Research Consulting

Discussion document

Indicators of research integrity: an initial exploration of the landscape, opportunities and challenges

Prepared on behalf of UK Research and Innovation, Cancer Research UK and GuildHE

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Indicators of research integrity: an initial exploration of the landscape, opportunities and challenges

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Contact:

Rebecca Veitch

Head of Research Integrity

researchintegrity@ukri.org

Report authors:

Andrea Chiarelli, Rob Johnson, Lucia Loffreda

www.research-consulting.com

Contact:

andrea.chiarelli@research-consulting.com

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1. Introduction

1.1 Context

Background and rationale

UKRI, Cancer Research UK and GuildHE sought to investigate potential indicators of research integrity, working on behalf of the sector to explore indicators that could help research organisations, funders of research and research infrastructures, researchers, publishers and others to identify and promote high levels of research integrity, building on the principles and commitments in the UK Concordat to Support Research Integrity.[1]

The present discussion document seeks to collect and summarise existing evidence around integrity indicators, to set out the landscape in the UK and internationally and, where possible, to identify some points where progress might be made toward identifying high integrity in research. This document is intended to inform further discussions across the research system and recognise the potential challenges, benefits and risks in adopting indicators in the area of research integrity, with the ultimate aim of improving partnership, collaboration and ways to achieve research integrity.

An Executive Summary of this discussion document is available via Zenodo.

The context of research integrity

The UK Concordat to Support Research Integrity notes that there is no universal definition of research integrity and seeks to address this by identifying its five core principles: honesty, rigour, transparency and open communication, care and respect and accountability.[1] Other initiatives such as those listed in Table 1 provide alternative definitions and principles, which are generally in line with or complement the Concordat.

Table 1. Examples of initiatives to strengthen research integrity

Initiative	Year
Singapore Statement on Research Integrity[2]	2010
UK Concordat to Support Research Integrity[3]	2012
Montreal Statement on Research Integrity in Cross-Boundary Research[4]	2013
European Code of Conduct for Research Integrity[5] Amsterdam agenda[6]	2017
Hong Kong Principles for assessing researchers[7] UK Concordat to Support Research Integrity (Revision)[8]	2019

UKRI's Policy on the Governance of Good Research Practice acknowledges that "research can fall short in terms of its integrity for a number of reasons, many of which do not reflect the intent of researchers".[9] The policy seeks to describe a wide range of behaviours that can have an impact on the integrity of the scholarly record, whether intentional or arising from a lack of knowledge or training, including:

- honest errors (e.g. miscalculation, mismeasurement);
- poor research practices (e.g. poor research design, weak analysis, poor quality assurance);

- questionable research practices (e.g. not submitting valid negative results for publication, not reporting flaws in study design or execution or selective citation to enhance one's own findings);[10] and
- research misconduct (e.g. fabrication, falsification, and plagiarism in proposing, performing, or reviewing research, or in reporting research results and issues,[11] mismanagement and misrepresentation of data).[12]

In the present document, we sought to consider the wide range of strategies, policies and systems that, in combination with research cultures and responsible publication practices, may (i) foster and communicate good research integrity practices; and (ii) prevent or mitigate questionable research practices and research misconduct.

Research integrity indicators

For the purposes of this report, we define an "indicator" as a quantitative or qualitative factor or variable that provides a reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance or state of play of an actor or system.[13]

Table 2 covers a range of intended uses for research integrity indicators, which we will explore further in the remainder of this report. We note that these purposes are intended as a starting point for discussion and may be revisited in the future.

Table 2. Potential purposes of research integrity indicators

Constituency / Organisation / Group	Potential purposes
Funders, research performing organisations, publishers and sector bodies (including Concordat signatories, the UK Research Integrity Office, the UK Reproducibility Network and learned societies)	1. Understanding, planning and evaluating interventions that aim to improve the research environment, the integrity and therefore the overall quality of research 2. Assessing whether research(er) practices and behaviours are in line with organisational expectations around research integrity (e.g. Concordat requirements, grant terms and conditions, author guidelines)
UK Committee on Research Integrity (on behalf of the research community)	As above, plus: 3. Identifying systemic pressures affecting research integrity, and harnessing opportunities for change among funders, research performing organisations, publishers and sector bodies to support an environment in which researchers can work with high levels of research integrity
Meta-researchers[a]	4. Enabling (meta)researchers to reference an agreed framework for evidence, in planning and reporting their research into aspects of the research system related to research integrity

[a] Meta-research is the study of research itself: its methods, reporting, reproducibility, evaluation, and incentives.

1.2 Our approach

Objectives

This discussion document aims to identify tractable points where progress might be made towards indicators for research integrity and to highlight particularly challenging areas. In preparing the present document, we considered the following research questions:

- What is the current practice in designing and using indicators of research integrity?
- What relevant indicators are currently used, by whom, for what, in the UK and internationally?
- What suggestions for new indicators might be made, e.g. drawing from expert opinion and meta-research?
- What are stakeholder and expert views on existing and potential indicators?
  - In particular, we focused on the extent to which indicators are perceived as being useful, valid, reliable, acceptable across a wide range of research disciplines and settings, ethical (including with regard to privacy), transparent, reproducible,[b] aligned with good practice principles and low or zero burden.
- What gaps exist, and what are important aspects of research integrity for which indicators seem difficult?

The Concordat principles mentioned in section 1.1 served as the basis for our investigation. Notably, our research and consultation were not limited to quantitative or qualitative metrics[c] for which data are readily available, but also considered (i) phenomena that are important to research integrity, but for which it is difficult to identify realistic indicators; and (ii) situations where indicators may be conceptually straightforward but are practically challenging (e.g. the data may not be available or would be difficult to gather).

Methodology

The present document was informed by desk research and a set of 22 stakeholder interviews with individuals from the UK, Europe and North America:

- The desk research considered over 120 sources, including academic articles, reports, disciplinary guidelines, concordats, tools (e.g. surveys, benchmarking approaches), generalist articles and relevant websites. Due to the inherent complexity of the subject matter and breadth of the research questions, sources for inclusion were identified via a mix of structured Google Scholar searches and snowball sampling. These sources were summarised and compared, and key themes have been extracted for discussion in the present document.
- Building on the desk research, we have shortlisted ten key documents that we considered to represent the perspective of different stakeholder groups (see Appendix A). We used these to extract a longlist of actions and measures that could be put in place to strengthen research integrity, which in turn informed our prioritisation of facets for the creation of indicators (see Figure 1 on p. 16). Further information on this exercise is available in Annex 1.

[b] Reproducibility is defined as obtaining consistent results using the same data and code as the original study (synonymous with computational reproducibility).
[c] Research metrics are quantitative measurements designed to evaluate research outputs and their impacts. Metrics include a variety of measures and statistical methods for assessing the quality and broader impact of scientific and scholarly research.

- Our stakeholder selection strategy sought to engage experts and thought leaders in different roles and with different disciplinary backgrounds, including academics, research funders, research managers, learned societies, publishers and more. Interview findings were coded using NVivo, a qualitative research software, to identify emerging trends and commonalities across the diverse set of interviewees.

Throughout this document, anonymised quotes are included to illustrate points being made and showcase how contributors think about research integrity and the potential for indicators in this area.

Scope of work and exclusions

Our analysis and consultation focused on the principles in the UK Concordat as priority areas for investigation, as these provided a reference point for the identification of potential research integrity indicators. The recent Concordats and agreements review usefully shows that, in a UK context, the Concordat to Support Research Integrity is only one of six existing initiatives seeking to improve research conduct and working practices.[14] A far wider range of initiatives are in place to support staff development, assessment and evaluation, and equality, diversity and inclusion globally. All these areas are also affected by organisational, national and international research and innovation policies, the availability of digital and physical infrastructures, collaboration networks and more.

Our focus on the UK Concordat to Support Research Integrity means that we have deprioritised a range of initiatives, efforts and developments in the research and higher education system that do have an impact on research integrity but operate at a higher level and have complex ramifications for individual and organisational behaviours.

Furthermore, we acknowledge that some facets of research integrity are closely related with open research practices (see Figure 1, under "Transparency and open communication") and have significant overlap with ongoing work. Although this document does not provide an in-depth overview of the open research landscape, we note that this is evolving fast across the globe and will significantly affect research integrity behaviours (and indicators). As a result, any future work on research integrity indicators that relate to open research practices should seek to draw from a range of ongoing efforts in this area (e.g. G7 2021 Research Compact,[15] recommendations on "Open Science by Design" by the National Academies of Sciences, Engineering, and Medicine,[16] FAIR Metrics group,[17] TOP Guidelines,[18] reproducibility badging),[19] to ensure an extent of alignment and avoid duplication wherever possible.

Limitations

This document is the result of an exploratory study conducted within a limited timeframe, and is therefore subject to a number of limitations:

- Our desk research aimed to provide an informed conclusion on the volume and characteristics of the evidence base and a synthesis of what that evidence indicates in relation to the topic of research integrity indicators. It did not include a critical appraisal of that evidence.
- The stakeholders consulted in our work were gathered via convenience sampling, that is, we interviewed expert stakeholders who were available in January or February 2022, and willing to participate.
- Our consultation was limited to individuals and organisations within the academic research ecosystem, namely individual academics and representatives of research organisations, funders of research and research

infrastructures, learned societies and publishers. The enabling and cultural impact of research infrastructures on research integrity has not been explored in detail, as this topic is not considered in the UK Concordat.

- At this exploratory stage, we have not sought the views of non-research users, including for example the general public, or industry, as they have limited control on the behaviours of those delivering and sharing research and the extent to which integrity best practices are followed. We note that the views of these stakeholders and their expectations may be materially different to those presented here.
- Our analysis of the interviews was underpinned by qualitative coding, which relies on analytical judgement and interpretation. While we have drawn on the literature to validate and contextualise the interview findings, it may not be appropriate to generalise some findings of this study, and outlying results may be over-represented.
- Our stakeholder engagement activities focused on a limited number of geographical regions, with an acknowledged bias towards stakeholders in high-income countries. It may not be appropriate to generalise the findings of this study to research cultures and contexts that were not consulted, particularly those in low- and middle-income countries.

Acknowledgements

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2. Facets of research integrity and potential for indicators

2.1 Characterising the research integrity landscape

Research integrity requires cooperation from a wide range of stakeholders

Over the past few years, the topic of research integrity has made the headlines time and again. Recent news from around the world features calls for a new Office for Research Integrity in Australia,[20] the adverse impact of false claims in the context of the Covid-19 pandemic,[21] calls for a coordinated approach to address failures of research integrity in Europe[22] and the development of a plan to assess and improve integrity policies and practices in the United States.[23]

This topic has also entered the UK policy discourse, for example as part of the reproducibility and research integrity parliamentary inquiry,[24] the R&D people and culture strategy,[25] the recently released Guidance to implement the Concordat to Support Research Integrity within government,[26] and the creation of UK CORI itself. The Minister for Science, Research and Innovation has commented directly on the importance of setting "clear ambitions around good practice" and of helping "make sure funding system incentives supported best practice".[27]

Furthermore, issues around research integrity have been highlighted directly by a wide range of research actors, for example in the context of efforts to promote open access and open science practices[28] or as part of claims that published research may not be reproducible or replicable[29] (although we recognise that these concepts may not be appropriate in all disciplines).[30]

We note that there is no panacea to failures of research integrity: addressing such a multifaceted area, while taking account of (sometimes conflicting) stakeholder interests, requires concerted action and a significant extent of alignment.

> *I think we have wasted tons of research money by people doing pointless things or non-reproducible things. And I think it's a serious concern that has to be tackled in the least bureaucratic way possible. Ideally, we should change the culture so that somebody who doesn't work in a more rigorous way is just no longer able to get ahead.*

Roles and responsibilities overlap, but research performing organisations are well placed to take the lead

Although many stakeholders have an interest in research integrity, research performing organisations, individual researchers, funders of research and research infrastructures and publishers are seen as the key actors:

- Sørensen et al. (2021) point out that issues such as cultural norms and values of an institution are key, and that the "responsibilisation of research integrity is unevenly targeted at the individual researcher rather than linked to institutions and the science system".[31] Our interview findings were in line with this, and we found a strong conviction that research integrity should be cultivated and fostered within research performing organisations in the first place. In this context, research

performing organisations are also responsible for investigating cases where research integrity is questioned.

- Researchers have a clear responsibility to align with disciplinary standards and expectations, but this is most effective when the research environment embeds positive values and fosters good practice. For example, calls to limit research(er) evaluation metrics[32] and support continuous institutional improvement are ongoing, and the prevalence of inappropriate incentives is generally seen as a significant obstacle to research integrity.[33] In some cases, training gaps may also hinder progress with regard to research integrity, but we note that efforts are being made in Europe to introduce innovative mechanisms to promote good practices, such as Integrity Games (H2020 INTEGRITY project)[34] and the Dilemma Game app (Erasmus University Rotterdam).[35] Importantly, there is a distinction to be made between high-level training on the *principles* of research integrity and more detailed discipline-specific programmes that should be delivered at the disciplinary level.
- The evaluation, review and award criteria of research funders can act as a strong motivator to both research performing organisations and researchers, for example in terms of checking that research performing organisations have the right systems in place to foster research integrity and address cases of misconduct. Funders are also responsible for acknowledging research integrity explicitly within their processes: for example, they monitor funded grants and ensure their own staff, committee members and external peer reviewers are held accountable for any potential breaches of research integrity standards.[36]
- Research performing organisations and funders may also provide grants or support for the development and maintenance of digital and physical research infrastructures, which can in turn affect individual and disciplinary practices with an impact on research integrity.[5] By encouraging or requiring the use of appropriate infrastructures (e.g. for the sharing or publication of data, interim findings, articles, protocols), good integrity practices can be shaped and fostered.
- Publishers and journals are important actors: as they directly filter, review and publish research, they often play a direct role when cases of misconduct are investigated and acted upon (although these may be identified in other fora, too) – including in collaboration with research performing organisations and/or funders. The publisher community is supported by the Committee on Publication Ethics (COPE), which provides a range of guidelines, flowcharts and examples around research ethics, research integrity and related issues.[37]

Furthermore, we note that several bodies in the UK are working on areas relevant to the topic. The 'Stakeholder spotlight' boxes below provide more detail on these, including the UK Research Integrity Office, the UK Reproducibility Network, the UK Forum for Responsible Research Metrics and the UK Committee on Research Integrity.

Funding agencies set expectations, and they usually give money to research institutions. Research institutions then have a responsibility to establish their standards of integrity. They then give the money to researchers, who have an obligation to live up to these standards. And then it's the research field that establishes the nuts and bolts, the day to day, around what are responsible practices, including authorship policies, data management, data handling, and so on.

Stakeholder spotlight: The UK Research Integrity Office (UKRIO) *Established in 2006*	The UK Research Integrity Office is an independent charity, offering support to the public, researchers and organisations to further good practice in academic, scientific and medical research.[38] They promote integrity and high ethical standards in research, as well as robust and fair methods to address poor practice and misconduct. UKRIO pursue these aims through their publications on research practice, in-depth support and services for research employers, education and training activities, and by providing expert guidance in response to requests for assistance from individuals and organisations. Established in 2006, UKRIO's aims are to: • promote the good governance, management and conduct of academic, scientific and medical research; • share good practice on how to address poor practice, misconduct and unethical behaviour; and • give confidential, independent and expert advice on specific research projects, cases, problems and issues.
Concordat to Support Research Integrity Signatories Group *Established in 2012*	The Research Integrity Concordat Signatories Group comprises research funders and sector representative bodies with significant reach, expertise, and capacity across the research sector who are collectively responsible for promoting and monitoring the implementation of the commitments and principles of the Research Integrity Concordat. They meet this commitment by: • periodically reviewing and updating the Concordat as appropriate; • monitoring and encouraging engagement with the Concordat, reporting annually on implementation; • sharing good practice that promotes the principles of the Concordat; • convening discussions with the research community on matters relating to the Concordat and research integrity, with an annual forum for all stakeholders; • working with other organisations to ensure a consistent approach to research integrity and address key issues; and • working with other research concordats and agreements to ensure that processes are aligned, and outcomes collectively improve research culture.
Stakeholder spotlight: The UK Forum for Responsible Research Metrics *Established in 2016*	The UK Forum for Responsible Research Metrics, chaired by Professor Max Lu (Vice-Chancellor at the University of Surrey), supports the responsible use of research metrics in higher education institutions and across the research community in the UK.[39] The Forum have a programme of activities, including: • advice to the higher education funding bodies on quantitative indicators in the Research Excellence Framework (REF) 2021; • advice on, and work to improve, the data infrastructure that underpins metric use; • advocacy and leadership on the use of research metrics responsibly; and • international engagement on the use of metrics in research and researcher assessment. The group was established in 2016, following the publication of the Metric Tide report.[40]
Stakeholder spotlight: The UK Reproducibility Network (UKRN) *Established in 2019*	The UK Reproducibility Network is a national peer-led consortium that aims to ensure the UK retains its place as a centre for world-leading research.[41] This is achieved by investigating the factors that contribute to robust research, promoting training

activities, and disseminating best practice. The UKRN also works collaboratively with various external stakeholders to ensure coordination of efforts across the sector.

The UKRN seeks to understand the factors that contribute to poor research reproducibility and replicability, and develop approaches to counter these, in order to improve the trustworthiness and quality of research. As these issues affect all disciplines, the UKRN aims for broad disciplinary representation. UKRN is coordinated by a Steering Group and supported by an Advisory Board, with representation across the UK through researcher-led local networks at several institutions, many of which have formally joined UKRN.

Stakeholder spotlight: The UK Committee on Research Integrity (UK CORI)

Established in 2021

The UK Committee on Research Integrity is being hosted by UK Research and Innovation as a free-standing committee.[42] Following wide engagement across the research and development sector, UK CORI will seek to:

- promote research integrity across the UK and internationally;
- create opportunities for discussion, build consensus and develop co-ownership of integrity issues across the sector;
- build and communicate the evidence base around UK research integrity;
- identify how systemic pressures affect research integrity, and harness opportunities for change and improvement; and
- work with partners to enhance progress through the Concordat to Support Research Integrity, and advise on how oversight of UK research integrity should operate over the long term.

There is limited clarity on how to implement and monitor (disciplinary) research integrity principles

There is a general sense that misconduct is only an issue with a minority of the overall researcher population, but our consultation suggests that questionable research practices are more widespread.[43] However, a 2020 landscape study on research integrity commissioned by UKRI found that "it is difficult to know with certainty what the true levels [of QRPs] are".[44] Shedding some light on this question, the latest Dutch National Survey on Research Integrity found higher prevalence of misconduct and QRPs than earlier iterations, though the QRPs listed were often discipline-specific in nature.[10]

Our interviewees identified a wealth of strategies – organisational and individual – that may underpin the monitoring and implementation of behaviours aligned with research integrity principles. Although this is a sign that progress is being made, several contributors described difficulties in operationalising theoretical principles (e.g. honesty, rigour) at both the organisational and individual levels: this illustrates the fact that QRPs affect not only researchers but also research leaders, research managers and administrators.

In practice, there simply is not a one-size-fits-all guideline for all organisations to follow, which leads to fragmented solutions that are difficult to map or measure. Importantly, this diversity in implementation is also a positive: organisational cultures and values vary significantly across the UK and internationally, leading to the need for flexibility when it comes to turning the principles of research integrity into practice.

Disciplinary differences further complicate matters. Organisations serving different domains of research will observe a range of concerns, standards, expectations, ethical and legal requirements and perceptions of QRPs, which call for specific support pathways and strategies. As an example, we note that it is easier to talk about research

integrity in disciplines with established protocols, rules and expectations (e.g. clinical medicine, natural and physical sciences), as these provide a focal point for discussion and, in some cases, quantitative assessment. On the other hand, practice-based disciplines (e.g. creative arts, performing arts) are at the opposite end of the spectrum: they are characterised by significant diversity in approaches and by integrity challenges that often extend to cover audiences and performers as well as those directly involved in designing or delivering the research. However, it should be noted that addressing research integrity across the disciplinary spectrum is a valuable endeavour, as we expect there to be significant opportunities for interdisciplinary learning.

At present, the majority of documents, guidelines and recommendations around research integrity speak to a generalist audience, and their practical efficacy remains difficult to assess. Unless attention to disciplinary differences is increased, not to mention differences in institutional size and resourcing levels, the research integrity discourse is liable to remain somewhat remote from the day-to-day experience of members of the research community.

There are examples of practices that are considered questionable within one discipline but are totally okay, or even a good practice, within a different discipline.

2.2 Conceptual framework for the creation of indicators

The Concordat principles are helpful to ground discussions around research integrity

As discussed above, research integrity is an inherently complex area and definitions of research integrity vary widely, with no single framework being broadly used worldwide. The remainder of this report will focus on the five principles in the Concordat to Support Research Integrity, as this is widely adopted in a UK context, to ground the discussion and suggest practical next steps towards the creation of research integrity indicators. This is not to say that other interpretations of research integrity are less valid but is an acknowledgement of the geographic focus of this study and of the fact that the Concordat presents an articulation of research integrity that has been agreed by UK-based research funders and bodies representing research organisations.

I think the biggest possible challenge to implementation is the fact that there isn't even a consistent definition of the elements of research integrity that are in scope.

The facets of research integrity are often related and address a set of shared themes or challenges

Building on the Concordat, we have identified a range of indicative 'facets' of research integrity arising from the five principles (see Figure 1 on p.16). Facets are intended as distinct areas of research integrity where the creation of indicators may be considered. We note that the mind map presented in Figure 1 could potentially be expanded to include a broader range of considerations, and so should be viewed as illustrative rather than comprehensive.

Although the Concordat describes five distinct principles, many of the facets identified in our work are relevant to more than one of these principles. As a result, the mind map shows the interconnections between facets of research integrity and the Concordat principles. This further illustrates the complexity of setting clear and unambiguous definitions for research integrity, with a concomitant risk that fixed definitions are liable to privilege certain disciplinary groups, stakeholders or institutional types over others.

Furthermore, future work would need to take account of the extent to which facets prioritise 'epistemic integrity', which focuses on the reliability of the results of research, as distinct from moral integrity, which concerns the moral acceptability of research practices.[45] While all facets will involve a degree of subjectivity, this is likely to be particularly evident for those centred on moral integrity, such as the Concordat principles of honesty, care and respect.

A pilot framework can be used to prioritise facets for the creation of indicators

Based on our research and consultation, we built a three-dimensional pilot framework to identify facets where early progress appears more or less achievable with regard to the creation of research integrity indicators. This relied on the analysis of actions and measures presented in Annex 1, which provided us with insight as to what facets of research integrity are currently being considered by practitioners and policymakers and may offer the highest potential for qualitative or quantitative assessment.

In our pilot framework, we estimated a score (1 to 3) for each facet shown in Figure 1, around the following dimensions (see Table 3):

- Who is primarily responsible for the facet of research integrity?
- How complex are the questions that could be asked about the facet?
- How difficult would it be to practically measure indicators around the facet, including based on existing sources of information?

The combined result obtained by multiplying scores across these dimensions informed a qualitative ranking of feasibility for research integrity indicators, as follows:

- Score 1-6: High feasibility.
- Score 8-12: Medium feasibility.
- Score 18-27: Low feasibility.

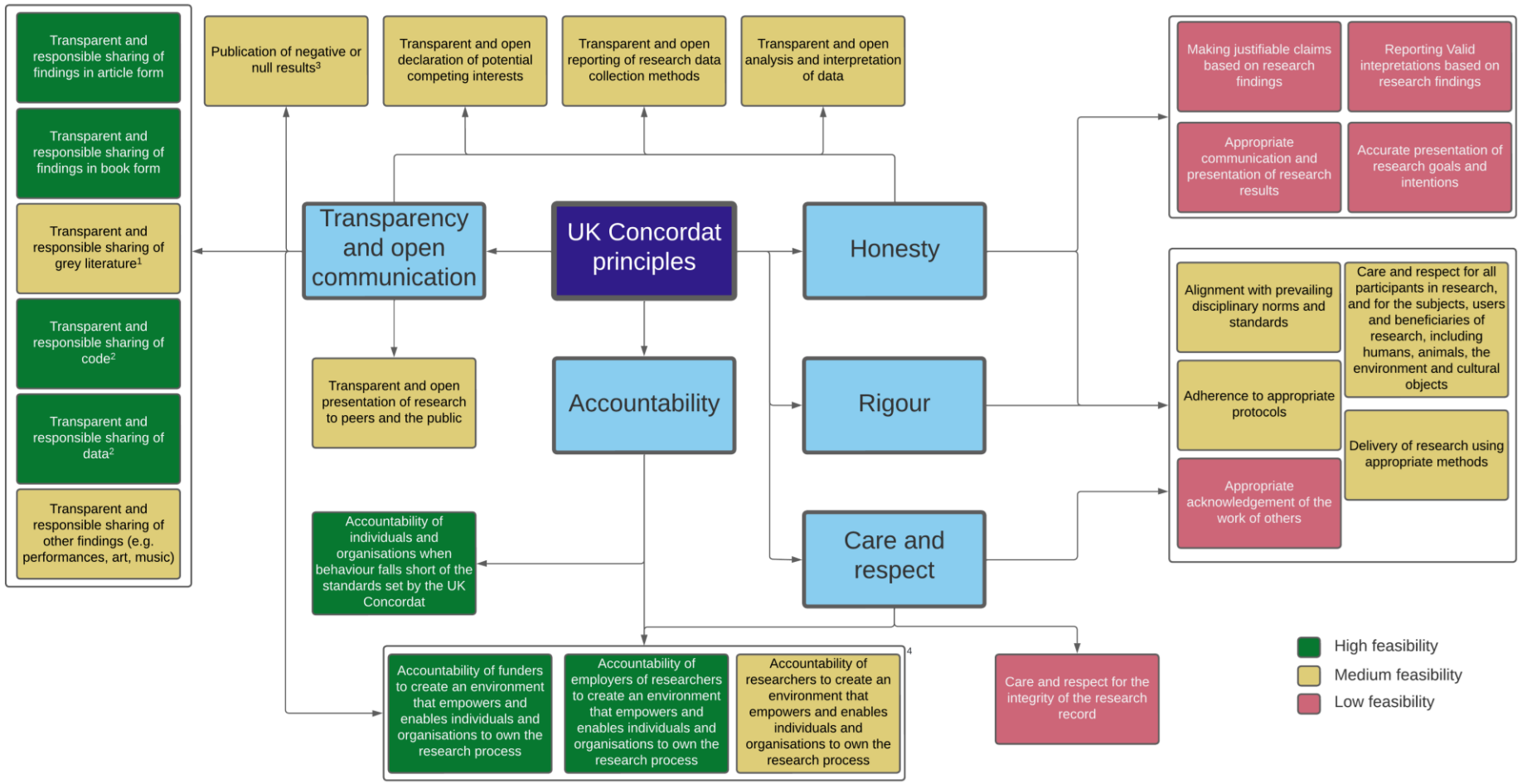
This qualitative feasibility score may be used as a proxy to decide where to start creating research integrity indicators, meaning that high-feasibility ones are more likely to be suitable for immediate progress. However, areas marked as low or medium feasibility should also be carefully considered in the short term, to ensure that the right discussions and efforts take place to underpin future work.

It should be noted that any scores assigned using this pilot framework are preliminary at this stage and have been developed by Research Consulting based on the evidence gathered and analysed. The scores are meant as a starting point for further discussion, and we recommend they are updated in the future by building on additional stakeholder engagement and emerging findings.

Table 3. Approach to prioritise facets of research integrity

Dimension	Scoring
Who is primarily responsible for a given facet of research integrity?	• Organisational responsibility [1]: the facet is mainly affected by organisational (e.g. funders, research performing organisations, publishers) policies and processes • Shared responsibility [2]: the facet is affected by a mix of individual, organisational or external behaviours • Individual responsibility [3]: the facet is mainly affected by individual behaviours
How complex are the questions that could be asked about the facet?	• Low [1]: the questions are straightforward (e.g. 'is there a policy on X?' or counts/percentages) • Medium [2]: the questions involve a mix of abstract concepts and straightforward ones • High [3]: the questions involve several complex and abstract concepts (e.g. 'are reported findings a fair representation of the data collected?')
How difficult would it be to practically measure indicators answering questions around the facet?	• Low [1]: There are substantial data sources and measurement is likely to be feasible • Medium [2]: There are some existing data sources or gathering data would be relatively straightforward; an extent of manual/programmatic analysis is needed • High [3]: mix of issues, including need for manual or programmatic analysis, limited sources of information, poor coverage of sources, difficulties in characterising the scope of the analysis

Figure 1. Facets of research integrity based on the principles of the UK Concordat.



[1] The term 'grey literature' describes a range of information and documents that are shared via pathways other than traditional academic publishing channels. Grey literature may include reports, theses, technical specifications and standards, technical documentation, policy papers and more.
[2] We acknowledge that terms such as 'data' and 'code' are understood differently across disciplines. In the context of Figure 1, they are meant to describe the sharing of any form of information or (computational) approach that underpins published findings.
[3] A negative or null result is an experimental outcome that does not show an otherwise expected effect. This does not imply a result of zero or nothing, simply a result that does not support the hypothesis.
[4] These three boxes appear in the Concordat as a single statement covering joint accountability of different stakeholder groups. They have been split due to the different estimated prioritisation. We also note that these boxes do not mention publishers: while publishers are not formal signatories to the Concordat, they are considered to have a crucial role to play in implementing the principles, and their role is acknowledged throughout this document.

3. Taking research integrity indicators forward

3.1 Potential approaches to indicators

There are several options to investigate research integrity

We note that an indicators framework will need to achieve a balance between the benefits of using metrics and the bureaucracy required to create them. Based on our research and consultation, our pilot framework includes possible approaches to create indicators around each facet.

As a starting point, we have identified the following range of options:

- Survey instruments: Online surveys focusing on one or more facets of research integrity. Surveys may include both closed-ended questions to create numerical indicators and narrative statements, i.e. descriptions of a research funder's, research performing organisation's or publisher's position with regard to a facet of research integrity. Surveys may also be designed to assess alignment with existing concordats, codes or commitments, for example by seeking information on an organisation's claimed alignment or compliance with a given initiative.
- Reporting based on organisational management systems: Export and aggregation of data from organisational management systems, including research funders, research performing organisations and publishers.
- Simple database queries: Queries of existing databases, typically via APIs,[d] seeking to answer quantitative questions.
- Text and data mining / machine learning: Programmatic analysis of databases, qualitative or quantitative data, based on sophisticated methods and significant tailoring around a question.

It can be inferred that some approaches are mainly qualitative in nature, while others are mainly quantitative. Clearly, it is practically simpler to showcase quantitative indicators (e.g. numbers, percentages) as part of reports or dashboards, but these would lack the context that only narrative or qualitative indicators can provide.

A number of our interviews emphasised the importance of qualitative research techniques, such as interviews, focus groups and workshops, when investigating the topic of research integrity. At the same time, narrative or qualitative indicators may present some difficulties due to the diversity of free text responses. We expect that narrative statements will be appropriate to inform case studies, but they are likely to require an extent of thematic coding or further analysis (e.g. peer review) to allow for meaningful aggregation and reporting.

[d] Application Programming Interfaces (APIs) are constructs made available in programming languages to allow developers to create complex functionality more easily. They abstract more complex code away from users, providing some easier syntax to use in its place.

Perspective A: The 'applied mindset'

If you are pursuing indicators or a metrics-based system, then in my mind that's a quantitative question. Yes, you can describe things qualitatively and that's useful – context brings meaning to the numbers. But I don't think it's actionable unless it's measurable.

Perspective B: Understanding the nuances

We are working from a perspective of understanding what the rules are of the work people do, their objectives, and how they feed into overall objectives. It is less about looking at quantitative data, as there isn't a way of quantitatively understanding their practices.

Future work will need to find a balance between lagging and leading indicators

We recommend that a balance is sought between lagging and leading indicators. Although the former are easier to measure, they also pose challenges, as change with regard to research integrity is likely to take significant time to materialise: as a result, comparing indicators against a baseline, e.g. at annual frequency, may provide limited or misleading insights in the short term. On the other hand, leading indicators could potentially help measure practices and behaviours that are, in theory, expected to lead to positive change with regard to research integrity. Leading indicators may take the form of the number of organisations supporting the Concordat, the number of research performing organisations offering training on research integrity or the level of investment the sector Is making in this direction.

The strategies, policies and systems that enable research integrity could be helpfully investigated

The concept of "quality by design" was advanced during our consultation, meaning that organisations involved in research should, in principle, ensure that research integrity is structurally encouraged rather than policed. For example, some interviewees noted that appropriate research practices should emerge naturally where the right combinations of strategies, policies and systems, but also disciplinary cultures and tools, are in place. Given that all organisations involved in research are likely to have at least an extent of strategies, policies and systems to encourage research integrity, assessment mechanisms around these are within reach.

Recent research has developed a taxonomy of documents supporting research integrity practices, policies and individual behaviours.[46] These include, for example codes, guidelines, checklists, flowcharts and legal documents/contracts. The extent to which these are adopted or supported by research funders, research performing organisations and researchers could be used as a proxy to assess the prevalence of good practices. As an example, narrative statements could be collected from relevant organisations to assess the extent to which these align with existing expectations. Indicators could be created via thematic coding of such statements and fed into benchmarking charts or comparisons showcasing whether the right strategies, policies and systems are in place between peers and across the sector. Notably, such an approach to measurement would not likely be able to assess whether, or the extent to which, any practical impact is arising from the presence of such strategies, policies and systems, nor whether associated behavioural changes are taking place.

The sharing of best practices and lessons learned was seen as a particularly valuable exercise by contributors as long as the time and effort required to assemble this information is not disproportionate. We acknowledge that any exercise to assess strategies, policies and systems should carefully consider ongoing exercises in this domain to minimise bureaucratic burdens. For example, research performing organisations in the UK already report on their alignment with Concordat principles, and this could be considered as a useful data source covering their institutional position (see examples from the Universities of Edinburgh,[47] Nottingham,[48] Sussex[49] and Wrexham Glyndwr).[50] These annual reports are currently not written in a consistent format (e.g. sections, length, level of detail, disciplinary coverage), nor is there a body that assesses and aggregates these documents in a way that could allow benchmarking or comparison. However, we understand that the Concordat signatories have recently commissioned work to develop a template and guidance to help research performing organisations develop their annual narrative statements. This effort seeks to reduce the burden on those creating reports, by providing clarity about what needs to be reported, and to achieve greater consistency across reports to allow for analysis across the sector.

Finally, we note that it would be important to consider what specific documents are applicable in a UK context (or other geographic context where indicators are being created), as legal frameworks and requirements often vary on a national basis: for example, the Concordat is signed by UK-based organisations only. By contrast, other initiatives such as the Declaration on Research Assessment (DORA) have international resonance.[51]

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*We also talk about "quality by design": do we have systems for managing **what** we do that build quality into **how** we do it?*

The effort needed to provide information underpinning indicators may be significant

In the process of considering research integrity indicators, it is key to consider the findings of the ongoing Review of research bureaucracy led by Professor Tickell.[52] The interim report notes that "there is a clear perception within the research sector that the bureaucratic burden has increased over time" and further efforts will seek to "identify appropriate mechanisms to ensure that we do not see an accretion of bureaucracy in the future" – an example of these efforts is the recently completed research concordats and agreements review, which aimed to understand how initiatives can best promote a more inclusive and welcoming research culture while minimising bureaucracy.[53] Notably, research bureaucracy is described as an issue by a wide range of stakeholders, including administrators, research managers and researchers themselves, as these all need to align their behaviours with a growing body of guidance, documents, concordats and more.

In their recent update to the House of Commons Science and Technology Committee, James Parry (Chief Executive, UK Research Integrity Office) and Professor Dame Ottoline Leyser (Chief Executive, UK Research and Innovation) agreed that UK CORI should avoid duplication of effort across the sector. Similarly, UKRN aims to work collaboratively across institutions so as to minimise duplication of effort.[54] We expect that discussion will be required between these stakeholders to establish appropriate communication and information sharing channels that will help align their ongoing and future work.

In this context, any new mechanisms to create research integrity indicators should consider whether undue burdens are being placed onto research funders, research performing organisations and researchers. In particular, the research community should weigh the cost and waste of resources associated with poor research practices, misconduct and QRPs against any mechanism being considered, to assess the cost/benefit ratio and make evidence-based decisions.

The above further points towards the usefulness of measuring alignment with existing concordats, codes of conduct or commitments, where possible, as opposed to the provision of new evidence in a different form, as this is likely to minimise new reporting burdens.

3.2 Attitudes towards research integrity indicators

We found very limited evidence on the use of indicators for research integrity

In our research and consultation, we found extremely limited evidence of the use of research integrity indicators. Currently, indicators are mainly conceptualised around publishing practices and research misconduct, focusing for example on numbers and reasons for article retractions, shares of open access publications, prevalence of data sharing and use of reporting guidelines.[55] The Hong Kong Principles for assessing researchers offer some additional examples of indicators around the research process and focusing more broadly on research cultures, such as the use of altmetrics[e] and markers of impact and engagement.[56] However, these present their own challenges, such as leading researchers to place undue focus on the 'marketability' of research outputs on social media. In many other respects, the discussion remains somewhat abstract and is yet to be translated into practical indicators for broader use.

Overall, 'quick wins' in the development of indicators are likely to centre on publishing and dissemination activities, including with regard to articles, preprints, research data, methods, protocols and more. However, this risks failing to heed William Bruce Cameron's warning that "not everything that can be counted counts, and not everything that counts can be counted." Indicators centred on publishing and dissemination also suffer from potential concerns around (i) data quality and comprehensiveness; and (ii) the extent to which the above-mentioned practices apply to different disciplines.

Some tools and frameworks are, indeed, available to assess the state of play of other facets of research integrity, particularly surveys such as the Culture, Employment and Development in Academic Research Survey (CEDARS, UK),[57] the National survey on research integrity (NSRI, Netherlands),[58] the Publication pressure questionnaire (PPQ, Netherlands),[59] the Survey of Organizational Research Climate (SOURCE, USA)[60] and the annual State of Open Data survey (international).[61] A combination of these might, in principle, be suitable to paint a comprehensive picture of research integrity at an organisational or national level, but we have not found evidence of concerted efforts in this direction.

[e] Altmetrics are metrics and qualitative data that are complementary to traditional, citation-based metrics. They can include (but are not limited to) peer reviews on Faculty of 1000, citations on Wikipedia and in public policy documents, discussions on research blogs, mainstream media coverage, bookmarks on reference managers like Mendeley, and mentions on social networks such as Twitter.

Finally, contributors shared a range of activities and internal metrics that their organisations have adopted to support research integrity. However, efforts are disconnected and not necessarily regular in terms of frequency and scope. Many internal metrics currently in use are also highly context-specific, and would not lend themselves to a standardised approach at sector level.

Researchers have to complete their ethics and integrity checklist, which I'm then responsible for monitoring. The downside of this system is that, as a very small institution, when I say "I", I mean that there isn't anyone else to do it besides me.

Contributors tend to be sceptical about the use of quantitative indicators for a topic as nuanced as research integrity

Contributors were generally sceptical about the use of quantitative indicators. Interviewees found the potential risk of ranking particularly concerning, including because of issues such as indicator gaming and inappropriate incentives (see section 3.3), which could lead to significant issues and competition in an area that should be authentically pursued by all higher education and research stakeholders. Furthermore, comparing organisations with different disciplinary mixes is seen as being potentially misleading, as it could lead to unfair or simply inaccurate comparisons. However, if aggregated at the national or international level, the use of research integrity indicators was seen as less controversial by contributors (although we note that the methodological validity of aggregated indicators would need to be investigated).

In some cases, the indicator becomes the driver of the whole sector. If we start getting league tables, and everyone knows that their institutional reputation is going to depend on where they end up based on the integrity indicators, these will become an extremely perverse incentive.

As noted above, qualitative and narrative indicators appear to be far more acceptable than quantitative ones, as they can more effectively communicate the nuance of good practices and support an environment in which researchers can work with high levels of research integrity. The immediate actionability or otherwise use of these types of indicators remains a concern, mainly because of the difficulty of aggregating large amounts of heterogenous information.

Indicators are also seen as a potentially useful tool to assess the impact of an intervention – for example, to compare an organisation's current state to a baseline. This does not necessarily involve the sharing of indicators or external comparison but could benefit from an extent of benchmarking with peer organisations. Whether such an approach will be found to be acceptable will depend on the specific mechanisms put in place to gather and share data, including the degree of anonymisation.

Research cultures and climate have a significant impact on research integrity

Given that commitment 3 in the Concordat focuses on "embedding a culture of research integrity", it is not surprising that this topic was mentioned by several contributors alongside the related concept of research climate.[62] For example, it was noted that pressures and expectations from the institutional, departmental or research group levels are very likely to affect individual behaviours and, in some cases, may lead to inappropriate conduct.

However, the Concordat *principles* do not explicitly mention topics such as research cultures, equality, diversity and inclusion or bullying and harassment, which is why Figure 1 does not directly cover these. Table 4 provides examples of existing initiatives that may help to monitor facets of research that the present study has not sought to investigate in detail.

Table 4. Parallel initiatives that may help monitor facets of research integrity not considered in the present study

Topic	Examples of existing initiatives
Research cultures	• CEDARS benchmarking survey[57] • National Survey on Research Integrity (Netherlands)[58] • Survey of Organizational Research Climate (SOURCE)[60]
Equality, diversity and inclusion (EDI)	• Athena Swan[63] • Race Equality Charter[64] • UKRI EDI strategy[65]
Bullying and harassment	• Concordat to Support the Career Development of Researchers[66] • Open letter: Seven principles to accelerate research culture change in the UK[67] • UKRI Forum for Tackling Bullying and Harassment in Research and Innovation[68]

The topics in Table 4 are also closely interconnected: for example, a culture where bullying and harassment are permitted is likely to perform poorly in terms of EDI and to be one in which researchers feel afraid to raise issues concerning misconduct and research integrity. This suggests that the scope of the topics in Table 4 extends beyond research integrity alone: they are part of higher-level conversations with ramifications on all aspects of higher education and research. For example:

- The recent report by the US Scientific Integrity Fast-Track Action Committee and the National Science And Technology Council acknowledges the importance of good leadership, training and transparency in establishing "organisational cultures to protect against violations of scientific integrity".[23] At the same time, leadership, training and transparency are known to affect a far wider range of areas of higher education.[69]
- It has been argued that 'turnover of research staff from underrepresented groups means lost expertise, and the narrowing of researcher perspectives ultimately compromises research integrity'.[70] At the same time, this is only one of the several negative impacts that may arise from a non-diverse workforce, including limited innovation, poor mental health outcomes and racial stigma (among others).[71]

We recommend that the discussion around research cultures, equality, diversity and inclusion and bullying and harassment is continued beyond the present document. We haven't considered these as part of our core scope of work, but we acknowledge that these areas can, indeed, have a significant impact on research integrity: it may therefore be appropriate to include them in a future indicators framework or to examine them as part of dedicated exercises.

Many aspects of research integrity share underlying issues with other things going on in higher education, which are now most frequently talked about under the term "research culture".

3.3 Practical challenges

Creating valid, acceptable and reliable indicators is a significant challenge

In addition to cultural barriers, there are some practical challenges that are likely to apply to any indicators developed. Our consultation identified the following key concerns that will affect the extent to which indicators are seen as being valid, acceptable and reliable:

- Miscalculation: incorrectly calculated indicators are likely to lead to misleading conclusions. Transparency is key to ensure that indicators are appropriately scrutinised and validated.
- Gaming ('cobra effect'): perverse incentives may have undesirable results that are contrary to the intentions of the designer, which typically happens when an incentive unintentionally rewards people for making an issue worse.
- Misalignment: indicators may lead to extrinsic motivation prevailing over intrinsic motivation, which could in turn lead to dissatisfaction and poorer practices.

Furthermore, we note that the use of indicators at one level of the system may lead to unintended consequences for stakeholders at other levels of the system. For example, if research performing organisations are assessed based on a given indicator (or set of indicators), they are likely to translate these expectations into requirements for their staff and researchers. In some cases, this type of dynamic may lead to gaming and misalignment, too.

The risk of setting up an intervention is that we just replace one set of incentives that are creating perverse outcomes with another set of incentives that are creating different perverse outcomes or problems. So, it's a whole system, and any improvements will be a really long game.

Contributors noted several practical barriers to the adoption of research integrity indicators

Beyond the methodological concerns listed above, contributors mentioned a range of barriers specific to indicators in the context of research integrity (see Figure 2). The barriers reported are not insurmountable, but several interviewees questioned the very need for research integrity indicators.

A real-life example is helpful to fully appreciate potential issues that may be encountered. Let us imagine that University A has recorded eight cases of retractions in one year and three the following year. On what basis could one tell where this represents a positive or negative development? At the very least, one would need to be aware of the national and local research integrity culture, the discipline, the output type (e.g. book, article, chapter), the reason for each retraction (e.g. honest mistake, data fabrication, plagiarism), what has been done to correct the behaviours leading to each retraction and any sanctions applied. This example illustrates why such a nuanced area of research cannot be immediately and

smoothly reduced to bar charts and comparisons: in research integrity, context is key, and this will vary by country, organisation, discipline, research group and individual researchers (including their motivations and incentives, for example the known issue of 'publish or perish').[72]

Our consultation showed that the sector is open to discussion. However, the barriers reported indicate an extent of scepticism from the community and make clear that arbitrarily selected or wholly quantitative indicators would not be welcomed.

Figure 2. Barriers to measuring research integrity

Definitions of research integrity and misconduct are not clear, and the shape of misconduct varies by discipline	*Some assessments of research culture are only possible if researchers 'on the ground' are consulted, including junior staff*
The existence of a research integrity policy does not necessarily imply appropriate behaviours in line with it	*Quantitative indicators may not be able to distinguish between honest error and purposeful misconduct*

3.4 Methodological notes

Transparency and clarity will be key in the development of research integrity indicators

This discussion document assesses scope to make progress towards research integrity indicators that are: useful, valid, reliable, acceptable across a wide range of research disciplines and settings, ethical (including with regard to privacy), transparent, reproducible, aligned with good practice principles and low or zero burden. Building on these principles, Table 5 includes a range of questions that can inform the practical development of indicators.[73]

Overall, the calculation or assessment of each indicator – whether quantitative or narrative/qualitative – will need to be transparent. This includes any further analysis applied to narrative or qualitative indicators: for example, a coding methodology or peer review approach could be shared to enhance trust in a given indicator. The above is particularly important if an element of benchmarking is considered, as concerns among contributors mainly referred to cases where data might be shared between different organisations.

Finally, caveats will have to be noted alongside interpretations of the indicators. This also includes inherent limitations in any data sources used. For example, an analysis of open data sharing behaviours that is based on open access full texts only would have to be caveated by recognising that the findings may not be comprehensive or generalisable (i.e. as opposed to considering subscription-only content, too).

Table 5. Methodological questions to help scope out actionable and acceptable indicators

Focus	Methodological questions
Purposes of the indicator	• Will the indicator give rise to otherwise unknown insights? • Will the indicator help make decisions to improve future performance? • Will the indicator support accountability to different stakeholders? • To what stakeholder(s) will the indicator be valuable? • To what extent does the indicator cover different disciplines and/or research contexts? (if relevant) • To what extent does the indicator apply in an international context? • What else might the indicator be used for?
Measurement	• How difficult will it be to collect information on the indicator, and where would the information come from? • Is the indicator likely to be accurate and credible? • How often will the indicator need to be collected? • Does the indicator require baseline information? If so, is it feasible to gather this information? • Does the indicator require access to personal or confidential information? If so, how can this information be protected?
Roles and responsibilities	• Who will own the indicator, and within what set of organisational arrangements? • Who will provide the information required to build the indicator? • How much will it cost to get the information in terms of staff time, beneficiary time and money? • Do staff have the capacity (or desire) to collect the information honestly and accurately?
Transparency	• To what extent can the indicator be audited and quality assured? • How robust is the methodology behind the creation of the indicator? • To what extent does the methodology build on best practice principles? • Is the indicator reproducible, given the input data and methodology? • To what extent is the methodology auditable? • To what extent can the methodology's robustness be checked by others? • To what extent can the indicator be applied in an international context?

4. Conclusions and recommendations

Research integrity indicators are currently uncommon, but there is room for progress

Research integrity is a complex and multifaceted concept, which is continually evolving to mirror developments in the research landscape. For example, research integrity used to focus on the conduct of researchers and the strategies, policies and systems put in place by research performing organisations, research funders and publishers to enhance the quality of research and foster positive practices and behaviours. However, for many, research integrity now incorporates open science principles, the reproducibility agenda, inter-organisational relationships and more. This suggests that any attempt to develop indicators will have to be guided by the shifting nature of what the sector means by "research integrity" and the growing range of stakeholders that have to be engaged.

Our research and consultation indicated limited or no use of research integrity indicators, at least not beyond the walls of individual organisations. Where organisational metrics exist, these tend to focus on specific internal matters and are not shareable nor comprehensive in most cases, even if the overarching themes and aims are similar across organisations. Some bibliometric indicators[f] are in use in today's research landscape (e.g. around open publishing practices) or could be created, but they are not typically associated with research integrity and would only cover a small fraction of its facets.

In Table 6, we hypothesise a set of options for future work mapping to the potential purposes for research integrity indicators discussed in Table 1.

Table 6. Options for future work.

Potential purposes for research integrity indicators	Options for future work
1. Understanding, planning, justifying and evaluating interventions that aim to improve the research environment, the integrity and therefore the overall quality of research 2. Assessing whether research(er) practices and behaviours are in line with organisational expectations around research integrity (e.g. Concordat requirements, grant terms and conditions, author guidelines)	• A set of pilot indicators ("high feasibility") could be built and trialled in the short to medium term, to assess the extent to which these can be used in practice to achieve the purposes in the left column. • The balance of quantitative vs narrative/qualitative indicators should be tested early on, to establish how to prioritise the creation of further indicators ("medium feasibility" and "low feasibility"). • It will be important not to solely focus on indicators related with publishing and open science/research practices, as these are likely to be quick wins but would only present a partial picture of research integrity.
3. Identifying systemic pressures affecting research integrity, and harnessing opportunities for change among funders, research performing organisations, publishers and sector bodies to	• Once pilot indicators are established, they could be aggregated and analysed to paint a picture of the research integrity landscape in the UK. • UK CORI is expected to support the sector in monitoring progress towards a set of shared research integrity issues.

[f] Bibliometrics are quantitative publication and citation data that can be used for various purposes, e.g.: to measure the impact of one's research, help authors decide where to publish, increase research visibility and citations, evidence one's strengths, or find collaborators.

support an environment in which researchers can work with high levels of research integrity	• Stakeholders, including UK CORI, could lead further discussion to assess whether there is room for benchmarking or comparison within peer groups, as opportunities for change may vary based on the type and size of organisation.
4. Enabling (meta)researchers to reference an agreed framework for evidence, in planning and reporting their research into aspects of the research system related to research integrity	• The prioritised facets of research integrity shared as part of this document should be further discussed with the research community and refined. Engagement with research users beyond our consultees should be considered to reflect facets of research integrity that may have been missed at this preliminary investigation stage (e.g. non-academic research users and the general public). • Future iterations of the UK Concordat to Support Research Integrity may be enriched by adding a more formal hierarchy (e.g. a table or chart) of research integrity principles and stakeholder responsibilities, building on the existing Concordat and the findings of this work (see Figure 1 on p. 16). This could be used as a reference point by UK CORI and as an evidence framework for the purposes of meta-research.

Future work should build on a set of shared principles

Contributors appreciated the importance of transparently and openly sharing good practices to improve research performance, generally agreeing that "approaches to improvement need to be open and transparent, and constructive rather than punitive".[33] In this spirit, pursuing the co-creation of indicators from narrative evidence appears to be a positive and promising way forward. Wholly quantitative indicators without a narrative context are strongly opposed, and contributors noted the risk of new institutional rankings that might lead towards inappropriate incentives and behaviours.

We note that research integrity indicators are not seen as an end in themselves, but as a tool to drive positive changes that can directly benefit the research community and beyond, including non-academic research users such as the general public and other stakeholder groups that were not directly engaged as part of this study.

In Table 7, we summarise three principles that we believe should underpin future work on research integrity indicators, with the overarching expectation that disciplinary and organisational differences and requirements will be weighed up throughout. We recommend that these principles are carefully considered in any future work in this area to lay the foundation for sustainable and credible indicators of research integrity.

Table 7. Principles for future work.

Principle 1 – Foster and share good research integrity practice	
Refine the goals of indicators	The present document hypothesises a set of purposes for research integrity indicators. These should be discussed with the research community and refined to acknowledge a broader range of views.
Kick off a broader discussion	Although contributors opposed wholly quantitative indicators, they did appreciate the importance of this discussion and of transparent good practice sharing to improve research performance.

Foster integrity and avoid rankings	If aggregated at the peer group, national or international level, the use of quantitative research integrity indicators is less controversial. There is room for further exploration of indicators, but only if the focus is on fostering good research integrity practices within a given institutional and disciplinary context, and not ranking individuals or organisations.
Principle 2 – Consider a breadth of approaches	
Remain aware of practical challenges	Challenges such as miscalculation, gaming and misalignment are frequent when indicators are used. The actionability of narrative or qualitative statements should also be considered.
Examine a range of measurement approaches	Several approaches can be identified to develop research integrity indicators. The non-exhaustive list in the present document can be further discussed and built upon to identify the path of least resistance.
Principle 3 – Ensure co-creation and inclusion	
Pursue co-creation in any further steps of this work	The significant scepticism from the community indicates that arbitrarily set or wholly quantitative indicators without a narrative context would be neither welcome nor effective. A focus on co-creation is crucial to take the discussion forward.
Keep inclusion and diversity in mind	Several interviewees commented on the importance of diversity and inclusion in indicators, as these should speak to broad audiences. The reporting burden on organisations of different sizes or types should also be balanced.

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Appendix A. Examining actions and measures to support research integrity

The present discussion document was informed by a longlist of actions and measures that organisations may put in place to support research integrity. Building on our desk research, we selected ten key documents that we considered to represent the perspectives of the stakeholder groups mentioned in the Concordat, including:

- researchers;
- employers of researchers (i.e. bodies that conduct or host research; employ, support or host researchers; teach research students; or allow research to be carried out under their auspices);
- research funders; and
- other organisations (e.g. professional, statutory and regulatory bodies; academies and learned societies; professional and subject-specific representative bodies; journals and publishers; and organisations offering advice, guidance and support).

Table A1 summarises the documents that informed our prioritisation of facets of research integrity for the creation of indicators (see Figure 1 on p. 16), while Annex 1 provides full details on the actions and measures we considered. It should be noted that Table A1 is not meant to imply that other documents are of lesser importance: it is only a starting point for discussion and seeks to represent different stakeholder views.

Table A1. Documents informing our scoping exercise.

Document	Lead	Main perspective(s)
UKRIO Self-Assessment Tool for The Concordat to Support Research Integrity	UK Research Integrity Office (UKRIO)	Employers of researchers
The Hong Kong Principles for assessing researchers: Fostering research integrity	Moher et al. (academic article)	Researchers, Employers of researchers, Research funders
Research integrity: a landscape study	UK Research and Innovation (UKRI), Vitae, UK Research Integrity Office (UKRIO), UK Reproducibility Network (UKRN)	All stakeholders
What Researchers Think About the Culture They Work In	Wellcome	Researchers, Employers of researchers, Research funders
The European Code of Conduct for Research Integrity	All European Academies (ALLEA)	All stakeholders
Handbook on Research Integrity	European Network for Research Ethics and Integrity (ENERI)	Researchers, Employers of researchers, Research funders
Guideline for Promoting Research Integrity in Research Funding Organisations	Standard Operating Procedures for Research Integrity (SOPs4RI)	Research funders
Guideline for Promoting Research Integrity in Research Performing Organisations	Standard Operating Procedures for Research Integrity (SOPs4RI)	Employers of researchers
Cooperation between research institutions and journals on research integrity cases: guidance from the Committee on Publication Ethics	Committee on Publication Ethics (COPE)	Publishers and Employers of researchers
COPE Retraction Guidelines	Committee on Publication Ethics (COPE)	Publishers

Appendix B. Contributors

The following stakeholders contributed to our discussion and their input is gratefully acknowledged.

Table B1. Contributors.

Name	Organisation	Role	Country
Noémie Aubert Bonn	Hasselt University / Amsterdam University Medical Centers	Postdoctoral Researcher, Medical Humanities Division	Netherlands
Elisabeth Bik	-	Independent Consultant	US
Dorothy Bishop	University of Oxford	Professor, Developmental Neuropsychology	UK
David Carpenter	UK Research Integrity Office / Association of Research Managers and Administrators	Independent Consultant, Research Ethics	UK
Tanita Casci	University of Oxford	Director, Research Strategy & Policy Unit	UK
John Catell	Historic England	National Head, Research	UK
Stephen Farrier	Royal Central School of Speech & Drama, University of London	Reader, Theatre & Performance, School of Speech & Drama	UK
Melanie Gainey	Carnegie Mellon University	Librarian	US
Michele Garfinkel	European Molecular Biology Organisation	Programme Head, Research Integrity	Germany
Chris Graf	Springer Nature	Director, Research Integrity	UK
Maura Hiney	Health Research Board Ireland / All European Academies	Head, International Cooperation, Evaluation & Targeted Programmes / Member of the Permanent Working Group on Science & Ethics	Ireland
Malcolm Macleod	The University of Edinburgh / UK Reproducibility Network	Professor, Neurology & Translational Neuroscience / Co-lead, UK Reproducibility Network	UK
Meesha Warmington	-	Independent Research Consultant	UK
Richard Malham	University of St Andrews	Head, Research Policy, Integrity & Governance	UK
Maja Maricevic	British Library	Head, Higher Education & Science, Department of Collections	UK
Judith Noble	Plymouth College of Art	Head, Academic Research / Associate Professor / Co-Coordinator of Black Mirror Research Network	UK
Bernd Pulverer	EMBO Press	Head of Scientific Publications	Germany
Joris van Rossum	International Association of STM Publishers	Director, Research Integrity	Netherlands
Rea Ščepanović	University of Split	PhD Student, School of Medicine	Croatia
Mads Sorensen	Aarhus University	Senior Researcher, Political Science	Denmark
Nicholas Steneck	University of Michigan	Professor Emeritus, History of Science / Independent Research Integrity Consultant	US
Anne Taylor	Wellcome	Associate Director, Funding Operations & Governance / Concordat Signatory	UK

Discussion document

Indicators of research integrity: an initial exploration of the landscape, opportunities and challenges

Research Consulting

The Ingenuity Centre, University of Nottingham Innovation Park, Nottingham, NG7 2TU, UK

www.research-consulting.com