●	0
SAIMAA	●	●	●	●	●	12
SAMK	●	●	●	●	●	11
Savonia-AMK	●	●	●	●	●	7
SeAMK	●	●	●	●	●	12
TURUN AMK	●	●	●	●	●	12
VAMK	●	●	●	●	●	2

3.4 Competence Development

Well-defined guidelines for the research community can enable an entire organisation to harness the benefits of openness. Coupled with competencies, a common understanding of such benefits facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 15 shows the criteria considered for the evaluation of activities in this indicator. Table 16 shows the scoring of each organisation for each criterion in this indicator.

Table 8: Criteria for the Competence Development indicator.

Competence development
a) Lifecycle management of research data b) The re-use and findability of research results c) Use of common open science services d) Building competence in Open Science See Appendix 2 for more details on scoring in these areas.

On the competence development, the results show that every university provides at least some support and guidelines for the life-cycle management and digital preservation of research data. In eleven out of thirteen universities and eight out of 24 universities of applied sciences the support provided is strong. All but one of the universities provide self-help guidelines for creating external links and persistent identifiers for research and research materials, and ten provide also sufficient support. Of the universities of applied sciences, more than 60 % provide self-help guidelines for creating a data management plan and creating external links and persistent identifiers for research and research materials.

More than one third of the HEIs have local services aligned with major scientific funders' guidelines on availability and publishing of research, and recommend the use of the Fairdata services or other national and international services for managing research data. Almost half of the universities and five universities of applied sciences have included open science training as a compulsory part of the researcher curriculum. Of the 38 HEIs, 22 actively organises own training with targeted educational materials.

The results show that the HEIs have been able to improve the support for competence development since the 2016 evaluation in every area. Already then, all universities were

supporting openness, at least to some extent, and they have been able to improve their services. Among the universities of applied sciences, the progress has been outstanding.

Table 9: Scoring for higher education institutions for the Competence Development indicator.

Organisation	Competence Development				Total Points
	a	b	c	d	
AYO	🟢	🟢	🟢	🟡	11
HY	🟢	🟢	🟢	🟢	12
ISYO	🟢	🟢	🟢	🟡	11
JY	🟢	🟢	🟢	🟢	12
LY	🟡	🟡	🔴	🔵	5
LTY	🟢	🟢	🟢	🟢	12
MPKK	🔵	🔵	🔵	🔵	0
OY	🟢	🟢	🟡	🟢	11
SHH	🟢	🔵	🟡	🔴	6
TaiY	🟢	🟢	🟡	🟡	10
TAU	🟢	🟢	🟢	🟢	12
TYO	🟢	🟢	🟢	🟢	12
VY	🟢	🟢	🟢	🟡	11
ÅA	🟡	🔴	🟡	🟡	7
ARCADA	🔵	🔵	🔵	🔵	0
CENTRIA	🔵	🔴	🔴	🔴	3
DIAK	🟡	🔵	🔴	🔴	4
HAAGA-HELIA	🟢	🟢	🟢	🟡	11
HAMK	🟢	🟡	🟢	🟢	11
HUMAK	🔴	🔵	🔴	🔴	3
HÅ	🔵	🔵	🔵	🔵	0
JAMK	🟢	🟢	🟢	🟢	12
KAMK	🔵	🔵	🔵	🔵	0
Karelia-AMK	🟢	🟢	🟢	🟢	12
XAMK	🟡	🟡	🔴	🟡	7
LAMK	🟢	🟢	🟡	🟡	10
Lapin AMK	🟡	🔴	🔴	🔴	5
LAUREA	🟡	🟡	🟡	🟡	8
METROPOLIA	🟡	🟡	🔴	🔴	6
NOVIA	🔵	🔴	🟡	🔴	4
OAMK	🔴	🔴	🔵	🔵	2
Polamk	🔵	🔵	🔵	🔵	0
SAIMAA	🟢	🟢	🟡	🟡	10
SAMK	🔴	🟡	🔴	🟡	6
Savonia-AMK	🔵	🔵	🔵	🔴	1
SeAMK	🟢	🟢	🟢	🟢	12
TURUN AMK	🟢	🟢	🟡	🟢	11
VAMK	🔵	🔵	🔵	🔵	0

3.5 Maturity Rankings of higher education institutions

Each organisation's ranking is based on the total aggregate of scores for each of the criterion, for all indicators. Table 10 shows the total aggregate of scores, across all indicators, for each research organisation included in this analysis. Note that there was one extra score point for organisations in earlier evaluations from commitment to open science.

Table 10: Preliminary aggregate scores in 2019 across all indicators for each research institution and the difference in total aggregate score compared to the total score in 2016. Organisations, which have improved their performance in openness by 20 or more indicator score, have been highlighted in green. The difference is not shown for organisations not included in 2016 evaluation.

Organisation	FINAL sum score in 2019	Difference to 2016 total sum score	Total sum score 2016
AYO	51	+12	39
HY	59	+5	54
ISYO	64	+29	35
JY	67	+19	48
LY	31		31
LTY	51	+7	44
MPKK	2		
OY	57	+13	44
SHH	26	-11	37
TaiY	39	+30	9
TAU	70		
TYO	72	+33	39
VY	42	+27	15
ÅA	52	+27	25
ARCADA	11	-3	16
CENTRIA	12	-3	17
DIAK	35	+12	23
HAAGA-HELIA	41	+26	15
HAMK	48	+35	13
HUMAK	38	+35	5
HÅ	2		
JAMK	61	+52	9
KAMK	22	+9	13
Karelia-AMK	58	+44	14
XAMK	46		
LAMK	50	+24	26
Lapin AMK	41	+32	9
LAUREA	57	+32	25
METROPOLIA	47	+30	17
NOVIA	32	+21	11
OAMK	20	+12	8

Organisation	FINAL sum score in 2019	Difference to 2016 total sum score	Total sum score 2016
Polamk	6		
SAIMAA	50	+35	15
SAMK	37	+29	8
Savonia-AMK	27	+14	13
SeAMK	58	+28	30
TURUN AMK	51	+34	17
VAMK	8	+3	5

The improvement has been quite amazing, for example one university being able to reach the highest possible scores in each category and one university of applied sciences increase score by 50 points (JAMK). Figures 2 and 3 show the score results for each indicator, based on the findings of the evaluation.

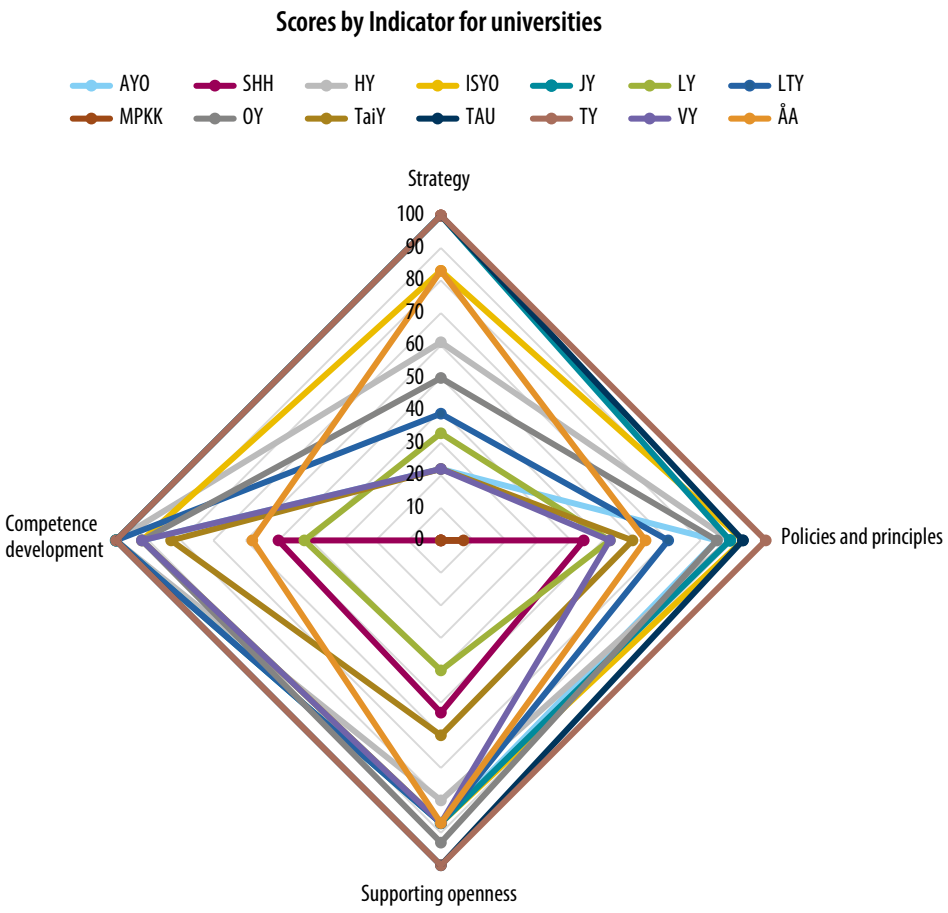

Figure 2: Scores by indicator as percentages from the maximum value for the universities.

Looking at the scores by indicator, it seems that development in openness has been quite balanced. However, strategic steering is the least mature and quite diverse area of openness at all universities.

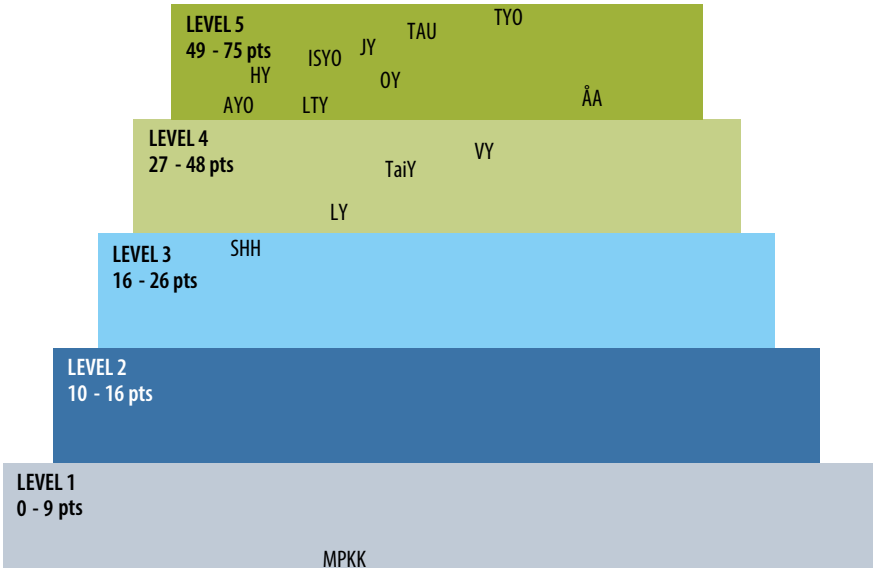

Figure 3: Maturity rankings for the universities in the openness of operational culture.

The development has been phenomenal since most organisations have been able to make relevant improvements in the openness of the operational culture and reach the highest level. In 2016, only one university made it to the level 5. University of Turku has evolved most, and is also the most mature university in open science culture.

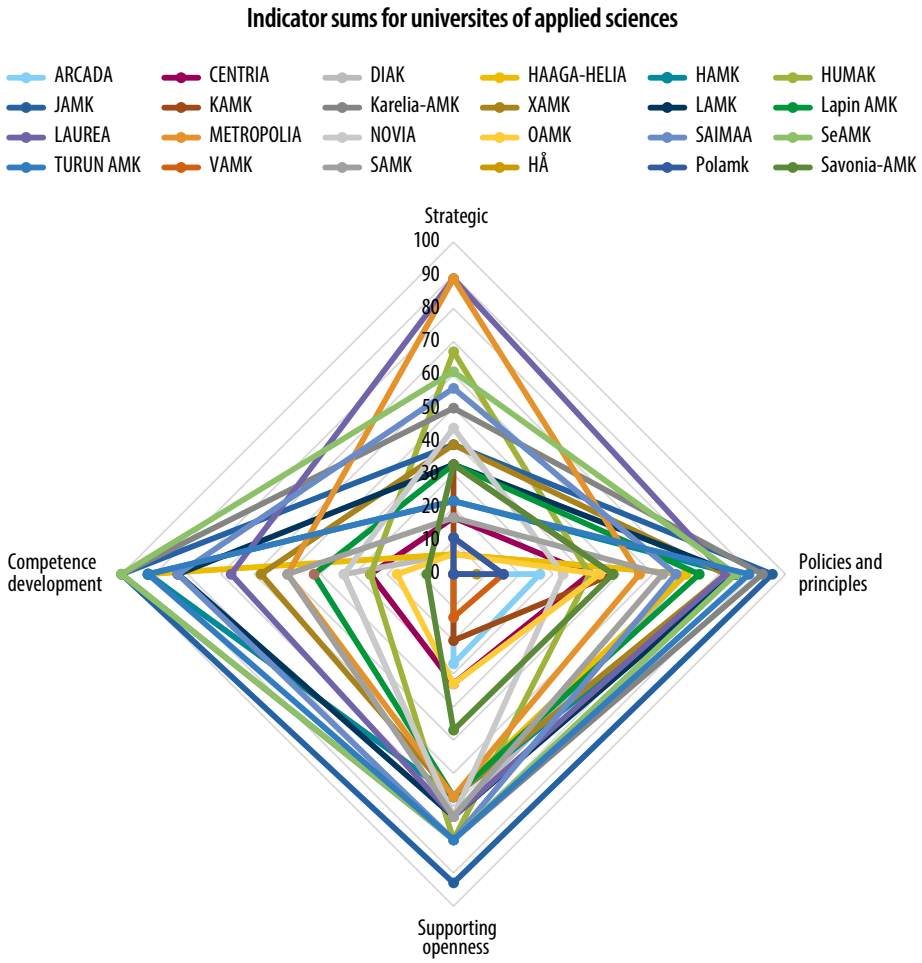

Figure 4: Scores by indicator as percentages from the maximum for the universities of applied sciences.

Scores by indicator reveal an interesting duality. Organisations strongest in strategy and supporting openness are generally not equally strong in policies and principles nor in competence development. On the other hand, organisations strong in policies and principles, supporting openness and competence development are not so mature in strategy.

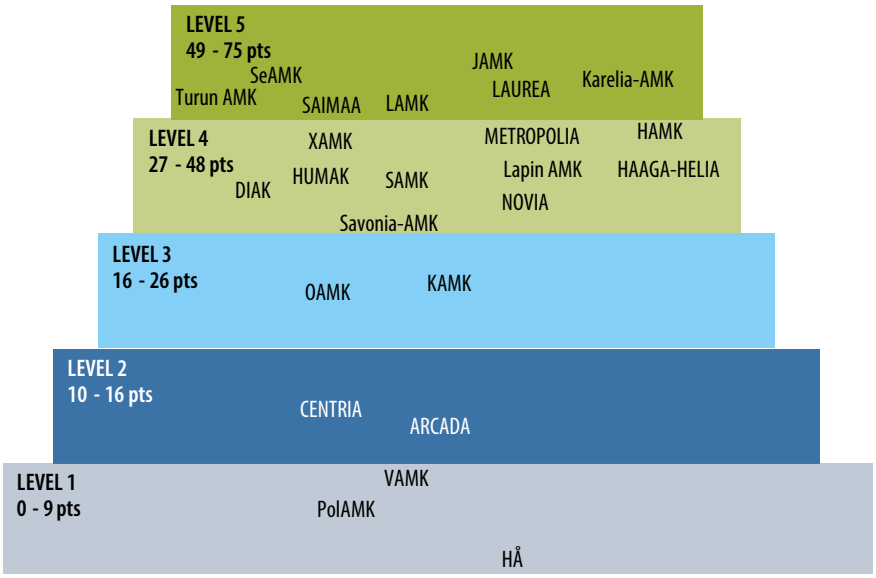

Figure 5: Maturity rankings for the universities of applied sciences in the openness of operational culture.

The results show that universities of applied sciences as a whole have been able to make relevant improvements in the openness of the operating culture. Seven organisations have made it to the top level. JAMK has evolved most and is also the most mature university of applied sciences in open science culture. In 2016, only one university of applied sciences reached the level 4.

4 Promoting openness in research institutes

Finnish state research institutes are evaluated to support the identification of best practices and areas of development in 2019.

Data was collected from information openly available in organisations' websites. The correction round was based on requests for information, sent by the Ministry of Education and Culture. In the requests for information, the research institutes were able to add information to and correct mistakes or misinformation in the preliminary data and analysis.

Finnish research institutes are compared with their results of the evaluation performed in 2017.

4.1 Strategic Steering

An organisation's strategy reveals both its long-term and short-term visions, and the organisation's strategic choices. An organisation uses its strategy to communicate its objectives not only to its own personnel but also to others. The openness of an organisation's operational culture should therefore be evident in its strategy. Transparency is at least as important as concrete actions. Table 11 shows the criteria considered for the evaluation of activities in this indicator. Table 12 shows the scoring of each organisation for each criterion in this indicator.

Table 11: Criteria for the Strategic Steering indicator.

Strategic Steering

a) Openness in the organisation's strategy
b) Openness in the research activity
c) Local, national and international cooperation
d) Managing interoperability
e) Openness of research results
f) Strengthening of openness-related competencies

See Appendix 1 for more details on scoring in relation to these criteria.

Table 12: Scoring for research institutes for the Strategic Steering indicator.

Organisation	Strategic Steering						Total points
	a	b	c	d	e	f	
Ruokavirasto	●	●	●	●	●	●	2
GTK	●	●	●	●	●	●	7
IL	●	●	●	●	●	●	11
FIIA	●	●	●	●	●	●	0
LUKE	●	●	●	●	●	●	8
MML	●	●	●	●	●	●	17
STUK	●	●	●	●	●	●	2
SYKE	●	●	●	●	●	●	7
THL	●	●	●	●	●	●	9
TTL	●	●	●	●	●	●	4
VATT	●	●	●	●	●	●	5
VTT	●	●	●	●	●	●	2

Research institutes are strong in collaboration at all levels. One of the institutes excel in the strategical openness (MML). Despite the progress of three research institutes since the 2017 evaluation, strengthening openness-related competence is the least developed area and only two of the institutes have defined openness-related competence as an area for development in the organisation's strategy.

Research institutes should utilise their cooperative culture and collaboration skills in the development of the strategic steering of open science and research. As a whole, they could benefit from collaboration with or a consultation of the Finnish universities.

4.2 Policies and Principles

The organisations implement their strategies in practice by defining and executing policies and principles that encourage openness. These include defining policies on the openness of data, methods, publications, collaboration, writing clear instructions for support services and aiming at establishing open research enterprise architecture, and including openness within an organisation's quality systems. Their various policies and principles describe openness as part of the organisation's activities and help actors to embrace openness. Table 13 shows the criteria considered for the evaluation of activities in this indicator. Table 14 shows the scoring of each organisation for each criterion in this indicator.

Table 13: Criteria for the Policies and Principles indicator.

Policies and Principles

1) Principles of openness for scientific publications
2) Principles of self-archiving for scientific publications
3) Principles of openness relating to research methods
4) Principles of openness relating to the availability, use and licensing of research data
5) Service principles supporting openness
6) Guiding principles from Open Science framework
7) Principles of openness in cooperation
8) Principles of openness in agreements
9) Guidelines for quality systems

See Appendix 1 for more details on scoring in relation to these criteria.

Table 14: Scoring for research institutes in accordance with the Policies and Principles indicator.

Organisation	Policies and Principles									Total Points
	a	b	c	d	e	f	g	h	i	
Ruokavirasto	🔴	🔵	🔵	🔴	🔴	🔴	🟡	🔵	🔵	6
GTK	🔵	🔵	🔵	🟡	🟡	🔴	🟢	🟡	🔵	9
IL	🔵	🔵	🟡	🔴	🟡	🔴	🟢	🔵	🔴	10
FIIA	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	🔵	0
LUKE	🔴	🔴	🔵	🟡	🟡	🟡	🟢	🟡	🔵	13
MML	🟡	🟡	🔴	🟢	🟡	🔴	🟢	🟡	🔵	16
STUK	🔵	🔵	🔵	🔵	🔴	🔵	🟢	🔵	🔵	4
SYKE	🔴	🔴	🔵	🟡	🟡	🔴	🟢	🔴	🔴	12
THL	🔴	🔵	🔵	🟡	🟡	🟡	🟡	🔴	🔵	10
TTL	🔴	🔴	🔴	🔴	🟡	🔴	🟡	🔴	🟡	12
VATT	🔴	🟡	🟡	🟡	🔴	🔴	🟡	🟡	🔵	13
VTT	🔴	🔴	🔵	🔴	🔵	🔵	🟡	🔴	🔵	6

Collaboration is traditionally a strong area for research institutes, and they are very mature in the openness of collaboration. Other areas of strength are principles of openness for research data, service principles supporting openness and adopting principles from Open Science Framework. Surprisingly, principles of openness to research methods (including code and algorithms) only appear in the policies of four research institutes.

Compared to the previous evaluation, the principles of openness for scientific publications and self-archiving and to research methods remain underdeveloped. Almost all of the research institutes seem to lack appropriate plans to implement the policies. Here, the Finnish universities could prove to be worth of benchmarking. Besides the implementation plans, also the principles of openness could be quite easily adapted from the universities.

4.3 Supporting Openness

The criteria are concrete actions in organisations with which openness can be promoted and encouraged. Well-defined guidelines for the research community enable the entire organisation to harness the benefits of openness. A common understanding of the benefits of openness coupled with competences facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 15 shows the criteria considered for the evaluation of activities in this indicator. Table 16 shows the scoring of each organisation for each criterion in this indicator.

Table 15: Criteria for the Supporting Openness indicator.

Supporting Openness

a) Monitoring the openness of publishing (Open Access, self-archiving)
b) Monitoring the openness of research data (making data available, utilisation)
c) Monitoring the visibility of research (impact; scientific and social media)
d) Services for catalogueing and creating metadata for research materials
e) Services for documenting research publications and materials

See Appendix 1 for more details on scoring in relation to these criteria.

Table 16: Scoring for research institutes for the Supporting Openness indicator.

Organisation	Supporting Openness					Total points
	a	b	c	d	e	
Ruokavirasto	🔴	🔴	🔵	🔴	🔵	3
GTK	🟡	🟡	🔴	🟡	🔴	8
IL	🔵	🟡	🔴	🟡	🔴	6
FIIA	🔵	🔵	🔵	🔵	🔵	0
LUKE	🟡	🟡	🟡	🟡	🔴	7
MML	🔴	🟡	🔴	🟡	🟡	8
STUK	🔵	🔵	🔵	🔵	🔴	1
SYKE	🟡	🟡	🔴	🟡	🔴	8
THL	🔴	🟡	🟢	🟡	🟡	10
TTL	🟡	🟢	🟢	🟢	🟡	11
VATT	🔵	🟡	🟢	🟡	🔴	8
VTT	🟡	🔴	🔵	🔵	🔴	4

Monitoring the openness of research data and services for cataloguing and creating metadata for research materials are the most mature criterion in supporting openness. Only five out of 12 institutes monitor the openness of publishing. Three institutes distinguish scientific and other media hits when monitoring the visibility of research activities.

4.4 Competence Development

Coupled with competencies, a common understanding of the benefits of openness facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness.

Table 17: Criteria for the Competence Development indicator.

Competence development

a) Lifecycle management of research data
b) The re-use and findability of research results
c) Use of common open science services
d) Building competence in Open Science

See Appendix 2 for more details on scoring in these areas.

Table 18: Scoring for research institutes for the Competence Development indicator.

Organisation	Competence Development				Total points
	a	b	c	d	
Ruokavirasto	●	●	●	●	0
GTK	●	●	●	●	7
IL	●	●	●	●	3
FIIA	●	●	●	●	0
LUKE	●	●	●	●	8
MML	●	●	●	●	7
STUK	●	●	●	●	0
SYKE	●	●	●	●	8
THL	●	●	●	●	8
TTL	●	●	●	●	10
VATT	●	●	●	●	8
VTT	●	●	●	●	4

The results show that half of the research institutes provide strong support and guidelines for the life-cycle management and digital preservation data. There has been relevant progress in this area since 2017.

Five institutes recommend participating in common training events and organise some own training, and three organise actively own training. Half of the institutes recommend the use of the Fairdata or other national services for managing research data.

4.5 Maturity rankings of research institutes

Each organisation's ranking is based on the total aggregate of scores for each of the criteria for all indicators. Table 17 presents the total aggregate of scores, across all indicators, for each research institute included in this analysis. Note that there was one extra score point for organisations in earlier evaluations from commitment to open science.

Table 19: Aggregate scores in 2019 across all indicators for each research institute and the difference in total sum score compared to the total score in 2017. Year 2016 results are also shown for comparison. Organisations, which have improved their performance in openness by 20 or more indicator score, have been highlighted in green.

Organisation	Final sum score in 2019	Total sum score in 2017	Total sum score in 2016	Difference to 2017
FIIA	0			
GTK	31	10	23	+21
IL	30	27	17	+3
LUKE	36	32	23	+4
MML	48	31	20	+17
Ruokavirasto	11	7	13	+4
STUK	7	12	5	-5
SYKE	35	32	30	+3
THL	37	35	11	+2
TTL	37	34	21	+3
VATT	34	12	11	+22
VTT	16	19	20	-3

Figure 6 presents the score results for each indicator, based on the findings of the evaluation of the research institutes.

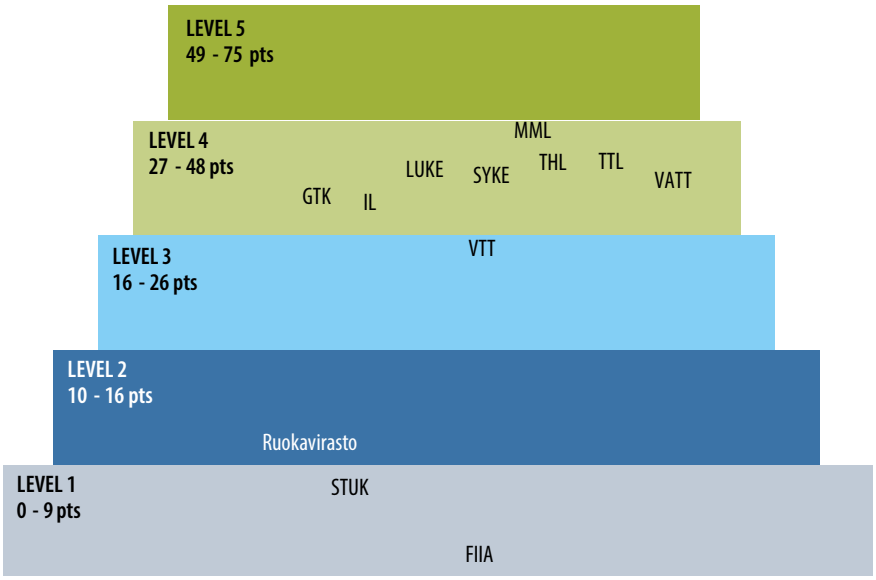

Figure 6: Maturity rankings for Research Institutes in openness of the operational culture.

The results show that some organisations have been able to make improvements in the openness of the operational culture, but most of them are still at the level 4. GTK, MML and VATT have noticeably improved their performance in openness since the 2017 evaluation. GTK and VATT have evolved most, but the most mature research institute in open science culture is MLL.

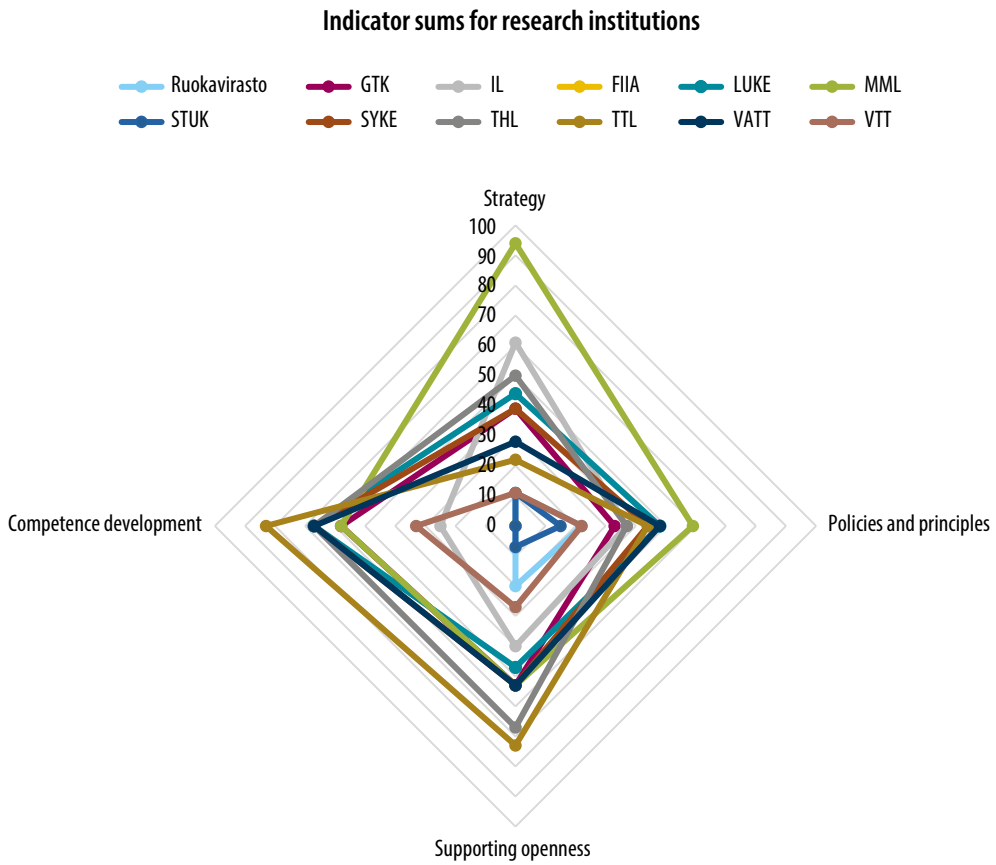

Figure 7: Indicators by section as percentages from the maximum for research institutes.

When studying the indicators by section, it is evident that research institutes build their strength in open science on supporting openness. The results are controversial: the institutes are very different when evaluating their maturity level in openness. MML is the most mature in strategy. This might be connected to the effect of fulfilling INSPIRE directive requirements.

5 Promoting openness in research-funding organisations

In 2019, data was collected from information openly available in organisations' websites. The correction round was based on requests for information, sent by the Ministry of Education and Culture. In the requests for information, the research-funding organisations were able to add information to and correct mistakes or misinformation in the preliminary data and analysis.

5.1 Strategic Steering and Principles for Openness

An organisation's strategy reveals both its long-term and short-term visions, as well as its strategic choices. An organisation uses its strategy to communicate its objectives not only to its own personnel, but also to others. Openness within the organisation's operating culture should therefore be evident in its strategy. Transparency is at least as important as concrete actions. Table 20 shows the criteria considered for the evaluation of activities in this indicator. Table 21 shows the scoring of each organisation for each measure in this criterion.

Table 20: Criteria for the Strategic Steering and Principles for Openness indicator.

Strategic Steering and Principles for Openness

a) Strategic steering of openness
b) Promoting the openness and re-use of research outputs
c) National and international cooperation
d) Interoperability of research infrastructures
e) Strengthening openness-related competence

See Appendix 2 for more details about scoring in these criteria.

Table 21: Scoring for research-funding organisations in the Strategic Steering and Principles for Openness indicator.

Organisation	Strategic Steering					Total Points
	a	b	c	d	e	
Academy of Finland	●	●	●	●	●	14
Business Finland	●	●	●	●	●	9
Kone Foundation	●	●	●	●	●	2

Strategic steering of openness has evolved since 2017. Data shows that one funder has openness as one of the prevailing strategic themes clearly at the core of all activities. One funder mentions openness as an aspect of operational culture and its significance has been explained. Two funders promote openness and re-use of the research results they fund as a principle.

National and international cooperation is well established for all of the research funders and it can be seen as core part of their strategic steering.

Based on the data, just one research funder has policies or principles on developing interoperability in the research infrastructures they fund. It should be noted though that not all of the research funders in this analysis fund research infrastructures. Only one funder has mentioned the strengthening of openness-related competencies in the strategy and defined this as an area for development.

5.2 Openness in research funding

The research funding organisation implements strategy in practice by defining and executing policies and principles that encourage openness. These include defining policies on the openness of data, methods, research infrastructures and publications. The principles describe openness as part of the research-funding organisations' activities and help actors to embrace it. Table 22 shows the criteria considered for the evaluation of activities in this indicator. Table 23 shows the scoring of each organisation for each measure in this criterion.

Table 22: Criteria for the Openness in Research Funding indicator.

Openness in Research Funding

a) Principles of open access publishing
b) Principles of research data openness
c) Principles of research method openness
d) Principles of openness for research infrastructures

See Appendix 2 for more details on scoring according to these criteria.

Table 23: Scoring for research-funding organisations in the Openness in Research Funding indicator.

Organisation	Openness in Research Funding				Total Points
	a	b	c	d	
Academy of Finland	●	●	●	●	10
Business Finland	●	●	●	●	5
Kone Foundation	●	●	●	●	2

All research funders have established openness to some extent in their research funding. Two funders require open access publishing and one recommends it, as the case has been in previous years. For research data, one funder requires, and two recommend openness.

Among research funders, there has been no progress regarding the principles of research methods since the 2017 evaluation. This differs from the significant progress made by the HEIs (cf. p. 23–24). Based on the findings, one research funder recommends openness for research methods, including algorithms and code. Only one funder has principles of

openness for the research infrastructures it funds. As noted in section 3.1., some of them do not fund research infrastructures at all.

Although only three research-funding organisations were included in the evaluation, it should be noted that in developing principles for openness, especially smaller research funders could benefit from a more intensive cooperation in the area with both research-funding organisations and universities.

5.3 Supporting and Promoting Openness

The criteria included in this indicator are concrete actions taken within the research funding organisation, with which openness can be promoted and encouraged. Using well-defined guidelines for the research community enables the entire organisation to harness the benefits of openness. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 24 shows the criteria considered for the evaluation of activities in this indicator. Table 25 shows the scoring of each organisation for each criterion in this indicator.

Table 24: Criteria for the Supporting and Promoting Openness indicator.

Supporting and Promoting Openness

a) Instructions for open science and research
b) Recommendations of openness for research outputs
c) Developing openness in research funding evaluation
d) Monitoring openness
e) Openness of funding decisions

See Appendix 2 for more details on scoring according to these criteria.

Table 25: Scoring for research funders in the Supporting and Promoting Openness indicator.

Organisation	Supporting Openness					Total Points
	a	b	c	d	e	
Academy of Finland	●	●	●	●	●	12
Business Finland	●	●	●	●	●	7
Kone Foundation	●	●	●	●	●	4

All research funders have instructions in some form for open science and research practices for funding applicants. One research funder excels in this (Academy of Finland). Additionally, all have information available on the possibilities of research outputs openness.

All research funders explain broadly the process of their funding calls and the review criteria used, but only one of them have openness or re-use of research as a review criterion in the funding calls. One research funder monitors the openness of the research they fund as a permanent part of their common reporting required from the funded research and promotes the re-use of research results. All research funders publish their funding decisions on their website, two in a machine-readable format.

When compared to the earlier evaluation, two research funders have been able to improve their operational culture in supporting openness. One funder has developed the monitoring of openness and openness in research funding evaluation and provides also better instructions for open research. One has shifted the emphasis from recommending to encouraging researchers to comply with the openness of research outputs.

5.4 Maturity rankings of research-funding organisations

Each research-funding organisations' ranking is based on the total sum of scores derived from each of the criteria used for each of the indicators. Figure 5 presents the indicator results of the research-funding organisations, based on the findings of the evaluation. Table 26 presents the total aggregate of scores across all indicators for each research-funding organisation included in this analysis.

Table 26: Total aggregate of scores across all indicators for each research-funding organisation and the difference in total sum score compared to the total score in 2017.

Organisation	Total sum score in 2019	Total sum score in 2017	Difference to 2017
Academy of Finland	36	31	+5
Business Finland	21	18	+3
Kone Foundation	8	8	0

Academy of Finland has reached the level 5 with definite actions and improvements especially in communicating the recommendations, policies, and instructions to applicants.

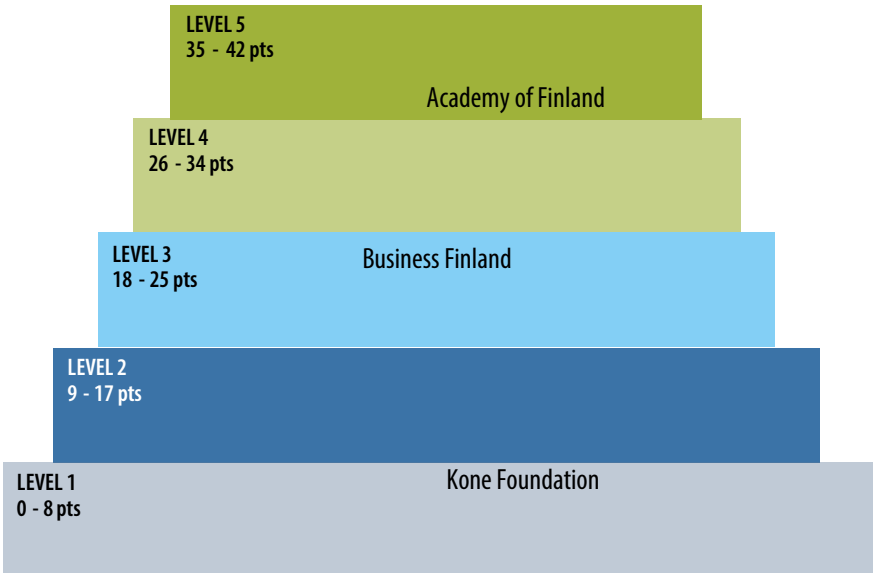

Figure 8: Maturity rankings for research funding organisations in openness of the operational culture.

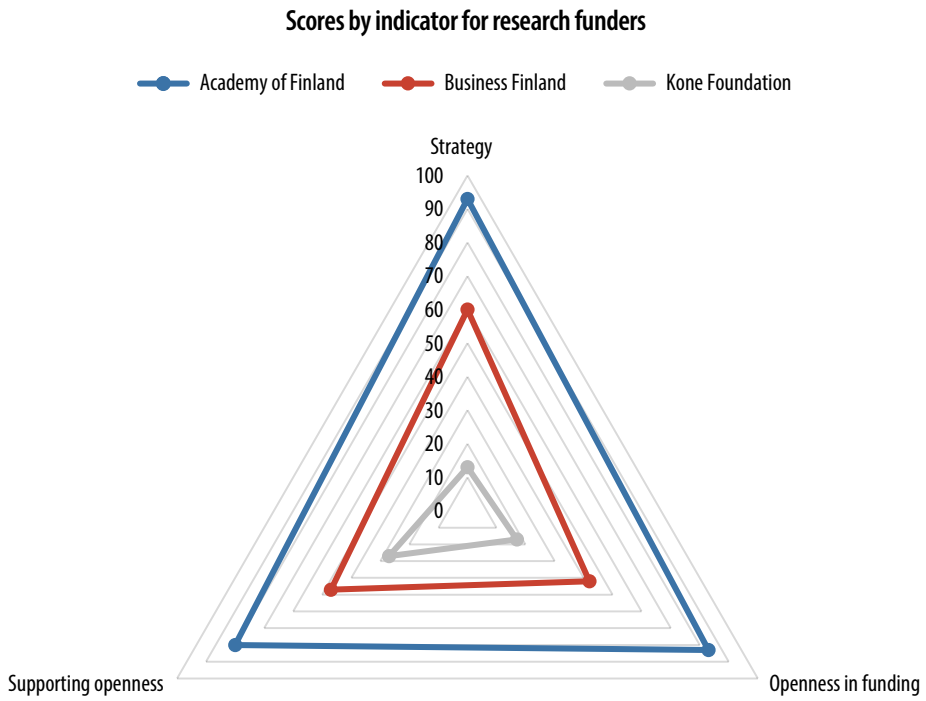

Figure 9: Scores by indicator as percentages from the maximum for research-funding organisations.

Scores by section reveal that all research funders are most mature in strategic openness. The Academy of Finland is very strong in all aspects of openness.

6 Promoting openness in Finnish academic and cultural institutes abroad

Data collected from the websites form the preliminary evaluation results. The Ministry of Education and Culture sent a request for information, in which the institutes were able to add information to and correct mistakes or misinformation in the preliminary data and analysis. The Finnish academic and cultural institutes abroad have not been studied earlier, so comparison data is not available.

6.1 Strategic Steering

An organisation's strategy reveals both its long-term and short-term visions, and the organisation's strategic choices. An organisation uses its strategy to communicate its objectives not only to its own personnel but also to others. The openness of an organisation's operating culture should therefore be evident in its strategy. Transparency is at least as important as concrete actions. Table 27 shows the criteria considered for the evaluation of activities in this indicator. Table 28 shows the scoring of each organisation for each criterion in this indicator.

Table 27: Criteria for the Strategic Steering indicator.

Strategic Steering

a) Strategic steering of openness
b) Promoting the openness and re-use of research outputs
c) National and international cooperation
d) Strengthening openness-related competencies

See Appendix 3 for more details on scoring in relation to these criteria.

Table 28: Scoring for the Finnish academic and cultural institutes abroad for the Strategic Steering indicator.

Organisation	Strategic Steering				Total Points
	a	b	c	d	
FI Middle East	●	●	●	●	5
FI Rome	●	●	●	●	5
FI Athens	●	●	●	●	3
FI Japan	●	●	●	●	6

Based on the data of this evaluation, these institutes have not included openness in their strategies. At the same time, all institutes have local, national, and international cooperation strongly noted in the strategies. Openness of research outputs is not yet mentioned in the strategies but all institutes are developing the openness of research outputs. Also the openness-related competence or services are defined as an area for development even though not yet mentioned in the strategies of the institutes.

6.2 Policies and Principles

The organisations implement their strategies in practice by defining and executing policies and principles that encourage openness. These include defining policies on the openness of data, methods, publications, collaboration, writing clear instructions for supporting services and aiming at establishing open research enterprise architecture, and including openness within an organisation's quality systems. Their various policies

and principles describe openness as part of the organisation's activities and help actors to embrace openness.

Table 29 shows the criteria considered for the evaluation of activities in this indicator. Table 30 shows the scoring of each organisation for each criterion in this indicator.

Table 29: The Policies and Principles indicator.

Policies and Principles

a) Principles of open access publishing
b) Principles of research data openness

See Appendix 3 for more details on scoring in relation to these criteria.

Table 30: Scoring for Institutes in the Policies and Principles indicator.

Organisation	Policies and Principles		Total Points
	a	b	
FI Middle East	●	●	2
FI Rome	●	●	0
FI Athens	●	●	0
FI Japan	●	●	1

The results show that two institutes recommend research publications to be published in open access publishing channels and one recommends openness to research data.

6.3 Supporting Openness

The criteria are concrete actions in organisations with which openness can be promoted and encouraged. Well-defined guidelines for the research community enable the entire organisation to harness the benefits of openness. A common understanding of the benefits of openness coupled with competences facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 31 shows the criteria considered for the

evaluation of activities in this indicator. Table 32 shows the scoring of each organisation for each criterion in this indicator.

Table 31: Criteria for the Supporting Openness indicator.

Supporting Openness

a) Instructions for open science and research
b) Developing openness in collaboration
c) Monitoring openness
d) Monitoring impact and visibility of research (scientific and social media)

See Appendix 3 for more details about scoring in these criteria.

Table 32: Scoring for institutes for the Supporting Openness indicator.

Organisation	Supporting Openness				Total Points
	a	b	c	d	
FI Middle East	🔴	🟡	🔵	🟡	5
FI Rome	🔴	🔴	🔵	🟡	4
FI Athens	🔴	🔴	🔵	🟡	4
FI Japan	🟡	🟡	🔵	🟡	6

The data shows that monitoring impact and visibility of research is the most developed area in supporting openness: all institutes monitor the visibility or impact to some extent. Monitoring the openness of research results is an area for urgent development and it should be developed alongside policies and principles.

6.4 Maturity rankings of Finnish academic and cultural institutes abroad

The institutes included in the evaluation were ranked based on a five-level maturity model. Each institutes' ranking is based on the total sum of scores for each of the measures, for all indicators. Figure 10 presents the maturity results for academic and

cultural institute, based on the findings of the evaluation, and Figure 11 the scores by section. Table 33 presents the total aggregate of scores, across all indicators, for each research organisation included in this analysis.

Table 33: Total aggregate scores across all indicators for each academic and cultural institute 2019.

Organisation	Total sum score in 2019
FI Middle East	12
FI Rome	9
FI Japan	13
FI Athens	7

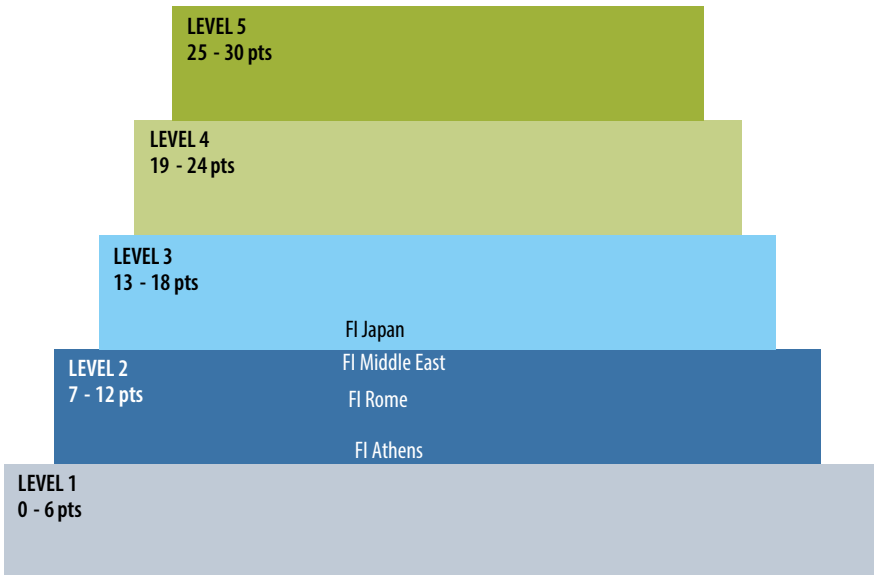

Figure 10: Maturity rankings for Finnish academic and cultural institutes abroad in openness of the operational culture.

Based on the evaluation, one institute is on the level 3 and others on the level 2.

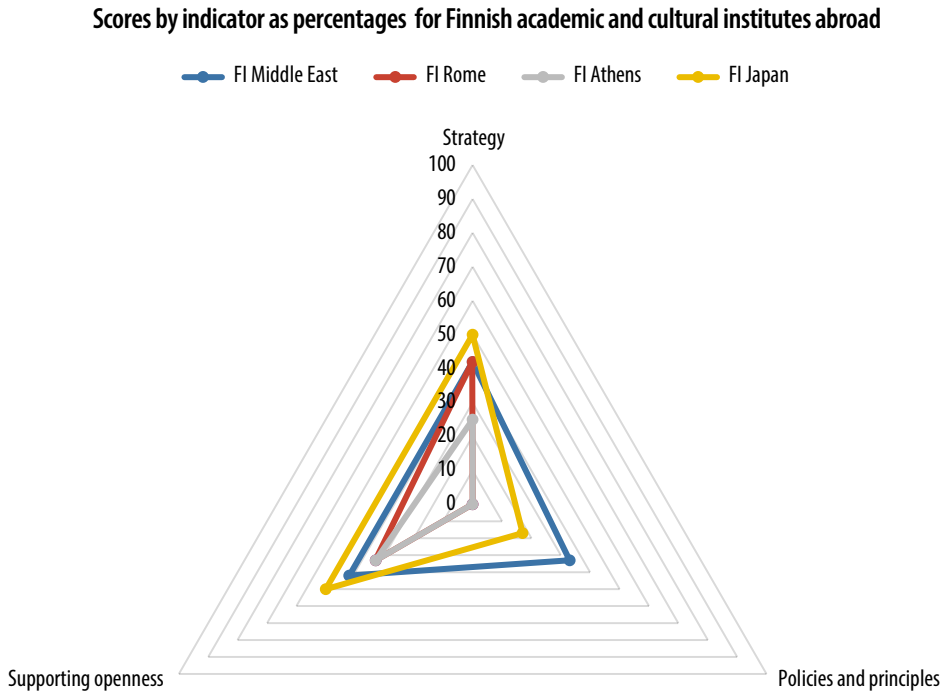

Figure 11: Scores by section as percentages from the maximum for Finnish academic and cultural institutes abroad.

Scores by section reveal that the Finnish academic and cultural institutes abroad are not yet mature in any of the areas under evaluation, however the strategic steering and supporting of openness are being developed.

7 Promoting openness in learned societies and academies

Data collected from the websites form the preliminary evaluation results. The Ministry of Education and Culture sent a request for information, in which the organisations were able to add information to and correct mistakes or misinformation in the preliminary data and analysis. These organisations have not been studied earlier, so no comparison data is available.

7.1 Strategic Steering

An organisation's strategy reveals both its long-term and short-term visions, and the organisation's strategic choices. An organisation uses its strategy to communicate its objectives not only to its own personnel but also to others. The openness of an organisation's operating culture should therefore be evident in its strategy. Transparency is at least as important as concrete actions. Table 34 shows the criteria considered for the evaluation of activities in this indicator. Table 35 shows the scoring of each organisation for each criterion in this indicator.

Table 34: Criteria for the Strategic Steering indicator.

Strategic Steering

a) Strategic steering of openness
b) Promoting the openness and re-use of research outputs
c) National and international cooperation
d) Interoperability of research infrastructures
e) Strengthening openness-related competencies

See Appendix 4 for more details on scoring in relation to these criteria

Table 35: Scoring for learned societies and academies for the Strategic Steering indicator.

Organisation	Strategic Steering					Total points
	a	b	c	d	e	
TSV	●	●	●	●	●	14
TENK	●	●	●	●	●	10
TJNK	●	●	●	●	●	12
Tiedeakatemia	●	●	●	●	●	3
Tiedeseura	●	●	●	●	●	6
TTA	●	●	●	●	●	3
STV	●	●	●	●	●	3

Based on the data of this evaluation, half of these organisations have included openness in their strategies. Only three promote openness and re-use of results.

Local, national, and international cooperation is present in the strategies since all have cooperation named as the core aspect of their strategies. Only two have mentioned the promotion of interoperability in their strategic steering, and three have mentioned openness-related competencies.

7.2 Policies and Principles

The organisations implement their strategies in practice by defining and executing policies and principles that encourage openness. These include defining policies on the

openness of data and publications, writing clear instructions for supporting services, and including openness within an organisation's quality systems. Their various policies and principles describe openness as part of the organisation's activities and help actors to embrace openness. Table 36 shows the criteria considered for the evaluation of activities in this indicator. Table 37 shows the scoring of each organisation for each criterion in this indicator.

Table 36: Criteria for the Policies and Principles indicator.

Policies and Principles

a) Principles of open access publishing
b) Principles of research data openness
c) Principles of openness relating to research methods (including algorithms and code)
d) Principles of openness for research infrastructures

See Appendix 4 for more details on scoring in relation to these criteria.

Table 37: Scoring for the Policies and Principles indicator.

Organisation	Policies and Principles				Total Points
	a	b	c	d	
TSV	●	●	●	●	4
TENK	not applicable				
TJNK	not applicable				
Tiedeakatemia	●	●	●	●	0
Tiedeseura	●	●	●	●	2
TTA	●	●	●	●	0
STV	●	●	●	●	0

Only two of the learned societies and academies have principles of openness for scientific publications, and only one for research data. It should be noted though that the criteria used for the policies and principles were not applicable to two organisations (TENK, TJNK).

7.3 Supporting Openness

The measures are concrete actions in organisations with which openness can be promoted and encouraged. Well-defined guidelines for the research community enable the entire organisation to harness the benefits of openness. A common understanding of the benefits of openness coupled with competences facilitates cooperation and researcher exchange. Guidelines play a key role in providing information and motivation, and thereby the more extensive promotion of openness. Table 38 shows the criteria considered for the evaluation of activities in this indicator. Table 39 shows the scoring of each organisation for each criterion in this indicator.

Table 38: Criteria for the Supporting Openness indicator.

Supporting Openness

a) Instructions for open science and research
b) Recommendation of openness for research outputs
c) Developing openness in collaboration
d) Monitoring openness
e) Monitoring impact and visibility of research (scientific and social media)

See Appendix 4 for more details about scoring in these criteria.

Table 39: Scoring for learned societies and academies for the Supporting Openness -indicator.

Organisation	Supporting Openness					Total Points
	a	b	c	d	e	
TSV	●	●	●	●	●	6
TENK	not applicable					
TJNK	not applicable					
Tiedeakatemia	●	●	●	●	●	0
Tiedeseura	●	●	●	●	●	0
TTA	●	●	●	●	●	0
STV	●	●	●	●	●	0

Only one of the learned societies and academies have instructions for open science and research, is developing openness in collaboration, and monitoring impact and visibility

of research. The criteria used for the policies and principles were not applicable to two organisations (TENK, TJNK).

7.4 Maturity rankings of learned societies and academies

Each organisation's ranking is based on the total aggregate of scores for each of the criteria, for all indicators. Figure 12 presents the results for learned societies and academies, based on the findings of the evaluation. Table 40 presents the total aggregate of scores, across all indicators, for each research organisation included in this analysis.

Table 40: Total aggregate scores across all indicators for each learned society and Academies in 2019. *Only strategic steering indicator applicable. TENK and TJNK are very good in strategic steering of openness, which was the only applicable criteria for them.

Organisation	Total sum score in 2019
TSV	24
TENK	10 *
TJNK	12 *
Tiedeakatemia	3
Tiedeseura	8
TTA	3
STVA	3

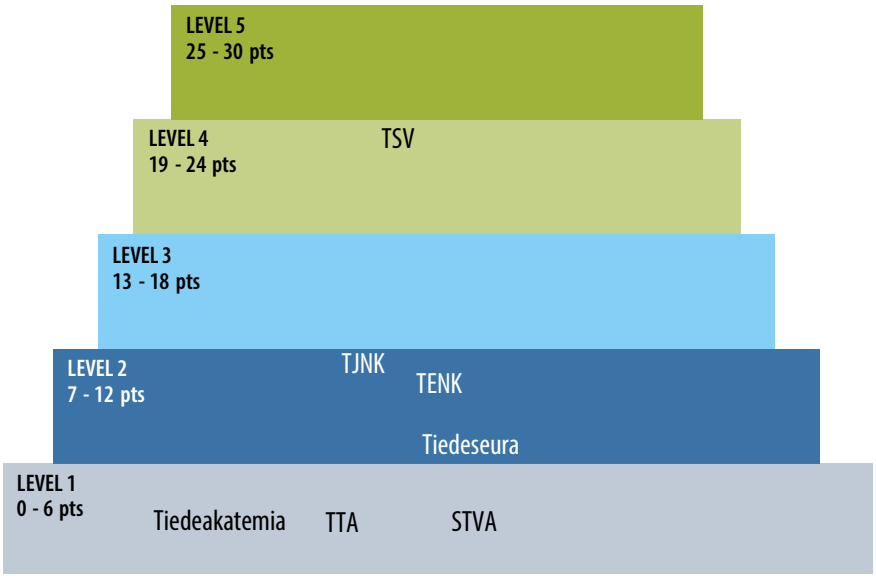

Figure 12: Maturity levels for learned societies and academies.

8 Barriers and Development needs

This year, the request for information also included a questionnaire for leaders of research activities to unravel the barriers and development needs for promoting open science. Especially, the higher education institutes were advised to distribute the questionnaire to researchers in a leading position (such as principal investigators, vice-rectors, heads of faculties, departments and other units). In total 71 responses were received for the questionnaire. Some of the answers were a combination of the responses of several persons. The disciplines represented in the responses include for example jurisprudence, social psychology, medical sciences, political sciences, veterinary science and future research.

8.1 Barriers

The responses described the obstacles in detail and included excellent suggestions for improvement. Figure 14 shows what all respondents from the evaluated organisations felt about the barriers.

	Not significant	Some significance	Moderately significant	Significant	Most significant
Insufficient training and instructions	7	13	19	16	6
Uncertainties in fulfilling legal demands	2	6	18	31	14
Descipline-specific differences	7	11	19	14	11
Researchers have to fulfil disproportionate standards	5	6	9	28	17
Conflicting incentives	5	10	13	22	16
Obstacles in open research communication	12	21	11	8	6
Merit system	9	7	18	17	11
Insufficient funding and resources	4	6	16	23	17

Figure 14: Compilation of all answers to questions about barriers in open science and research. Colour code: Red: > 20, Orange :> 15, Yellow: >10, Light green: > 5 and Blue: < 5 references

The most significant barriers include juridical uncertainties, disproportionate standards for researchers to fulfil, conflicting incentives and insufficient funding and resources to promote openness. In total, the respondents do not feel that there are significant barriers in open research communication, and that discipline-specific differences and practices are not too large.

In an earlier (2016) survey on barriers, the most noteworthy barriers were:

- research quality issues
- juridical uncertainties
- issues on funding and resources

As the two latter barriers are still seen as significant in 2019, it underlines the urgency of actions to remove these barriers. Conflicting incentives and unproportioned standards for researchers to fulfil might be an effect of multitude of existing policies and demands. These policies and demands are apparently not wholly congruent.

Still, the landscape is not that simple. Viewing the barriers by research organisation type reveals significant differences. The research institutes consider conflicting incentives and insufficient funding and resources as the biggest barriers. They do not consider insufficient training and instructions, nor discipline-specific differences nor troubles in merit system as being important barriers of open science and research. This might be explained by the fact that the research institutes are strong in supporting the data life-cycle management, as seen in results in previous sections. This might also result from the research institutes' developing maturity level open science policies are not yet requiring openness of research outputs but rather recommending and encouraging openness which allows more flexible practices to flourish and perhaps need for training arises at later stages when open research practices are required to be followed.

Universities experience the biggest barriers with uncertainties in fulfilling legal demands, conflicting incentives and disproportionate standards for researchers to fulfil. The merit system is also felt as being somewhat significant barrier; however, conflicting incentives seem to create bigger barriers for some of the respondents. Some feel that conflicting incentives exist, but simultaneously others feel that they are not significant. A similar duality appears in training and instructions. There are not so many barriers in open research communication.

Among the organisations evaluated, discipline-specific differences and practices are seen as being much more significant barrier at universities. This might be explained by the multidisciplinary character of universities when compared to research institutes and by the research-intensive and inherently international character of discipline-based

research when compared to the universities of applied sciences: universities are matrix organisations where different disciplines belong also to international research communities and are not restricted to the organisational boundaries of the university.

Universities of applied sciences clearly see the legal uncertainties as most significant barrier. Insufficient funding and resources follow next, then the merit system and conflicting incentives. Open science communication is not seen as a barrier. Discipline-specific differences are also not seen as significant. The most significant barrier is insufficient funding and resources. Next are merit system, disproportional standards for researchers to fulfil and uncertainties in fulfilling legal demands. An explanation to this might come from having the focus in the strategy and policy development, and not yet in pragmatic actions. Open research communication is not seen as being a big barrier.

8.1.1 Insufficient training and instructions

The remarks on insufficient training and instructions can be classified in the following categories:

- there is no systematic training encouraging openness
- existing training for openness is not valued
- ack of resources and knowledge for teaching openness
- no integration to curriculum method courses
- open science is not explained from the researchers' viewpoint

These categories include suggestions and remarks for several target groups. These suggestions are compiled to Appendix 12 by target group.

8.1.2 Juridical uncertainties

The most significant juridical uncertainties focus on copyright and data protection issues. These can be divided further to see more details.

The copyright uncertainties include:

- re-use of materials
- students' materials
- use of images
- educational materials
- artistical materials
- legal responsibility

The data protection uncertainties include:

- sufficient actions for protecting individuals
- support services for fulfilling obligations
- clarifying responsibility issues (who is responsible and of what)

Suggested solutions include actions for several target groups. These suggestions are compiled to Appendix 13 by target group.

8.1.3 Discipline-specific differences

The most significant discipline-specific differences focus on the following five categories:

- trade secrets
- sensitive information
- research traditions and practices
- discipline-specific preparedness for openness
- research evaluation

These can be divided further to see more details. This division is compiled to Appendix 14.

All and all, these differences manifest in:

- differences in instructions needed
- differences in preparedness
- differences in research evaluation and practices

The suggestions have a clear guideline for action:

1) recognising and accepting differences
2) strengthening peer networks
3) developing common information desk for peers
4) drafting sectoral best practices (flexible processes and platforms for data, publishing etc.)
5) education and workshop, noting preparedness levels. Additional support for disciplines with challenges in opening.

8.1.4 Disproportionate standards to fulfil

The most significant disproportionate standards for researchers to fulfil focus on the following four categories:

- not enough support
- academic merit system
- managing demands
- resources

These categories include suggestions and remarks for several target groups. These are compiled to Appendix 15 by target group.

8.1.5 Conflicting incentives

The most significant disproportionate standards for researchers to fulfil focus on the following three categories:

- the rationale for publishing
- discipline-specific differences
- missing alternative metrics for data and publication sharing

These categories include suggestions and remarks for several target groups. These are compiled to Appendix 16 by target group.

8.1.6 Obstacles in open research communication

The most significant discipline-specific differences focus on the following five categories:

- making and indicating impact
- effort of popular communication
- incentives to communicate
- communication channels

There were several clarifications and suggestions on how to proceed and develop in this area. The clarifications and suggestion are compiled to Appendix 17.

8.1.7 Merit system

The most significant discipline-specific differences focus on the following five categories:

- metrics and indicators
- valuation of publications
- differences in traditions and practices
- career path management

These can be divided further to see more details. This division is compiled to Appendix 18.

8.1.8 Funding and resources

The most significant barriers in funding and resources focus on the following five categories:

- Services
  - Not enough services to support openness. Additionally, new professional skills are needed.
  - Openness demands more resources from organisation.
- Research funding
  - Covering OA costs (organisations and not individual researchers should cover, e.g. after a project ends).
  - Principles of paying for openness.
- Skills
  - Support personnel skills for educated advising in these matters.
- Steering
  - Steering by the home organisation is not strong.

These can be divided further to see more details. This division is compiled to Appendix 19.

There were several suggestions how to proceed and develop in this area. The suggestions include:

1) Stronger collaboration of research organisations

a) joint support services
b) stable common resources for data management (like fsd)
c) common process descriptions
d) joint projects for openness
e) sharing information on existing service costs (national and local)

2) Training

a) regular support personnel training program
b) training researchers in understanding and registering all costs of openness

3) Funding

a) specific openness funding for projects publishing after funding period
b) national funding for oa publishing for the transfer period
c) merit and funding from openness
d) funding instrument for data availability and sharing
e) replacing jufo with citation metrics
f) incentive funding to disciplines struggling with openness

4) International collaboration

a) stronger collaboration in putting pressure on the international publishing companies to change their business logics
b) finelib set to bigger international context
c) getting rid of OA-fees with collaborative force

5) Priorisations

a) setting oa higher
b) setting quality oa publishing over jufo classification

8.2 Development needs

The suggestions for development mirror solutions for removing barriers, with some more detailed solutions. These include:

- merit system and incentives
- understanding individuality
- cost provisioning of publications
- re-use of research materials
- deeper collaboration
- developing skills
- managing costs of openness
- trust, confidence and resources

The compiled development needs are depicted in Figure 15.

	Not significant	Some significance	Moderately significant	Significant	Most significant
Merit system and incentives	0	0	0	2	4
Chracteristics of actors	0	0	0	0	1
Cost provisioning of publications	0	1	1	3	6
Re-use of materials	0	0	1	0	1
Deeper collaboration	0	0	0	3	2
Developing skills	0	0	1	2	2
Managing costs of openness	0	3	1	6	2
Trust, conficence and resources	0	0	0	2	2

Figure 15: The compiled development needs. Colour code: Red: > 5, Orange: 3-4, Yellow: 2, Light green: 1 and Blue: 0 references

Most significant development needs relate to publication cost provisioning, managing costs of openness and merit system and incentives. As most of these have surfaces in the barrier analysis, and will be compiled in Suggested Actions, they are not addressed deeper here.

8.3 National Open Science Coordination

In general, Open Science coordination by TSV was seen as positive. Especially the respondents appreciate:

- TSV coordination has involved admirably support personnel from organisations
- there is a good spirit and skilled and helpful persons at TSV
- open commenting is largely adopted
- based on voluntarily participation

The development needs and suggestion can be classified as:

- involving researchers
- prioritizing and phasing national open science actions
- paying attention and accepting different needs of different actors
- correcting representation bias in working groups
- increasing the amount of available educational materials
- increasing national and global collaboration

There were several suggestions on how to proceed and develop in this area. The suggestions involve all stakeholders, as the advancement of Open Science is a collaborative effort. The suggestions are compiled to Appendix 20.

8.4 Suggested Actions

The essential preconditions for research is that researchers have sufficient time for it. Demands for openness should be balanced with appropriate support and training, with the aim of diminishing the administrative burden for researchers. All researchers, from junior and early career researchers to the most merited ones ,should get proper training on relevant issues of openness. No researchers should feel abandoned when facing open science and research issues.

Table 41 compiles the inferred suggestions for actions by target group.

Table 41: Suggested actions.

Everybody	1) Make sure you are informed about open science policies and their content and aims. 2) Increase the understanding of the open science policies and base discussion on facts. This may take away some of the concerns of the academics. 3) Actively educate yourself on open science and research issues. Ask for specific and tailored training. 4) Communicate development ideas and needs
Research funders	1) **Set national optimal target level.** Invest in discussing and communicating the perceptions of the content and aims of open science policies. 2) **Reform researcher evaluation, merit system and incentives to promote open culture.** One way to proceed in this immediately and in a responsible way, is to focus on the openness in research strategy instead of the outcomes when evaluating open science practices ex-ante (what is the proposed strategy for openness in research plan and research funding application etc.) or ex-post (what strategy for openness in research was followed). Value all achievements in different stages of the research process, not only openly accessible outputs. Applauding all achievements demonstrates that success in openness is manifold and achievable. Train evaluators in the evaluation of open science and research practices. 3) **Re-structure funding to cover the costs for openness** 4) **Foster global collaboration** (connecting national with global activities (Plan S, EOSC, Nordic EOSC etc.)) 5) **Promote changes for the better** (lighter administrative burden for researchers, strive keeping data protection in research regulation on same level as in other EU member states. Recast Copyright Law (especially self-archiving). 6) **Review the effect of funding model, JUFO and artificial quantitative metrics.** 7) **Demands** (no demand without clearly defined benefit).
National Coordination	1) **Prioritize actions** (more priority to nationally important issues (OA, costs of open science and research, merit system, incentives)) 2) **Plan a stepwise progress** (ensuring resources for reaching targets) 3) **Focus on getting researchers involved.** Innovate and offer multiple ways of participating. Organise and facilitate debates about open science and research in universities, in universities of applied sciences and in research institutes. In universities these should be discipline-based. 4) **Build on networked collaboration** (involving everybody is possible only with strong, distributed collaboration) 5) **Develop metrics and incentives for research impact.** Focus on the impact / societal benefit strategy instead of the outcomes when evaluating research impact. Value all achievements. Applauding all achievements demonstrates that success societal impact is achievable. Pave the way to realise the use of qualitative indicators. (Recommendations for responsible evaluation of researcher nationally and internationally). 6) **Train academics and evaluators in order to better understand what research impact is** – a broader sense of impact than short-term outcomes and financial benefits (such as patents and spin-off companies). Academics may be actively conducting impactful research without even knowing it. Academics and evaluators should understand what research impact and related processes are and also how these relate to openness. 7) **Facilitate updating the academic merit system** 1) **Acknowledge diversity in the field** 2) **Focus training activities to needs** (help the weakest, learn from the best) 3) **Communicate especially to researchers**

Peer Networks	1) **Develop and strengthen networks** (data protection officers, jurists and their network given responsibilities and tasks, activation of discipline-based peer networks to record and share best practices). 2) **Make it a common practice to discuss open science and research questions** as it is to discuss the methodological choices and the strategy to publish in scientific journals. 3) **Discuss how open science practices can be included in evaluation and career development.** Value all achievements in different stages of the research process, not only openly accessible outputs. Applauding all achievements demonstrates that success in openness is manifold and achievable. 4) **Start joint Information desk** (for data protection and Open Science issues, development of coherent service processes and shared support service processes) 5) **Provide guidelines and best practices** (create clear discipline-specific guidelines and recommendations and shared instructions and check lists for legal issues, data protection and licenses. 6) **Reinforce collaboration** (bigger organisations and peer networks to support smaller ones) 7) Boost educational activities (train specialists to help others, Entry-level textbook for open science) 8) **Pay attention to differences** 9) **Communicate actively** (there can be no impact without communication)
Home organisations	4) **Provide clear instructions and guidance** (especially IPR and GDPR issues) 5) **Collaborate** (build dialog with networks and national coordination) 6) **Provide incentives that support the vision and encourage researchers to open culture.** 7) **Include openness in researcher and research evaluation and in Human Resource Management.** One way to proceed in this immediately and in a responsible way, is to focus on the openness in research strategy instead of the outcomes when evaluating open science practices ex-ante (what is the proposed strategy for openness in research plan, academic portfolio etc.) or ex-post (what strategy for openness in research was followed). Value all achievements in different stages of the research process, not only openly accessible outputs. Applauding all achievements demonstrates that success in openness is manifold and achievable. Train evaluators in the evaluation of open science and research practices. 8) **Create a model to cover the costs of openness** (for example a bursary for OA fees) 9) **Provide more support resources** (define in collaboration with researcher's a necessary service levels for support services) 10) **Communicate** (research communication should be an integral and multichannel part of research process) 11) **Set goals** (clear incentives for openness, solve the dilemma of finding time for both customer work and high impact publication) 12) **Boost training** (Provide resources and training for the trainers: width and depth of educational courses is already challenging with existing resources)
Others	• Indicating the role of research results for society • Defining CSC's role - Communicating about the services that Minedu provides (CSC, DMPTuuli etc.) should be customer-friendly • Putting pressure to global publishers (FinElib)

9 Discussion and conclusions

Research organisations have been able to significantly improve their performance in open operational culture. Universities, especially, have quite uniformly progressed and reached the highest maturity rankings. They have a thorough understanding of what openness means across the scientific process, so that research can be reproduced and evaluated. This is especially clear in the comparison of the principles of openness for research methods (Figure 16).

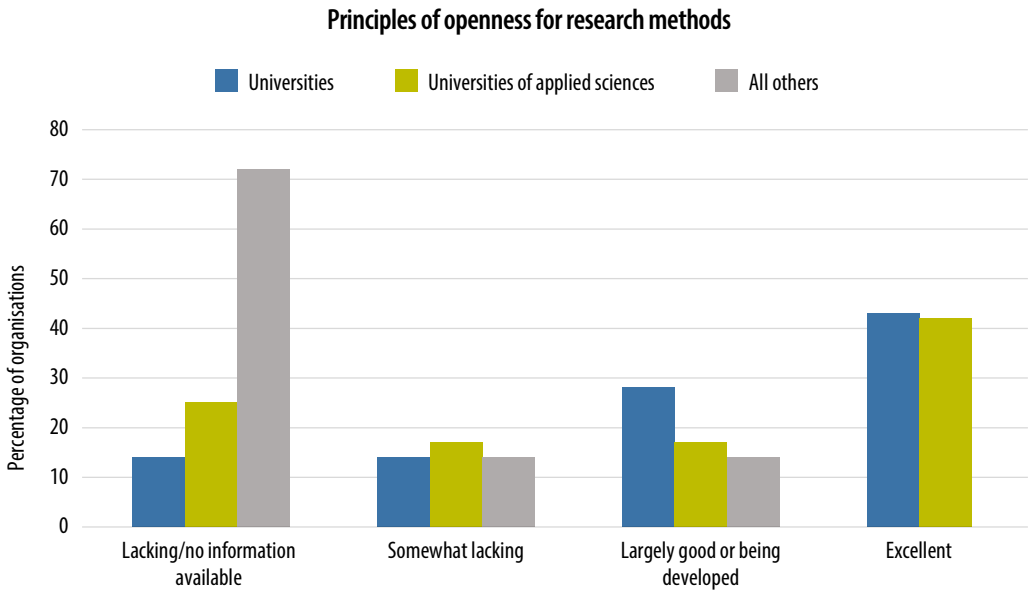

Figure 16: Indicator scores on the Principles of openness for research methods for universities, universities of applied sciences and all other organisations combined.

Most of the HEIs have understood the importance of openness and transparency of research methods. Excellent standards may require greater implementation effort, but have even greater effect in helping others to access the results and collaborate in developing research methodology.

The most mature research organisations have truly invested in developing their capabilities to support openness. The most mature research institute, the National Land Survey has clearly made a commitment on the openness of research and science and its Open Science Policy specifies the institute's principles and recommendations. Particular attention is paid to open access publishing and open research data.

Of the universities of applied sciences, JAMK University of Applied Sciences has evolved most, and is also the most mature university of applied sciences in open science culture. JAMK excels in the criteria of policies and principles, supporting openness, and developing competence, and is committed to follow the principles of openness in research, development and innovation operations.

The University of Turku achieves the highest possible scores in all areas and supports researchers in advancing openness throughout the research cycle and encourages researchers to provide access to research as early as possible to enable open collaboration. The promotion of open science and openly available research outputs are recognized as being part of academic merits and qualifications, and researchers at the University Turku can distinguish themselves by promoting open science in different ways in different stages of their research process.

However, there still are important improvements to be made, with the most pressing is to have researchers truly heard and involved in open science and research activities. National coordination is based on voluntarily participation and faces the consequences of lack of time from researchers. The best way forward is to strengthen the support network nearest to researchers and activate academic peer networks. Home organisation's support functions already are interacting with researchers on a daily basis and are the natural interfaces. The essence of open science and research should be manifested in research activities. It is no mean task. Other actors should design their role in order to support and sustain open research in practice.

The barriers and development needs describe the state of affairs felt by researchers, and include excellent suggestions for improvement. As several studies show that research productivity is declining[11], it is essential to hear the voice of scientists. Scientific discovery and development depend on individuals being able to conduct the research that caught their imagination. Their ability to conduct research depends on the activities of funders, organisations and support activities. One clear message from the evaluation is that the administrative burden of researchers can no longer grow. This means no new demands for researchers but rather re-defining the processes and research lifecycle management

11 Bloom, N., Jones, C.I., van Reenen, J, Webb, M. 2019. "Are ideas getting harder to Find?"

in home organisations. On the funder side, more effort is needed to build a coherent evaluation model for openness.

The maturity and barrier data highlight the strengths and weaknesses of research organisations in open science culture. These are depicted in Table 42.

Table 42: Strengths and weaknesses in Finnish open science culture.

Strengths	Weaknesses
· Ability to change · Understanding the openness of whole research process · Strong pioneer organisations · Collaborative effort, willingness to support each other	· Legal uncertainties inhibit progress · Incentives do not stimulate openness coherently · Researchers are not in the key role · Lack of shared information base

The improvement has been so steady on the chosen indicators that there is no need for exactly similar kind of maturity evaluation in the future. In addition, metrics generate behaviour and it is not advisable to keep these metrics similar for too long. In future years, the evaluation would benefit on focusing on the barriers and what activities have been implemented to overcome these barriers. A real measure for success in open science is that researchers are able to share their data, publications and methods, and collaborate openly - and do this willingly and with the support needed. For that, there is still some way. We encourage research organisations to further support openness in research practices. Acknowledging that research should be responsible and of excellent and good quality, research organisations should make it appealing to pursue a rigorous and transparent scientific research and evaluate researchers also based on their open science efforts and practices; recognize how they deal with open science and research and value their efforts and all achievements in different stages of the research process, not only openly accessible outputs. Applauding all achievements demonstrates that success in openness is manifold and achievable.

In the years to come, Agenda 2030 Sustainability Goals (SDGS) in particular coincide with goals for openness. In addition, EOSC actions, FAIR[12] and CARE[13] principles modify the landscape. SDG 4 to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Open science and research facilitate the availability of research results, material and methods for everyone, and especially for future generations. Competence development in openness especially supports this. SDG 9 to build resilient infrastructures, promote inclusive and sustainable industrialization and

12 https://www.force11.org/group/fairgroup/fairprinciples

13 https://www.gida-global.org/care

foster innovation is supported especially by clear principles and policies for openness for research materials, services, co-operation, agreements and framework. Resilience is built on an ability to change and to adapt to changes. An open and collaborative culture builds a collaborative ability to change, to learn from others. Responsible Research and Innovation (RRI) is about anticipating and assessing potential implications and societal expectations with regards to research and innovation[14]. The fundamentals of RRI include the alignment of its outcomes with societal values, by engaging citizens. The main tool is discussion: how science and technology can contribute to create the kind of world to which we aspire for present and future generations. The co-evolution of science and society will help us to lead an effective transition to democratised science and society. Awareness, participation, and intentional strategies or initiatives to open science and society enable its multiple benefits, including skills for the future. Involving everyone gives us a better chance to find solutions to sustainability challenges. As a future trend, openness as an aspect of dialogue is expected to become a major value in all areas of human culture and activities. It means sharing and applauding ideas and innovations to solve sustainability and social problems.

We are at an interesting junction on the road to openness. The lessons learned and the challenges before us are all too clear, but so are many of the solutions. Cooperation will be needed, and not just among policymakers and infrastructure providers. Open science is multi-dimensional and actionable, and involves all countries, regions and people working together to improve in openness and transparency. We all need to start building on the understanding that an inclusive, resilient open science system relies mostly on the work of researchers. It is about fostering the best use of their knowledge-capital to make a measurable and positive difference in the research system.

14 https://www.orion-openscience.eu/resources/rri

10 Appendices

Appendix 1 – Indicators and Measures for Research Organisations

Appendix 2 – Indicators and Measures for Research-funding organisations

Appendix 3 – Indicators and Measures for Academic and Cultural Institutes

Appendix 4 – Indicators and Measures for Learned Societies and Academies

Appendix 5 – Abbreviations Used in the Analysis

Appendices 6 – 11: Data Collected for the Analysis

Appendices 12 – 20: Aggregated data Collected for Barriers and Development needs

Appendix 1: Indicators and Measures for Research Organisations

HEIS AND RESEARCH INSTITUTES

1) Strategic Steering

a) Openness in the organisation's strategy documents (as a value and a commitment)

1. Openness is mentioned as, for example, one of the organisation's values or principles
2. Openness has been named as an aspect of operational culture and its significance has been explained in this context
3. Openness is one of the prevailing strategic themes and clearly visible in organisation's activities

b) Openness in the research activity

1. Openness is mentioned as an aspect of the organisation's research activity
2. Openness is declared as an aspect of the organisation's research activity and its significance and practices have been explained in this context
3. Openness is one of the core aspects of the organisation's research activity, and it is actively supported, developed, encouraged and required.

c) Local, national and international cooperation

1. Cooperation with a variety of actors has been mentioned in the organisation's strategy
2. Cooperation with a variety of actors is evident in the organisation's strategy and areas for development have been defined
3. Noticeably diverse cooperation in all level and cooperation is a core aspect of the organisation's strategy. Organization is responsible of collaborative activity, and actively monitors the results.

d) Managing interoperability

1. The organisation shares the use of research services and infrastructures with other organisations and the promotion of such activities have been mentioned in its strategy
2. Developing general interoperability of services, infrastructures and data have been mentioned in the organisation's strategy
3. Both developing general interoperability of services, infrastructures and data and the benefits it generates have been considered in the

organisation's strategy, and investments and support actions and resources in this area are present.

e) Openness of research results

1. The sharing and openness of research results have been mentioned in the organisation's strategy
2. The re-use and openness of research results are encouraged and developed
3. The openness of research results has been named as a core aspect of the organisation's research activities and the benefits it generates have been extensively identified

f) Strengthening openness-related competence

1. Openness-related competence, or tools and services that enable it, have been mentioned in the organisation's strategy
2. Openness-related competence and the tools and services that enable it have been defined as an area for development in the organisation's strategy
3. Openness-related competence and the tools and services that enable it have been defined as a focus area for resourcing in the organisation's strategy, and the benefits they generate have been identified.

2) Policies and Principles[15]

a) Principles of openness for scientific publications

1. The organisation recommends the use of open access channels for its research publications
2. The organisation encourages the use of open access channels for its research publications with incentives
3. The organisation requires the use of open access channels for its research publications

b) Principles of self-archiving for scientific publications

1. The organisation recommends self-archiving (green open-access) research publications in an institutional repository or other open archives.

15 Politiikkatyökalu: https://www.openaire.eu/d3-1-toolkit-for-policy-makers-on-open-access-and-open-science

2. The organisation encourages self-archiving (green open-access) research publications in an institutional repository or other open archives, and has a support process in place for it.
3. The organisation requires self-archiving (green open-access) research publications in an institutional repository or other open archives, and has a support process in place for it.

c) Principles of openness relating to research methods (including algorithms and code, both developed and utilized)

1. The organisation recommends openness in the publication and development of research methods and algorithms and code, and has an incentive in place for it.
2. The organisation encourages openness in the publication and development of research methods and algorithms and code, and has an incentive in place for it.
3. The organisation requires openness in the publication and development of research methods and algorithms and code.

d) Principles of openness relating to the availability, use and licensing of research data

1. The organization has a data policy and policy implementation plan recommending openness of research data, open licensing and open data repositories.
2. The organisation has a data policy and policy implementation plan encouraging the open licensing of research data in accordance with the national recommendations and using open data repositories.
3. The organisation has a data policy and policy implementation plan requiring open licensing of research data in accordance with the national recommendations [16]and use of agreed open data repositories

e) Service principles supporting openness[17]

1. The organisation has recommendations for service principles (for the resources it administers, and can give access to users from other organisations.

16 https://avointiede.fi/fi/koordinaatio/hankearkistot/att-hankkeen-arkisto/keskeiset-linjaukset/tiedon-saatavuus: Tutkimusdatan ja -julkaisujen jatkokäyttöä ei rajoiteta tarpeettomasti ja niiden käyttöehdot tuodaan selkeästi esille. Noudatetaan yleisiä, standardimuotoisia lisenssejä (suositus CC BY 4.0.), jotka ovat koneluettavia. Metatiedot julkaistaan CC0 -lisenssillä.

17 https://avointiede.fi/fi/koordinaatio/hankearkistot/att-hankkeen-arkisto/keskeiset-linjaukset/palveluperiaatteet

2. The organisation has written service principles for most of the resources it administers, and others can get access for research purposes. Descriptions can be found on the organisation's website.
3. The organisation has written service principles for most of the resources it administers, and it is easy to gain access and get open information on resource usage. Descriptions can be found on the organisation's website.

f) Guiding principles from Open Science framework [18](for example in managing research data life cycle, availability and reliability)

1. The organisation has considered the principles of openness, and implemented these in relevant policies.
2. The organisation's enterprise architecture encourages compliance with the principles of openness.
3. The organisation's enterprise architecture requires compliance with the principles of openness.

g) Principles of openness in cooperation (for example in publication platforms for national journals)

1. The organisation is in the starting phase in open collaboration, but does not describe this in detail.
2. The organisation is committed to some collaboration and openly describes its collaboration activities, but not the expected results and principles.
3. The organisation invests in dialogue with other actors and invests in communicating about principles and expected results of open collaboration.

h) Principles of openness in agreements (licensing and re-use)

1. The organisation recommends that principles of openness should be considered in agreements whenever juridical requirements allow
2. The organisation encourages the consideration of principles of openness in agreements whenever juridical requirements allow, and has a contract framework for it.
3. The organisation requires that principles of openness must be considered in agreements whenever juridical requirements allow, and has a contract framework and model contracts available for it.

18 https://avointiede.fi/fi/koordinaatio/hankearkistot/att-hankkeen-arkisto/keskeiset-linjaukset/arkkitehtuuriperiaatteet

i) Guidelines for quality systems

1. The organisation has drawn up a quality manual or other quality-related document, and it is available on organisation's external website
2. The organisation's quality manual recommends openness or names openness as one of its quality principles, and has guidelines on how to use openness to increase quality.
3. The organisation's quality manual recommends openness and names openness as one of its core quality principles. It includes a process for developing openness.

3) Supporting Openness

a) Monitoring the openness of publishing (open access, self-archiving, APC, BPC)

1. The organisation does not yet monitor the openness of its publishing activities, but has plans to do so.
2. The organisation monitors the openness of its publishing activities to some extent and is developing the monitoring process.
3. The organisation monitors the openness of its publishing activities and processes by type, and data is being actively collected

b) Monitoring the openness of research data (making materials available, utilisation)

1. The organisation does not yet monitor the openness of its research data, but has plans to do so.
2. The organisation monitors the openness of its research data to some extent and developments for the monitoring process are ongoing.
3. The organisation monitors the openness of its research data and data and metadata is being actively collected and used to improve the process.

c) Monitoring the visibility of research (for impact; scientific and social media)

1. The organisation does not yet monitor the visibility of its research activities, but has plans to do so.
2. The organisation monitors the visibility of its research activities to some extent but does not distinguish scientific and other media hits.
3. The organisation monitors the visibility of its research activities and data is being actively collected. The organization does distinguish scientific and other media hits.

d) Services for catalogueing and creating metadata for research materials

1. The organisation does not yet use such services, but has plans to do so.
2. The organisation uses such services to some extent and is developing its metadata management.
3. The organisation actively uses such services, and uses the metadata for insight and steering.

e) Services for documenting research publications and materials

1. The organisation provides self-help guidelines for storing research publications in its own archives and information about parallel publishing.
2. In addition to the aforementioned, the organisation provides guidelines and some support personnel helping on storage and metadata for research materials, and information about open access publication.
3. In addition to the aforementioned, the organisation has a sufficient amount of support personnel guiding documentation, suitable storage sites for research materials and metadata, and explaining what must be considered when storing them. The topic is extensively covered and its benefits for researchers have been explained.

4. Competence development

a) Lifecycle management of research data[19]

1. The organisation provides self-help guidelines for creating a data management plan and its significance and benefits for research are explained
2. The organisation provides some support and guidelines for the life-cycle management and digital preservation of research data and its significance and benefits for research are explained.
3. The organisation provides strong support and guidelines for the life-cycle management and digital preservation of research data and its significance and benefits for research are acknowledged via supporting incentives.

19 PSI-renewal: http://data.consilium.europa.eu/doc/document/ST-13418-2018-INIT/en/pdf

b) The re-use and findability of research results[20]

1. The organisation provides self-help guidelines for creating external links and persistent identifiers for research and research materials (including DOI, URN, ORCID, licensing research publications and data (including CC, ODC) and gives grounds for their use.
2. The organisation provides guidelines and some support for creating external links and persistent identifiers for research and research materials (including DOI, URN, ORCID, licensing research publications and data (including CC, ODC) and gives grounds for their use.
3. The organisation provides guidelines and sufficient support for creating external links and persistent identifiers for research and research materials (including DOI, URN, ORCID, licensing research publications and data (including CC, ODC). These topics are extensively covered and their benefits for researchers have been explained.

c) Use of common open science services*

- The organisation has local services aligned with the Academy of Finland's or other major scientific funders guidelines on availability and publishing of research
- The organisation recommends the use of the Fairdata services (IDA, Etsin, AVAA) or other national services (such as AILA, DMP-Tuuli, Journal.fi) for managing research data
- The organisation recommends the use of international or European services (such as PubMed Central, arXiv, OpenAIRE, Zenodo, EUDAT, EOSC) for managing research data

* For the measures marked with bullet points the organisations were able to receive points for each criterion they fulfilled. For example, an organisation could fulfill only the last criteria for it to receive one point for the measure.

d) Building competence in Open Science

1. The organisation participates and recommends participating in common trainings, and organises some own training.
2. The organisation actively organises own training, with targeted educational materials and recommends participation to personnel and students.
3. Open science training is a compulsory part of the researcher curriculum, and is actively developed further and new materials added.

20 An example of FAIR guidelines: http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

Appendix 2 – Indicators and Measures for Research-funding organisations

RESEARCH FUNDERS

1) Strategic Steering and Principles of Openness

a) Strategic steering of openness

1. Openness is mentioned as one of the organization's values or principles
2. Openness has been named as an aspect of operational culture and its significance has been explained in this context
3. Openness is one of the prevailing strategic themes and clearly lies at the core of the organization's activities

b) Promoting the openness and re-use of research outputs

1. Openness of funded research's outputs is mentioned in the organization's strategy
2. Openness of funded research's outputs is encouraged and research funding is developed with this in mind
3. Openness and re-use of funded research's outputs is named as one of the core aspects of the organization's research funding

c) National and international cooperation

1. Cooperation in research funding activities on the national and international level is mentioned in the organization's strategy
2. Cooperation in research funding activities on the national and international level is mentioned in the organization's strategy and there are funding calls and instruments in use based on this cooperation
3. Cooperation in research funding activities on the national and international level is named as one of the core aspects of research funding organization's activities and there are funding calls and instruments in use based on this cooperation

d) Interoperability of research infrastructures

1. Interoperability and shared use of funded research services and infrastructures is mentioned in the organization's strategy
2. Interoperability and shared use of funded research services and infrastructures is mentioned in the organization's strategy and those are being developed

3. Interoperability and shared use of funded research services and infrastructures is mentioned in the organization's strategy and those are developed even further acknowledging the benefits

e) Strengthening openness-related competence

1. Openness-related competences are mentioned in the organization's strategy
2. Openness-related competences are defined as an area for development in the organization's strategy
3. Openness-related competences, are defined as a focus area for resourcing and development in the organization's strategy, and the opportunities created by these are identified extensively

2) Openness in Research Funding[21]

a) Principles of open access publishing

1. Funded research's publications are recommended to be published in open access publishing channels
2. Funded research's publications are urged to be published in open access publishing channels
3. Funded research's publications are required to be published in open access publishing channels

b) Principles of research data openness

1. Funded research's data is recommended to be published open
2. Funded research's data is urged to be published open in accordance with the national recommendations on open data publishing services and open licensing
3. Funded research's data is required to be published open in accordance with the national recommendations on open data publishing services and open licensing

21 Policy toolkit: https://www.openaire.eu/d3-1-toolkit-for-policy-makers-on-open-access-and-open-science

c) Principles of research methods openness methods (including algorithms and code, both developed and utilized)

1. Openness of funded research's methods is recommended and developed further
2. Openness of funded research's methods is urged and developed further
3. Openness of funded research's methods is required and developed further

d) Principles of openness for research infrastructures

1. Funded research infrastructures are recommended to enable shared use in their policies and terms of use
2. Funded research infrastructures are urged to enable shared and open use in their policies and terms of use
3. Funded research infrastructures are required to clearly enable shared and open use in their policies and terms of use in accordance with the national recommendations.

3) Supporting and Promoting Openness

a) Instructions for open science and research

1. Instructions on open research practices are available and benefits of open science are presented to research funding applicants
2. Comprehensive instructions on open research practices are available and benefits of open science are presented to research funding applicants
3. Comprehensive instructions on open research practices are available, benefits of open science and how these are taken into account by research funder, for example in funding instruments, are presented to research funding applicants

b) Recommendations of openness for research outputs

1. The possibilities of research outputs openness are presented to research funding applicants
2. The possibilities of research outputs openness are presented and openness is recommended to research funding applicants
3. The possibilities and benefits of research outputs openness are broadly presented and openness is recommended to research funding applicants

c) Developing openness in research funding reviewing

1. The research funder explains broadly the process of funding calls and the review criteria used
2. The research funder explains broadly the process of funding calls and the review criteria used. One review criterion in funding calls is openness and re-use of research
3. The research funder explains broadly the process of funding calls and the review criteria used. One review criterion in funding calls is openness and re-use of research and the indicators to measure these are explained

d) Monitoring openness

1. The research funder monitors the openness of funded research alongside the common reporting required
2. The research funder monitors the openness of funded research alongside the common reporting required and the re-use of research results are promoted during the research
3. Monitoring the openness of funded research is a permanent part of the common reporting required and the re-use of research results are promoted during the research

e) Openness of funding decisions

1. The research funder opens its own information for example by publishing the funding decisions on its website
2. The research funder opens its own information for example by publishing the funding decisions on its website in a machine-readable format
3. The research funder opens its own information for example by publishing the funding decisions on its website in a machine-readable format and through an open API

Appendix 3 – Indicators and Measures for Academic and Cultural Institutes

ACADEMIC AND CULTURAL INSTITUTES ABROAD

1) Strategic Steering and Principles of Openness

a) Strategic steering of openness

1. Openness is mentioned as one of the organization's values or principles
2. Openness has been named as an aspect of operational culture and its significance has been explained in this context
3. Openness is one of the prevailing strategic themes and clearly lies at the core of the organization's activities

b) Promoting the openness and re-use of research outputs

1. Openness of research outputs is not yet mentioned in the organization's strategy but openness of research outputs is being developed and encouraged
2. Openness of research outputs is mentioned in the organisations's strategy and encouraged
3. Openness and re-use of research outputs is named as one of the core aspects in the organisation's strategy

c) National and international cooperation

1. Cooperation on the national and international level is mentioned in the organization's strategy
2. Cooperation on the national and international level is mentioned in the organization's strategy and there are funding calls and instruments in use based on this cooperation
3. Cooperation on the national and international level is named as one of the core aspects of research funding organization's activities and there are funding calls and instruments in use based on this cooperation

e) Strengthening openness-related competence

1. Openness-related competence, or services that enable it, are not yet mentioned in the organization's strategy but openness-related competence or services is defined as an area for development
2. Openness-related competence, or services that enable it, are mentioned in the organisation's strategy and defined as an area for development

3. Openness-related competence, or services that enable it, are defined as a focus area for resourcing and area for development in the organization's strategy, and the opportunities created by these are identified extensively

2) Openness in Policies and Principles[22]

a) Principles of open access publishing

1. Research publications are recommended to be published in open access publishing channels according to the principles of the institute or the principles of affiliation organization of the researcher
2. Research publications are urged to be published in open access publishing channels according to the principles of the institute or the principles of the affiliation organization of the researcher and the institute has ensured that the principles comply with open access
3. Research publications are required to be published in open access publishing channels according to the principles of the institute or the principles of the affiliation organization of the researcher and the institute has ensured that the principles comply with open access

b) Principles of research data openness

1. Research data is recommended to be published open
2. Research data is urged to be published open in accordance with the national recommendations on open data publishing services and open licensing
3. Research data is required to be published open in accordance with the national recommendations on open data publishing services and open licensing

22 Policy toolkit: https://www.openaire.eu/d3-1-toolkit-for-policy-makers-on-open-access-and-open-science

3) Supporting and Promoting Openness

a) Instructions for open science and research

1. The institute does not yet have instructions on open research practices but has plans to make instructions.
2. The institute does not have own instructions on open research practices but recommends to comply with the open research instructions of the affiliation organization of the researchers.
3. The institute has its own instructions on open research practices or recommends to comply with the open research instructions of the affiliation organization of the researcher. Benefits of open science are presented to researchers.

c) Developing openness in collaboration

1. The organization operates in collaboration and develops openness in collaboration.
2. The organization is committed to collaboration and has openness as a guiding principle in collaboration.
3. The organization invests in open collaboration and explains broadly the benefits and principles of open collaboration.

d) Monitoring openness

1. The organization monitors the openness of research results
2. The organization monitors the openness of research results and the re-use of research is promoted during the research
3. Monitoring the openness of research is an elementary part of the operations and monitoring the results steer actions.

e) Monitoring impact and visibility of research (scientific and social media)

1. The organization does not yet monitor the visibility or impact of its research activities, but plans to do so.
2. The organization monitors the visibility or impact of its research activities to some extent.
3. The organization monitors the visibility or impact of its research activities, and data is being actively collected.

Appendix 4 – Indicators and Measures for Learned Societies and Academies

LEARNED SOCIETIES AND ACADEMIES

1) Strategic Steering and Principles of Openness

a) Strategic steering of openness

1. Openness is mentioned as one of the organization's values or principles
2. Openness has been named as an aspect of operational culture and its significance has been explained in this context
3. Openness is one of the prevailing strategic themes and clearly lies at the core of the organization's activities

b) Promoting the openness and re-use of research outputs

1. Openness of research outputs is mentioned in the organization's strategy
2. Openness of research outputs is encouraged in the organization's strategy
3. Openness and re-use of research outputs is named as one of the core aspects of research in the organization's strategy

c) National and international cooperation

1. Cooperation on the national and international level is mentioned in the organization's strategy
2. Cooperation on the national and international level is mentioned in the organization's strategy and there are funding calls and instruments in use based on this cooperation
3. Cooperation on the national and international level is named as one of the core aspects of research funding organization's activities and there are funding calls and instruments in use based on this cooperation

d) Interoperability of research infrastructures

1. Interoperability and shared use of services and infrastructures is mentioned in the organization's strategy
2. Interoperability and shared use of services and infrastructures is mentioned in the organization's strategy and those are being developed

3. Interoperability and shared use of services and infrastructures is mentioned in the organization's strategy and those are developed even further acknowledging the benefits

e) Strengthening openness-related competence

1. Openness-related competence, or services that enable it, are mentioned in the organization's strategy
2. Openness-related competence, or services that enable it, are defined as an area for development in the organization's strategy
3. Openness-related competence, or services that enable it, are defined as a focus area for resourcing and area for development in the organization's strategy, and the opportunities created by these are identified extensively

2) Openness in Policies and Principles[23]

a) Principles of open access publishing

1. Research publications are recommended to be published in open access publishing channels
2. Research publications are urged to be published in open access publishing channels
3. Research publications are required to be published in open access publishing channels

b) Principles of research data openness

1. Research data is recommended to be published open
2. Research data is urged to be published open in accordance with the national recommendations on open data publishing services and open licensing
3. Research data is required to be published open in accordance with the national recommendations on open data publishing services and open licensing

23 Policy toolkit: https://www.openaire.eu/d3-1-toolkit-for-policy-makers-on-open-access-and-open-science

c) Principles of research methods openness methods (including algorithms and code, both developed and utilized)

1. Openness of research methods is recommended and developed further
2. Openness of research methods is urged and developed further
3. Openness of research methods is required and developed further

d) Principles of openness for research infrastructures

1. Research infrastructures policies and terms of use recommends to enable shared use
2. Research infrastructures policies and terms of use urges to enable shared and open use
3. Research infrastructures policies and terms of use clearly requires to enable shared and open use, and the terms of use are in accordance with the the national recommendations

3) Supporting and Promoting Openness

a) Instructions for open science and research

1. Instructions on open research practices are available and benefits of open science are presented to researchers
2. Comprehensive instructions on open research practices are available and benefits of open science are presented to researchers
3. Comprehensive instructions on open research practices are available, benefits of open science and how these are taken into account by research funder, for example in funding instruments, are presented to researchers

b) Recommendations of openness for research outputs

1. The possibilities of research outputs openness are presented to researchers
2. Openness of research outputs is recommended to researchers
3. Openness of research outputs is required for researchers

c) Developing open collaboration

1. The organization explains broadly the process of collaboration and the possible review criteria used
2. The organization explains broadly the process of collaboration and the possible review criteria used. One review criterion in collaboration is openness and re-use of research

3. The organization explains broadly the process of collaboration and the possible review criteria used. One review criterion in collaboration is openness and re-use of research and the indicators to measure these are explained

d) Monitoring openness

1. The organization monitors the openness of research alongside the common reporting required
2. The organization monitors the openness of research alongside the common reporting required and the re-use of research is promoted during the research
3. Monitoring the openness of research is a permanent part of the common reporting required and the re-use of research is promoted during the research

e) Monitoring impact and visibility of research (scientific and social media)

1. The organization does not yet monitor the visibility or impact of its research activities, but plans to do so.
2. The organization monitors the visibility or impact of its research activities to some extent.
3. The organization monitors the visibility or impact of its research activities, and data is being actively collected.

Appendix 5: Abbreviations Used in the Analysis

Organisation	Abbreviation
Aalto University	AYO
Academy of Finland	Aka
Arcada University of Applied Sciences	ARCADA
Finnish Institute in Athens	FI Athens
Business Finland	Business Finland
Centria University of Applied Sciences	CENTRIA
Diakonia University of Applied Sciences	DIAK
Finnish Academy of Science and Letters	Tiedeakatemia
Finnish Environment Institute	SYKE
Finnish Food Authority	Ruokavirasto
Finnish Institute in Middle East	FI Middle East
Finnish Institute in Rome	FI Rome
Finnish Institute of International Affairs	FIIA
Finnish Institute of Occupational Health	TTL
Finnish Meteorological Institute	IL
Finnish Society of Sciences and Letters	Tiedeseura
Geological Survey of Finland	GTK
Haaga-Helia University of Applied Sciences	HAAGA-HELIA
Häme University of Applied Sciences	HAMK
University of Helsinki	HY
Åland University of Applied Sciences	HÅ
Humak University of Applied Sciences	HUMAK
University of Eastern Finland	ISYO
Finnish Institute in Japan	FI Japan
JAMK University of Applied Sciences	JAMK
University of Jyväskylä	JY
South-Eastern Finland University of Applied Sciences	XAMK
KAMK University of Applied Sciences	KAMK
Karelia University of Applied Sciences	Karelia-AMK
Kone Foundation	Kone Foundation
Lahti University of Applied Sciences	LAMK
Lapland University of Applied Sciences	Lapin AMK
University of Lapland	LY
Lappeenranta-Lahti University of Technology LUT	LTY
Laurea University of Applied Sciences	LAUREA
National Defence University	MPKK
Metropolia University of Applied Sciences	METROPOLIA
Novia University of Applied Sciences	NOVIA
National Institute for Health and Welfare	THL
National Land Survey of Finland	MML
Natural Resources Institute Finland	LUKE

Organisation	Abbreviation
Oulu University of Applied Sciences	OAMK
University of Oulu	OY
Police University College	Polamk
Radiation and Nuclear Safety Authority	STUK
Saimaa University of Applied Sciences	SAIMAA
Satakunta University of Applied Sciences	SAMK
Savonia University of Applied Sciences	Savonia-AMK
Seinäjoki University of Applied Sciences	SeAMK
Hanken School of Economics	SHH
Svenska Tekniska Vetenskapsakademien i Finland r.f.	STV
University of the Arts Helsinki	TaiY
University of Tampere	TAU
Teknillisten Tieteiden Akatemia	TTA
Committee for Public Information	TJNK
Federation of Finnish Learned Societies	TSV
Turku University of Applied Sciences	TURUN AMK
University of Turku	TYO
Finnish National Board of Research Integrity	TENK
VAMK University of Applied Sciences	VAMK
University of Vaasa	VY
VATT Institute for Economic Research	VATT
VTT Technical Research Centre of Finland	VTT
Åbo Akademi University	ÅA

Appendices 6 - 11: Data Collected for the Analysis

Data for organisations are available for download at respective pages at:
https://avointiede.fi/kypsyystasoselvitys/2019/

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement006.xls

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement007.xlsx

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement008.xlsx

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement009.xls

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement010.xlsx

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement011.xlsx

Appendices 12 - 20: Aggregated data Collected for Barriers and Development needs

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement012.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement013.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement014.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement015.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement016.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement017.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement018.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement019.pdf

https://avointiede.fi/sites/avointiede.fi/files/evaluation2019supplement020.pdf

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