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WELLCOME – RESEARCH CULTURE

EXTENDED REVIEW

WRITTEN BY: DR LENA KARLIN

CONTENTS

Preface to the literature review

This literature review explores different discourses around research culture. By including diverse points of view and narratives we aim to explore whether there is alignment in what works and what doesn't in the current research culture. What seems to be evident after comparing these different conversations is that, in the existing structure, research performance comes at a high human cost. Implementing a more positive research culture is a challenge, but it seems to be a badly needed effort to make sure the integrity of researchers' work and the quality of their lives is not threatened.

CONTEXTUALISING RESEARCH CULTURE

This section of the literature review explores the social, economic, cultural and political climate to provide a context for understanding the issues, challenges, practices and priorities that contribute to the current research culture.

RESEARCH SUCESSES

Key takeaway: narratives around research performance tend to be organised around the themes of impact, innovation, international relevance and investment.

There are many success stories in the world of research. If we zoom out to look at the wider context, **Europe** can be described as "a global scientific powerhouse"[11] where research can thrive due to a positive socio-economic environment, with such factors as:

- 1.8 million researchers.
- Thousands of universities and research institutions.
- A strong industry and enterprise base.
- Well-developed research infrastructures.

The result is that "with just 7% of the world's population and 24% of global GDP, it produces around 30% of the world's scientific publications" [11].

The UK is one of the most important research, science and innovation centres within this European environment[5]. **British research** is thought to be performing well on an international scale and is described as productive in terms of outputs per investment, and well-rounded in terms of delivering results in different research fields. The report commissioned by the UK's Department for Business, Energy & Industrial Strategy (BEIS) highlights that "in 2014, the UK represented 0.9% of global population, 2.7% of R&D expenditure, and 4.1% of researchers, while accounting for 6.3% of articles, 9.9% of downloads, 10.7% of citations, 15.2% of the world's most highly-cited articles" [26].

If we look at **UK Higher Education** research specifically, it is considered world-leading, impactful, generating growth and conducted with integrity. For example, Universities UK highlights the following markers of success:

- "76% of research at higher education institutions was considered as 'world-leading' or 'internationally excellent' for its overall quality in 2014"
- "Research performed by UK universities in 2014–15 equates to an increase of £28.9 billion in gross value added"[30].

UK biomedical research can also be presented as a success story – thriving in a supportive environment characterised by a strong pharmaceutical industry, well-developed academic base, and high levels of public investment. It has been producing knowledge and innovation that changes people's lives and improves health and is supported by high levels of individual donations to medical charities[12].

These narratives of success share some common themes – highlighting the importance of **impact, international relevance and investment** in defining research performance. Interestingly though, these three factors are also the main themes in the key challenges facing research culture.

RESEARCH CHALLENGES

Of course, it's not all success. The sources included in this literature review also highlight many entrenched and emerging challenges facing the world of research. These can be broadly grouped into two types:

- Challenges to research performance
- Challenges to research quality

Key takeaway: The same themes presented as measures of success are also talked about as problems. The indicators of research performance are also thought of as posing challenges to research quality, research community and research's relationship with society.

Naturally, most research addresses a challenge; such as a societal, environmental, technological and health issue connected to living in a fast-changing world. These challenges are present in the visions of policy makers and industry leaders as driving forces shaping research goals and priorities. They will not be discussed in this literature review in more detail, but do provide important context for understanding research culture, as **the relationship between research and society** is a prominent theme in accounts about what good research and good research culture should deliver.

There are many **challenges to research performance**, especially if these challenges are narrated from a London-based perspective.

If international relevance and investment are important measures of success, then Brexit poses a challenge for the future. The UK's currently debated exit from the EU will redefine how UK research is funded. For example, "in 2015–16, UK universities received £7.8 billion in research income. £840 million came from EU sources and £440 million from non-EU sources"[30]. New models of cooperation between the UK and Europe will need to be developed, so that the UK remains part of the European Research Area[11].

But the European Research Area is also facing **challenges in terms of international relevance and impact**. Looking through the lens of driving innovation, the EU "spends less than half as much on business R&D as a share of GDP compared to South Korea and the share of value added in high-tech manufacturing is half the South Korean average. The EU produces three times less quality patent applications than Japan. The amount of venture capital available in the EU is at least five times lower than in the US; the number of fast-growing start-ups, so-called unicorns, is equally five times lower"[11].

Whether considered as part of the European Research Area or not, UK research exists in an environment of increasing competition from other research-intensive nations[26]. While some sources highlight such geopolitical issues as threats to the UK's research performance, others ask if we measure and define

performance in the right way. There are concerns voiced by researchers and research organisations that the current framework focusing on performance, productivity and impact poses **challenges to research quality.**

As the UK's Independent Review of the Role of Metrics in Research Assessment and Management found out, **how research quality is measured is a challenge in itself: "**Across the research community, the description, production and consumption of 'metrics' remains contested and open to misunderstandings"[18]. From a UK perspective, this mostly relates to the Research Excellence Framework (REF), which aims to provide a comparative and comprehensive model for measuring quality and performance of research[6].

This challenge is complex. While policy makers acknowledge that it's becoming more difficult to measure performance meaningfully[26] , researchers and industry bodies point out that the current focus on **research performance can be considered a challenge to research's relationship with society, as well as a challenge to research quality**.

For example, Nesta (The Innovation Foundation) argues that **biomedical research has a problematic relationship between investment, impact and quality**: "For researchers in biomedicine and other fields, maintaining funding relies on being able to demonstrate a regular flow of successful results, even though the significance and impacts of research can take years to become apparent. In the absence of better information, funders, institutions and policymakers often reach for available but inadequate metrics"[12]. This in turn leads to problems with research quality, especially reproducibility, as researchers might feel under pressure to focus on productivity and performance and compromise research standards. How investment and funding is allocated and research incentivised can also manifest as systemic inefficiencies that warp researchers' careers – leading to a situation in which researchers spend too much time securing funding and where young researchers cannot expect permanent positions and stable career pathways.

UNDERSTANDING RESEARCH CULTURE

The rest of this report will focus on how individual researchers, research organisations, industry authorities and policy makers talk about research: the measures of success and sources of challenges; the practices and conditions that lead to good and bad research; and the hotspots in the system that both manifest and reinforce current research culture.

PERSPECTIVES ON RESEARCH CULTURE

Different discourses, sources and stakeholders define research culture in different ways. They also vary around the extent to which research culture features as a prominent theme on their agenda. Below we compiled a brief, and probably incomplete, overview of different perspectives on research culture present in the literature. Many of those perspectives present a reductionist approach to research culture that focuses on one element of the research environment.

PERFORMANCE-ORIENTED VIEW OF RESEARCH CULTURE

Present mostly in policy papers and strategic 'top-down' sources, this perspective could be summarised as **research culture equals research performance**. It relies heavily on quantitative measures and focuses on research outputs and their impact on the economy and society.

> *"Dual support combines project funding for excellent research proposals, which is forward-looking and assessed through peer review, with formula based quality-related research funding that rewards performance retrospectively based on peer review and proven impact from the research."*[4]

QUANTITY AND CAPACITY-ORIENTED VIEW OF RESEARCH CULTURE

This perspective considers producing **more research as a value in itself**. More research is a goal that is thought to be beneficial for organisations, sectors, disciplines and society. The sources tend to come from geographic or thematic contexts in which there is thought to be too little research focus or an insufficiently developed research culture.

> *"Embedding a culture of research within public and private health systems remains a challenge. In this rapid review we critically evaluate frameworks for embedding research into routine allied health practice, as the basis for high quality, safe, efficient and consumer-focused care."*[52]

An extreme variety is a **binary view**, where research culture is used synonymously with research focus. The narratives focus on the degree to which research is present or absent in organisational practices, in the field or in the sector. Although these generally non-research-oriented contexts are not part of this literature review, it is worth noticing this perspective for context. While discourses in intensive research environments focus on research quality and performance, some fields, institutions, sectors and countries define the main issue around research culture in terms of embedding research into practice almost from scratch and setting up conditions needed to implement this.

QUALITY-ORIENTED VIEW OF RESEARCH CULTURE

This perspective focuses on methodological issues, quality of research design and research practices. Such narratives tend to be present in contexts with **more established research environments**. The issues discussed, such as questionable research practices, are often presented as unintended consequences of current research culture, especially the pressures to produce and publish too much research. This perspective is likely to come from research-intensive nations, where focus on research productivity is thought to warp research culture.

> *"[We] aim to inform and advance debate about the ethical consequences of the culture of scientific research in terms of encouraging good research practice and the production of high quality science."*[22]

ENVIRONMENTAL VIEW OF RESEARCH CULTURE

This perspective tends to explain current research culture as a **result of wider environmental conditions** – especially economic and business pressures and policies. This top-down view explains the trends in research as outcomes of strategic leadership, with research objectives serving bigger social aims. While it often characterises policy sources, it is also present in some academic sources, especially those that seek to conceptualise research culture as an unintended consequence of the discourses of neoliberalism, knowledge society and governmental strategy for higher education and research and innovation.

> *"In the late nineteenth and early twentieth centuries, the scholarly culture of research – grounded in learned societies and periodicals – had rubbed along happily enough with the emerging institutional cultures of modern universities But since the Second World War, both universities and research culture have undergone huge changes in scale and focus Academic publishing has also been transformed"*[75]

ORGANISATIONAL VIEW OF RESEARCH CULTURE

This tends to be a bottom-up perspective in which 'culture' is talked about through the lens of structures and practices within an organisation. From this perspective, research culture focuses on behaviours, norms and attitudes that add up to an **institutional level of culture**. Even though wider factors are not discounted, this perspective either focuses on how they are or should be internalised on an institutional level, or how systemic issues manifest in workplaces and can be addressed through organisational solutions.

"The team is the molecular unit where real production happens, where innovative ideas are conceived and tested, and where employees experience most of their work. But it's also where interpersonal issues, ill-suited skill sets, and unclear group goals can hinder productivity and cause friction."[13]

A HOLISTIC VIEW OF RESEARCH CULTURE

This approach aims to present a more comprehensive overview of research culture, accounting for both top-down and bottom-up factors. It is likely to blend narratives around research performance, research quality, organisational culture and wider research environment. It tends to **take into account multiple lenses** and contexts, such as individual, organisational and societal. The focus is on tracing the process by which research culture is transmitted – from what drives it, to how it manifests, to what it impacts. While this view tries to avoid the reductionist approach, it is more likely to suffer from lack of focus, insufficient level of context / practical details, or find it hard to represent conflicting interests and perspectives.

DISCOURSES ON RESEARCH CULTURE

Because of such a diverse range of approaches to research culture, this literature review will look separately at discourses in 5 different types of source, before bringing them together to highlight: where narratives complement each other or diverge; where there are gaps between audiences; and where there is alignment in messaging. The final sections will gather evidence from all types of sources around recommendations for changing research culture and implementing positive practices.

- **Policy narratives** – policy papers and strategies outlining the current research system and the vision for the future, including trends, performance etc. in the national, regional, sector-specific or field-specific context.
- **Sector narratives** – top-down visions, strategies and evaluations of the research environment produced by research organisations, watchdogs, research industry authorities and commentators.
- **Academic narratives** – primary and secondary academic sources around any of the individual issues related to research culture.
- **Insider narratives** – surveys and industry magazines with content coming from individual researchers' perspectives.
- **Social narratives** – social commentary and opinion pieces from a variety of key opinion leaders, practitioners, journalists – showing which issues related to research culture reach a more general audience.

POLICY NARRATIVES

What are the current approaches of policy makers to defining and measuring "good" research? What does it mean for research culture?

This section covers policy literature published by the UK Government, UKRI, Universities UK and The European Commission. These sources shape the wider discourse of the knowledge economy, marketisation of higher education, and governmental strategies for research and innovation.

Key takeaway: The first type of source (policy literature) is dominated by a performance-oriented view of research culture. Measuring and defining impact and excellence, as well as international relevance, underpin the agendas.

FOCUS

Which elements of research culture are talked about?

EUROPEAN CONTEXT

Successful research is defined in terms of outputs, which include publications, commercial research products, and innovations[10]. There is a **focus on research impact**, which is presented as driven by the following elements of research culture[11]:

- Training.
- Involvement of citizens.
- International collaboration.
- Communication of results.

NATIONAL CONTEXT

The governmental 'Higher education: success as a knowledge economy' white paper from 2016 includes only a small section on research in general, which focuses on impact, outcomes and incentives – mentioning **funding mechanisms, citations, innovation and commercial application of research**[4].

The UK International Research and Innovation Strategy dedicates one chapter to **research governance, ethics and impact**[5]. And in the context of UK Higher Education specifically, Universities UK present research performance as supported by **integrity of research practices, access to research outputs and diversity of students and staff**[8].

The performance narrative is fleshed out in the source describing the current centralised research assessment – the Research Excellence Framework. Here, **research culture and people** are seen as a key condition of high-performing research[6].

DISCIPLINE-SPECIFIC CONTEXT

UKRI's Biotechnology and Biological Sciences Research Council delivery plan for 2019 focuses on research culture in relation to:

- Attracting people and talent.
- Accountability of themselves as an organisation[1].

UKRI's Arts and Humanities Research Council delivery plan for 2019 covers research culture in some more detail, referring to "priority research enablers", which include:

- Equality, diversity and inclusion.
- Skills.
- Public engagement[2].

Meanwhile, UKRI's Economic and Social Research Council delivery plan for 2019 discusses research culture in terms of "people and behaviour" and "mobilising knowledge, impact and engagement", which refers to:

- People and teams – phrased as "talent" and "leadership".
- Research processes and methods – especially quantitative and interdisciplinary research.
- Sharing research – focusing on impact and public engagement[3].

AGENDAS, GOALS AND OBJECTIVES

EUROPEAN

The European Commission aims to fund research "on the sole criteria of **excellence**"[11]. The main requirement seems to be that good research should "**have an impact**", especially in relation to **contributing to the economy**.

This translates to specific objectives around **research outputs**, where quality research is about projects that lead to:

- Publications in peer-reviewed journals.
- Open-access publications.
- Commercialised research products (patent applications, clinical trials, trade-marks).
- Driving innovation in the marketplace[10].

These objectives are connected to the European Commission's following goals for research culture:

- Moving more towards a interdisciplinary model of research.
- Attracting more women to research.
- Making scientific data accessible and re-usable; commitment to open access.
- Improving communication of the results to the public.
- Involving users and citizens more in agenda and implementation of research (co-creation) [11].

NATIONAL

The narrative of **excellence and impact** also permeates UK policy sources. Excellent research is linked to long-term funding, supportive policy environment, maintaining the reputation of UK science and research, sharing research outputs with industry and society, as well as producing research that is relevant to people's lives[9].

This translates to specific UK Government and Universities UK objectives related to research culture:

- Securing diverse and sustainable income and funding; with the government "committed to the Haldane Principle, i.e. decisions on individual research proposals are best taken by researchers themselves through peer review"[4,8].
- Devolving decisions and responsibility to research leaders[4,8].
- Reducing bureaucracy "freeing up research and innovation leaders to focus on strategic decision-making."[4].
- Facilitating global co-operation and international partnerships[5].
- Facilitating commercialisation of scientific outputs[4,5].
- Supporting collaborative and interdisciplinary research models[8].
- Strengthening research governance and ethics[5].
- Supporting researchers' cooperation with industry and transfer of skills and ideas[4,5].
- Facilitating knowledge sharing and exchange[5,9].
- Recruiting and retaining talent[8].
- Developing researchers' careers and providing support for early career researchers[8,9].
- Improving research integrity, minimising misconduct[9].
- Setting the environment to support world-class research (through funding, infrastructure and assessment)[8,9].
- Building public's trust in research and science[5].

DISCIPLINE-SPECIFIC

UKRI's Biotechnology and Biological Sciences Research Council echoes the European and national policy rhetoric by proclaiming "commitment to excellence" and setting the following objectives:

- Setting the environment to support world-class research, which focuses on people, infrastructure and collaborations.
- Supporting interdisciplinary teams, leadership, teamwork and management skills, especially through developing researchers' careers and support.
- Understanding and increasing diversity.
- Facilitating knowledge sharing and exchange.
- Contributing to the economy and wider society[1].

"Creating economic value" is also a main goal of UKRI's Arts and Humanities Research Council. Aside from this focus on the importance of economic impact, it also identifies the following objectives related to research culture:

- Transparency of funding and review processes.
- Measuring research success and impact.
- Launching interdisciplinary research initiatives.
- Global engagement with researchers in the Global South.
- Embedding equality, diversity and inclusion in their processes.
- Increasing impact on public policy and deepening public engagement[2].

Meanwhile, UKRI's Economic and Social Research Council focuses on the following objectives related to research culture:

- Increasing research's impact on policy and policy makers.
- Improving training of researchers, especially addressing shortages of quantitative skills among graduates.
- Supporting interdisciplinary collaborations.
- Supporting international collaboration.
- Deepening public understanding and engagement.
- Collecting and curating world-class data[3].

TERMINOLOGY AND METRICS

What language and measures are used to describe and define "good" research and research culture?

EUROPEAN POLICIES

The term 'excellence' reigns as a key descriptor of what is good in research. On the one hand, excellence is linked to researchers' qualities (mostly referred to as skills), while on the other hand it is the quality and economic value of research outputs:

> *"As shown by the interim evaluation of Horizon 2020, the ERC has become a global beacon of scientific excellence and provides those that do the science of the future with the skills and competences that Europe needs to stay at the forefront of development. The ERC's synergy grant scheme has great potential to stimulate multidisciplinarity, while the ERC proof of concept scheme holds great promise to help bridge the valley of death between fundamental research and commercialising a new product or service."*[11]

NATIONAL POLICIES

National-level policies tend to describe good research and good research culture as**: impactful, world-leading, high performing and excellent.** Below are examples of how these qualities are defined and contextualised:

- **Excellent means internationally competitive**: "76% of REF 2014 submissions were rated either world-leading (4*) or internationally excellent (3*) in quality"[8].
- **Impactful means benefiting humanity**: "We are committed to playing a strong role in the global research architecture, and ensuring that the research carried out within global organisations has the greatest possible impact for the benefit of humanity"[5].
- **Impactful means increasing prosperity**: "For every £1 invested by the Government in research, private sector productivity rises by 20p annually, in perpetuity"[4].
- **Impactful means driving innovation**: leading to creation of new companies and start-ups and in turn increasing the economic contribution of those companies[5].
- **Impactful means highly cited:** "at the moment the UK is second only to the US, and the UK has overtaken the US to rank first by field-weighted citation impact"[4].
- **World-leading means highly cited**: "15% of the world's most highly cited articles come from the UK"[5].
- **World-leading means performed by top researchers:** "since 2001 there have been 20 British Nobel Laureates"[5].
- **World-leading means conducted to the highest quality**: where the current REF framework rates "the research activity out of four stars. Research rated 4* is world-leading in terms of originality, significance and rigour"[8]. However, this focus on scientific value is not a sufficient determinant for being world-leading quality, as: "the overall quality profile awarded to each submission is based on the quality of research outputs, the impact of research beyond academia, and the research environment"[8].

Under the current centralised assessment framework, research units that produce research assessed as excellent, world-leading and impactful are described as **high-performing**. REF correlates this high-performance of research units with two key dimensions:

- **People**, which includes staff who have PhDs, are senior, have international experience and whose salaries are funded by external sources.
- **Research culture**, which includes accountable autonomy of research units and strong leadership[6].

DISCIPLINE-SPECIFIC POLICIES

Research councils focus on **measuring inputs, impact and outputs**. This echoes the language used in European and national-level policies, again defining good research in terms of delivering impact, driving innovation, but also being relevant to society.

UKRI's Biotechnology and Biological Sciences Research Council provides a granular indication of the range of processes and outputs that get measured to assess the quality of research and research culture:

- In the short term: funding inputs, progress against actions, monitoring and reviews of major investments.
- In the medium term: tracking progress against relevant outcomes (e.g. publications), measures of research quality, assessing training, tracking patents, new business spin-outs and start-ups, and the development of new tools and technologies.
- In the long term: developing more and better ways of measuring outcomes and impact[1].

"We will work with partners to develop benefits realisation plans that help drive and capture the intended outcomes and impacts of specific investments, and will conduct and commission evaluation to understand the relevance, performance, efficiency and impact of investments in bioscience. In addition we will draw on a range of internal and external data to understand and demonstrate the longer-term impacts of our activities and investments on knowledge, the economy and society."[1]

UKRI's Arts and humanities Research Council identifies the following "key measures of success":

- Case studies mapping advances in human knowledge and understanding.
- Case studies mapping economic, social and cultural impacts of research, including policy impacts.
- Economic measures such as jobs and placements created, spin-outs, start-ups and new intellectual property created.
- Leveraging of additional investment from other sources, and return on investment.
- Data on new research collaborations, networks and international and interdisciplinary partnerships created.
- Data on number and type of outputs and evidence of esteem, such as prizes and awards.
- Public engagement reach, such as reader and visitor numbers and media uptake.
- Application rates to each funding scheme and success rates, including the ratio of funded to fundable but unfunded applications.
- Applicant, grant holder and peer reviewer diversity[2].

UKRI's Economic and Social Research Council is less specific and granular about their measures, but they highlight their commitment to making sure evidence is gathered to support progress in two key areas:

Efficient and effective operations:

- Seek a more effective and efficient business model.
- Use business improvement tools and techniques to positively challenge delivery processes.
- Increase efficiency of funding to deliver more effective social science outcomes.
- Review decision-making structures to ensure they deliver value for money.
- Manage investments to maximise their impact.
- Have an active programme of work on public affairs to ensure users are informed about social science research.
- Be more strategic in the way resources are deployed to ensure they deliver improved outcomes.

Progress against the UKRI success framework and council's plan:

- To use the highest standards of evidence to inform investment in research and innovation and monitor how the UK research and innovation system performs.
- To contribute to UKRI's approach to using evidence to inform research and innovation investment and policy.
- To identify barriers to and challenges for Equality, Diversity and Inclusion, build knowledge of what works to improve outcomes in this area and support development and implementation of effective practices.
- To better capture and understand the diversity data held on the grant holders.
- To undertake detailed analysis to uncover and address EDI challenges.
- To continue to review delivery of objectives at individual and project level[3].

VALUES, PRINCIPLES

What values and principles underpin the policy discourse on research culture?

The agendas, challenges, terminology and measures present in the top-down policy literature are underpinned by discourse centred on **support, contribution and partnerships.** The following sentence illustrates this narrative well:

> *"We aim to provide leadership, advice and support to the academic community and build a culture of dialogue, trust, collaborative working and advocacy, to help social scientists respond to the new opportunities presented by UKRI initiatives."*[3]

These are the values and principles most frequently mentioned in policy discourses:

- **Contribution**: the importance of real-life impact and economic value of research[1,2,3,10]:

> *"[Research should] contribute to a more prosperous economy, more effective public services and a more sustainable, healthy, secure society."*[3]

- **Accountability**: commitment to assessment, evaluation and reporting evidence around processes, practices and outcomes[1,6,7]:

> *"We have adopted a culture of continuous improvement and regularly seek opportunities to improve the efficiency and effectiveness of our key business processes."*[1]

- **Diversity and inclusion**: attracting and retaining more diverse research staff[1,3,7,9,10].
- **Transparency**: commitment to greater transparency in how research is evaluated and researchers treated[10,1,2,7].
- **Integrity**: attention to research being conducted with scientific rigour[8,9].
- **Openness and accessibility:** commitment to open science[1,5,8,10,9,11]:

> *"We support the ambition of the Open Science movement to make research transparent and ensure research methods, findings and data are accessible to all."*[5]

- **Collaboration**: especially on an international level, but also with industry[11,5,1,2,3,4,5,8].

> *"We show how we will open all parts of our research and innovation system to international partnership with the best in the world in order to tackle global challenges and create growth. We are looking for impact in all areas of research and innovation."*[5]

- **Interdisciplinarity**: supporting interdisciplinary research models and projects[1,2,3,4,10].
- **Support**: providing a supportive environment for researchers' careers and leadership development[1,3,4,8,9].
- **Trust**: sharing knowledge in a way that builds public trust in science and research[1,3,5,11].

> *"We will reach out to other nations to help build international consensus on research ethics, standards and integrity, for equitable research partnerships and to build public trust in science and technology".*[5]

- **Engagement**: involving communities and the public in the research process from agenda setting to communication of results[2,3,8,11].

CHALLENGES AND ISSUES

The most frequently mentioned challenges concern research staff, in terms of diversity and skills:

- Diversity in the HE system and among research staff [2,3,4,7,9], which tends to be seen as part of a wider challenge in relation to attracting people[3] (e.g. EU staff in relation to Brexit[8]).

> *"Statistical evidence from the Equality Challenge Unit suggests that there is still scope for improvement in terms of equality of opportunity in research careers. Women are under-represented in more senior research positions and minority ethnic groups are generally under-represented amongst researchers ….[9]"*

- The skills and training of researchers [1,2,3,8,11]:

> *"We will … invest in building research talent and plan to extend provision across researchers' entire careers to build the skills needed to lead large inter-disciplinary and international projects and exploit our data resources. Investment to generate major improvement in research talent, methods and leadership is a core aspect of our strategic vision and of this delivery plan[3]."*

There are also less frequently mentioned **challenges that tend to be phrased as objectives or opportunities rather than problems**. However, the context suggests policy makers think there is more to be done in the following areas:

- Increasing career mobility between sectors[2].
- Reducing bureaucracy in research[4].
- Raising research ethics and regulatory procedures[5].
- Changing models of research: collaborative, interdisciplinary, international partnerships[1,3,5].
- Committing to open science[5].
- Benefitting communities[1].
- Supporting positive teamwork and leadership[3,6].
- Treating researchers fairly[7].

SECTOR NARRATIVES

How these measures and approaches are talked about, evaluated, criticised (based on academic and thought leadership sources) by sector authorities, industry bodies and commentators.

Key takeaway: An environmental view of culture shapes the narratives about problems and challenges. An organisational view and quality-oriented approach dominate the sections focused on addressing the problems. Focus on workplaces and people working in research. The narrative of pressure associated with a performance-oriented approach to research permeates these sources.

It is difficult to pin down what elements exactly constitute research culture and how they relate to the wider environment of research strategy, environment and infrastructure. Research organisations and industry authorities have approached the issue from different angles – below we present a selection that highlights some similarities and differences in the narratives across this type of sources.

THE ROYAL SOCIETY

In its work aiming to assess research culture, the Royal Society conceptualised it in four parts:

- Research.
- Researchers.
- Researcher career development.
- Research outputs/results.

And proposed to explore these elements of research culture, and surrounding themes, through two lenses:

- **'Top-down'** – the role that public policy, funding and research assessment frameworks play in setting the incentives that shape research culture.
- **'Bottom-up'** – the potential for researchers to catalyse behavioural and attitudinal change at the level of research groups and institutions, and how this might bubble up to form new social norms[14].

NUFFIELD COUNCIL ON BIOETHICS

In a series of engagement activities exploring the culture of scientific research in the UK, they explored the characteristics of high quality science and concerns about the culture of scientific research, including:

- Competition
- Funding of research
- Assessment of research
- Research Integrity
- Career progression and workload

NESTA

In their report on biomedical research, Nesta focused on the link between research quality and **plurality of perspective**, where the thriving research culture is thought to be enabled by the four dimensions of diversity:

- Diversity of priorities.
- Diversity of politics.
- Diversity of people.
- Diversity of place[12].

WELLCOME

Wellcome's external and internal documents reflect its aspirations in relation to research culture. In its forward-looking investigation of research culture, Wellcome highlights the importance of paying attention to **valuing "what" and "how" equally** – defining good research not only by its outputs and performance, but also by the way in which it was conducted[17,19,20].

Wellcome aims to address this through the organisational approach to culture, focusing on such issues as:

- Building an optimal team.

- Developing management and leadership skills.

And commits to gathering the evidence of how research culture impacts on:

- Researchers.
- Research.
- Research enterprise.

THE 'METRIC TIDE'

This delivers **a critical perspective on current research culture,** especially on the drive to measure every aspect of research, the challenges associated with it and unintended consequences. The report traces how metrics are not only a result of performance-driven research culture but in turn reinforce the following trends:

- Growing pressures for audit and evaluation of public spending on higher education and research.
- Demands by policy makers for more strategic intelligence on research quality and impact.
- The need for institutions to manage and develop their strategies for research.
- Competition within and between institutions for prestige, students, staff and resources.
- Increases in the availability of real-time 'big data' on research uptake, and the capacity of tools for analysing them[18].

ELSEVIER

Their report presenting projections about how research will look in the future, highlights the following trends as **key drivers shaping research culture**:

- Open access, which changes not only the modes of sharing research, but also business models in scholarly publishing and incentive structures for scientists.
- Technological impacts, with large technology and data-analytics companies becoming the curators and distributors of knowledge, and technology impacting on how research is carried out and shared.
- Changes to the model of funding, which will raise questions about ethics and models of international collaboration[16].

While this collection of research sector sources is by no means exhaustive, for comparative purposes we have included a specific example from outside the sciences to provide an alternative view on how to define and assess work culture and work outcomes. Coming from the tech sector, **Google**'s Project Aristotle offers the following insights into how to build optimal teams and work culture:

- There are differences of perspective on quality of work, teams and results between leaders and team members.
- Team culture can be seen as a key dimension of performance.
- Effectiveness rather than excellence might be a more meaningful measure[13].

AGENDAS, GOALS, OBJECTIVES

While agendas in policy sources focused on enhancing performance and the excellence of research outputs, research organisations and industry leaders shift the focus toward interests of the research community.

NESTA – ACKNOWLEDGING THE DIVERSITY OF STAKEHOLDERS AND PRIORITIES

Nesta sets the main objective as a vision for research where performance is not only beneficial for the economy, country and the sector, but also the research community:

"We want to see a UK research and innovation system which is not only more productive and dynamic, securing long-term economic growth and competitiveness, but also fairly geared towards addressing the priorities of the people within it."[12]

They prioritise the following issues:

- Challenges that impact the quality of research: flawed metrics around research and problems with reproducibility of results.
- Insufficient diversity: not only in terms of research staff but also geographic location.
- Accountability of researchers to their local communities and making sure the research is responsive to their problems[12].

THE ROYAL SOCIETY – UNDERSTANDING THE RESEARCH COMMUNITY

The Royal Society sets a similar goal – making sure research culture enables not only "excellent" research, but also supports the research community:

"The Society has started a programme of work to explore how the UK can promote the cultural conditions that will best enable excellent research and researchers here and elsewhere to flourish in the future. The focus of this programme is on the assessment of research and researchers, researcher career development, and open science."[14]

They focus on the following five themes in relation to the elements quoted above:

- **Recognition and esteem:** valuing research activities that don't directly translate into measurable outputs and changing the relationship between esteem and quantitative metrics.
- **Setting culture:** acknowledging the role and influence of leaders on setting positive values and behaviours.
- **A culture of mobility:** where researchers can transfer between disciplines and sectors.
- **Open science:** increasing availability and accessibility of research outputs.
- **Fostering scientific leadership:** recognising the difference between leading scientists (advancing their field of research) and scientific leaders (supporting and developing researchers in their field)[14].

NUFFIELD COUNCIL ON BIOETHICS- SUPPORTING GOOD RESEARCH PRACTICE

Their objectives focus on the quality of research processes and on how efforts from the wider research community can build a more positive research culture to enhance the production of science:

"We believe there is a collective obligation for the actors in the system to do everything they can to ensure the culture of research supports good research practice and the production of high quality science."[22]

They highlight the following objectives targeted at different stakeholders from the research environment:

- **Funders**: ensure funding strategies, policies and opportunities are communicated clearly to institutions, researchers and peer reviewers
- **Research institutions**: cultivate an environment in which ethics is seen as a positive and integral part of research; ensure that the track record of researchers is assessed broadly; and provide mentoring and career advice to researchers throughout their careers.
- **Publishers and editors**: consider ways of ensuring that the findings of a wider range of research meeting standards of rigour can be published; consider ways of improving the peer review system; and consider further the role of publishers in tackling ethical issues in publishing and in promoting openness among scientists.

- **Researchers:** actively contribute to the adoption of relevant codes of ethical conduct and standards for high quality research.
- **Learned societies and professional bodies**: promote widely the importance of ensuring the culture of research supports good research practice and the production of high quality science.[22]

THE WORLD ECONOMIC FORUM – HIGHLIGHTING THE ROLE OF THE ORGANISATION

The World Economic Forum emphasises the role of the organisation (and not only policies, funding, strategies) in creating a positive research culture. They focus on the following objectives:

- **Research integrity**: the role of rules and guidelines researchers follow in their work environment.
- **Communication**: the role of informal communication channels in creating a supportive environment.
- **Leadership**: the role of leaders and senior administrators in setting positive examples[15].

GOOGLE'S ARISTOTLE PROJECT – UNDERSTANDING TEAMS

This comparative source from the tech industry further highlights the shift in focus from performance in policy sources to organisational dynamics in reports from industry leaders. Project Aristotle proposes to focus on **effectiveness** when the world of research tends to talk about excellence. It presents effectiveness drivers and ways to measure them. It also highlights the **diversity of perspectives** within an organisation – something that strategic policy documents setting out their vision were unlikely to acknowledge:

> *"Executives were most concerned with results (e.g., sales numbers or product launches), but team members said that team culture was the most important measure of team effectiveness. Fittingly, the team lead's concept of effectiveness spanned both the big picture and the individuals' concerns saying that ownership, vision, and goals were the most important measures."*[13]

ELSEVIER – ANTICIPATING CHANGE AND DISRUPTION

Elsevier's report outlined the dynamic nature of research and the fact that the drivers and conditions that shape current research culture operate in a **fast-changing environment**. The most relevant message is that many expectations around how research is conducted and shared will need to be reimagined:

> *"As this study has made clear, we have reached a tipping point. How research is conceived, completed and communicated will change dramatically over the next 10 years. New funding models will emerge, new methods of collaboration will develop, and new ways of conceptualising research and measuring its impact will arise, driven by advances in technology and the ideas of a new generation."*[16]

TERMINOLOGY AND METRICS

What language and measures are used to describe and define "good" research and research culture?

In policy sources, there is a focus on terminology and measures that aim to capture research performance and productivity. But sources from industry authorities question **what gets defined and measured – and how**.

This begins with the very definition of research culture, which is not that easy to find across sources. **The Royal Society** defines it by focusing on its manifestations: values, expectations, attitudes and norms, and its impact on research processes and careers.

"Research culture encompasses the behaviours, values, expectations, attitudes and norms of our research communities. It influences researchers' career paths and determines the way that research is conducted and communicated."[14]

Wellcome expands that definition to cover drivers, manifestations and impact – complementing the cognitive and behavioural elements of research culture with more structural elements of the research system that shapes it.

"Research culture results from the combination of the attitudes, values and beliefs of research communities; the structure of the research system and its incentives; and the behaviours and practices of individuals and institutions that are involved in shaping it. Our exploration of research culture in the UK revealed three main categories of existing and potential impact: impact on researchers, impact on research, impact on the research enterprise." [19]

These are general definitions of research culture. But how do research organisations and industry authorities identify, define and measure "good" research culture specifically?

ROYAL SOCIETY – MINIMISING PRESSURE

Positive research culture is associated with minimising the pressures on researchers (funding, deadlines, quantity of outputs) and creating **nurturing environments** in which researchers can thrive (collaborative space, more generous timelines, career growth opportunities). Such culture is thought to be enabled by the following conditions:

- **Exploration**: researchers should be given time to do blue-sky thinking, risky research, synthesis and replicability studies.
- **Funding people not projects**: associating funding with fellowships and programmes and moving away from project grants.
- **Mobility**: allowing researchers to pursue different careers in teaching, charities, public sector and industry.
- **Collaboration**: providing shared places for co-working and interaction.
- **Leadership**: research leaders should communicate well and know how to develop the talents and skills of their research teams[14].

NUFFIELD COUNCIL ON BIOETHICS

They highlight the fact that the best indicators of good quality research are often qualitative, which makes defining and measuring quality challenging.

They demonstrate that by referring to SMART objectives and showing why they are not a good fit for research:

- Specific – research often has broad, rather than specific, criteria or aims
- Measurable – qualitative measures are often the best indicators but more difficult to compare
- Assignable – it is not always known who will do different tasks in the research project and process
- Realistic – they hope that research should at least be realistic
- Time limited – the benefits of research can take a long time to be realised and evaluated

And suggest replacing them with more qualitative 'NICE' criteria:

- Nuanced
- Inclusive

- Courageous
- Ethos-oriented

WORLD ECONOMIC FORUM – SETTING AN EXAMPLE

They argue positive culture should be embedded at an institutional level and associate it with supportive work spaces, which meet the following conditions:

- **Leadership**: organisation, department and team leaders promoting positive behaviour by setting a good example and discussing the training needs of all team members.
- **Communication**: making sure everyone is on the same page.
- **Sharing**: facilitating open discussions, giving researchers the chance to share their experiences and not only their successes.
- **Support**: establishing support systems that boost morale[15].

NESTA – BALANCE

The language focuses on commitment to balance as a **driver of innovative research**. Balance is defined in relation to funding, strategy and metrics, and it's seen as a way to create a more collective, distributed, accountable research environment that values plural views.

> [Reviewing the balance of funding across the UK biomedical research] *"Addressing multiple dimensions of balance: between individual disciplines and councils, and new cross-disciplinary schemes; between quality-related (QR), responsive mode and directed funding for industrial strategy, global challenges and other strategic priorities; between the south-east of England and the rest of the UK"*[12]

The report considers the measures implemented by the performance-driven approach to research as risky, especially in relation to what is measured and in what time-frames:

- **Short-term measures:** metrics are often available but they are not necessarily adequate, e.g. it can take years for research to really show impact.
- **Proxy measures:** in the meantime, proxy measures are used to evaluate research quality, such as a researcher's track record or journal's impact factor.

> *"There is concern that this encourages scientists to aim for 'short-term success instead of cautious, deliberative, robust research that will take substantially longer to produce less exciting (but more valid) findings'."*[12]

THE METRIC TIDE – RESPONSIBILITY

This source problematises the role of metrics in driving research culture, which is described as audit-based, evaluation-driven and characterised by the demand for more data and measures around research quality and impact.

It proposes a set of responsible metrics[18] as part of a 'responsible research and innovation' (RRI) framework for research governance:

- **Robustness**: basing metrics on the best possible data in terms of accuracy and scope.
- **Humility**: recognising that quantitative evaluation should support – but not supplant – qualitative, expert assessment.
- **Transparency**: keeping data collection and analytical processes open and transparent, so that those being evaluated can test and verify the results.

- **Diversity**: accounting for variation by field, and using a range of indicators to reflect and support a plurality of research and researcher career paths across the system.
- **Reflexivity**: recognising and anticipating the systemic and potential effects of indicators, and updating them in response[21].

WELLCOME – EXCELLENCE OF MEANS NOT ENDS

In their scoping documents, they aim to define how the idea of "excellence" translates into **how research is done**, with such excellence manifesting in:

- Stronger leadership, management and training.
- Supportive workplaces:
    - Inclusive – able to attract and retain a more diverse and inclusive research workforce.
    - Nurturing – allowing researchers to thrive in a system that sees their well-being and mental health as an asset.
- Incentives encouraging the production of consistently high-quality and reproducible research.
- Recognition of a wider range of contributions: valuing findable, accessible, interoperable and reusable publications as only one outcome of research – recognising the variety of contributions that transform research into impact on practice and policy.
- Long-term and sustainable practices that engender public trust and produce meaningful outcomes[19].

GOOGLE – EFFECTIVENESS

Project Aritstotle focuses on a set of indicators very different to those associated with research performance culture. First of all, the drive to measure as much as possible is replaced with **finding out what really matters**. They found that optimal teams were less about individual team members, which the world of research tends to talk about in terms of skills, and more about team work and team dynamics. The following traits were found meaningful, in order of importance, with the ever-present impact coming fifth:

- **Psychological safety**: In a team with high psychological safety, teammates feel safe to take risks around their team members. They feel confident that no one on the team will embarrass or punish anyone else for admitting a mistake, asking a question, or offering a new idea.
- **Dependability**: On dependable teams, members reliably complete quality work on time (versus the opposite: shirking responsibilities).
- **Structure and clarity**: An individual's understanding of job expectations, the process for fulfilling these expectations, and the consequences of one's performance are important for team effectiveness. Goals can be set at the individual or group level, and must be specific, challenging, and attainable.
- **Meaning**: Finding a sense of purpose in either the work itself or the output is important for team effectiveness. The meaning of work is personal and can vary, e.g. financial security, supporting family, helping the team succeed, or self-expression for each individual.
- **Impact**: The results of one's work, the subjective judgement that your work is making a difference, is important for teams. Seeing that one's work is contributing to the organisation's goals can help reveal impact[13].

ELSEVIER – THE DRIVERS OF CULTURE CHANGE

While the Elsevier report doesn't focus on conditions facilitating positive research culture, it identifies broader **factors and drivers that are likely to shape how research is done**. Many of these changes relate to the structure of funding, scholarly publishing models, technology and use of data and metrics, and thus can be expected to create both opportunities and challenges for the ever-changing research culture:

Funding the future:

- The funding mix is changing; public funders will have less influence over research priorities.
- China is stepping up the funding and production of research.
- The research agenda is changing; there is an increased focus on making research accessible.

Pathways to open science

- Research grants will increasingly have open science conditions attached.
- Researchers are expected to spearhead adoption of open science, but not without experiencing conflicts of interests.
- Metrics will continue to expand, enabled by new technology.

How researchers work:

- New technologies are expected to transform the researcher workflow over the coming 10 years.
- Behaviours and skillsets will change as a new generation of researchers arrives on the scene.
- Collaboration will drive research forward.

Technology: revolution or evolution?

- Big data is fast becoming the lifeblood of nearly all research.
- Artificial intelligence (AI) and machine learning tools are changing the shape of science.
- Blockchain has the potential to facilitate open science, but the technology is still in its infancy and may not fulfil its promise.
- Augmented reality (AR) and virtual reality (VR) will become key learning tools for a number of institutes.

Building the future

- The role of the journal is transforming to meet modern needs.
- The article structure is evolving and new forms will become the norm.
- The measurement system will become even more critical.

The academy and beyond

- Courses will diversify from a lecture-focused model.
- Higher education institutions are changing structure.
- EdTech will become a serious higher education contender[16].*

VALUES AND PRINCIPLES

The values underpinning industry leaders' narratives around research culture tend to focus on work environments and interpersonal relationships in research teams:

- Effectiveness[13].
- Communication; information and sharing[14,15,22].
- Support; for career development and training[15,19].
- Strong leadership[14,15,19,22].
- Collaboration and collective research[14,22].
- Safety and stability; to share failures, to explore research ideas freely, to feel safe in the work environment, to feel financial security[13,14].
- Inclusivity[19-22].

* Language describing the themes and drivers has not been changed; direct quote from the source.

- Diversity of research staff and career pathways[12,14,18].

And to a lesser extent on research quality and enterprise:

- Integrity[16,18,19,22].
- Responsibility for research conduct and quality[18,22].
- Academic freedom; unhurried, thorough, explorative research[14].
- Meaningful contributions[12,13,19].
- Balanced priorities, funding and perspectives[12].
- Sustainability; long-term focus[12,14,19].

CHALLENGES AND ISSUES

Compared to policy documents, this type of source presents a more open and honest overview of challenges and problems. Most of them focused on the negative effects of current research culture on researchers, but there were also some around research integrity – where researchers' behaviour was seen as both a result and a driver of poor research culture.

RESEARCHERS

- **Researchers' diversity**: not enough is known about the current make-up of the research workforce – not only on an individual level, but also the dynamics of exclusion at an institutional or systemic level. This is also about intersectionality and how different dimensions of disadvantage can reinforce one another[12].
- **Team dynamics**: Not enough is understood about interpersonal dynamics in the workplace and the benefits and challenges of collaborative working[13].
- **Workload**: expectations to 'publish early and often' and work long hours[14,15,22].
- **Insufficient leadership:** management and leadership skills not being developed ad valued enough[14,15,17].
- **Career progression**: difficult for early-career researchers to get permanent positions and stable careers, plus the gulf between aspirations and opportunities[12,22].
- **Career mobility**: perceptions that moving away from academia is stigmatising and difficult[14].

RESEARCH

- **Reproducibility**: addressing not only the questionable research practices, but also the reward structures that are a root cause[12,17,18,22].
- **Research outputs**: publications are over-prioritised at the expense of a wider range of meaningful contributions[12,22].

RESEARCH ENTERPRISE

- **Regional imbalance**: concentration of research industry in London and in the south-east, which perpetuates social and economic inequality[12].
- **Proliferation of poor metrics**: their damaging impact on research culture – identifying and replacing these poor metrics with meaningful measures[14,16,18,22].
- **Too much competition**: the fight for resources in a project-grant-based research environment[18,22].

ACADEMIC NARRATIVES

Key takeaway: Academic sources encompass diverse perspectives on research culture; some reinforce the performance-oriented approach, but a critical view seems to dominate. There are many conversations about the impact of the current research culture on scholarly integrity and professional identity and on how it negatively affects researchers' relationship with their work. Problems with research quality, such as plagiarism or reproducibility crisis, are sometimes presented as structural issues linked to the 'publish or perish' principle.

The structure for evaluating academic narratives will be slightly different. While the top-down discourses were compared in terms of their focus, agendas, terminology and metrics, values and principles, and challenges and issues, the bottom-up academic discourses will be analysed in terms of how they discuss:

- *Research culture drivers.*
- *Characteristics of the current research culture.*
- *The impact and unintended consequences of these characteristics.*
- *Ambitions and principles of a positive research culture.*
- *Ambivalence around terminology, measures and values underpinning current approaches to research.*

Before seeing what comes up in recent academic articles about research culture, it's worth highlighting that they **don't present a uniform narrative**. Sources included here vary in terms of their aims and the disciplines and geographic locations of their authors. While some aimed to outline the broader characteristics of the current research culture, others were focusing on how it manifested in specific areas of the research environment, without analysing the cultural drivers and mechanics responsible.

Despite the plurality of points of views and coverage, by taking a liberal approach to piecing together these voices into a coherent narrative, we can see some interesting **trends that offset top-down discourses**.

However, some academic sources embrace and contribute to the performance-oriented approach to research and research culture set out in policy visions. And **geopolitics** seem to matter here. The performance-oriented perspective seems to be adopted less critically by developing research regions, which perhaps aim to match the performance of research-intensive leaders, as in this example:

> *"If India aspires to be a world power in the 21st century, it will have to become a knowledge society by promoting research not only by guaranteeing substantial financial support, but also by regenerating a research culture and ceaselessly transmitting it among the coming generations of students."*[65]

However, many academic sources adopt a more **ambivalent view of performance focus**. While they tend to acknowledge it as a reality in which academic and scientific work is done, and to which researchers conform and adapt, some sources focus on the unintended consequences of a performance-oriented approach on research culture, especially on researchers and the quality of their work.

DRIVERS

The ultimate drivers explicitly or implicitly mentioned as responsible for the current research culture tended to be portrayed in academic sources as **elusive dark forces**, such as the neoliberal agenda or the discourse of knowledge economy[99,100]. These forces then translate into more tangible macro drivers, such as the publishing business model[75], the expansion of the HE system[48,100], and the research and innovation funding structure[48].

Another macro factor discussed in some academic sources, and largely absent in top-down discourses, is the role of **societal culture** in shaping research culture. This becomes evident in academic papers coming from non-Western countries or those that bring up such issues as:

- How socio-political and economic dynamics in Africa shape production of quantitative health data:

> *"While research practices are often understood within a clean/dirty binary, Biruk shows that data are never clean; rather, they are always 'cooked' during their production and inevitably entangled with the lives of those who produce them."*[74]

- Or how the nationality and cultural background of foreign staff working in the Anglosphere shape their approach to research practices, which might differ from those of 'native' researchers'[90]:

> *"Most of the researchers interviewed agreed that cultures do shape individual character, which influences the way that such individuals conduct research, their decision-making, and their style of academic writing. Our findings also showed that working culture within the institution also influences research practices, as well as faculty mentorship of the younger generation of researchers."*[90]

This quote also shows that some academic sources focus on organisational culture as a driver of research culture and assume that positive culture change can be implemented at the level of the institution[57,58,90].

Even though perspectives vary, academic narratives tend to convey the idea of the individual researcher being just a **cog caught in the system**; this view seems to be stronger than in top-down discourses, which focus on opportunities for researchers (policy sources) or advocacy on behalf of researchers (industry reports).

CHARACTERISTICS

The academic sources included in this literature review tend to associate the current research culture with the following characteristics:

- Commercialisation
- Assessment
- Accountability
- Productivity
- Competition
- Scarcity

COMMERCIALISATION

All types of source included in this literature review highlight that research is an enterprise and research culture **cannot be decoupled from commercial interests**[48]. These interests relate to changes in the education and research sectors, most notably the growing scale of the research enterprise, and the expansion of the research community, the changes in the policies affecting the management of HE and transformations within scholarly publishing[100].

ASSESSMENT, ACCOUNTABILITY AND PRODUCTIVITY

While the six macro factors can be thought of as drivers behind a variety of norms, values, behaviours, attitudes and practices within the research environment, two seem to stand out as top-level characteristics.

The push for more evidence describes a condition where more data around everything – from funding to research practices to outcomes – seems to be the expectation, the norm and the goal[51]. This is manifested in, and perpetuated by, funders focusing on impact-driven research and the implementation of centralised assessment systems (e.g. REF)[83,91]. This focus on evidence is associated with higher expectations around accountability:

> *"Since the 1980s, increasing demands for accountability by government of universities, and in turn by universities of their staff, have significantly increased the perceived role of research and research outputs in demonstrating institutional and individual excellence."*[7]

The push for more productivity in turn describes a condition where producing more publications is incentivised and rewarded. It's seen as the most valued research outcome and a proxy for quality of researchers and research units. Productivity is linked to the trend around evidence gathering and assessment, as citations and publications provide convenient units of measure. It is also strictly associated with the publishing industry, the dynamics of which, although important for research culture, will not be explored at length. Instead, this review situates the push for more publications in a time "of growing divergence between the different roles of academic publishing: as a means of disseminating validated knowledge, as a form of symbolic capital for academic career progression, and as a profitable business enterprise"[75].

In fact, the terms "audit culture"[85] and "publication culture"[66] – sometimes critically described as the "publish or perish"[56] culture – are sometimes used to symbolise the whole academic or research culture.

COMPETITION AND SCARCITY

From such a perspective, the performance-focused quality of excellence is used as a measure for distributing scarce resources in the world of research[76]. This focus on performance and the condition of scarcity was associated with behavioural values of efficiency and competitiveness:

> *"The manifestations of the new research culture is characterised by the quest for efficiency and competitiveness at all levels and bodies."* [54]

However, some see the notion of competition not only as an effect of performance-driven culture, but as one of its key drivers[55].

IMPACT AND UNINTENDED CONSEQUENCES

The academic discourse paints a vision of research culture favouring more evidence, more accountability, productivity and competition. None of these are necessarily problematic. The problem lies in how these characteristics and dynamics reinforce each other and in their unintended consequences, including:

Warped incentive structures: rewarding a focus on the quantity and impact of research outputs rather than the quality of research processes[87,89].

Workload: academic and researcher careers mostly depend on the performance of their research outputs[75]. However, producing measurable research outputs is only part of their work. This is especially true for academics, many of whom also teach or serve as peer reviewers[60]. This is thought by some to lead to unrealistic expectations around workload.

Low morale: where pressure to produce and perform "causes dissatisfaction of the researchers that in this context have to deal with the increasing pressure to publish and obtain external funding to assure 'survival'"[54]. As reported by one study from the biomedical field in the Netherlands:

> *"Senior scientists tended to display a more cynical perception of the publication culture than their junior colleagues. However, even among the PhD students and the postdoctoral fellows, the sentiment was quite negative. Positive perceptions of specific features of contemporary scientific and publication culture were rare."*[66]

Insufficient support: for practices and areas of research work, such as training or supervision, that don't immediately translate into measurable outputs[54].

Erosion of scientific standards: where "the hyper-competitiveness of the HE market is resulting in impact sensationalism and the corruption of academics as custodians of truth."[55] Some sources also see questionable research practices as a result of pressure to publish[66,82].

Replicability problems: connected to questionable research practices (such as cherry picking statistically significant findings, HARKing, and p-Hacking[67,69,71,76]), as well as other types of research misconduct and unethical research practices (such as plagiarism[77,89,90]), reproducibility problems seem to be common problems facing academics and researchers. However, while some directly saw them as side effects of the current research culture, this was not true across the board. Some narratives presented them as problems and challenges to the current research culture, which is after all geared toward excellence.

Commodification of academic work: where assessments focusing on performance and impact can curtail academic freedom[83,100].

Threat to identity: where evaluating academics and researchers by their measurable research outputs can endanger their professional identity. Some felt pressured into becoming more entrepreneurial rather than exemplifying and developing scientific traits. For example, they might sacrifice scholarly integrity to make their research more appealing to funders by focusing on proving its socio-economic, rather than scientific, benefits[55]:

> *"Within the rigours and disciplines of performativity we are required to spend increasing amounts of our time in making ourselves accountable, reporting on what we do rather than doing it. There are new sets of skills to be acquired here – skills of presentation and of inflation, making the most of ourselves, making a spectacle of ourselves. As a consequence we become transparent but empty, unrecognisable to ourselves."*[100]

Deprioritising other areas of work: such as teaching, training, supervising, or developing leadership and management skills. There were also suggestions for more research around how focus on research productivity impacts on institutions that serve other functions, such as universities[60,80,99].

Reproducing global divisions and power differences: there are views that current research and HE culture, aligned with the neoliberal vision of globalisation, contributes to unethical trends in knowledge production, such as "knowledge monopoly" and divisions between the Global North and South[86].

AMBITIONS AND PRINCIPLES

Academic sources also suggested a range of ambitions, suggestions and principles that were thought to contribute to a more positive research culture. The following themes stood out:

Relationship between research and society

- Balancing between academic values and the social usefulness of research[79].
- Finding good models for social involvement in research (participatory, collaborative)[52,53,72,79,92].
- Making research useful and meaningful for the community it's supposed to benefit[52].
- Making research more trustworthy and reliable[67].

Knowledge production

- Increasing open practices (sharing data, assets, results, publications) within science[61,68,75,89].
- Instilling in research communities the idea of collaborative commons rather than competitive pressure[68].
- Enhancing knowledge democracy and epistemological diversity[86].

Belonging in academia

- Understanding belonging and inclusion in academia and research[72,90].
- Increasing support for research staff[84,90]:

> *"Systematic culture change requires interventions in terms of purpose, process and people; significant among these is training and support for people (researchers, support staff and non-academic stakeholders) at all stages in the research cycle, from conception to publication and beyond."*[84]

- Building a healthy and respectful working culture[94].

Research quality

- Reconnecting research culture with academic values: "grounded in the values of empiricism, transparency, and a commitment to an ongoing critical perspective"[63].
- Improving the integrity and quality of research practices: "our focus should be on thoroughness, completeness, and appropriate standards of description, evidence, and probity rather than flashy claims of superiority"[76].
- Training research staff about the importance of research ethics[90].

Research models

- Conducting research across contexts: transcending disciplines, sectors and academia; including such models as collaboration with diverse stakeholders, multi-centre projects, interdisciplinarity, cross-functional research[62; 68,72,79,92].
- Using methodologies as a way to counter 'hegemonic' research culture (e.g. practice-based research evidence, action research): "auto-, duo-, and collaborative-ethnographies as caring practices and research methodologies) that may in fact push back against such hegemonic neoliberal practices in the academy."[85]

AMBIVALENCE AROUND TERMINOLOGY, MEASURES AND VALUES

Even though ambitions and principles underpinning academic sources focus on the quality of research, its impact on society and models based on collaboration, this literature also brings a more critical perspective to the current approaches to defining quality, measuring impact and increasing collaboration.

MEASURES

Using metrics to determine the value and quality of research and researchers tends to be considered problematic. On the one hand, the idea of having an **objective and comparative framework** for assessment and standards of various elements and research is accepted by many academics and researchers. On the other, there seems to be a lot of **criticism around the metrics currently used**. While some object to the very idea of reducing merit and value to quantitative metrics[100], others point out the methodological limitations of current measures (such as journal impact factor and h-index) and their side effects[49].

However, it's not all criticism and opposition. Some academic sources also embrace the measures. There are papers that outline how to best measure research culture across different fields by using the metrics

associated with research performance, such as the h-index, reinforcing the idea that research culture can be quantified[5]. One paper from Asia Pacific covered the development of the Research Culture Index (RCI):

> *"An instrument that shows the sum of different dimensions [of research culture] namely research competency, research process and research productivity"*[93]

EXCELLENCE

The rhetoric of excellence is problematised in a similar way, with some voices pointing out it doesn't quite measure research quality, or even that it's possibly counterproductive:

> *"It has no intrinsic meaning in academia. Rather it functions as a linguistic interchange mechanism. To investigate whether this linguistic function is useful we examine how the rhetoric of excellence combines with narratives of scarcity and competition to show that the hyper-competition that arises from the performance of "excellence" is completely at odds with the qualities of good research. We trace the roots of issues in reproducibility, fraud, and homophily to this rhetoric."*[76]

There are some suggestions for using alternative approaches to defining research quality, such as "responsible metrics"[18] or a less structured set of values, such as soundness and capacity[76].

IMPACT AGENDA

Current policies incentivise researchers to **prove the social and economic impact** of their research work. Some see this as challenging to scientific integrity and especially problematic in research areas that, due to their nature, find it more difficult to demonstrate real-life impact.

> *"Even where academics are personally committed to impact, the weight of complying with assessment rhetoric can corrode even the most impassioned resolve. Impact offers challenges to academics and the institution alike."*[91]

Others are less critical, but highlight that the prominence of impact requires more training for early-career researchers to teach them how to adapt to the "impact agenda". As it's not a natural way of thinking, it needs consistent efforts and programmes to "embed in them the commitment to engagement with society and understanding impact and influence of their research on society".[84]

INTERDISCIPLINARY COLLABORATION

While some academics see doing research with various others as a value[72], others point to challenges associated with interdisciplinary collaboration, such as the differences between institutional and disciplinary cultures[75]. Research culture differs between disciplines and it can lead to frictions in interdisciplinary fields and projects. This includes negotiating different value systems, incentive structures, ways of working, and approaches to reward and recognition[78].

SOCIAL AND INSIDER NARRATIVES

Key takeaway: social sources and insider narratives present a bleak picture of research culture, focusing on how it negatively affects individuals and the quality of science. Open research and publishing seems to be one of the few positive cultural trends that reach general public opinion.

This section utilises source material published online by Science, Nature, The Guardian, Times Higher Education and The Conversation between January 2016 and July 2019. A total of 62 sources have been examined. Within these, we have included pieces either written by or discussing PhD students and early career researchers wherever possible, in addition to those presenting views of professors and other senior figures. However, our choice has been selective, based on searching for articles discussing research culture in addition to specific areas of interest for Wellcome, and so does not constitute an exhaustive list of relevant social conversations around these topics.

CHALLENGES AND ISSUES

Social sources identify the following themes as widespread and serious challenges within research culture:

- scientific integrity - research fraud, misconduct & reproducibility
- research quality – issues with reproducibility
- working environments - researcher wellbeing, bullying and harassment
- fair treatment of staff – inequality and diversity issues

RESEARCH FRAUD, MISCONDUCT & REPRODUCIBILITY

Untrustworthy or outright fraudulent research, its effects and ways to prevent its occurrence are often discussed in public channels, and there are many articles aimed at non-researchers which discuss a lack of academic integrity.

Perhaps communicating this most strongly here are news media reports on falsification and fabrication of data. A 2017 Guardian piece suggests that academic journals do not always select the research to publish based on scientific rigour alone and that some published research findings are falsified[164]. The argument connects inconsistencies in academic work with the wider discourse on disinformation and 'fake news'. We also see headlines which may fuel doubts in the integrity of clinical treatments, for example: "Dozens of recent clinical trials may contain wrong or falsified data"[163]. The seemingly authoritative voices quoted within suggest that analyses should be urgently reviewed, which may be alarming for members of the public:

> *"It's very scary that we may be treating patients based on false evidence." he said. "It may be the case that certain treatments may need to be withdrawn from use."*[164]
>
> ***Dr Andrew Klein, the editor-in-chief of Anaesthesia, Guardian 2017***

The results of misconduct trials, e.g. the account of long-term fraudulent activity being uncovered at the UCL Institute of Child Health under Prof David Latchman are also reported - "Research misconduct claim upheld against former head of UCL lab".[143]

Untrustworthiness is discussed in the THE as well: "some universities tacitly encourage such behaviour [malpractice] and the boundary between academic integrity and malpractice is becoming blurred" when presenting the results of "Academic Integrity: Exploring Tensions Between Perception and Practice in the Contemporary University" by Joanna Williams and Dave Roberts, published by the Society for Research into Higher Education on 30 June 2017.[151]

This online survey[151] of UK academics conducted in March and April 2016, reported a number of 'tricks' in place, including:

- Fabrication of data
- Falsification - misrepresentation of data
- Ethics form misuse - completing forms in such a way as to 'complete the process', rather than fully disclose all possible ethical issues
- Reference misuse - using references to support predetermined arguments rather than illuminate debate
- Authorship abuse – being listed as an author on a paper "despite having done little to deserve it".
- "Salami slicing" - knowingly splitting results to maximise the number of publications.

The same research found that academics at newer, less research-intensive universities were more likely to locate the lack of integrity in the "system" – especially the REF and university league tables, while those working at older universities tended to see malpractice as an issue of "rogue" individuals reacting to institutional pressure to maximise metrics. In this second case, corner cutting was seen as a matter of being economical, rather than understood as manipulating data.

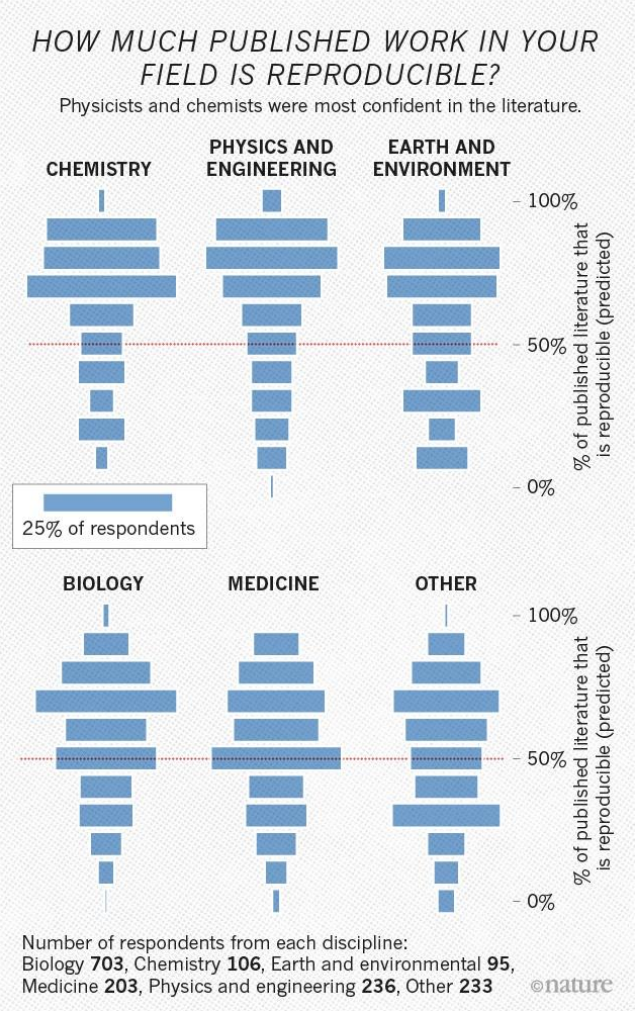
Different attitudes to academic integrity were also discussed in relation to career stage, with the sense that integrity was a "luxury" accessible only to senior academics able to assert their personal responsibility without fearing reprisal.

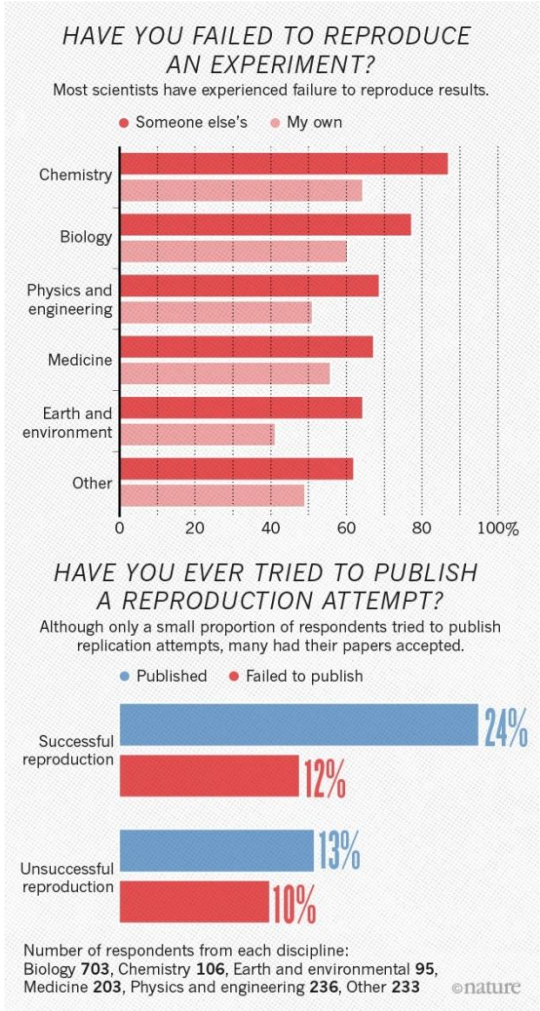
Reproducibility

Reproducibility and replicability were highlighted in higher education and research-specific publications as a particular cause for concern, often seen as a 'crisis'. A Nature piece detailing a 2016 survey of 1,576 researchers found that:

- 52% believed there was a "significant reproducibility crisis" and 38% said there was a "slight crisis"
- More than 70% of researchers have tried and failed to reproduce another scientist's experiments
- More than half have failed to reproduce their own experiments[166]

Findings here are a little contradictory. Even where feelings on reproducibility appear to be strong, less than 31% of those surveyed think that failure to reproduce published results means that the result is probably wrong, and most say that they still trust the published literature. Of all respondents, 73% thought that at least half of the papers in their field could be trusted, with physicists and chemists generally showing the most confidence. [166]





Reproducibility by discipline

Looking further into evidence of "questionable research practices", The Conversation published discussion of a survey of 800 **ecologists and biologists** which finds evidence of cherry picking or hiding results, for example excluding data to meet statistical thresholds and presenting unexpected findings as though they were predicted all along within these disciplines. Key findings were:

- 64% of surveyed researchers reported they had at least once failed to report results because they were not statistically significant (cherry picking)
- 42% had collected more data after inspecting whether results were statistically significant ("p hacking")
- 51% reported an unexpected finding as though it had been hypothesised from the start ("HARKing").[158]

Nature reported that within **social sciences**, researchers attempted to replicate 21 discipline-specific results from publications in Science and Nature between 2010 and 2015, and were able to reproduce 62% of the findings[119] and found that the strength of the effect was often smaller than what was originally reported. This potentially raises issues about the validity of high-impact journals and what they offer, with two out of every five papers studied demonstrating questionable practice.

Looking at Economics specifically, Science published a research which aimed to replicate 18 studies published in the American Economic Review and the Quarterly Journal of Economics between 2011 and 2014[130]. The researchers found a significant effect in the same direction as in the original study for 11 replications (61%),

with the replicated effect size, on average, of 66% of the original. The overall replicability rate varied between 67% and 78%.

Causes of misconduct

Social and insider sources tended to provide two theories of the root cause of misconduct:

1. Individual & human factors

The 'Nine pitfalls of research misconduct' article, published in Nature, 2018[118], describes cognitive biases and other factors which can lead to bad decisions, a view supported elsewhere[158]. These can be represented by the mnemonic TRAGEDIES:

- **Temptation:** "Getting my name on this article would look really good on my CV."
- **Rationalization:** "It's only a few data points, and those runs were flawed anyway."
- **Ambition:** "The better the story we can tell, the better a journal we can go for."
- **Group and authority pressure:** "The PI's instructions don't exactly match the protocol approved by the ethics review board, but she is the senior researcher."
- **Entitlement:** "I've worked so hard on this, and I know this works, and I need to get this publication."
- **Deception:** "I'm sure it would have turned out this way (if I had done it)."
- **Incrementalism:** "It's only a single data point I'm excluding, and just this once."
- **Embarrassment:** "I don't want to look foolish for not knowing how to do this."
- **Stupid systems:** "It counts more if we divide this manuscript into three submissions instead of just one."

2. Systemic factors

Elsewhere, frameworks and systems are said to be at fault, with the structures of publication, funding protocols and an increasing pressure to publish over-ruling autonomy and personal integrity. These systemic fault can be found in:

- **Academic publishing:** The publishing of negative or non-statistically significant results is uncommon in many journals and disciplines. Replication studies are less likely to be published than work demonstrating "ground-breaking" results.
- **Scientific funding:** Novel (usually positive and significant) findings are valued more than replication studies or more careful, incremental procedures.
- **Employment practices:** hiring and promotion practices within academic, and to some extent industry-based, science focus on publication metrics and overvalue quantity at the expense of quality. Junior researchers may feel unable to question unexpected results, fearing it will have a negative effect on their career trajectory.

Overall, a combination of these factors are thought to be at play-their combined pressure, alongside that of securing impactful publications, leads to a tendency to focus on exciting and ground-breaking results. Ignoring one data point might make the difference between being able to report a statistically significant finding and author a highly-cited article and on the other hand and ending up with another inconclusive result which does not lead to publication on the other.[142, 166, 138, 140, 118, 119, 141, 142, 143, 145, 151, 163, 164, 165]

Effects of misconduct

While reproducibility studies do show inaccuracies within the presentation and analysis of research data, they also suggest that outright fabrication of data is rare[158]. However, this does not mean it is non-existent. In terms of the effects of fabricated data on the scientific community, these were mentioned[140,158]:

- Denying prestigious roles, progression and other employment opportunities to others

- Receiving grants and awards on the back of made-up research consumes resources that could have been put to better use elsewhere
- A lack of trust in science by members of the public and policy makers may have serious effects, for example in the fields of health and environmental studies[158].

Suggested solutions

Social sources vary in their suggested approaches to tackling challenges around scientific integrity, ranging from formal to informal, from those that need to be addressed by the community as a whole to those that might be implemented by one institution:

General approaches

- Bottom-up approaches, such as informal exchanges of best practice between labs, rather than top-down directives [119]
- The open science movement aims to stop rewarding questionable practices (see later section)[158]

Institutional approaches & internal safeguards

- Self-assessment of the integrity of an institutions research culture, e.g. using a tool such as Nature's Academic Unit Diagnostic Tool (AUDiT), to help understand what strengths and may exist
- Exit interviews with PhD students, postdocs and professors, and looking for patterns in these
- Institution-wide or department-wide surveys about student and staff experiences.
- Validated tools to assess integrity; e.g. the Survey of Organizational Research Climate (SOURCE). This assesses seven dimensions, including integrity norms, adviser–advisee relations and departmental expectations.
- The development of relevant research ethics training. This should include information about how to take action and to make decisions in difficult circumstances, whistle blowing best practice, how to approach senior academics over concerns about data and how to find those able to give impartial advice[118]
- The use of publisher-created reproducibility checklists.[115]

Formal safeguards

Looking outside the research community, there have been calls for more formalised safeguards against misconduct or perceived malpractice alongside more, and more thorough, investigations into malpractice.[142] For example, in 2018 MPs debated the creation of a body which would monitor universities to ensure that allegations of malpractice are properly investigated and punish those failing to tackle research misconduct by withdrawing funds[141]. These discussions followed a survey by the Commons Science and Technology Committee which found that a quarter of institutions fail to report cases of potential malpractice.

POOR HEALTH, BULLYING AND HARASSMENT

While prominent, mistreatment of people appears to have secondary significance to that of mistreatment of data when looking at the social sources included in this review. However, those that do raise the issue do so strongly. For example; "Science is a social endeavour; ignoring harassment perpetuates a culture in which people who experience or witness hostile behaviours are afraid to speak up, cannot do their best work, or leave science altogether" writes Erika Marín-Spiotta in Nature. This article gives an account of how harassment, bullying and discrimination cause damage to science at the individual, community, institutional and societal level. Such behaviours cause health problems, fear, mistrust, depression and trauma, resulting in decreased productivity and the exclusion of those who may have otherwise made important contributions.

The following section gives a brief overview of examples of poor research culture and wellbeing discussed in insider and social narratives:

Bullying

The Guardian in particular has highlighted bullying within research environments, with a number of pieces detailing accusations of senor members of staff engaging in the harassment and intimidation of others.[132,135,146,137] Significant examples of groups said to be responsible for bullying and harassment include: PhD supervisors, senior managers and leaders, senior figures in industry.

PhD supervisors[137]

PhD students appear to be particularly vulnerable because of the power imbalance in their relationship with their supervisor, on whom they depend for publications, references and career opportunities. Examples from social sources discussed bad student-supervisor relationships include:

- Offering little support or supervision of research work
- Insisting upon extremely long working hours, with holidays and time off denied or actively discouraged
- Claiming false credit for authorship
- Requiring their students to carry out menial non-academic tasks
- Unethical practices being tacitly supported by institutions, with complaints having no effect
- A negative impact of these dynamics on mental health

Senior academics, laboratory directors & managerial staff

Power differences and strict hierarchies seem to also provide fertile ground for harassment, with The Guardian covering multiple instances of aggressive behaviour, pressure to deliver results, career sabotage and HR managers protecting senior staff after receiving complaints about them, to the detriment of those being bullied. There are discussions of how these attitudes have become "ingrained in the culture" of some academic institutions, with these listed as key causes[135]:

- Strict hierarchies, with senior figures holding control over the career progression of those in lower positions
- Lack of day to day oversight
- Ineffectual policing and policy not taken seriously by central teams, or decisions always made in the senior staff members' favour
- A managerial culture which favours results at any cost
- Prioritising institutional reputation, e.g. through the use of non-disclosure agreements to resolve bullying cases, with staff signing confidentiality clauses in exchange for financial pay-outs.

Senior figures in industry

The case of Prof Nazneen Rahman, who left the Institute of Cancer Research (ICR) in 2018 after facing multiple allegations of bullying over 12 years, provides a good example of a poor research culture. Employees described how the ICR's working environment was often "intimidating, hostile, degrading, humiliating or offensive" which left employees "psychologically damaged and disillusioned."[146]

Diversity and discrimination

Sexual harassment and sexual assault do not figure prominently in the social sources reviewed, though this perhaps may in itself be the result of discrimination on the part of those publishing articles about research. However, those that do detail instances of these serious issues suggest that power imbalances and institutional reluctance to hold perpetrators to account represent the root cause, with older males able to use

their power without fear of reprisal. Again, victims report a sense of helplessness brought about by the hierarchical system and their need to keep focused on their career at all cost:

"I'm applying for jobs and really hoping they don't know what happened at my institution. If I'm known as a 'troublemaker' they won't want me. In a lab group there's a very hierarchical system and they can prevent you from doing your own work. They can be very buddy-buddy – it's not like a big office, where a manager may have more of an unbiased stance."[167]

Less-represented populations are said to be disproportionately affected by harassment and bullying. A 2017 study in astronomy and planetary science found that women of colour were more likely than other groups to report skipping professional events because they felt unsafe. In a 2016 survey of US LGBT physicists, one-third of respondents reported that they had considered leaving their institutions; this group was also more likely to have experienced or witnessed hostile behaviours. Other groups are also likely to be vulnerable.[116]

Solutions

Social sources report some top-down solutions coming from leading funders, including the Wellcome Trust and Cancer Research UK (CRUK). Those organisations have anti-bullying and harassment policies that can lead to grants being revoked from scientists whose institutions uphold allegations made against them.[114] In the US, institutions that accept a National Science Foundation (NSF) grant must now notify the agency of any finding related to harassment by the leading scientists working on it. If major problems are uncovered, they face the possibility of losing access to funds. Suspension of funding can also occur via individuals reporting harassment directly to the agency, which may in turn conduct its own investigation.[157, 125]

INEQUALITY & DIVERSITY

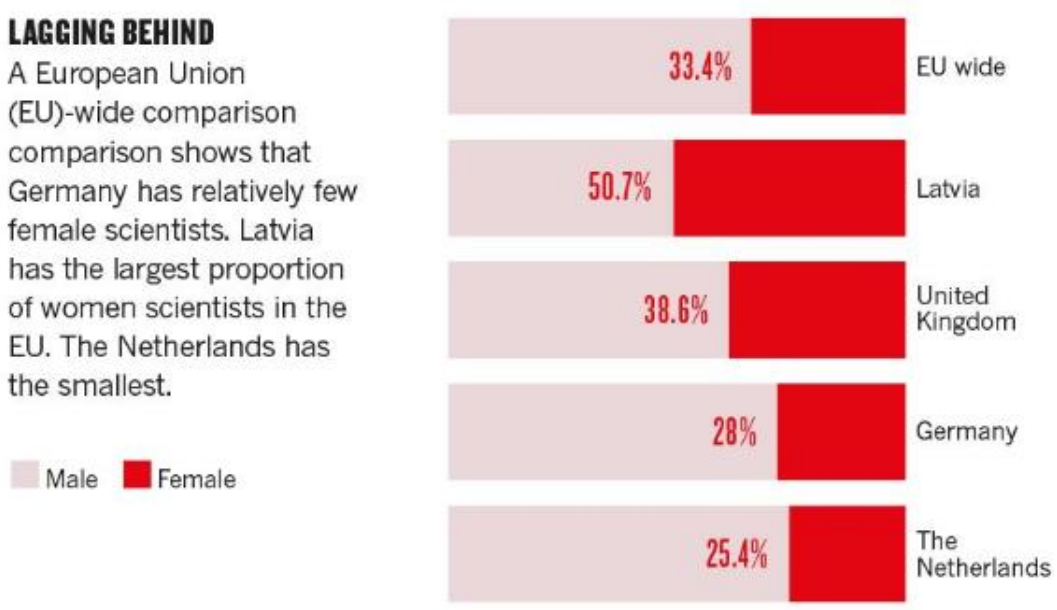
A survey of HE researchers run in 2017 by THE reported a firm belief that the academy does not treat women and ethnic minorities fairly on issues such as career progression, rewarding them for their work and getting them involved in decision making.[149] About a quarter of research staff at higher education institutions disagreed that institutions treated all staff equally in these areas. Around a third of women in research leadership positions disagreed that promotions and rewards were fair and decision-making inclusive.

25% per cent of research staff disagreed or strongly disagreed that there was fair treatment in terms of promotions, 22% in terms of rewards, 23% in terms of participation in decision making and 13% in day-to-day treatment.

While the majority of those surveyed believed that their universities are committed to equality and diversity, the results reveal that there is "increased uncertainty…overall as to whether there is fair treatment and equity of opportunity for different sub-groups". [149]

Women in science

Social sources also discuss issues around women's experiences in research professions, with Nature reporting that nearly half of US female scientists leave full-time science after the birth of their first child.[103]
Nevertheless, the UK does hold a slightly higher proportion of female scientists than the 2019 EU average:



Source: Eurostat

Looking across sources, there is some recognition of the importance of intersectionality; and the fact that those at the intersection of several minority statuses suffer the most, with Nature Astronomy asking "When was the last time you met a black woman professor while at a conference?"[120]

A THE comment piece calls for university staff and scholars from all disciplines to be better informed about real-life experiences of racism and sexism in academia in order to become more empathetic. The article suggests that institutions and academics should take into account the embedded structures and power differences that affect society as a whole, not just the world of research.[147]

VALUES AND PRINCIPLES OF GOOD RESEARCH CULTURE

TRANSPARENCY & OPEN SCIENCE

Open science, or at least the principles of this movement, are prominent amongst social sources in relation to the ways to improve research culture. Making scientific processes and results more transparent and accessible to people outside research teams are described as a powerful antidote to the reproducibility crisis. Science[128] discussed how the field sciences (e.g., geology, ecology, and archaeology), where each study is unique, provide good examples for the importance of preserving data and samples for further analysis. Transparency was also linked to consistency and accountability, perceived as vital for gaining the trust of the public and policymakers.

Good practices around transparency included:

- Journals publishing analysis code and data along with their articles
- Signing up to Transparency and Openness Promotion (TOP) guidelines
- Sharing pre-specification of the details of a study, including the study predictions and how the data will be analysed.
- Combining this with peer review of a Registered Report, most popular in psychology and medical fields, where articles are reviewed before data is collected on the strength of their underlying premise and approach, removing the temptation to select only positive results[128]

Some examples of how these practices are implemented in practice:

- In 2015, the Center for Open Science launched the **Transparency and Openness Promotion – or TOP – Guidelines**, a certification scheme for journals aimed at raising standards. Many of these require authors to either publicly archive their data or state why archiving isn't possible.
- The signatories of the Peer Reviewers' Openness initiative commit to only providing in-depth peer reviews of articles that either make data and materials available, or which state publicly why they can't be.[136]
- Additionally, many journals are now offering Badges for Open Practices – kitemarks indicating whether authors have made data or materials available. The Guardian note that, as these indicators become the norm, articles without them will begin to raise flags for those looking for quality research.[136]

These changes in policy and practice give data more value in itself, opening the door to further studies and improving replicability. There are arguments that researchers should receive credit and recognition for their efforts in providing well-documented and useful data. However, there are costs associated with such wholescale change; for example research teams might need to rely more on data experts.[104]

COLLABORATION

Collaboration was also discussed as a model for implementing good research principles. It was talked about in relation to different contexts from the research environment:

In **research teams**, particularly across international boundaries. While collaborating between research teams and institutions is considered a fruitful research model, there are also many challenges to overcome to facilitate truly collaborative, ethical and high quality research between disciplines and across borders[109]

In **publishing**, with approaches such as Octopus and PubPub which provide a modular, collaborative, open publishing platform.[124]

Between academia and **industry**,[139,153] European universities are pressured to work more collaboratively with private companies in order to meet national research and economic goals. Since 2017, the UK government has urged universities to support its industrial strategy agenda, with institutions' commercial collaborations assessed as part of the REF. This kind of relationship may be problematic in itself, with "curiosity-based" work risking being ignored in favour of research with a specific end point in sight, for example the development of a product.[153]

RESPONSIBLE EVALUATION

Social sources also discussed initiatives and principles around evaluating and assessing research in a better way. For example;

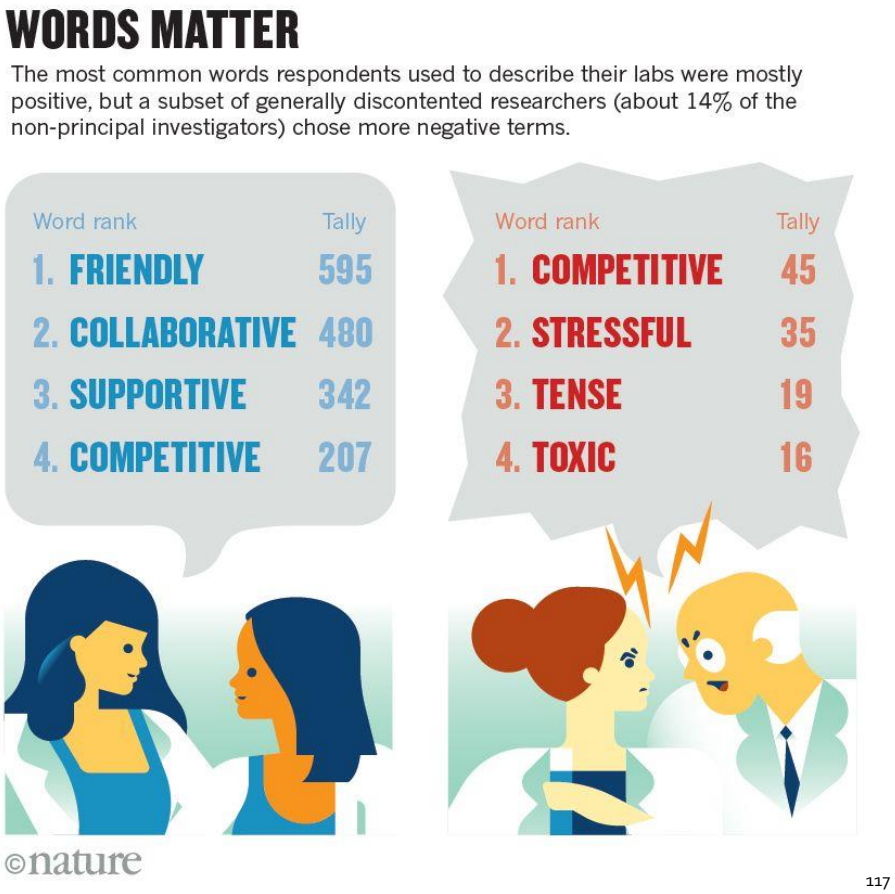
Responsible Research and Innovation (RRI), implemented as part of Horizon 2020 (H2020), "challenges scientists… to take a more inclusive, reflective, and anticipatory approach to their research". As the EC currently defines it, RRI is above all "an inclusive approach to research and innovation" that "aims to better align both the process and outcomes of [research and innovation] with the values, needs and expectations of European society."[127] RRI helps to ensure research contributes to the social good, by understanding what sorts of innovation are actually desired, and to learn what their negative effects may be and how these might be managed.

LEADERSHIP

A 2018 Nature survey of more than 3,200 scientists found out that those who run labs have a much more positive view of the dynamics in their research groups than do their staff. Nature notes that the results suggest that a lack of training in leadership and management is one of the strongest contributors to an unhealthy lab culture.[117] The results suggest that more training is a key requirement for improving lab culture.

Findings related to leadership in labs included:

- Two-thirds of researchers who head laboratories said they had not had training in managing people or running a lab in the past year — and the majority of those said they wanted some
- Of the PIs who had received training, five-sixths found it useful.
- One in five respondents in more junior positions were negative about their labs, describing them as 'stressful', 'tense' and 'toxic' (see 'Words matter' graphic below).
- Scientists who took the survey said they wanted more principal investigators (PIs) to take training courses, and suggested that PIs ask for feedback from their lab groups more regularly.
- Slightly more than half of non-PIs said they had often or occasionally felt pressured to produce a particular result in the past year.



117

The survey also revealed there is a disconnect between junior and senior roles:

- Senior researchers — 655 lab heads — were hugely positive about their workplace practices. More than 90% said that they consistently reviewed their research group's experimental designs and could summarize which projects every member of their group was working on. They were equally confident about their availability to discuss staff members' experiments or career development; that they valued negative results; and that they gave their scientists freedom to explore interesting findings that were not necessarily core to the lab's research activities.
- The 2,632 non-PIs sampled were much less optimistic. Around 80% agreed their PIs could summarise each group member's project; around 70% that their PI was readily available for discussions and let them explore non-core results. Just two-thirds said that their PI consistently reviewed the design of experiments or valued negative results.

Almost 90% of PIs felt that their lab or group members were clear about what was expected of them, and two-thirds said the group 'never' or 'rarely' condones research practices that cut corners — such as valuing speed over quality, or fundability over accuracy. Only two-thirds of non-PIs said that they personally were clear about what their PI expected of them, and only 43% felt their group never or rarely cut corners.

Suggested solutions included:

- The importance of training in management and leadership.While many institutions, including the Howard Hughes Medical Institute in the United States and the European Molecular Biology Organization, have set up highly subscribed courses in mentoring and management, most don't mandate such training for their senior teams.[117]

- Making lab health someone's job, by employing sustainable-science officers aiming to improve the working environment for everyone by holding researchers accountable, and providing a central point to discuss concerns and ideas.
- Establishing a culture of openly discussing community issues across lab groups and among junior and senior researchers. This might include topics such as burnout, data-sharing dilemmas or how to best maintain work–life balance
- Implementing mandatory method courses for group and departmental leaders, which might cover:
    - basic statistics, e.g. such as blinding, randomization and transparent analysis,
    - contemporary methods for storing and analysing data
    - open science
- Getting lab members multiple mentors. This would stop PIs have so much control over their lab members' research decisions and career opportunities.

EQUALITY, DIVERSITY AND INCLUSION NARRATIVES

Key takeaway: While there is a variety of initiatives addressing different dimensions and issues around EDI, there are also gaps in understanding. Gendered experiences in academia, sciences and research seem to be quite well researched and associated with many initiatives that aim to address gender-related issues. Other dimensions of diversity, and the efficacy of initiatives seeking to address them, could be better understood.

When searching for recent academic papers using keywords strictly related to research culture, we didn't come across many relevant papers that focused on the make-up of the research or academic workforce.

Some workplace related issues (e.g. workload and insufficient support for research staff) and some narratives around belonging in academia did come up. However, these mentions seemed to poorly reflect the commitment to equality and diversity present in policy sources and industry bodies' reports on the one hand and social conversations around unhealthy work culture disproportionally affecting certain demographics of researchers and academics on the other.

It doesn't mean there is a lack of academic literature or studies addressing these issues. Quite the contrary in fact – the overview of sources included below is far from exhaustive. EDI literature just doesn't seem to be strictly connected to academic sources discussing research culture in the same way as problems around research integrity.

This literature review makes an assumption that equality, diversity and inclusion issues are central to **understanding the mechanisms of belonging** in research workplaces, careers and sectors and this in turn is central to the concept of research culture.

> *"Decades of research underscore the extent to which socially diverse groups are more creative and innovative than homogenous groups, and as a recent editorial in Nature summarised: 'A more representative workforce is more likely to pursue questions and problems that go beyond the narrow slice of humanity that much of science (biomedical science in particular) is currently set up to serve'"*[12]

Therefore, this section includes a brief overview of what EDI issues and initiatives are currently researched and evaluated. However, this does not include theoretical literature from social sciences, but focuses on **practice-oriented studies** that describe EDI issues and initiatives in higher education, sciences and research specifically.

UNDERSTANDING DIVERSITY AND INCLUSION

There are many research studies and projects trying to broaden the understanding of issues around EDI. These gaps in understanding can be categorised into the following themes:

- **Understanding dimensions of diversity**[201,240,243]:
  - Conceptualising and operationalising individual characteristics relevant for the EDI narratives.
  - Understanding what issues they translate to in educational and work settings.
  - Understanding intersectionality and how different dimensions of disadvantage interact and reinforce one another[209].
- **Understanding reasons behind diversity issues and mechanisms of exclusion,** such as biases and stereotypes[220,243] and how they manifest, for example in female underrepresentation in STEM[228].
- **Understanding attitudes toward diversity,** such as policies, legislation, professional norms and organisations' commitments to increasing diversity[204].
- **Understanding what works:** evaluating the effectiveness of current equality, diversity and inclusion initiatives, spotting gaps and imbalances in research[243], offering solutions and practical recommendations, for example:
  - Insufficient focus on different dimensions of disadvantage, e.g. a number of disability-specific diversity training sessions and resources exist, but they haven't been well-researched and evaluated[220].
  - Comparison of initiatives across different countries[229].
- **Understanding the demographics of research workforce**: supported by ethically collected, transparent, comprehensive and accurate data[243].
- **Understanding progress and trends in diversity and equality in HE and the research and innovation sector,** for example:
  - In European HEIs:

> *"There is very little evidence as to the causal link between programmes, methodologies for their use and increases/improvements in equity in institutions. This creates a significant information gap for institutions and public authorities seeking for indicators to allocate limited resources to equity improving initiatives, without adequate evidence*

of effectiveness. The IDEAS project and this publication aims at addressing and improving this information gap."[223]

- In UK HEIs:

"The review of the range of equality and diversity practice undertaken across the higher education sector highlights that "the majority of submissions were not targeted at specific equality characteristics, and there were noticeably very few submissions on age, gender identity, religion and belief, and sexual orientation."[244]

WHICH EDI ISSUES ARE ON THE AGENDA?

There seems to be a lot of focus on gender, such as women in STEM careers. There is some evidence that **other dimensions of diversity are less researched**[243,244] – that there is less information about issues related to age, disability, gender identity, religion and belief, and sexual orientation in research careers. The issues that came up from our (non-exhaustive) search focused on the following themes:

- **Women's experiences in academia,** such as underrepresentation of women in senior academic positions[207, 224,232,237,245].
- **Racial and ethnic diversity among academic staff**[236,249].
- **Women underrepresentation in stem professions**[220,234,228,238,239,241].
- **Lack of diversity in leadership positions**[230,232].
- **Not only inclusivity in terms of numbers but more holistic representation:** where academia and workplaces acknowledge the diversity of approaches and contributions coming with more diverse staff[210].
- **Bias in hiring** (e.g. related to sexuality or ethnicity[211,246]).
- **The experiences of people with chronic illness or disability** in academia and the workplace[215,218,220].
- **Doctoral experience and challenges to mental health, workload and supervision**[221].
- **Staff retention**[202,213,235].
- **Inclusion of indigenous communities in academia**[248].

WHAT WORKS?

While there are a variety of initiatives around EDI in the workplace, HE and research careers, and the list below is far from exhaustive, there is some evidence around the usefulness and effectiveness of these specific approaches:

MENTORSHIP PROGRAMMES

Across different types of source, there were suggestions that mentoring programmes might be a good way to improve research culture. There is some evidence looking at the value of mentoring, especially for early-career research staff[208] and female academics[207].

- Mentorship programmes can be a way to increase staff retention and increase inclusion in research. For example, the mentoring programme implemented among the biomedical faculty members at an academic health centre in the US has helped with staff retention and has been associated with increased inclusion of women and underrepresented minorities in the institutional research enterprise.[202]
- Peer-mentoring forums can provide opportunities for support and knowledge sharing for early-career researchers[222].

DIVERSITY TRAINING AND EDUCATION PROGRAMMES

There is some evidence that they work[203], but the devil is in the detail and design; for example:

- **Interventions that increase bias literacy** (such as knowledge of gender bias) and decrease sexism are needed to address gender biases in STEM:

> *"However, interventions that highlight existing gender inequities may inadvertently act as a social identity threat cue for women … Including identity-safe cues, which present a positive female scientist role model or suggest that gender bias can be overcome helped alleviate … harmful effects on women's belonging and trust in the sciences, but had limited impact on stereotype threat."*[206]

- **Bias literacy workshop**: this case study on gender in STEMM (including Medicine) presents the theoretical basis and conceptual model underpinning an educational intervention to promote bias literacy among university staff as a step toward institutional culture change[241].
- **Perceptions and messaging:** diversity messages are not enough; leadership in the workplace has to be diverse as well for the organisation to be perceived as committed to diversity and attractive places to work[205].
- **Monitoring perceptions:** EDI should not only be seen as a goal but as a culture; not a status but an ongoing process:

> *"Findings from this study suggest that organizations perceived as successfully supporting diversity might be afforded particular legitimacy to enact policies and procedures that disadvantage the very groups they are perceived as valuing."*[233]

STRATEGIC-LEVEL INITIATIVES

There is a top-down international, national and organisational interest in addressing gender inequality in academia, research and STEM careers, such as:

- **Bridging the talent gap in Denmark:** insights around female representation in STEM[212].
- **Committee for Gender Balance and Diversity in Research:** solving the problem of inequality in Norwegian academia[216].
- **Women in science, technology, engineering and mathematics:** a strategy for Scotland[247].
- **The GENOVATE action-research project,** which aims to ensure equal opportunities for women and men by encouraging a more gender-competent management in research, innovation and scientific decision-making bodies, with a particular focus on universities (funded by the European Commission)[217,242].
- **Athena SWAN:** established and managed by the UK Equality Challenge Unit (part of Advance HE)[226].

HE AND RESEARCH-SPECIFIC INITIATIVES

- **Creating inclusive campus:** the University of Rochester used:

> *"The philosophy that ACCESS + SUPPORT = SUCCESS. In order to help our campus grow in intellectual diversity, we cannot simply open our doors to students with intellectual and developmental disabilities (IDD). We must also provide support to help students thrive academically and socially during their college education." They use a mentoring scheme, where traditional undergraduates mentor fellow students with intellectual and developmental disabilities.*[218]

- **Embedding critical race theory and diversity training in the biomedical curriculum from the undergraduate level:** the California State University uses critical race theory to train diverse scientists from undergrad level:

"Students are empowered not only to gain access but also to thrive in graduate programs and beyond. … Implications: Biomedical research programs may benefit from a reanalysis of the fit between current training programs and student strengths. By incorporating the voices of talented youth, drawing upon their native strengths, we will generate a new science that links biomedical research to community health and social justice, generating progress toward health equity through a promising new generation of scholars."[219]

- **Acknowledging multilingual researchers and language as a dimension of diversity and important component of research**:

"This research has been conducted with the aims of promoting the multilingualism of Australian universities and activating linguistic communities of scholars to use their full linguistic repertoire in their research. The main finding arising from this program of research has been the development of post-monolingual research methodology"[240].

- **Educational programmes about race in HE**: Advance HE's 'Achieving Race Equality in Higher Education' programme is effective in improving participants' familiarity with terms related to race equality and their confidence in engaging with race equality[225].
- **Programmes about gender in HE**: Athena SWAN has positive impact on gender issues in HE and women career in STEM, but more challenges need to be addressed, especially those related to postgrad students[226].
- **Gendered innovations:** this initiative focuses on incorporating gender perspective into sciences:

"Fixing knowledge by incorporating gender analysis into basic and applied research. This paper … [presents] concrete examples of how gender analysis has enhanced scientific knowledge and technology design. Realizing the full potential of gendered innovations in the next decade will require deep interdisciplinary collaborations between gender experts, natural scientists, and engineers".[234]

WORKPLACE PRACTICES:

- **Supportive leadership** is important to translate policies into practice and increase gender equality at faculty level[245].
- **Domestic partner benefits** are important for successful LGBT recruitment and retention at HEIs in the US[213].
- **Online tutorials on recruiting diverse staff,** which every search committee member is required to take. They help to improve racial diversity of university faculty staff[227].
- **Positive action:** HEIs should adopt positive action in recruitment and promotion to tackle women's under-representation in senior leadership roles[232].
- **Positive induction experience** helps with staff retention:

"This article considers links between induction (orientation) and retention for academic staff. We report on a qualitative study of thirty academic staff in five United Kingdom HEIs who were recruited on the basis of their professional experience. Their practice-based knowledge lends our participants particular insight into their HEI induction experience which, where found wanting, led in several cases to resignation."[235]

- **Faculty learning communities** enhances academic careers:

"The analysis of retention and advancement data showed that participation in faculty learning communities positively impacted retention and promotion of participants … The authors found that Faculty Learning Communities created third spaces that allowed

individuals to face and transgress the most damaging aspects of organizational culture and dwell, at least for some time, in a space of different possibilities."[236]

- **Involving male staff members** can improve women's experiences in academia. North Dakota State University created a programme of male faculty advocates to engage in gender equity/climate improvement efforts[237].
- **The Positive Action Project** (funded by government under Equate Scotland) has been working for over 10 years on increasing women's participation and progression in the STEM and built environment industries. They implement the following practices:

"1-2-1 MEETINGS: Held in person or over the phone, these meetings allow in-depth, tailored discussion on key issues such as work culture, language and interview practice.

BESPOKE TRAINING: Training sessions are designed with the organisation's specific needs in mind and allow positive action to be explored in depth.

OPEN COURSES: Open courses provide training on both positive action and unconscious bias, and offer a unique opportunity to make links with other professionals.

LANGUAGE REVIEWS: Reviews are typically focussed on recruitment, helping organisations detect gender bias in their recruitment materials."[239]

UNPICKING RESEARCH CULTURE

This section of the literature review brings different sources together to highlight where narratives complement each other and where they diverge, where there are gaps between audiences and where there is alignment in messaging.

KEYWORDS

This literature review has focused on the language and terminology, values, principles, objectives and measures of research and research culture. It is worth unpacking a few keywords present across different sources and discourses:

- **Diversity:** while organisations and policy-makers commit to increasing diversity in the research environment, the current state of affairs is far from ideal. Many consider research and academic careers not inclusive enough, or even openly discriminatory. There are opinions that priorities and policies also lack diversity – being too narrow in their agendas, assessment of quality and allocation of resources.
- **Collaboration:** the value of collaboration comes up in all narratives. This can mean collaborating within a team of researchers, across disciplines / sectors, or on the international level. While this model of research seems to be trending, it's not without problems. These are mostly raised in academic literature, including:
    - There are geopolitical differences in research culture. As science, education, research and innovation are not global enterprises, positive research culture is likely to have to address unequal power relations and new ethical problems in the era of international partnerships.
    - While policy-makers talk about the virtues of collaboration, some sources argue that in fact the world of research is competitive (even hyper-competitive) and the current research culture does not necessarily incentivise or facilitate collaborative behaviours.
- **Interdisciplinarity:** the problems of making collaboration work are also visible in the push for more interdisciplinary research. While many see it as a fertile model driving innovation and creativity, it can

also create challenges for research culture. Collaboration across contexts involves negotiating individual disciplinary cultures and developing a new set of cultural practices suited to doing research in this way.

- **Contribution:** currently, the research culture focuses on research results. Paradoxically, some consider this to have a negative impact on both the quality of the culture and research results. The criticism is that too much value is placed on a narrow range of research outcomes – mostly measurable, and publishable, outputs. There are suggestions that a positive research culture should seek to recognise, and reward, more diverse contributions to research and society.

OVER A HALF OF RESPONDENTS BELIEVE THE WAY FUNDING FOR SPECIFIC PROJECTS AND PROGRAMMES IS AWARDED IS HAVING A NEGATIVE OR VERY NEGATIVE EFFECT. ONE QUARTER FEEL IT IS HAVING A POSITIVE OR VERY POSITIVE EFFECT.

The Nuffield's survey on the culture of scientific research

THEMES

Here we aim to group the most important gaps, alignments, and divergences in the narratives into three themes:

INCENTIVES → IMPACT → INTEGRITY

All types of narrative seem to agree that the current incentive model (funding and recognition based on output metrics) leads to a **focus on research impact**. While there isn't necessarily anything wrong with wanting research to make a difference in the real world, there are arguments that the measures currently used to assess research impact are not adequate. There are voices, in academic and social narratives specifically, which argue that incentivising impact leads to **problems with research integrity**, where researchers feel pressure to compromise scientific and academic values to produce more outputs and make their research look more attractive to those who fund and hire them.

PERFORMANCE = PRODUCTIVITY = PRESSURE

Policy discourses tend to focus on research performance. While they talk about excellence, this is strictly related to comparative and **competitive performance of research results** rather than the intrinsic quality of research processes. Performance in turn is tightly associated with productivity; for many researchers it would mean producing more publications that perform well. This is sometimes referred to in academic, insider and social sources as **'publish or perish'**. Work associated with publications, peer reviews, applying for funding and complying with assessment frameworks (as well as expectations from their institutions and managers) can lead to unmanageable workload. Some argue that this creates an **unhealthy amount of pressure** that negatively affects researchers' wellbeing, work relationships and research culture.

TALENT + TRAINING + TEAMS

While policy sources tend to talk about talent and skills, research organisations highlight the need for more training, especially in the area of leadership and management, and social narratives report unhealthy and **toxic dynamics** in academic and research teams. Even though there is some divergence between these narratives, they in fact point to interconnected issues.

Current research culture impacts research career quality. There seems to be a need for interventions around researcher training and PhD supervision, as well as training for senior researchers in, or aspiring to, leadership roles. After looking at different perspectives, it seems that focusing on talent through the lens of

individual researchers and their skills is not enough. Some talented researchers face more entrenched **structural problems** that negatively affect the trajectory of their careers and career progression is stymied for some groups. There are arguments that **solutions should focus on relationships in the workplace** (such as mentorship) and more supportive and effective team management that works for diverse staff members.

POSSIBLE HOTSPOTS

This section is about how various issues and structural problems converge at different levels of the research environment to create "bad research culture" hotspots. The list below should be treated as merely signposting to what looks the most promising to target. It's only a starting point that will be further researched to gather more evidence:

RESEARCH CAREERS

Insufficient professional development, including leadership and management training, and insecure career pathways, reinforced by the expansion of HE and current funding models, create a situation where career **aspirations might not be met by available opportunities** and current career pathways might be too restrictive.

For example:

- In the Nuffield's survey on the culture of scientific research, the majority of respondents considered applying for funding (94%) or jobs and promotions (77%) as the most competitive aspects of being a scientific researcher. Over half of respondents thought that the way scientists are assessed for promotion is having a negative or very negative effect.[22]
- In the Nature Lab Culture survey, 47% of the principal investigators who took part wanted training in managing people or a lab but haven't been able to get it recently[30].

RESEARCH PRACTICES

Questionable research practices and research misconduct seem to be on the rise. This is partially due to the expansion of research, publications and available data, but many sources link it to what is prioritised and incentivised in the research environment. The **focus on results and impact** rather than research conduct / integrity and scientific process seems to make it more likely that studies will be designed and conducted in a way that makes them difficult to replicate.

For example:

- In the Nuffield's survey on the culture of scientific research, almost six in ten (58%) respondents were aware of scientists feeling under pressure to compromise on research integrity and standards, with poor methodology and data fraud frequently mentioned in the free text responses.[22]
- In the Nature Lab Culture survey, more than half of the respondents (56%) have been unable to reproduce a result at some point.[30]
- In the Nature Salary survey, 56% of respondents were unhappy with their current pay. Women were more likely to say that they were unhappy than men. While 68% of respondents reported being satisfied with their job, more felt their satisfaction is worsening (37%), rather than improving (32%).[29]

RESEARCH ASSESSMENT

These issues have already been discussed. However, it's worth highlighting that the proliferation of metrics is not only a *result* of the **assessment- and accountability-oriented research culture**, but also a *driver* that exacerbates other problems – such as career insecurity or the quality of publications and journals.

For example:

- There is a mixed response towards the Research Excellence Framework's (REF) effect on scientists in terms of encouraging the production of high quality science. Around a quarter of respondents (26%) believe it is having a positive or very positive effect overall, whilst around four in ten (38%) disagree, and believe it is having a negative or very negative effect.[22]
- The findings from a survey about the impact of REF on early career researchers suggest: "an overwhelming detrimental impact of the REF upon ECR mental health and wellbeing: respondents both in secure early-career positions and on the job market noted that the REF exacerbated feelings of anxiety, insecurity and precarity, and some experienced substantial mental health impacts of this. ECRs also said that they felt isolated and unable to admit to these impacts in the highly competitive workplace environment that REF created."[32]

Trying to capture the idea of excellence in quantitative measures is also seen as problematic and has serious consequences for how researchers and research institutions are funded and work. The appendix of this review (Changing research culture) includes a few suggestions from across the literature as to how quality and performance of research could be measured in a more responsible way.

RESEARCH WORKPLACES

As issues relating to leadership and unhealthy work relations have been covered above, we'll just briefly restate the fact that initiatives to develop positive research culture would in many ways need to transform **organisational cultures**. Many solutions focus on developing management skills and leaders setting a good example. Workplace-related problems around unhealthy work relations are not only brought up by industry bodies and research practitioners but also filter to social narratives and to general opinion, potentially damaging the relationship between research and society.

- In the Lab Culture survey, Nature identified a group of scientists who were consistently negative about their experiences. They used words such as 'abusive', 'oppressive' and 'hostile', and reported that the bad vibes in their lab harmed their work. These discontented researchers made up around 14% of the non-PIs — 376 scientists. Although they do not represent all the unhappy respondents, they reflect a group that clearly and consistently voiced frustration.[30]

RESEARCHERS

Narratives included in this literature suggest there are problems around dynamics of belonging and exclusion in academia and research professions. There are sources that suggest the current research culture facilitates a **process of unbelonging**. This could be due to issues related to EDI, workload, pressure, mental health, lack of career opportunities or disassociating from work and work-related identity.

For example:

- In the Best University Workplace Survey, one-third of all university staff (33%) feel that their job is having a negative impact on their health. 87% of respondents in academic positions said they often worked more than their contractual positions and 67% of academics did not think that they had enough time to do the research they need to do to get ahead.[31]

RESEARCH ENTERPRISE

The issues of **incentive structures and publishing models** point to big challenges in the research environment. Changes to how research is funded, while perceived as needed in many narratives, will also disrupt the status quo and trigger a cultural transformation where some will likely lose out.

The current system has supported the expansion of the scholarly publishing sector. While **open access** is hailed by many as the future of research, the way to build a better relationship between research and society and a solution to some of the issues in the current system, it will also significantly disrupt almost every

element of the research environment. While it tends to be considered a move in the right direction towards implementing a more positive research culture, it will require a lot of adjustment, while creating new ethical questions and business challenges.

RESEARCH VALUES

Many of the hotspots can be connected to the issue of **trust,** and seen as undermining trust in:

- Research results being valid and reliable.
- Research serving the right purpose and benefitting communities.
- Public money being well spent.
- Research being a promising career choice.
- Feeling safe and supported in the workplace.

RESEARCHING RESEARCH CULTURE

It is very tempting to summarise this literature review with a cynical statement that, to understand research culture, you have to follow the money. While there is a strong case for solving some problems embedded in research culture by readjusting incentive and investment models, there also seems to be **more work needed in understanding and researching research culture**. The notion of *following* might be useful here.

As Wellcome is interested in a holistic understanding of different levels and mechanisms through which research culture operates, we propose a number of areas that could be **explored further using a processes and relations-focused approach to culture**.

> *"Wellcome [aims to] complement its reactive tools for dealing with poor behaviours and practices with a proactive strategy to tackle the underpinning factors which generate these challenges in the first place."*[20]

Approaching research culture through a processual lens would include:

- **Researching how culture is transmitted**
  - Understanding the unintended consequences of top-down strategies and visions for research.
  - Understanding the importance and interaction between different drivers of culture.
  - How research culture manifests, and is reinforced, in practice at individual and organisational levels.
  - Where research culture leads (impact on individual, research community, enterprise and society levels).
- **Researching the role of contexts in research culture**
  - Understanding cultural differences between disciplines.
  - Understanding cultural differences between institutions, regions and countries.
- **Researching relationships**
  - Understanding teams and interpersonal dynamics in workplaces.
  - Understanding the relationships between research and society.
  - Understanding the conflicting interests and needs of different stakeholders.
- **Researching power dynamics of research culture**
  - Understanding and disentangling political / economic from academic discourses.
  - Understanding the impact of rhetoric and language on norms and values.
  - Understanding bottom-up resistance to top-down discourses and policies.
  - Understanding who specifically is negatively impacted by research culture (demographics and geopolitics).

Some of these themes will be explored in the other stages of this research project.

APPENDIX: CHANGING RESEARCH CULTURE

A portfolio of principles, recommendations and good practices from the sources reviewed.

This portfolio is not critically evaluated but provides an indication of a range of practices and approaches proposed by different experts and implemented in a variety of contexts. In most cases, the phrasing of recommendation has been left as close to the original source as possible and not paraphrased. The list of good practices in relation to EDI issues specifically can be found in the EDI narratives section.

The list below largely points to what has been tried and done successfully, but also in some cases, what has failed. It's organised by the stages of the research process:

- Funding and facilitating research
- Conducting research
- Sharing research
- Using research
- Evaluating research

FUNDING AND FACILITATING RESEARCH

The recommendations in this section focus on transforming the funding models, creating institutional culture change, supportive research environments, happy teams and inclusive workplaces.

RECOMMENDATIONS FOR GOVERNMENT/RESEARCH AGENCIES

- There is a need for more research on research. The study of research systems – sometimes called the 'science of science policy' – is poorly funded in the UK[18].
- Researcher funding should be associated with fellowships and programmes and move away from project grants[14].
- Making it easier for researchers to pursue different careers in teaching, charities, public sector and industry[14].
- Government departments should make annual declarations of lobbying by academic publishing companies[75].
- National funding agencies should seek, where possible, to record systematically the total cost of enabling access to academic publications (e.g. through subscriptions, processing charges for open access articles and books, book purchases)[75].
- The UK government should work with other nations to develop consistent support systems for the rapid communication of academic research, and value for money[75].
- To better support interdisciplinary health research, UKRI needs to be more experimental in the modes of funding it deploys – for example, through greater use of sandpits, lottery-based mechanisms, and co-design of research with patients, carers and clinicians. There should be a particular focus on supporting early-career researchers through diverse, cross-disciplinary career pathways[12].

RECOMMENDATIONS FROM RESEARCH CULTURE WORKSHOPS ORGANISED BY THE NUFFIELD COUNCIL ON BIOETHICS

Participants [in the workshops] highlighted the importance of being realistic and proportionate in any attempts to bring about change and that the success of existing initiatives should be built upon. Suggestions included:

- Providing mentoring and appropriate careers advice for researchers.
- Creating a set of tools aimed specifically at PIs and Heads of Department.
- Aligning and being open about HR policies for promotion and recruitment.

- Using a broader range of metrics and indicators in the assessment of research and encouraging more universities to sign up to DORA.
- Focusing more on rewarding teams or departments rather than individuals.
- Levering the next Research Excellence Framework to provide financial incentives for change.
- Encouraging universities to be more open about research integrity issues
- Improving communication between funding bodies and universities, and within universities.[22]

RECOMMENDATIONS FOR RESEARCH INSTITUTIONS

GUIDELINES FROM WELLCOME

- **Organisational governance:** We expect organisations to have policies, structures and training in place that enable students and researchers to understand and adopt good research practice. Organisations must publish on their external websites how breaches of good research practice and professional disputes will be managed.
- **Promoting a positive research culture:** Researchers and organisations should encourage practices that promote a positive research environment so that research can flourish. Examples include: providing support for collaborations, undertaking and recognising peer review and advisory board activities, demonstrating commitment to diversity and inclusion. We consider bullying and harassment of any kind, in any context, to be unacceptable. Our policy sets out what we expect from the organisations we fund and the people involved in our funding.
- **Teaching, training and mentoring:** Teaching, training and mentoring are vital to develop the next generation of researchers and entrepreneurs. Organisations should provide training for researchers in good research practice, e.g.: record keeping, research design, regulatory and ethical approvals, equipment use, data management, data protection. We expect researchers across all career stages to take part in teaching and training. They should also find opportunities to provide mentorship.
- **Supervisors should support their trainees and staff in all aspects of research**: This includes: study design and methodology, data analysis and interpretation, preparation of papers, funding applications, career advice.[17]

RECOMMENDATIONS FROM THE ROYAL SOCIETY

- Good communication from leaders plays a crucial role in driving positive organisational culture.
- Allowing opportunities for researchers to interface with industry and investors.
- Research leaders should know how to develop the talents and skills of their research teams.
- Providing shared places for collaboration and interaction.
- Supporting creativity in the workplace. Research is an inherently creative endeavour. There are excellent examples of how large and central facilities such as DIAMOND, ISIS and CERN have supported staff to undertake ground-breaking research, to benefit from planned and serendipitous meetings with others from the same and different disciplines, and to build on the findings and approaches of current and future leaders in their fields.
- Supporting researchers' mobility: rotating individuals through different disciplines and sectors as a core and embedded part of their research activities might begin to bridge the cultural divide between different research environments. GlaxoSmithKline hosting researchers in its Open Lab, BP's International Centre for Advanced Materials (ICAM) collaboration and the Heilbronn Institute, a collaboration between UK GCHQ and the University of Bristol, are examples of this.[14]

EXAMPLES OF GOOD PRACTICES FROM DIFFERENT WORKPLACES AND RECOMMENDATIONS FROM THE WORLD ECONOMIC FORUM

- WORK PRESSURE: The Fred Hutchinson Cancer Research Center provides a career-counselling service solely to their scientists, providing the opportunity to discuss their career paths and the steps they need to take to progress.

- CLARIFYING NORMS: The Barcelona Biomedical Research Park developed a code of good scientific practice, which sets out the expectations of individuals and the collective research team.
- LEADERS SETTING STANDARDS: Participants at the Royal Society's research culture workshops gave examples of leaders initiating small but impactful ways to set culture and improve morale in the workplace. An example of this is setting regular hours, to tackle the perception that only academics working extensive hours are successful.
- SKILL TRAINING: Researchers can feel more valued if skills needs are reviewed individually and as a group, ensuring they all possess the necessary skills for their role, such as statistics, data-handling, proposal-writing and resource management. And following on from this, identifying gaps and offering courses for development. Software Carpentry developed such an initiative, by running training workshops at the University of Florida, to increase the data literacy of university staff.
- DISCUSS CULTURE: Highlight the importance of research culture and engage all staff across the organization by hosting a research culture and integrity day. Presentations, workshops and panel discussions could be given from across the organization. Different departments could showcase the ways they have improved research culture and integrity, as well as addressing areas where there is still room for improvement. The University of Nevada organised an "Ignite Integrity week" where all staff were encourage to participate in activities to discuss good practice.[15]

EIGHT FACTORS ASSOCIATED WITH HIGH-PERFORMING RESEARCH UNITS ACCORDING TO REF ANALYSIS

- High-performing research units have more of the staff with PhDs, professorial positions, international experience and externally funded salaries.
- They recruit the best and retain them.
- They provide training and mentorship programmes to develop staff, while offering rewards for strong performance.
- Staff within high-performing research units display a distinct ethos of social and ethical values.
- The leaders of high-performing research units have earned 'accountable autonomy' within their higher education institution.
- High-performing research units have strategies that are real, living and owned, and more than merely a written document.
- High-performing research units receive more income per researcher than the average research unit.
- High-performing research units enable and encourage researchers to initiate collaborations organically as opposed to using a top-down approach.[6]

SUPPORTING INDIVIDUAL STAFF CIRCUMSTANCES: GUIDELINES FROM REF

HEIs are required to put measures in place to support staff with individual circumstances. This includes creating safe and supportive structures for enabling staff to declare voluntarily any relevant circumstances and putting in place processes to adjust expectations of an individual's contribution to the unit's output pool, where the individual is entitled to a reduction. Where the cumulative effect of individual circumstances has disproportionately affected a unit's output pool, a unit may optionally request a reduction without penalty in the total number of outputs required for submission, where the individual circumstances of Category A submitted staff have constrained their ability to produce outputs or to work productively throughout the assessment period. This includes measures to remove the minimum of one requirement where an individual's circumstances have had an exceptional effect on their ability to work productively, so that the individual has not been able to produce an eligible output.[7]

SUPPORTING EARLY-CAREER RESEARCHERS: CASE STUDY FROM THE ARTS AND HUMANITIES RESEARCH COUNCIL

Beyond standard doctoral training and early-career fellowship provision, we have created additional opportunities for doctoral and early-career researchers to engage beyond the academic environment via internationally recognised initiatives with external partners. These include the International Placement Scheme, with major cultural organisations outside the UK, New Generation Thinkers with the BBC, the Engaging with Government course with the Institute for Government, and Foreign and Commonwealth Office (FCO) policy internships in collaboration with the FCO and ESRC.

CDPs and Collaborative Doctoral Awards (CDAs) provide a unique opportunity for students to undertake joint projects with the UK's major cultural institutions, with unparalleled access to their expertise and resources. The students make a significant contribution to the work of these institutions and strengthen the connections between them and academia. A study of our collaborative studentships examined a sample of 14 cultural institutions and traced the current employment status of the 198 former students they supported between 2005 and 2014. Of the 184 former students traced so far, 41% are working in higher education and 49% in museums, galleries, libraries, heritage or visual arts, making a vital contribution to the skills pipeline in the £29bn GVA heritage economy. The study also indicates that the schemes have attracted more female and mature students than the DTPs and are likely to be widening participation to those who may not have considered a 'traditional' studentship.[2]

SUPPORTING EARLY-CAREER RESEARCHERS: A RECOMMENDATION FROM THE LAB-FAB-APP REPORT

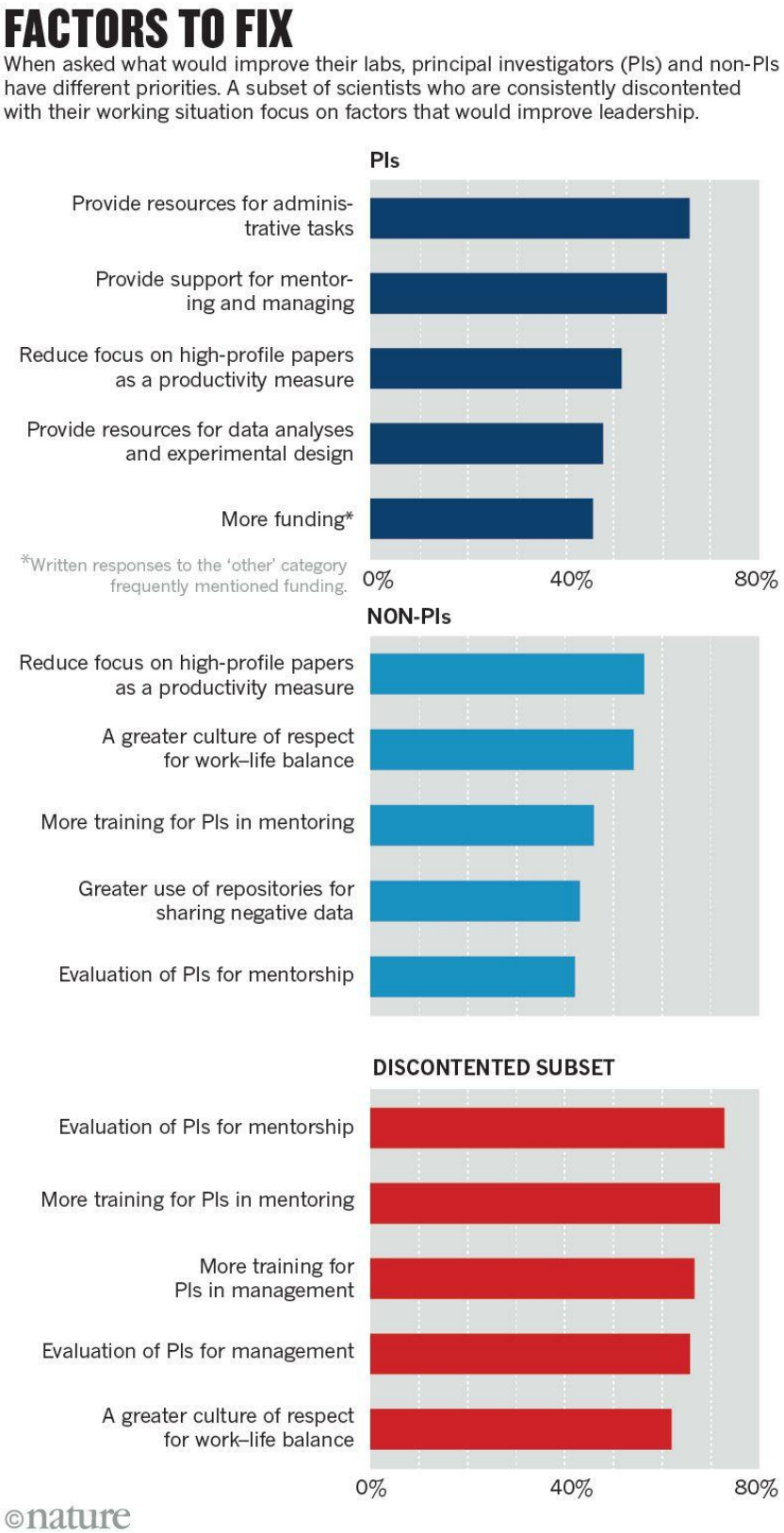
The post-2020 EU R&I programme should also increase the resources for Marie Skłodowska-Curie Actions which support researchers' career development and training. New training and career development schemes are needed. A well-endowed EU Industry Research Fellowship scheme will help break down barriers between sectorial and disciplinary silos. It should be open to talent from everywhere, supporting innovators returning to an EU country from elsewhere, as well as providing entrepreneurial training schemes for refugees."[11]

SUPPORTING HEALTHY AND RESPECTFUL WORKING CULTURE: GUIDELINES FROM CRUK

Host institutions must have an effective workplace conduct policy and take reasonable steps to implement that policy effectively and to build a healthy and respectful working culture for all staff. We will request information on steps taken as part of our regular audits:

- Policy sets a clear expectation that all allegations of bullying and harassment must be handled and investigated appropriately to their full conclusion.
- Applies to researchers, and their host institution, who are part of a grant application or award, sit on Cancer Research UK's (CRUK's) funding panels or committees, or who speak at research events. Host institutions must disclose any active formal disciplinary findings for bullying and harassment against applicants and any formal investigations into CRUK researchers and their outcomes.
- For upheld allegations, CRUK will act and may impose sanctions both against individuals and at an institutional level (in cases where we believe there has been a failure to respond appropriately).[94]

SUGGESTIONS FOR IMPROVING WORKING CULTURE FROM NATURE'S LAB CULTURE SURVEY[30]



CONDUCTING RESEARCH

Recommendations in this section focus on conducting research with integrity and to the highest standards, and on sharing good practices, for example:

- Establishing research culture "cafes" are an excellent way to share best practice[15].
- Researchers should be given time to do blue-sky thinking, risky research, synthesis and replicability studies[14].

GUIDELINES FROM WELLCOME

- Research integrity and rules around research misconduct: Anyone who suspects that misconduct has taken place should report it to their organisation.
- Research involving people: Researchers must protect the rights, interests and safety of research participants.
- Research involving animals: Researchers should consider replacing, reducing and refining the use of animals in research.
- Conflicts of interest: Conflicts of interest should be recognised, declared and managed.
- Research design: Research methodology must be rigorous and well-planned to ensure that results are as robust and unambiguous as possible, and to enable reproducibility of studies.
- Authorship: Authors must have had significant input into the research. This could be through the design, execution or interpretation of the research. They must also accept accountability for the content of the publication. Publications must properly acknowledge the contributions of collaborators and funders.[17]

PRINCIPLES FOR TREATING RESEARCH STAFF FAIRLY FROM REF GUIDELINES

- Transparency: processes and codes of practice should be clear, communicated and easily accessible.
- Consistency: the principles behind the codes of practice should be consistent within the institution and across all stages and processes of decision-making.
- Accountability: Responsibilities should be clearly defined and levels of training the staff have had easy to assess.
- Inclusivity: The processes described in the code should promote an inclusive environment, enabling institutions to identify all staff who have significant responsibility for research, all staff who are independent researchers, and the excellent research produced by staff across all protected groups.[7]

CASE STUDY FROM CRUK

For the past 7 years, the Cancer Research UK Beatson Institute, a non-profit organisation in Glasgow, have ensured that the discussion of practices around research integrity are integrated into the daily routines of its research teams by employing a research quality expert. This involves supporting data curation & archiving, improving manuscript quality, providing training and acting as a first point of contact for concerns about integrity. Checks of any research outputs are compulsory but informal, and have been said to lend a more collaborative air to the Insitute.[169]

SHARING RESEARCH

Many of the recommendations around sharing and disseminating research focus on open science – arguing that policy for scholarly publishing should continue to focus on enabling open access to ensure free and digital access to publicly funded research.[14,75]

GUIDELINES FROM WELLCOME

- Sharing research outputs: We expect all outputs of research funded by us to be shared openly and as quickly as possible. At the same time, we recognise that there may be an overriding need for

confidentiality in some instances. For example, if researchers generate intellectual property during a grant, they must consider how to protect it before disclosure and in line with our policy.
- Besides publications, patents and pre-prints, other important research outputs may include datasets, technologies, software reagents and policy.
- Negative findings are as important as positive ones and we encourage you to share them, e.g. through Wellcome Open Research.[17]

POSSIBLE FUTURE SCENARIO FROM ELSEVIER

Globally, state funders and philanthropic organizations have joined forces and pushed through the creation of platforms where the research they fund must be published open access (OA). But the form of that OA varies by region; Europe is mostly gold, while North America and Asia Pacific is generally green. Rapid advances in artificial intelligence (AI) and technology mean these platforms are flourishing – they are interoperable, and content is easy to access and showcase.

As a result, there are fewer subscription-based journals. A number of broad science, gold OA mega-journals with low article publishing charges exist to publish content not captured by open platforms. Major society journals remain active, many operating a gold OA model, but struggle for manuscript submissions, so revenue is low. Preprints thrive in this world and are linked to the final article versions, which are still recognized as the authoritative version. Researchers benefit from access to data in a variety of ways, for example, via bite-sized publications and dynamic notebook-style articles. The advances in AI and technology have also provided new methods of generating and communicating results. While research quality is still an important measure of performance, journal publication plays a diminishing role in determining a researcher's career progress. Increasingly, research is assessed against agreed societal impact standards.[16]

CASE STUDY ON THE FAIR DATA PROJECT

The Enabling FAIR Data Project have a Commitment Statement in the Earth, Space, and Environmental Sciences for depositing and sharing data, which has been signed up to by over 100 repositories, communities, societies, institutions, infrastructures, individuals and publishers (including Nature and Scientific Data). The statement's principles state that research data should be 'findable, accessible, interoperable and reusable' (**FAIR**). In practice, this means that the vast majority of Earth-science journals will no longer accept separate data supplements; key data must be made available in repositories that support the FAIR principles.[104]

USING RESEARCH (PUBLIC ENGAGEMENT, KNOWLEDGE EXCHANGE, IMPACT)

Recommendations in this section focus on increasing public engagement in research and ensuring knowledge and results generated by researchers are used by society.

GUIDELINES FROM WELLCOME

- Maximising the impact of research: We want the outputs, knowledge and discoveries that research generates to have as much impact as possible. Researchers should explore ways to do this both within and beyond academic routes. Organisations should have mechanisms in place to enable and reward these activities (detailed examples available on the webpage).
- Translation: New knowledge and discoveries should be exploited wherever possible, such as through industrial collaboration or translation to the clinic.
- Public engagement: Engaging the public with research increases its impact and broadens understanding.
- Using research to inform policy: Some research findings inform decisions made by governments and policy makers. This can lead to changes that improve people's lives.

- Researchers should share any findings or expertise that could have an impact on policy. For example, through: direct engagement through government representatives, university groups, learned societies, Wellcome.[17]

PUBLIC ENGAGEMENT RECOMMENDATION FROM NESTA

Our hope is that UKRI will commit to a more ambitious approach to dialogue and engagement, linked to the commitment in its prospectus to "promote and safeguard the public value of research and innovation." ...The Netherlands is one instructive example: it recently assembled its 'Dutch national research agenda' from the bottom-up, by asking citizens what they wanted to know about the world, and the challenges they wanted to see addressed. This process generated 11,700 questions across the entire research base, later narrowed to 140 'cluster questions'. In this way, the national research agenda has become "a route map in which the cluster questions bridge the gap between research supply and research demand". UKRI should now do likewise.[12]

EVALUATING RESEARCH

Recommendations in this section focus on implementing more responsible, and wider, measures of research quality and highlight the importance of qualitative evaluations.

NEGATIVE CASE STUDY ON REF

Our correlation analysis of the REF2014 results at output-by-author level (Supplementary Report II) has shown that individual metrics give significantly different outcomes from the REF peer review process, and therefore cannot provide a like-for-like replacement for REF peer review. Publication year was a significant factor in the calculation of correlation with REF scores, with all but two metrics showing significant decreases in correlation for more recent outputs. There is large variation in the coverage of metrics across the REF submission, with particular issues with coverage in units of assessment (UOAs) in REF Main Panel D (mainly arts & humanities). There is also evidence to suggest statistically significant differences in the correlation with REF scores for early-career researchers and women in a small number of UOAs.

Within the REF, it is not currently feasible to assess the quality of units of assessment using quantitative indicators alone. In REF2014, while some indicators (citation counts, and supporting text to highlight significance or quality in other ways) were supplied to some panels to help inform their judgements, caution needs to be exercised when considering all disciplines with existing bibliographic databases. Even if technical problems of coverage and bias can be overcome, no set of numbers, however broad, is likely to be able to capture the multifaceted and nuanced judgements on the quality of research outputs that the REF process currently provides.[18]

RRI INDICATORS

The Responsible Research and Innovation initiative provides a plethora of objectives, recommendations and resources for use by different stakeholders, including policy and funding institutions, on different levels of the research environment and in different stages of the research process.[21]

RRI Indicators and Trends[23] might be especially useful. They provide selected quantitative and qualitative indicators which help to put the RRI Trends country reports in perspective. The selected indicators cover the following topics:

- Science in Society
- Innovation Capacity
- R&D Intensity

- Interaction of Public and Private Research
- Gender Equality
- Research Excellence

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