

# The SHAPE of Research Impact

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*“Engineering and medicine are the handmaidens to society. They provide solutions, but they can only be solutions if they are adopted by society. So, I think this government and many governments get it totally wrong. Technology isn’t the solution. Technology can be used, but it can only be used by a society which is made out of individual humans. And if you don’t understand individual humans, you don’t understand what makes an effective culture. There is nothing more important to the survival of society than social science and the humanities”.*

– STEM Panel Member for the Research Excellence Framework, 2021

# Preface

The British Academy and the Academy of Social Sciences commissioned researchers at the Leverhulme Centre for Demographic Science, University of Oxford to examine and uncover “the stories, successes and cumulative effects on people, the economy, policy and society of the impact of research in the SHAPE (Social Sciences, Humanities and the Arts for People and the Economy) disciplines” within the United Kingdom’s Research Excellence Framework 2021 (REF2021). The project was tendered via a competitive process to provide a robust evidence base for the higher education sector and policymakers to articulate the value of research and its impact on society in the UK and around the world. The report, an accompanying online dashboard, and an enhanced REF2021 dataset aim to serve as a starting point for the SHAPE community to explore the scope and reach of their evidence base.

The report leverages the Research Excellence Framework 2021 Impact Case Study (ICS) dataset to reveal new insights about the contribution of SHAPE to the wellbeing of society, culture and the economy. The Research Excellence Framework is the UK’s system for assessing the quality of research in higher education providers. The results are used to inform the distribution of approximately £2 billion per year of public funding for universities’ research. The publication of ICSs presents an opportunity for the research community to demonstrate the broader footprint of their research and to recognise the achievements and successes of research across the UK.

We develop and apply a novel mixed-method approach. The bulk of our work is based on a joint machine-learning and human feedback approach which applied the most advanced generative artificial intelligence models to identify key topical clusters of SHAPE impact, which were then further refined via manual recoding efforts. We focus on ICSs submitted within SHAPE disciplines, in the social sciences (Panel C, N=2,146), arts and humanities (Panel D, N=1,528) and Psychology, Psychiatry and Neuroscience (Unit of Assessment 4, N=326), sometimes in comparison to other non-SHAPE disciplines (total ICSs N=6,361). We supplement the REF2021 ICS database with newly developed material, which includes our topic modelling results, scientometric information obtained from Dimensions and OpenAlex databases, and the REF environment and REF quality databases. These results are then interrogated and enhanced with in-depth narrative qualitative interviews (N=48), as well as information from a questionnaire answered by SHAPE panel members (N=263) with the intention of revealing the stories and successes of the impact of SHAPE activity. The project was overseen by a Steering Group consisting of representatives from business, academia, UKRI funders, and Fellows of the British Academy and the Academy of Social Sciences.

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# Executive Summary

The overarching question commissioned for this report asked:

*“What are the stories, successes, and cumulative effects of research in the SHAPE (Social Sciences, Humanities and the Arts for People and the Economy) disciplines on people, the economy, policy and society?”*

Through the lens of this guiding question, we uncover narratives that chronicle, categorise and celebrate the stories of SHAPE research impact, while simultaneously providing data-driven empirical descriptions of the nature and types of impact. **SHAPE impact comprises ten ‘Grand Impact Themes’** that emerged from 84 distinct topics uncovered by generative artificial intelligence combined with human calibration of the results:

## 1. Arts, Literature and Design

This theme included case studies developing novel music and auditory experiences; preserving musical heritage; celebrating the four nations’ literary and language heritage; fostering community and inclusion through performance and theatre; developing and implementing arts-based approaches to health and social care; and impact in the areas of design, fashion, illustration and the digital humanities.

## 2. History and Cultural Heritage

This theme included multiple examples where research had invigorated heritage institutions and industry by informing museum exhibits and re-inventing curation. This also encompassed engagement with historical sites and archaeological findings, film projects, and historical commemoration events. Many case studies raised awareness of and undertook public engagement with less well-known historical areas, impacting community identities and informing policy.

## 3. Education and Teaching

This theme contained instances where research has influenced teaching techniques, curricula and teacher training; educational policy reforms; resource development and subject-matter related insights; social mobility initiatives; and programmes for disadvantaged students. This also included educational initiatives to preserve language diversity across all nations and regions of the United Kingdom.

## 4. Business, Economics and Management

This theme featured research as a driver of business and economic innovation. This included businesses founded by researchers or created off the back of new inventions or business solutions. It contains examples of researchers improving technology and management practices in existing companies, providing policies and advice for SMEs and start-ups, supporting entrepreneurialism, and generating mechanisms for increased productivity and the creation of regional business and innovation hubs. Research on macroeconomic policy and central banking produced advances in practices that supported stability in the economy, helping to

avoid financial crises. Research changed institutional practices and financial market research and was picked up in myriad of ways by pension funds and asset management firms. Another key focus was research protecting consumers through smart regulation of markets and legal safeguards as well as research improving development interventions and international aid.

### **5. Employment**

Research led to changes in workers' rights, conditions and wellbeing and fostered workplace improvements for both employees and employers. It impacted pay and labour law regulations as well as access to workplaces and rights protections for disabled individuals, minorities, and vulnerable groups. Researchers sought to develop ways to improve justice within the workplace as well as efficiency in market regulation, taxation and benefit schemes.

### **6. Crime and Exclusion**

Impact in this theme focused on crime reduction, policing, the criminal justice and prison systems, fighting hate crime, reducing substance abuse, preventing torture and protecting human rights.

### **7. Family and Gender**

This included examples where researchers used evidence to help vulnerable families, change regulations to protect children and mothers, and provide evidence-based care and education for children both within the family setting and in social care. Research influenced charitable and state organizations providing social services and influenced family policies with the goal of child and family wellbeing. Efforts included the strengthening of rights for children, victims of domestic abuse as well as the protection of reproductive rights.

### **8. Governance and Law**

Case studies in this theme improved governance, regulations, and legislation in both the international arena as well as domestically, with a focus on media, human rights, political processes and NGO activities. Impact strengthened civil society, civic norms and democracy to prevent political violence, conflict, and marginalisation. This also included providing expertise to complex regulatory and legal questions, including work on the UK's departure from the European Union and its effects on trade and immigration, as well as on cybersecurity, privacy and data.

### **9. Health and Wellbeing**

This theme spanned impact from sports and nutritional science to managerial and technological innovation in treatment that improved the efficiency of the National Health Service. It included diagnosis and behavioural-led interventions that improved care, support and therapeutics for specific diseases, alongside other novel approaches to support neuro-diverse and physically disabled individuals. Humanities, design and arts inspired approaches to healthcare and therapeutics were integral to many projects. Research also informed policy and funding for health services as well as the training and support of healthcare professionals.

### **10. Sustainability and Infrastructure**

Impact case studies within this theme show how researchers developed tools and policies that changed regulations related to sustainability, ecosystems and biodiversity, carbon

reduction, net zero, energy management, green energy supply, climate change mitigation, sustainable agriculture, and food supply. This theme also included impacts on the design and development of built infrastructure and road improvement, urban planning, disaster management, and housing.

ICS submissions were first assigned to topics according to which topic they had the highest probability of belonging to according to the language model generated by artificial intelligence. This assignment was then manually verified by two independent researchers to further enhance the algorithm-generated mapping based on language proximity, to more adequately reflect a mapping based on the human interpretation of meanings. We recognise that any method that reduces complex material into typologies masks nuance, and note that in many instances, impact case studies often span multiple themes.

## Key findings

**SHAPE impact occurs across many disciplines and realms of society.** Impact that has been influenced by SHAPE research penetrated virtually all scientific disciplines and realms including technological, industrial, health and environmental impact. Impact ranged from developing new technologies and spinouts to changing policies, legislation, and international regulations; from reviving regional and local economies to preserving and expanding a rich cultural, literary and artistic heritage. Public knowledge was increased, perceptions and behaviours were changed, and regulations and policies were introduced across a range of settings, including teachers employing better pedagogical tools, improvement of consumer protection in diverse markets, encouraging communities to celebrate their heritage, and reduction of energy costs through better grid management and environmentally sound buildings and behaviour.

**SHAPE research and impact is highly inter- and multi-disciplinary.** Scientometric analysis of the research underpinning ICSs in SHAPE Units of Assessment and their disciplinary ‘tagging’ within the REF2021 database revealed that it was both highly multidisciplinary (draws knowledge from different disciplines but stays within their boundaries) and interdisciplinary (synthesises and harmonises disciplines into a coherent whole). Cooperation occurred most often in closely related fields, but with considerable novel collaboration across SHAPE with disciplines in medical sciences and other STEM fields. We frequently found underpinning research for SHAPE impact in Mathematics, Biomedical Science, and Information Technology. Multidisciplinarity was also notable between less traditional combinations spanning SHAPE and STEM when observed at an aggregated level of disciplinary groups. For social sciences, there is evidence of multidisciplinarity with the physical sciences, while for the humanities multidisciplinarity was observed with medical sciences.

The technique employed highlights core topics and themes for SHAPE and does not set out to explicitly compare SHAPE with STEM. Nevertheless, simple Grade Point Average calculations reveal **no substantive difference in assessed quality** between Panels or Units of Assessment.

**Beneficiaries of research were concentrated in the UK but span a global geographical context.**

The UK was the most prominent beneficiary in the humanities (Panel D), social sciences (Panel C), and Psychology, Psychiatry and Neuroscience (Unit of Assessment 4). Most impact was centred on beneficiaries in the UK, Western Europe, the United States, and Australia. International impact was also concentrated in certain areas such as China and India. The geographical distribution of impact varies substantially by research area, and, importantly, the geography of beneficiaries should not be conflated with the ‘reach’ of impact. The varied geographical impact is underpinned by particularly strong and direct impact in Scotland, Wales and Northern Ireland, where much local impact was achieved as further evidenced by our wide-ranging set of qualitative interviews.

**SHAPE funding within UKRI is found to be supporting a considerable proportion of impact case studies.** UK Research and Innovation (UKRI) funding represented 25.64% of funder acknowledgements across all Panels and were key to the success of many ICSs. The ESRC represented 14.42% of all funder acknowledgements in Panel C and the AHRC represented 22.75% in Panel D. These two funders also made contribution to STEM research impact, and numerous mentions are observed in ICSs submitted to Panels A and B. The two SHAPE-relevant Research Councils received 2.36% (ESRC) and 1.26% (AHRC) of the total UKRI budget in 2021.

**An interactive, data-driven dashboard and enhanced REF 2021 dataset accompany this report (available at [shape-impact.co.uk](https://shape-impact.co.uk)).** It brings together the quantitative and qualitative elements of this analysis, including a searchable topic option, division of ICSs by topic clusters, top funders of each topic, and their Unit of Assessment and geographical impact in the UK and globally. Descriptions and example case studies bring the 84 topics of this report to life on the dashboard.

**Limitations and caveats** are that this report only examines ICSs which were selected for submission within the confines of the REF2021 eligibility and definitions, and thus only represent a fraction of the impactful research conducted by SHAPE researchers at Higher Educational Institutions in the UK. Our mixed-method approach is designed to highlight key exemplars of SHAPE impact as commissioned and is not in any way an evaluation of the ICS submitted as part of REF2021.

# 1.0 Background, Aims, and Methodology

## 1.1 Background and Aims

The British Academy and the Academy of Social Sciences commissioned the authors of this report to examine and uncover “the successes and cumulative effects on people, the economy, policy and society of the impact of research in the SHAPE disciplines” within the United Kingdom’s Research Excellence Framework of 2021 (hereafter REF2021). REF2021 was the UK’s system for assessing the quality of research in UK Higher Education Institutions (HEIs), and the results are used to inform the distribution of approximately £2 billion per annum of public funding for universities’ research (see Pinar and Horne, 2022 for a comprehensive overview; UKRI Research England et al., 2021b, 2021a).

During the REF2021 process, HEIs were evaluated across three areas: research output, impact, and environment. The publication of ICSs serves as the primary tool to measure the impact of research (Bornmann et al., 2019) and presents an opportunity for the research community to recognise the achievements and successes of research across the UK (see Box 1). This project was commissioned to provide a robust evidence base which the higher education sector and policymakers can access to articulate the value of SHAPE research and its impact on society in the UK and around the world. The report also aims to serve as a starting point for the SHAPE community to explore the scope and reach of this evidence base.

Using the REF2021 ICS textual corpus as a basis and supplementing it with environmental and research quality ratings, bibliometric data, generated topics, and qualitative interviews, we investigated the following research questions:

- What are the main **topic areas** and overarching ‘**Grand Impact Themes**’ of SHAPE impact?
- What are some **key stories, successes and cumulative effects** of SHAPE impact on people, the economy, policy and society?
- What are the **defining features of SHAPE impact generation**, namely by multi- and inter-disciplinarity, gender representation, and the geographies of impact?<sup>2</sup>
- How can we build an **engaging, intuitive, and open-access online digital dashboard** that allows policymakers, funders, researchers, industry, political and other public bodies, to search, engage with and champion SHAPE impact?

## 1.2 Data and Design

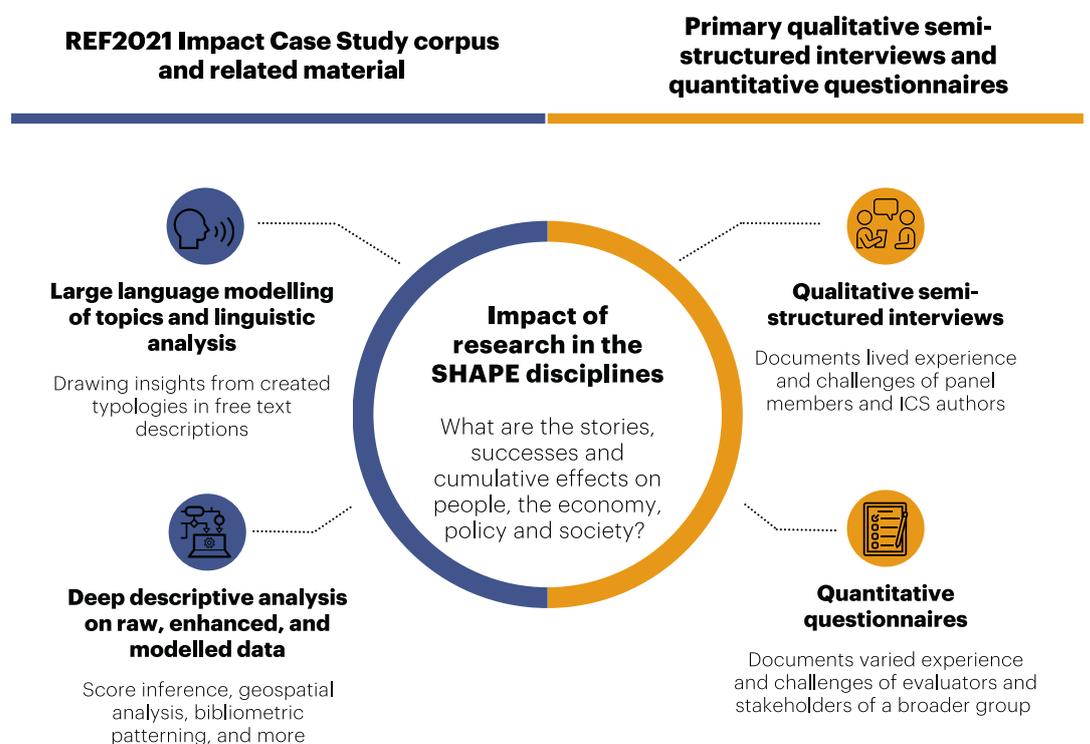
The research adopts an ‘Open Science’ approach that allows the textual and quantitative analysis of ICS to complement each other and be fully reproducible.<sup>3</sup> As illustrated in Figure 1, we developed a novel mixed-methods approach that combines the frontier of generative artificial intelligence (AI) based large language models with ‘human in the loop’ style analysis (Filippova et al., 2019) to identify 84 key topics and group them into ten higher level aggregations, which we term ‘Grand Impact Themes’. We subsequently use this typology to show how SHAPE impacts our world. Our quantitative work focuses on analysing

<sup>2</sup> We note that there are multiple important ways to examine variation and diversity. We examine gender diversity since it is the most feasible and practical given the type of data available. We note that other types of diversity such as ethnicity, class and intersectionality are important, but outside the scope of the data available and current report.

<sup>3</sup> The code to reproduce this project is available in its entirety via Github ([github.com/OxfordDemSci/ICS\\_Analysis](https://github.com/OxfordDemSci/ICS_Analysis)) and via an equivalent Zenodo repository, with a DOI available upon request from the authors.

the REF2021 ICS corpus submitted within SHAPE disciplines in Panel C (Social Sciences, N=2,146), Panel D (Arts and Humanities, N=1,528) and Unit of Assessment 4 (Psychology, Psychiatry and Neuroscience, N=326), a subset of all ICSs submitted to REF2021 (total N=6,361). We supplement the REF2021 ICS database (and its associated dataset which contains ‘tags’) with a large bibliometric database (licensed from Dimensions, a subsidiary of Digital Science), REF environmental and REF research quality databases, generative AI modelling, and other customised fields and metrics which we feature engineer, both programmatically and through a process of extensive manual curation. This is then enhanced with qualitative interviews of REF panel members (N=36), case study authors (N=12), and, in parts, quantitative surveys of SHAPE REF panel members (N=268). Where appropriate, we discuss pertinent methodological issues, primarily in Section 3. The ‘Enhanced REF 2021 ICS Dataset’ is made available on our online interactive dashboard ([shape-impact.co.uk](http://shape-impact.co.uk)), and in our supplementary online materials.

**Figure 1. Overview of data, analytical methods, and contribution of each approach**



### **Box 1. What are Impact Case Studies and how were they evaluated?**

Impact Case Studies are the REF’s primary tool for measuring research ‘impact’ (Bornmann et al., 2019). Case studies are supplemented by an institution-specific impact report that outlines the institution’s approach to, and resources for, achieving research impact (Greenhalgh et al., 2016). These case studies are meant to measure the scope and importance of research impact on broader society beyond academia, including their impact on culture, the economy, and public policy (Reichard et al., 2020). In REF2021, ICSs contributed 25% of a total REF score within each institution’s Unit of Assessment (UoA) submission (which may or may not be a specific department within a university, as it can also be a cluster of related sub-units).

Each case study is between four to five pages long. They are formatted according to a prescribed template (Bornmann et al., 2019) with maximum and indicative lengths. Case study components include an impact summary (100 words), supporting research (500 words), research references (up to six references), impact details (750 words), and impact references (up to ten references). Those reporting continued or longer-term impact were permitted to describe research impact achieved during the twenty-year period prior to REF2021, although our qualitative interviews suggest that some still interpreted the guidelines as impact having to occur within the same five-year window. After each REF, submitted case studies are made available via a public, searchable database.

Panels of academic peer reviewers and research users evaluated each case study, giving it a qualitative assessment from unclassified to between 1\* to 4\* (Greenhalgh et al., 2016; Reichard et al., 2020). Case studies in 2014 with ongoing and longer-term impact only counted as being a 'continuing' body of work if they used the same body of work from an ICS submission in a previous REF cycle. In 2021, adding additional pieces of evidence did not need to constitute a new case study and could be classified as continuing.

### 1.3 Generative AI: Large Language Model Based Classification

Our primary mode of analysis is a sophisticated large language model (LLM) built in BERTopic (Grootendorst, 2022), situated against the backdrop of the increased utilisation of machine learning and generative AI within the social sciences more broadly (Rahal et al., 2022). The model takes free text written about an ICS as the input, with the aim of capturing the rich narratives of ICS text to reduce complexity and create coherent groupings of topics and hierarchical clusters of typologies. The approach utilises three primary steps: 1) dimensional reduction of word representations; 2) clustering corpuses; and 3) calculating topic representations. To accomplish this, we trained our model on the combination of three response fields in the raw REF2021 database: '1. Summary of the impact', '2. Underpinning research', and '4. Details of the impact'.

Our BERTopic-based algorithm identified an initial 83 distinct topics across the nearly 4,000 SHAPE-related REF2021 ICSs, of which an additional topic was added during the manual reassignment phase making it 84 topics in total. For each ICS, BERTopic calculated the probability of it belonging to each identified topic. We then initially assigned the ICS to the topic with the highest probability. We set thresholds such that every ICS belonged to one singular topic, as long as the highest probability for an individual topic was greater than 0.01. It should be noted that some case studies had similar probabilities of being assigned to multiple topics, given the inter/multidisciplinary, multi-topic content of some documents in the corpus. The strength of this method is that it provides an objective way to assign an ICS to an overarching topic (i.e., using the highest probability), as opposed to purely manual and potentially subjective allocations. However, it suffers the universal challenge of any method that attempts to reduce complexity and draw out key topics and themes: by virtue of this reduction in dimensionality, some of the more nuanced aspects of the case study texts remain unseen.

We then cross-validated our results with multiple human reviewers which validated the suitability of topics suggested by the algorithm. The primary insight of expert recoding was that the language model provided meaningful topical blocks capturing diverse and internally consistent areas of impact, but that topical fit based on meaning rather than purely on language proximity could be improved via manual reassessment. This process considered: i.) partially

or entirely breaking up topics where clearly different domains had been clustered together due to bridges of language proximity (n=4), and ii.) creating novel topics where a coherent ensemble was identified in the residual case studies (n=2). This left us with a total of 84 final topics with no residual category. We then individually verified the fit of each ICS into the assigned topic and reassigned ill-fitting ICSs as well as those in the residual topic to clusters that made meaningful sense for them (1,366 ICS or 34% reassignment rate). Reassignment was primarily done among ICSs to which the model assigned a low probability of fit, highlighting the capacity of the model to span a meaningful topography of impact areas but also its limitations in fitting often differently worded ICSs into these topics meaningfully at the margins. Once we had humanly verified the integrity of the topics with multiple coders, we used a combination of expert domain knowledge and dendrograms to group the topics into ten broad high-level 'Grand Impact Themes'. The relative frequency of ICS topic assignment by UoA, and how they fit within the Grand Impact Themes, are shown in Figure 2.<sup>4</sup> Table 1 displays the names (x-axis, Figure 2) and descriptive statistics of all UoAs to which ICS submissions can be made, along with the distribution of key properties amongst them. A lookup table which maps an ICS to topics, topics to short and long topic names, and topics to 'Grand Impact Themes' is available in our accompanying online supplementary material (found at [shape-impact.co.uk](http://shape-impact.co.uk), see file: topic\_lookup.csv).

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<sup>4</sup> Note that Figure 2 utilises 'short' names for each of our topics, which are subsequently grouped into the ten Grand Impact Themes therein (which are also represented via their 'short' name). The full names of both levels of document clustering can be found in a lookup table in our online supplementary materials.

**Figure 2. Visualising the Relative Frequency of Final Topic Allocation Across UoAs, Topics, and Grand Impact Themes.**



As an aid to interpret Figure 2, consider the first listed topic, which has the ‘short’ name of ‘Music’ (top row of graphic), which represents a group of ICSs with the ‘long’ topic name titled ‘Music and Acoustics’. The ICSs are mapped according to relative frequency and UoA, with relative frequency shown on a scale from 0 (light blue) to 0.8 (dark yellow). Here we see a very strong average weight of concentration in UoA 33 (Music, Drama, Dance, Performing Arts, Film and Screen Studies), signified by the yellow colour on the legend scale. Focusing on the first ‘Grand Impact Theme’ of ‘1. Arts’ (shown in top right hand of graph), we see that there is a high overall concentration within the aforementioned UoA 33, as well as UoA 27 (English Language and Literature), UoA 31 (Theology and Religious Studies) and UoA 32 (Art and Design: History, Practice and Theory). This figure and general analytical design also permits us to consider the absolute number of topics which a UoA spans. For example, UoAs 15 (Archaeology), 24 (Sports and Exercise Science, Leisure and Tourism), and 29 (Classics) span the fewest topics, and UoAs 17 (Business and Management Studies), 20 (Social Work and Social Policy), and 28 (History) span the largest number of topics.

**Figure 3. Distribution of Topic Weights and Reassignment Probabilities**

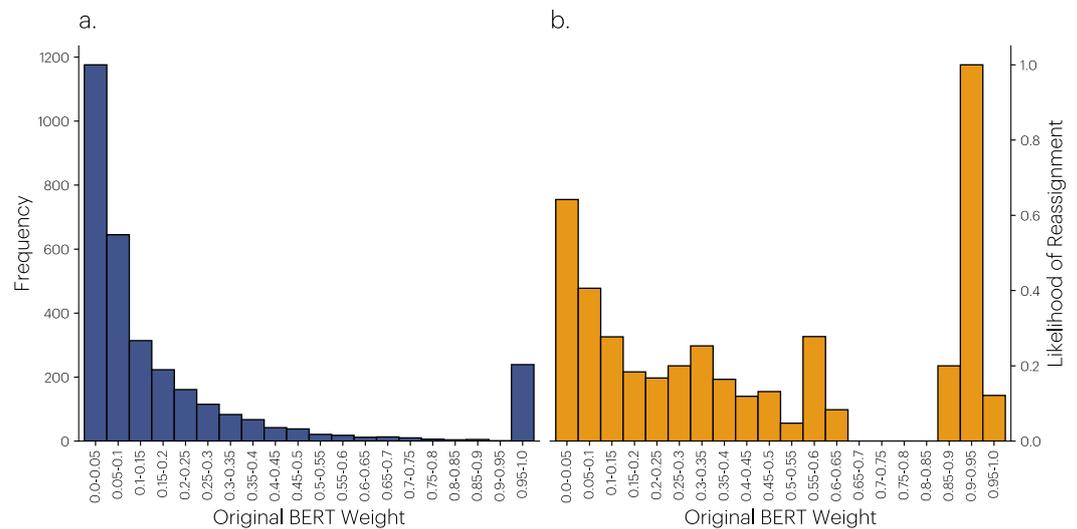


Figure 3 illustrates the distribution of weights (Subfigure a.) and the distributed likelihood of manual reassignment across these weights (Subfigure b.). It emphasizes the degree of manual reassignment required to sharpen the topic fit of ICSs after the initial assignment based on BERTopic model probabilities. We can see that a modest amount of ICSs were assigned with considerable uncertainty (i.e., low ‘highest’ weights), and that this is where the majority of reassignment took place. The bar on the right shows that there was also a certain, but relatively fewer, number of defining case studies with very high ‘highest’ weights which required manual assignment (e.g. in the 0.85-1.0 region).<sup>5</sup> In total, we reassigned 34.2% of ICS into new topics (29.45% for UoA 4, 31.78% for Panel C, and 38.22% for Panel D).

## 1.4 Roadmap

The ten clustered Grand Impact Themes are individually described in detail in Section 2, providing a breakdown of impact generated and submitted to SHAPE-related UoAs in REF2021. Each subsection contains examples of impact, specific case studies, quantitative facts, and various visualisations as a function of our manual review. Section 3 analyses ICSs across the social sciences and humanities as broad subject bodies. Section 4 describes our interactive online dashboard, and Section 5 provides concluding remarks and reflections.

<sup>5</sup> The .9-.95 probability range is an outlier, since there is only one case study in this category and does not affect this overall interpretation.

**Table 1. Distribution of Key Environmental Statistics across UoAs**

Panel	UoA	Unit of Assessment	ICS (#)	ICS (%)	FTE	PhD Degrees	Income (£bn)
A	1	Clinical Medicine	254	3.99	4879	12174	9.88
A	2	Public Health, Health Services and Primary Care	151	2.37	2032	2799	3.23
A	3	Allied Health Professions, Dentistry, Nursing and Pharmacy	393	6.18	4704	9203	1.69
A	4	Psychology, Psychiatry and Neuroscience	326	5.12	4040	10528	2.68
A	5	Biological Sciences	192	3.02	2816	9245.3	3.9
A	6	Agriculture, Food and Veterinary Sciences	103	1.62	1293	2904	1.03
B	7	Earth Systems and Environmental Sciences	148	2.33	1772	4062	1.27
B	8	Chemistry	113	1.78	13892	6687	1.55
B	9	Physics	169	2.66	2214	6442	2.51
B	10	Mathematical Sciences	176	2.77	2407	4426	0.68
B	11	Computer Science and Informatics	271	4.26	2938	6518	1.35
B	12	Engineering	391	6.15	7253	23725	6.97
C	13	Architecture, Built Environment and Planning	127	2	1497	2452	0.33
C	14	Geography and Environmental Studies	180	2.83	1855	3051	0.58
C	15	Archaeology	59	0.93	497	1189	0.21
C	16	Economics and Econometrics	88	1.38	911	1427	0.19
C	17	Business and Management Studies	504	7.92	6634	9200	0.52
C	18	Law	226	3.55	2494	3129	0.17
C	19	Politics and International Studies	166	2.61	1963	3413	0.26
C	20	Social Work and Social Policy	222	3.49	2105	2751	0.37
C	21	Sociology	107	1.68	1104	1997	0.27
C	22	Anthropology and Development Studies	77	1.21	614	1479	0.17
C	23	Education	230	3.62	2168	6155	0.39
C	24	Sport and Exercise Sciences, Leisure and Tourism	160	2.52	1453	1881	0.15
D	25	Area Studies	57	0.9	532	888	0.08
D	26	Modern Languages and Linguistics	154	2.42	1556	2924	0.16
D	27	English Language and Literature	273	4.29	2671	4549	0.14
D	28	History	240	3.77	2341	3773	0.24
D	29	Classics	48	0.75	448	793	0.06
D	30	Philosophy	85	1.34	692	1320	0.1
D	31	Theology and Religious Studies	68	1.07	505	1723	0.06
D	32	Art and Design: History, Practice and Theory	262	4.12	2566	2937	0.24
D	33	Music, Drama, Dance, Performing Arts, Film and Screen Studies	196	3.08	1375	2200	0.08
D	34	Communication, Cultural and Media Studies, Library and Information Management	145	2.28	1258	1579	0.09

## 2.0 The SHAPE of Impact: Ten Grand Impact Themes

Our generative AI model clusters SHAPE impact into ten ‘Grand Impact Themes’. The themes were made up of a collection of topics, which themselves were made up of ICSs, assigned via a combination of the large language model and manual review. In this section, we describe each of these ten core themes in detail, beginning with a brief overview of key facts. We then provide examples of impact via ‘deep dives’ into selected ICSs from each Theme. Those desiring a deeper understanding of each of these impact areas are encouraged to visit our online interactive dashboard and accompanying enhanced REF 2021 dataset, described later in this report (Section 4). As noted in Section 1, reducing thousands of ICSs into discrete topics and Themes can result in some loss of nuance, particularly since multiple ICSs display topic co-membership. For example, an ICS that used dance for therapy may have been classified in the first Theme ‘Arts, Language and Design’, whereas a similar arts project with a strong health focus may have been placed within the ‘Health and Wellbeing’ theme. We tried to minimize loss of nuance through extensive human validation reassignment to maximise fit to ‘topic meaning’. Despite our intensive effort to assign an appropriate topic to every case study, we acknowledge the models' limitations in assigning meaningful categories based on language proximity in every single case.

Table 2 summarizes some of our key quantitative findings for each of the ten themes, and Table 3 provides the key facts for the research which underpins each of the ICS themselves, drawn from our analysis of the Dimensions bibliometric database (where each row in Table 2 and 3 corresponds to each ensuing subsection of Section 2.1-2.10). It shows the inferred distribution of gender in research underpinning ICSs, the distribution of publication type (not including preprints), the highest Altmetric Attention Score, the highest citation score, and the highest individual Relative Citation Ratio (RCR) for ICSs in each of the ten Grand Impact Themes. We make two key clarifications about this analysis, made possible using the Dimensions bibliometric database. First, we note that gender is just one way in which diversity could be examined, but other characteristics such as ethnicity are fraught with problematic measurement issues. Additionally, our inference of gender is naive (simplifying to male and female names alone), in that it is based solely on a cache of administrative data as opposed to a more methodologically sophisticated approach or to self-reported measures. We also clarify that the scientometric evaluations of the highest scoring individual pieces of research are purely for the interested reader and were not part of the explicit set of information considered in the REF 2021 ICS assessment exercise.<sup>6</sup>

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<sup>6</sup> The Altmetric Attention Score provides a composite, weighted measure of how much attention an individual article has achieved. While not without controversy, it largely measures a piece of research's reach beyond typical academic channels through dissemination via ‘popular’ channels such as social and news media. The citation count is a measure of the number of citations discovered within a large bibliometric database. The RCR is a citation-based measure of the scientific influence of a publication, comparing an individual output with the median output in that field. It is crucial to note that the value of citations as an indicator of scientific influence can strongly vary across different fields and is not easily interpretable as equivalent to influence in many domains.

**Table 2. Key Facts Across Ten Grand Impact Themes**

<b>Grand Impact Theme</b>	<b>ICS (#N)</b>	<b>Modal Topic</b>	<b>Modal UoA</b>	<b>Modal Funder</b>
1. Arts, Language & Design	426	Music	33	AHRC
2. Archaeology, Exhibits & Galleries	613	Heritage & Archives	32	AHRC
3. Education, Teaching, Skills	290	Teaching	23	ESRC
4. Business, Economics and Management	349	Business	17	ESRC
5. Employment	187	Labour	17	ESRC
6. Crime & Exclusion	247	Crime & Justice	18	ESRC
7. Family & Gender	272	Family & Social Support	20	ESRC
8. Governance & Law	583	Politics, Trade & EU	19	ESRC
9. Health & Wellbeing	668	Sport & Health	4	NIHR
10. Sustainability & Infrastructure	365	Conservation	14	ESRC

**Table 3. Key Facts of Underpinning Research Across Ten Grand Impact Themes**

Theme	Gender (%)	Publication type (%)					Highest Scientometric Scores		
		Article	Chapter	Book	Monograph	Proceeding	Altmetric	Citations	RCR
1. Arts, Language & Design	51.42	69.4	11.27	4.03	13.69	1.61	1645	761	34
2. Archaeology, Exhibits & Galleries	44.27	73.56	8.72	5.36	10.92	1.15	5603	9298	231
3. Education, Teaching, Skills	57.60	86.32	5.44	3.45	4.12	0.13	692	1478	8
4. Business, Economics and Management	28.37	88.37	3.38	1.99	2.98	0.4	305	1701	3
5. Employment	39.28	90.3	3.93	0.93	2.08	0.23	773	1033	6
6. Crime & Exclusion	56.04	86.14	4.21	1.58	5.61	0.53	1022	501	14
7. Family & Gender	66.34	86.01	5.19	2.99	4.25	0	1085	1048	31
8. Governance & Law	39.27	79.73	5.68	3.88	7.84	0.72	1917	936	61
9. Health & Wellbeing	45.53	93.59	2.6	0.87	1.93	0.34	2777	5548	255
10. Sustainability & Infrastructure	35.00	93.36	1.68	1.09	2.18	0.42	2160	3638	50

## 2.1 Arts, Literature and Design

*“...impact has been helpful for the arts and humanities as we try to win hearts, minds, and funding. Impact has given humanities disciplines another way to demonstrate the broader resonance of their work.”*

– Humanities Panel Member

This vibrant Grand Impact Theme is driven by the arts and humanities, operating to preserve and reinterpret traditional and contemporary material (music, literature, poetry, dance) while also fostering social inclusion, cohesion and a deeper sense of identity. The core topics in this area represented a broad range of impact emanating from the arts and culture, literature, fashion, design, dance, performance, and immersive virtual reality (VR), with key facts summarised in Figure 4.

Within the broader Arts, Literature and Design impact area, several sub-topics emerged. Music and acoustic-based research flowed from university corridors to reach large local and international audiences. Music-based projects preserved, rediscovered, and re-interpreted traditions, ranging from classical composers and ancient church music to traditional music that plays a central part in preserving and celebrating cultural identities (e.g., in Mali and Cuba). Technological advances were developed and implemented, such as new machine-learning software for musical composition, audio design for commercially successful racing video games, and soundscapes for museums and heritage sites. Another core element within this topic was education and broadening engagement, with the development of apps to make classical music more accessible to younger audiences, new software to allow students to compose music within educational curricula, and measures to increase access to music education for disadvantaged groups. Researchers also supported the UK music and festival industry through innovative approaches to curation and audience engagement, and ticketing and on-site software applications for festival goers. As one REF panel member noted, impact in performing and curatorial arts flourished, despite significant COVID-19-related challenges and site closures.

*“Almost a quarter of the impact case studies which were reviewed on my panel included COVID-19 impact statements. This proportion is one of the highest of any subpanels and illustrates the effects of the pandemic on the performing arts disciplines. However, the imagination through which people still found ways to undertake impact despite the pandemic were incredibly impressive.”*

– Humanities Panel Member

Another striking topic was the area of arts and performance for heritage and community. Theatre research exited the stage and entered classrooms and educational settings, with efforts in retelling the history of theatre and in active performance to make theatre more inclusive and participatory, and projects highlighting the roles of different communities. There was particularly strong engagement with the elderly and young people, such as conceptualising care homes as cinematic communities and theatre designed to encourage youth participation. Work was also fruitful in raising awareness of marginalised groups, such as deepening public understanding of migrant and refugee experiences. This topic included, for example, an award-winning ten-part BBC Radio 4 documentary on the historical contributions made by artists of African and Caribbean descent to British theatre, film and television.

Therapeutic art, which appeared both in this grand theme as well as in the Health and Wellbeing theme was full of novel applications with different approaches to performance, music, play, and other forms of art as therapeutic tools to assist various groups (e.g., maternity, dementia, autism). Performance and theatre were also employed for societal engagement,

such as performances at the bedsides of sick children and projects engaging audiences to raise awareness in areas such as the environment or discrimination.

The topics of ‘Language, Poetry and Translation’ and ‘Literature, Authors and Libraries’ represent a core aspect of this theme, engaging the public in performances and events, rediscovering voices of past artists and local communities, and providing forums to perform, read, and celebrate the diverse language traditions of the nations of the UK. Work on authors and in support of libraries enhanced education and the promotion of reading, influenced library policies, gave voice to marginalised artists through poetic expression, and raised awareness about important writers and literary traditions within and beyond the four nations of the UK. Material design, textile and fashion ICSs celebrated the history of fashion, while also looking to the future. Research developed fashion and materials that are more environmentally friendly and led to cutting edge advances in textile design that resulted in new technologies.

The topic on cartoons and illustration ranged from the use of comics in history and political satire to children’s picture books which encourage imagination and educational development. A final topic around digital creation, immersive technologies and Virtual Reality emerged, including use of immersive technologies for simulating classroom environments, creating health-based therapies and training, and use of digital and animation techniques for art, performance, video games, and film production. Impact included multiple start-up companies driven by research in the multi-disciplinary creative arts, health, and education sectors.

Research impact in the Arts, Literature and Design theme was diverse, spanning from public engagement and community cohesion to therapeutic interventions, preservation, performance, educational tools, and many new technologies and business spinouts. As one humanities REF panel member noted, capturing this impact via REF2021 showcased the value of arts and humanities research and degrees:

*“Impact can also be used as a way to understand how degrees in the arts and humanities hold and demonstrate value. The value of these degrees which are often viewed as less useful can be illustrated more clearly through impact.”*

– Humanities Panel Member

### Examples of Impact

**Classical music for youth:** Development of an app to introduce younger audiences to classical music, now used by nine of the UK’s leading symphony orchestras and resulting in 11,000 ticket sales for over 200 concerts annually.

**Sound in museums:** Research on sound history led to the enhancement of auditory experiences in many museums, including the 2017 National Science and Media Museum relaunch as the first UK museum dedicated to sound technologies, which included the creation of a Sound Technology Collection. It also generated new creative and digital approaches to exhibiting sound at other museum organisations, including Nottingham City Museums and Galleries.

**Preserving global musical heritage:** Research into West African music led to the formation of an ensemble of Malian musicians reviving a pre-colonial style, touring the world with famous classical musicians, and recording albums, garnering over three million streams.

**Broadening access to Shakespeare performances:** Based on research about bringing theatre to the screen, the ‘Royal Shakespeare Company Live from Stratford-upon-Avon’ project broadened public access (including during the pandemic), reaching over one million viewers and around 376,000 UK pupils in secondary education during the recent REF period.

**Bringing visual and digital technology to modern dance:** Modern visual technologies that allowed dancers to interact with animated 3D counterparts were integrated into acclaimed performances of modern dance and ballet companies, enabling their performances and screenings of their performances to reach an audience of 778,904.

**Improving animation of faces and bodies:** Research improved techniques for character animation for film and video games, reducing the time needed to create a facial rig from several weeks to several minutes. Techniques were used by private sector firm Humane Ltd. and attracted over £1 million in investment including contracts with HBO and Microsoft.

**The world’s largest archive of TV broadcasts:** Considerable recent historical heritage is stored in television programmes. This was the focus of a research project building databases of 2.5 million TV content items. Almost all UK HEIs subscribe to the database, using content from news and documentaries to sitcoms and reality shows to enhance teaching. In total there are 1.7 million programme streams per year.

**Textile research for space technology:** Research into textiles and knitting led to the development of micro-knitting technology that produced a much lighter knitted metal mesh reflector for satellite technology. The product has been adapted by aerospace company Oxford Space Systems.

## Case Study Examples

### Enhancing UK nurse training using drama

“It touches on the emotional aspects of their role that they don’t necessarily talk about in an educational context” says Alex Mermikides, now the D’Oyly Carte Senior Lecturer in Arts and Health at King’s College London, of her work with over 2,500 nursing trainees. Her research in performance studies focuses on health, illness, and disability, which led her to take up a summer residency in the nursing department of Kingston University. Mermikides does “artistic work as a form of research” and thereby develops tools that allow nurses to explore care-giving aspects of their profession, which are rarely included in their education. “Performance is a way of learning those overlooked aspects: the interactions between nurses and patients and the subtle ways you can make a patient feel cared for. There are things anyone can do to increase the chance of someone experiencing an interaction with you as beneficial, as thoughtful, and careful”. At Kingston she worked with professional performers who interpreted students’ experiences of care, first performing in a simulated hospital ward with audiences in the bed. Mermikides summarises the emotional learning that took place in this workshop: “It gave them [trainee nurses] an experience of what it’s like to be a patient, and the vulnerability that results from that”.

Related workshops adapted theatre techniques to enhance sensitive and effective communication, preparing students for the demanding emotional labour required from their profession. What was initially planned as a small-scale summer residency achieved an unexpected reach as 15 other HEIs and one NHS hospital integrated performances, practical workshops, or remote resources into their training programmes. The President of the Royal College of Nursing described Mermikides' work as "a hugely significant contribution to nursing pedagogy", and 90% of workshop participants report a positive effect on their practice. Mermikides is now building on her experience and research in using artistic performance to develop educational resources and experiences for medical students in her new role at King's College.

### **Virtual Reality for Pain Relief**

The Impact VR team at Sheffield Hallam, led by Ivan Phelan, developed immersive VR rehabilitation systems for paediatric and adult patients with neurological and musculoskeletal conditions, orthopaedic trauma, and chronic pain. Of this extraordinarily impactful research, Phelan says simply "it just seems like something you'd want to do".

The research approach was patient and practitioner driven, using observations as well as workshops to prioritise "listening and trying to understand what patients need". In 2014 a simulated virtual interactive experience that allowed amputees to experience what it would be like to use a prosthetic limb was developed in partnership with Sheffield Children's Hospital. In collaboration with Loma Linda University Medical Centre, California, the virtual environment was repurposed as a method for relieving phantom limb pain. Then in 2016-2017 Phelan's team started using immersive VR to distract burns victims during burns dressings, reducing pain and anxiety. In 2017-2019 they developed immersive VR scenarios for children at Sheffield Children's Hospital with upper limb injuries to facilitate less painful and more effective recovery of limb movement.

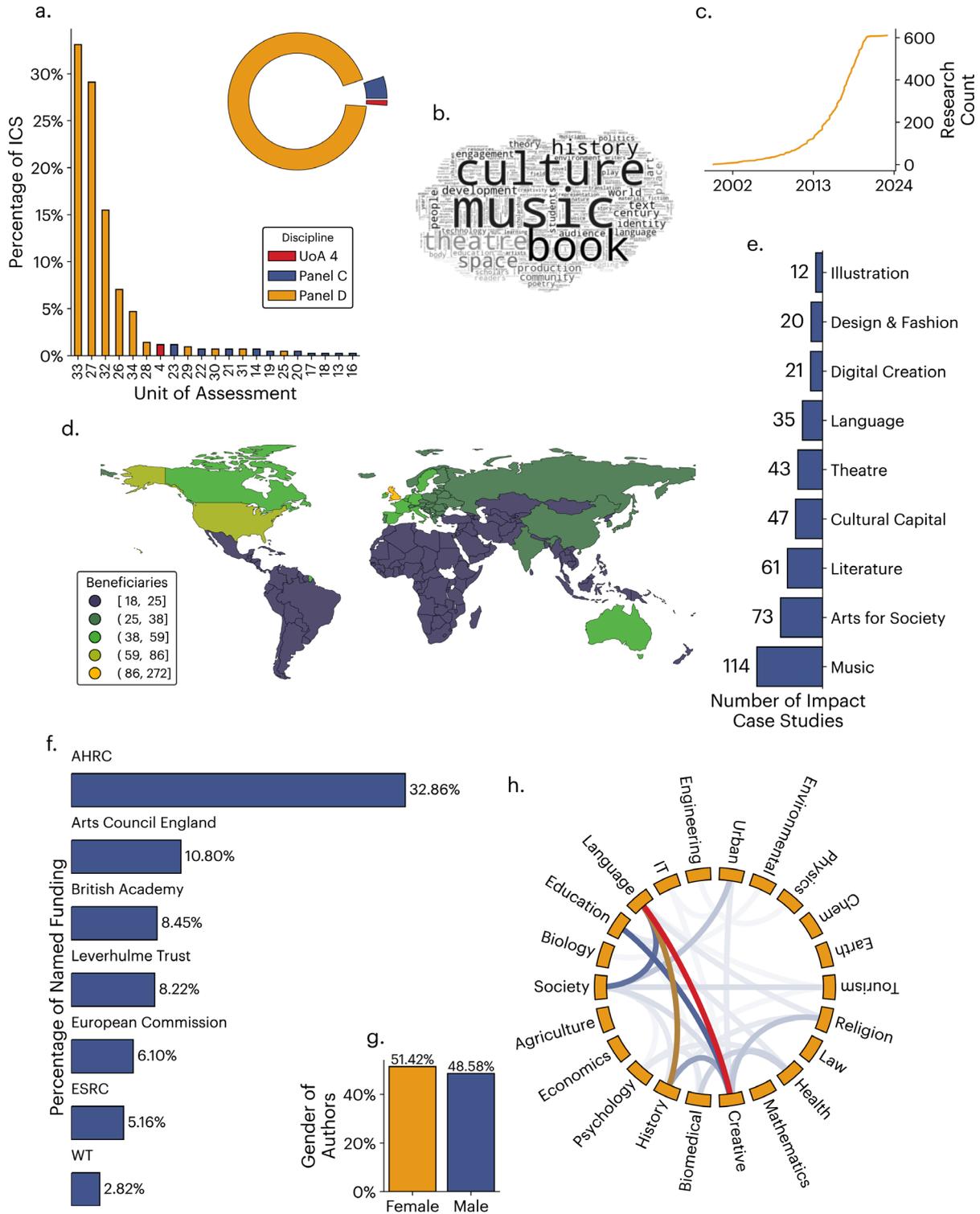
The research enabled more effective execution of care within the NHS where the VR therapy was employed. Burns nurses were able to spend more time changing dressings and providing care which sped up the healing process, reducing the amount of time patients needed to spend on the burns ward by up to half. Physiotherapists participating in the studies predict that VR therapy will become a cornerstone of rehabilitation treatments. Phelan says, "it means less time having to go back to the clinic, and that's a big part of your cost savings".

Widespread interest in the research has drawn further commercial and medical collaborations. The technology is currently used in treatments at Sheffield Children's Hospital and Lucile Packard Children's Hospital Stanford. Other collaborations include the Unreal Engine Enterprise team at Epic Games, which provided Impact VR with a Technical Account Manager and game development software to support medical VR applications and InHealth, who contacted Impact VR to develop a bespoke VR system for chronic pain. Before the COVID-19 pandemic halted the project, the team were involved in the development of a portable version of the system to be trialled in patients' homes to help reduce strain on NHS time and resources. As Phelan says of the work moving forward: "we've had a lot of hospitals reaching out with new onward needs, and everything we do we base around what they're looking for... we're getting better and better at what we do, and we're getting more and more ambitious with what we want to achieve".

### Distinguishing facts of Arts, Literature and Design theme:

- **Impact most prominently located in humanities UoAs:**
  - UoA 33: Music, Drama, Dance, Performing Arts, Film and Screen Studies (33.1%)
  - UoA 27: English Language and Literature (29.11%)
  - UoA 32: Art and Design: History, Practice and Theory (15.49%)
- The five most seen concepts are: ‘music’, ‘culture’, ‘book’, ‘theatre’, and ‘history’.
- **Geographical impact largely in UK and USA:** Primary beneficiary is the UK (272 instances), followed by the USA (86), and then Germany (59).
- **Funding mostly from AHRC and Arts Council England:** The Arts and Humanities Research Council, UKRI was the most prevalent funder, representing 32.86% of all funder acknowledgements, followed by Arts Council England (10.80%).
- **Gender-balance in underpinning research:** Across the underpinning research used to drive this impact, 51.42% of the authors are female.
- **Interdisciplinarity largely within the humanities:** Interdisciplinarity is classified according to ANZSRC (Australian and New Zealand Standard Research Classification).<sup>7</sup> The most commonly occurring interdisciplinarity linkage in the underpinning research are between: ‘Language, Communication and Culture’ and ‘Creative Arts and Writing’, and ‘History, Heritage and Archaeology’ and ‘Language, Communication and Culture’.
- **Academic articles are the most prominent publication type underpinning research:** Most of the underpinning research was published in the form of academic articles (69.4%), with monographs extremely well represented (13.69%).
- The highest Altmetric score (a measurement of the amount of attention received by a publication) within this theme was 1,645 and the highest citation count was 761. The highest relative citation ratio was 34.

Figure 4. Main Characteristics for 'Grand Impact Theme 1: The Arts, Literature and Design'.<sup>7</sup>



<sup>7</sup> Each subsection of Grand Impact Theme analysis contains an associated infographic of equivalent style and structure, split into eight subfigures. Subfigure a. displays the distribution of ICSs across Units of Assessment. Subfigure b. shows a word cloud of the most frequently mentioned concepts of the underlying pieces of research as made available by Digital Science. Subfigure c. shows a cumulative time series plot which details when underpinning research was published. Subfigure d. shows the geographic distribution of beneficiaries of ICSs within this Grand Impact Theme. Subfigure e. shows the frequency of topics observed within a Theme. Subfigure f. shows the distribution of funders as mentioned within the raw REF 2021 data. Subfigure g. shows the distribution of gender within the pieces of underlying research. Subfigure h. shows the interdisciplinarity links between articles underpinning research within this Cluster. Fields of Research are classified according to ANZSRC (Australian and New Zealand Standard Research Classification).

## 2.2 History and Cultural Heritage

*“You know, I think traditionally archaeology has always had its hand on public engagement, moving beyond just simple dissemination, but also to try to generate real change and impacts, with communities”.*

– Humanities Panel Member

The history and cultural heritage of the United Kingdom as well as that of the wider world was safeguarded and brought to life by arts and humanities scholars. A wealth of impact and public engagement has occurred in the realms of archaeology, cultural and historical exhibits, galleries, museums, the heritage sector and the creative industries, with key facts summarised in Figure 5.

Cultural exhibits fuelled by UK university research ignited public curiosity, inspiring people to discover more about the intercontinental Silk Road, explore British tattoo art, reminisce with photos of coastal communities, and support the preservation of multiple castles and other heritage sites. Impact in this theme focused on increasing public understanding and building local identity and engagement, as well as remembering and commemorating the past through exhibits and events, all with the effect of revitalising important heritage sites and fostering public engagement with archaeological findings. A humanities panel member remarked that the REF2021 case studies highlighted the humanities’ “potentially vital role for rebooting the heritage sector”. Commemoration and educational work around historical events (e.g., Holocaust studies, WWII) emerged as topics with substantial impact.

Beyond exhibits, public engagement and preservation, research in this category influenced concrete policy change and resulted in new legal regulations and practices to safeguard archives and heritage. Fresh approaches to heritage management and conservation were developed. These largely focused on fostering public engagement with novel museums and exhibit curation methods. Numerous research-led projects also pioneered involving local communities in collaborations with researchers in archaeological fieldwork. This not only revitalised the cultural life of local communities but has also supported local growth and economic prosperity via tourism. Research likewise led to the development of international protocols and practices, helping to ensure the survival of endangered communities and important cultural artefacts, with UK researchers emerging as global leaders in cultural heritage preservation.

*“I think one of the things that we noted a lot is that archaeology as a subject is quite well situated for impact because it’s had long-established links with professional archaeology, with government agencies, national heritage agencies, overseas partner agencies, museums, and education programmes in schools and so on.”*

– Humanities Panel Member

Strands of historical and archaeological research also took on the most compelling contemporary questions of our times. This ranged from engaging in debates and cultural policymaking around the decolonisation of objects to the application of the most cutting-edge technologies like virtual reality to create immersive museum experiences. Within this Grand Impact Theme, we also saw humanities and arts research in the UK emerging as a superpower in heritage preservation, film, the creative industries, arts, and festivals. This included systems being developed to inform event programming, with university research strengthening curation as well as archival and documentary work to foster public engagement, supporting Britain’s already strong film industry and culture. Like the previous theme, the COVID-19 pandemic affected this area deeply, particularly through site closures.

### Examples of Impact

**Attributing important historical paintings:** The correct attribution of important, often newly discovered historical artworks by art history scholars, including paintings by Caravaggio and Parmigianino, had considerable economic impact on the art market. Caravaggio's Judith Beheading Holofernes achieved a market sale of around £100-150 million. The Parmigianino was estimated to be worth £245 million and was subsequently purchased by the Getty Museum.

**Virtual Reality app for touring Florence:** An award-winning app, developed with scholars in art theory, history and literary studies, allows visitors to experience places they are visiting as they would have been in Renaissance Florence. The digital product, which was developed by a creative industry enterprise, has been downloaded 12,000 times in over 40 countries. The expertise that has underpinned this development has gone on to improve the quality of experience for tourists, contribute to urban heritage management, and shape the branding strategies of regional companies.

**Agincourt 600 celebration:** Historian-led event to commemorate the 600th anniversary of the battle of Agincourt led to 100 projects including concerts, plays, educational resources, and exhibitions commemorating the battle and its place in British history. Events were attended by over 500,000 people.

**Documenting and preserving world cultural heritage:** Researchers digitised and documented over 80,000 unique modernist architectural drawings, maps, and buildings in Asmara, the capital of Eritrea. The effort resulted in a UNESCO Nomination Dossier, allowing Asmara to become inscribed on the World Heritage List.

**A volunteer-run museum for Exeter City fans:** Research into audience engagement influenced exhibitions at museums such as the Tate. It also led researchers to develop community initiatives. Among these is the first volunteer-run sporting heritage museum in Exeter, giving Exeter City fans a space to commemorate their club's history.

**Research-led art exhibits:** Researchers helped conceive and inform many important exhibits, such as the COLOUR exhibit (133,656 visitors) on medieval miniature paintings at the Fitzwilliam Museum and the Raphael exhibit (67,628 visitors) at the Ashmolean Museum. New forms of audience engagement were pioneered, with 58% of Raphael visitors engaging in drawing during their visit, and 3,800 primary school pupils being enabled to engage with how monks used to illuminate paintings in COLOUR-inspired school drawing lessons.

**Digital Rome:** Revolutionizing traditional methods of presenting ancient architecture, researchers developed a 3-dimensional digital reconstruction of ancient Rome, unique in scale and method, offering powerful new ways of studying ancient environments. The model's vivid moving interactive imagery supports innovations in education (for pupils; training educators; creating educational resources), such as a Massive Open Online Course offering a virtual tour of the ancient city. It also informed a broad range of commercial contexts, such as using the model for consulting video game production and digital visualisation firms as well as use by broadcasters.

**Protecting endangered ancient heritage sites:** In spring 2015, ISIS/Da'esh released a propaganda video showing their destruction of ancient Assyrian buildings and sculptures at the archaeological site of Nimrud, near Mosul in northern Iraq. Research on Nimrud's ancient and modern history, conducted before and after that event, enabled

cultural heritage organisations, news media and policymakers to understand Nimrud's importance as the world's first imperial capital in the 9th century BC. The research led to subsequent protection and management plans of the site and raised the international profile of Iraqi experts, inspired artistic responses, and deepened public debates on heritage in conflict.

### Case Study Examples

History and Cultural Heritage case studies employed enormous creativity in engaging audiences, ranging from exhibits and visiting historical sites through virtual reality to video games. By doing so, they fostered unique economic impacts in the arts, heritage, and tourism sectors. This is illustrated by two examples: an unexpected archaeological discovery fostering cultural investments and a local tourism boom, and the development of a commercially successful video game based on historical and psychological research.

#### The Discovery of Richard III

“You could see it was going to be big from the moment that it became clear that this was who we'd hoped to find”, recalls Jo Appleby, who upon starting at the University of Leicester joined a team of archaeologists that had just discovered the remains of King Richard III underneath a car park in Leicester. The surprise find caused a sensation and fostered cultural investments and increased tourism. In 2014, the city's cultural life was enriched by the construction of a new Richard III Visitor Centre, which received 347,155 visitors by 2020. This research also contributed to Leicester Cathedral's 2020–2023 £11.3 million National Lottery-funded restoration, including a new Heritage Learning Centre. Leicester City Council estimated that the upsurge in visitors following the discovery generated 1,012 new jobs and brought £79 million to the Leicestershire economy by 2015. Appleby and other researchers of the multidisciplinary team behind the discovery would often split their time between outreach to cater to the enormous public interest and continued scientific work. Appleby, an osteology expert, comments on her scientific role in identifying the skeleton “I just really enjoy trying to understand people from their remains.” She sums up the experience of being part of a research effort which ended up having broad implications for the local cultural and economic life with the observation, “I like to do work that makes a difference which seems odd, because I work in an obscure corner of an obscure field.”

#### Hellblade Video Game

It is the late 8th century, and Senua, a Pict warrior, suffers from a curse that causes her to hear the voices of spirits, referred to as 'Furies', in her head. She arrives at the border of Helheim, an afterlife location in Norse mythology, in a quest to save the soul of her dead lover. Such is the premise of Hellblade, a multi-award winning and commercially successful video game, which has sold over 1.5 million copies. Two Cambridge academics were key to fleshing out different elements of this storyline. Elizabeth Ashman Rowe, Professor of Scandinavian History in the Department of Anglo-Saxon, Norse and Celtic at the University of Cambridge, assisted in “providing an accurate historical account” of the Vikings, their society, and beliefs. Paul Fletcher, Professor of Neuroscience, contributed his research on psychosis. The voices that Senua, the game's protagonist, hears in her head are grounded in his work, explaining psychosis via subtle shifts in information processing.

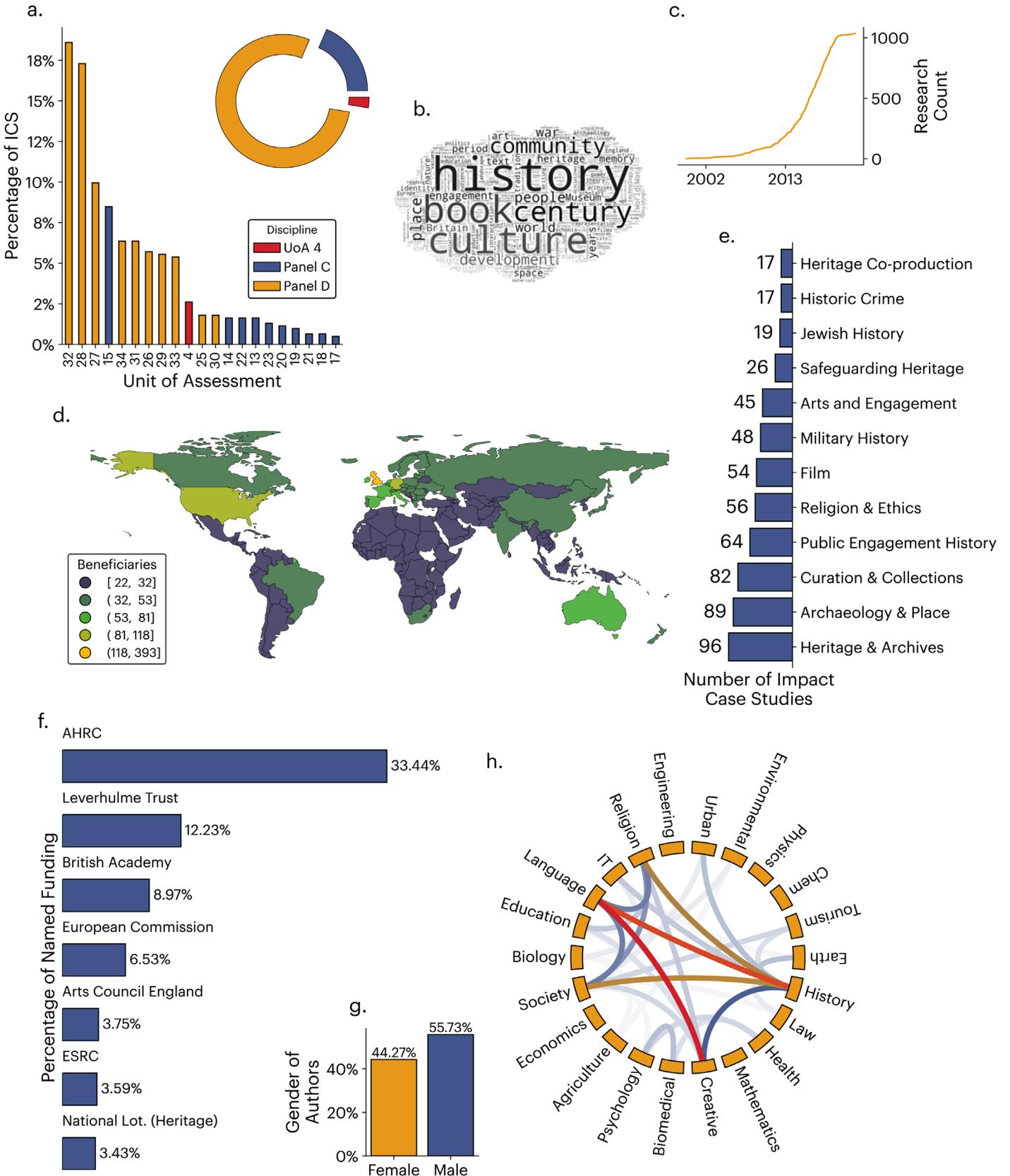
Rowe's research into Norse myth and saga and its accounts of warrior women, swords, monster-slaying, torture, blindness, illusion, curses, and sacrifice were used to enrich the storyline. She also helped with the development of historically accurate visual elements: "I commented on visual aspects, like the colour of the soil, what kind of trees they put in, what was the design of swords and costumes and ships". Fletcher's research on mental illness, on the other hand, was key for developing the protagonist's character. All parts of the game revolved around her mental condition, including the fights and puzzles which furthered the depiction of Senua's psychosis. "He was able to connect the development team with patient groups or people who were recovering schizophrenics to get their feedback on what it was like and talk about how the game might be an educational tool around schizophrenia", Rowe recalls of Fletcher's work. The two researchers' insights combined to create a videogame that was able to offer a unique depiction of psychosis in a particular historical context. In the words of the Commercial Director at Ninja Theory, "the success of Hellblade, by whichever measure, be it critical, commercial or social impact, simply would not have been possible without our collaboration with the University of Cambridge".

#### **Distinguishing Facts of History and Cultural Heritage theme:**

- One of the ten Grand Impact Themes with the most ICSs allocated to it: 613 individual ICSs fall within this Grand Impact Theme.
- **Impacts most prominently located in humanities UoAs:**
  - UoA 32: Art and Design: History, Practice and Theory (18.6%)
  - UoA 28: History (17.29%)
  - UoA 27: English Language and Literature (9.95%)
- The five most seen concepts are: 'history', 'culture', 'book', 'century', and 'community'.
- **Geographical impact largely benefited those in the UK but also in the USA:** The primary beneficiary of the Impact was the UK (393 instances), followed by the USA (118) and Germany (99).
- **Funding mostly from AHRC and Leverhulme Trust:** The Arts and Humanities Research Council, UKRI was the most prevalent funder, representing 33.44% of all funder acknowledgements, followed by the Leverhulme Trust (12.23%).
- **Men were authors on a higher proportion of underpinning research:** Across the underpinning research used to drive this impact, 44.27% of the authors of the underpinning research were female and 55.73% were male.
- **Interdisciplinarity occurring largely across and within the humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Language, Communication And Culture' and 'Creative Arts And Writing, and 'Language, Communication And Culture' and 'History, Heritage and Archaeology'
- **Publication type of underpinning research primarily in article format:** Most of the underpinning research was published in the form of articles (73.56%) and book chapters and monographs (10.92%). The highest citation count of any piece of underpinning research within this Grand Impact Theme was 9298, and this was by far the most highly cited article.

**Figure 5. Main Characteristics for 'Grand Impact Theme 2: Archaeology and Exhibits'**

See footnote 7 for full explainer of graphics



## 2.3 Education and Teaching

*“There is quite a lot of policy-focused work where government policies changed partly because of some educational research... There are other forms of impact that affect things like curriculum, more abroad than in England. But certainly, there’s a strong link between some research and some of the things that whole education systems offer.”*

– Social Sciences Panel Member

The Grand Impact Theme of Education and Teaching demonstrated profound impacts in teaching, training and educational policy, access, social mobility, equity, literacy, pedagogy, and the acquisition and preservation of languages, illustrated in Figure 6. Impact manifested in myriad forms including institutional educational reforms, redrafting of curricula, rethinking of government skills policy, redesigns of student loan policies around the world, and teacher training. Researchers sought ways to bring about improvements for all levels of education from pre- and primary school to university and vocational training, as well as apprenticeships, workforce training, and continuing education.

A core area of research-driven impact has been in transforming teaching, training, and educational policy. The ICSs in this area exerted a strong influence on educational practice by developing new programmes, reforming policy and curricula, and by modernising education tools to reflect novel research insights. Insights and better practices were brought to UK classrooms via programmes that improve and support teacher training, career progression, and assessment. Enhancing subject-specific teaching was another key impact area. This included transmitting insights on innovations in teaching particular subject areas such as languages, physical education, maths, and science. Research also introduced digital innovations and mobile technologies for teaching in rural communities and low-resource classrooms. Researchers developed a wealth of materials to improve teacher training and career development, as well as the evaluation of teaching quality, workload, and the development of best practice in teacher assessment (e.g., avoiding gender bias in teaching evaluations).

Researchers also focused on the role of education as an engine for social mobility and equal access. Impact primarily focused on techniques, tools, and policies to widen participation, improve access and reduce inequalities in admissions amongst underrepresented groups (e.g., social class, disadvantaged regions). Impacts included evidence-based funding and policy recommendations that led to government and foundation programmes aimed at improving the educational access and outcomes of students from disadvantaged backgrounds. Programmes broadening access to higher education, changing admissions policies, and helping students with admissions systems also feature here. For example, the ‘Paired Peers’ project focused on improving access, university experience, and career opportunities for young working-class people. Opportunity and mobility were also fostered through projects improving skills acquisition and via policies that were introduced to transform the student loan system.

The literacy, reading, and dyslexia topic produced a plentiful array of programmes, interventions, curriculum changes, and new tools to enhance literacy, aid with dyslexia and learning disabilities, support multilingualism, and increase enjoyment of reading across multiple domains. Programmes were introduced to foster literacy in families, communities, and prisons, and to find creative paths to engage youth in reading (e.g., via play or ‘reading for pleasure’ programmes in schools). Teacher training and classroom practice changes were also developed to aid children with dyslexia and learning disabilities. Further aid was provided in programmes focusing on the development of comprehension skills, as well as increasing financial and digital literacy. Technological tools such as a web-based tool to diagnose literacy skills were introduced into education settings by researchers.

Language acquisition, language preservation and linguistics was another strong area of impact arising from primarily humanities research. This work had multiple impacts, focusing on the production of resources for English language teaching, resources for A-level teachers, and guidance for teaching English online. A related focus was language learning instruction for multilingualism and intercultural learning. Technological development also occurred, including online interactive engagement material, open access tools (e.g., for Ancient Greek, Latin) and AI-run, automated linguistic and annotation tools. There was a strong emphasis on language as heritage and the creation of frameworks and tools for language preservation and policy, particularly of Gaelic language acquisition and preservation. ICSs engaged in activities such as the creation of accessible dictionaries and providing classes and online learning tools to further the historical appreciation of languages such as Welsh, Irish, and Scottish Gaelic to understand their present-day use and significance.

### **Case Study Examples**

Much research in the education theme was focused on improving the education of children in their early years of schooling, illustrated by the following two case studies.

#### **Bringing Foreign Languages to UK pupils**

The work of Associate Professor Alison Porter and Professor Rosamond Mitchell from the University of Southampton provided novel insights, policy recommendations and pedagogical resources for early foreign language learning. Mitchell's research had shown that young foreign language learners were enthusiastic and motivated but that areas of pedagogic practice needed development to sustain motivation and achieve language learning outcomes. These insights contributed to the inclusion of foreign languages in the Primary National Curriculum in 2014.

Porter, who had worked for ten years as a primary school teacher before becoming a researcher, built on Mitchell's insights and went about devising a research-informed approach to teaching foreign languages to young children. She described her research as "interested in a learner-centred approach to the teaching and learning of languages, but at the same time also really interested in getting teachers to think about research-based practice".

In 2017 Porter and Mitchell founded the Southampton University Primary Languages research and practice partnership, which enabled them to work directly with teachers in developing face-to-face and online training to improve classroom practice as well as curricula. Porters' own experience as a teacher helped in taking her research into the classroom and in encouraging other teachers to experiment with pedagogical techniques. The results showed that "a lot of assumptions were misplaced". For example, it was widely assumed that children had to learn how to speak and pronounce words before starting to read. Porter went into classrooms of children aged 9-11 and said "I'm going to teach you French. And whilst you're learning to speak French, you're going to also learn how to read and write at the same time", and results supported the idea that literacy should be integrated into curricula at earlier stages. She also explored the use of multimodality (gesture) to support spoken language learning for children aged 4-7.

To share the pedagogical insights and resources she developed, Porter then co-created a three-week massive online open course (MOOC) that offered training and resources for teachers on a global scale. Over 6,000 participants from 90 countries registered to join. A participating teacher summarised the effects of the course:

“I’m more confident to innovate and explore. I’ve been inspired to try something new in the classroom - I have experimented with phonics and linked phonics to written outcomes/writing from memory”.

### **Changing practice in the early years of primary schooling: Teaching and Learning Playfully**

Dr Glenda Walsh, Head of Early Years Education at Stranmillis University College, influenced Irish government policy and pedagogical practice with her 20-year research project on play in the early years of primary schooling in collaboration with researchers at Queen’s University, Belfast. Northern Ireland (NI) has the youngest statutory school starting age in Europe, and there has long been concern about the appropriateness of a formal curriculum for children as young as 4 years old. The 2000-2009 Early Years Enriched Curriculum (EC) Evaluation Project made a longitudinal evaluation of a large-scale, quasi-experimental play-based curriculum for 4-6-year-olds. The EC project ran in 24 schools, involving around 1,000 children, 24 principals, 150 teachers, and 1,500 parents. Researchers found that the play-based curriculum held significant benefits for children’s attitudes to learning, social development, and emotional well-being.

Based on these findings, in 2007 and 2008 the Foundation Stage (FS), a statutory play-based curriculum, was introduced across all NI primary schools for all Year 1 and Year 2 children. This has directly impacted approximately 650,000 children since 2007. Walsh’s research has gone beyond NI, also informing the work of the National Council for Curriculum and Assessment (NCCA) in the Republic of Ireland, including the development of a new statutory Early Years Primary Language Curriculum, impacting over 6,000 teachers and 180,000 children annually since 2015.

Further analysis of the EC data has led to new understandings of the importance of playfulness as a central characteristic of effective teaching in early years education, which then led to development of Playful Teaching and Learning (PTL), a pedagogy integrating playfulness, teaching, and learning more fully. PTL rests on a framework of three core dimensions: the degree of playfulness, the locus of control, and the nature of the learning taking place. Training early years teachers in the PTL principles at Playful Learning hubs has positively impacted professional knowledge and practice, with around 1,500 FS teachers trained at the end of the REF period, accounting for over half of all NI FS teachers.

### **Examples of Impact**

**Reformed teacher training:** Research into the effectiveness of teacher training has led to reforms in the training of Welsh teachers, including a new accreditation procedure, a revised inspection framework, and extensive investment in educational capacity. Around 2,700 teacher trainees in Wales and their subsequent students were affected by this.

**Making the Welsh language accessible:** The Geiriadur Prifysgol Cymru (GPC) is a historical dictionary like the Oxford English Dictionary. A research team maintains and updates entries and makes the GPC available online and as a mobile app. The number of words searched has risen from 216,418 in 2014 to over 3.2 million in 2020.

**Online grammar resources for schoolteachers:** Englicious is a free online platform containing a library of original English language teaching resources, enabling primary school teachers to teach grammar to the 2014 National Curriculum in England. Over 10,000 teachers signed up to Englicious in January 2021.

**The Pupil Premium Toolkit:** The Pupil Premium Toolkit is a synthesis of research from 200 systematic reviews, meta-analyses, and quantitative studies and provides a resource for schools to improve outcomes for learners, particularly those from disadvantaged backgrounds. It guides the work of the Education Endowment Foundation (EEF) and its £200m funding being spent over 15 years to reduce inequalities in pupil outcomes in England.

**Rediscovering Ireland's past in words:** The Electronic Dictionary of the Irish Language is a historical dictionary that reveals the development of the language over a millennium. The Dictionary has had 200,000 unique users over the last five years with nearly 3.4 million page views.

**Revitalising Scottish Gaelic:** Research in Celtic and Scottish Studies helped policymakers address the fragile state of Scottish Gaelic, categorised by UNESCO as an endangered language. It influenced the third National Gaelic Language Plan. As a result of increased promotion and provision, Scotland saw a 34.4% increase in the number of pupils enrolled in Gaelic-medium education between 2013 and 2020.

**Enhancing children's reading comprehension:** Research demonstrated the importance of including three discourse-level skills that support successful reading comprehension (inference and integration, knowledge and use of text structure, and comprehension monitoring) in early reading instruction. Integration of this research has improved reading instruction for 4 million children in the UK by underpinning policy changes requiring reading comprehension to be taught. Since 2014, these changes have reached 6,000 school leadership teams globally.

**Speech therapy for children with cerebral palsy:** Research showed that intensive speech therapy, based on motor learning theory, led to significant increases in children's intelligibility. This research informed UK National Institute for Health and Care Excellence (NICE) guidelines and therapeutic practice.

#### **Distinguishing facts of Education and Teaching theme:**

- **Considerable variation across UoAs**, situated across both the social sciences and humanities:
  - UoA 23: Education (49.31%)
  - UoA 26: Modern Languages and Linguistics (16.9%)
  - UoA 27: English Language and Literature (8.62%)
- The five most seen concepts are: 'education', 'schools', 'teachers', 'students', and 'learning'.
- **Geographical impact was largely seen in Anglophone countries:** The primary beneficiary of the impact was the UK (197 instances), followed by the Republic of Ireland (41), and Spain (40).

- **Funding mostly from the ESRC, followed by AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 23.10% of all funder acknowledgements, followed by the Arts and Humanities Research Council (15.17%).
- **Gender:** Across the underpinning research used to drive this impact, 57.60% of the authors were female.
- **Wide interdisciplinarity was evident across the social sciences (education), psychology and humanities (language, culture):** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Education' and 'Language, Communication And Culture', and 'Psychology' and 'Language, Communication And Culture'.
- **Publications underpinning research are mostly articles:** Most of the underpinning research was published in the form of articles (86.32%) and book chapters (5.44%). The highest Altmetric score within this cluster was 692, the highest citation count was 1478, and the highest relative citation ratio was 8.



## 2.4 Business, Economics and Management

*“There’s obviously a lot that is impacting commercial organisations. Either the performance of those commercial organisations or the practices of those organisations. And you know, hey, we’re business and management so you’d probably expect that, wouldn’t you?”*

– Social Sciences Panel Member

Impacts in this theme arose from research in the areas of business, entrepreneurship and management, macroeconomics, banking, monetary policy, market regulation, consumer protection and anti-corruption, illustrated in Figure 7. A core topic cluster was business, entrepreneurship, management, and investment, which aims to improve productivity and firm growth in various forms. Researchers regularly worked with firms to implement effective research-based management practices or to use research insights to foster, encourage, and fund entrepreneurship. ICSs also evidenced multiple business spinoffs emerging from research or the application of research in large companies, often by providing high-end software and production management or art and design tools, as well as founding small researcher-led or research-aided start-ups.

Many projects also aided in the success and growth of small and medium enterprises (SMEs), creating regional hubs and business environments, organisational practices, public policies, and financial opportunities, particularly in economically disadvantaged regions of the UK. Research on management informed both private sector firms and their training of higher and mid-level managers as well as public sector organisations and publicly procured projects, providing insights to make them more efficient. Sectoral impacts ranged from farming and supply chains to social enterprises and large infrastructure projects. Focus on firm growth as well as creation of new companies and start-ups was coupled with hard evidence documenting job creation resulting from the interplay of business and research. Several projects were also concerned with sustainable practices in business and entrepreneurialism for a greener economy.

Another core area in this theme was the shaping of macroeconomic and monetary policy and, relatedly, of financial market and banking regulation. Research on designing macro-prudential policies and new tools for monetary policy has made financial markets more resilient to shocks and sought to increase the odds of averting financial crises. Improved regulation practices in the banking sector, as well as tools for macroeconomic management developed by researchers at UK universities, have been implemented by the Bank of England, the European Central Bank, and key monetary policy institutions around the world. Research into the functioning of financial and currency markets and the management of portfolios, often offering predictive tools, has also been adopted in the decision-making processes of monetary policy institutions, global asset management firms, pension funds, and financial market participants.

Research concerned with the psychology of consumers and the optimal regulation of markets influenced policy and generated initiatives to protect consumers. Policy impact ranged from influencing financial and lending regulations to housing market policies, as well as consumer protection measures such as transparency requirements in cost and fee declaration. Research insights also helped households make better decisions via programmes improving financial literacy and providing debt advice.

Work in this domain also focused on fostering international development in low-income countries and anti-corruption initiatives globally. Sustainability and sustainable economic development were a focus of many projects. A significant proportion of ICSs worked to increase efficiency in aid-giving and measuring and implementing successful targeted development programmes ranging from micro-loans and the fostering of entrepreneurship to implementing

better agricultural management. Work on aid efficiency also concentrated on reducing corruption and improving public procurement for international aid and projects.

### Examples of Impact

**Training mid-level managers:** Research provided the intellectual backbone through which successive cohorts of area managers have been trained. Over 800 multi-site managers in 22 organisations, mostly large chains, were trained to enhance business performance. When surveyed, 94% agreed the programme improved their impact and performance.

**Improved contracting in construction:** To reduce legal disputes and poor value for money in construction projects, law scholars developed the Framework Alliance Contract (FAC-1) which improves integration of the roles of consultants, contractors, and subcontractors, and ensures the timely sharing and agreement of designs, costs, programmes, and risk information. Procurements under FAC-1 in social housing, schools, highways, and public buildings have an estimated value of £45 billion.

**Regenerating regions with tramway infrastructure:** Research on the use of tramways for regeneration in urban areas and regions underpinned €22.3m in strategic investments in public transport across Northwest Europe. Among the newly supported projects was the popular extended Blackpool tramway along the Fylde Coast.

**Software systems for managing complex manufacturing activities:** Software modules and service systems that enable manufacturing companies to collaborate more effectively in the supply chain for European aerospace created savings of €10 million per annum in operating costs, a 30% increase in speed of procurement, and a 10% increase of throughput for a major European aerospace company.

**Helping small and medium enterprises in deprived areas:** Management research helped 465 SMEs access a total of £1.5m of funding, as well as providing advice and training support for company finance and growth.

**Making start-ups and scale-ups grow:** Research on effective business models and the entrepreneurial life cycle provided the foundation for programmes supporting 253 start-up companies, which have raised £230.6 million in grant and venture capital funding and created hundreds of jobs. Affected enterprises achieved an average 28% sales growth in the following year, with 89% executing the growth plans developed during the programme.

**Improving financial stress resilience:** The Bank of England's Indexed Long-Term Repo (ILTR) operation has become a key policy tool for the Bank of England to ensure sufficient liquidity for the financial system at times of stress. It is based on economic research on auction design and has been implemented and tested together with researchers. The design has led to practice changes in other central banks.

**Forecasting financial and currency markets:** New forecasting models have changed key practices in both private and public sector decision-making, and have been used by the Bank of England, the European Central Bank, and major asset management companies.

**Improving consumer financial protection:** Behavioural economics research influenced the Financial Conduct Authority (FCA) design of a price cap on payday loans in the UK, protecting 4.3 million loan applicants.

**Fostering innovation in low-income countries:** Research on the Diffusion of Innovation in Low Income Countries (DILIC) generated a new approach to innovation at the UN, influencing the Sustainable Development Goals 9 and 17, and leading to the creation of the UN Technology Facilitation Mechanism.

### Case Study Example

Many case studies in the Business, Economics and Management Grand Impact Theme aimed at improving management practices at companies or were concerned with influencing economic productivity in the United Kingdom through economic policies. The work of John Van Reenen, the Ronald Coase Chair in Economics at the London School of Economics, shows that these two efforts are more intricately linked than previously understood. “The work on management practices started almost 20 years ago out of my interest in trying to understand ‘what were the important drivers of economic growth and the wealth of nations?’” is how Van Reenen describes the motivation behind his research.

“When you talk to people, normal non-academics, they often talk about management and the problems stemming from effective or less effective management. Whereas as economists, we had relatively little to say about whether management practices are really affecting productivity”. Van Reenen set out to generate an innovative new survey tool – the World Management Survey (WMS) – which now covers 35 countries and includes over 20,000 interviews with managers “typically in the middle of the organisation, so for example, the plant manager in a big manufacturing company”.

Numerous research projects involving this data allowed for the establishment of three broad facts: 1) there is extraordinary variation in management practices across firms, 2) measures of good management strongly correlate with measures of performance, and 3) there exist identifiable drivers of management quality, such as increased competition. “Economists think badly managed firms don’t exist because competition should drive them out, but they absolutely do exist as most people will recognise”, Van Reenen remarks. Showing that identifiable management practices account for more than 20% of total variation in productivity, similar to the effects of R&D and human capital, offered a unique tool for impact, as management can be changed.

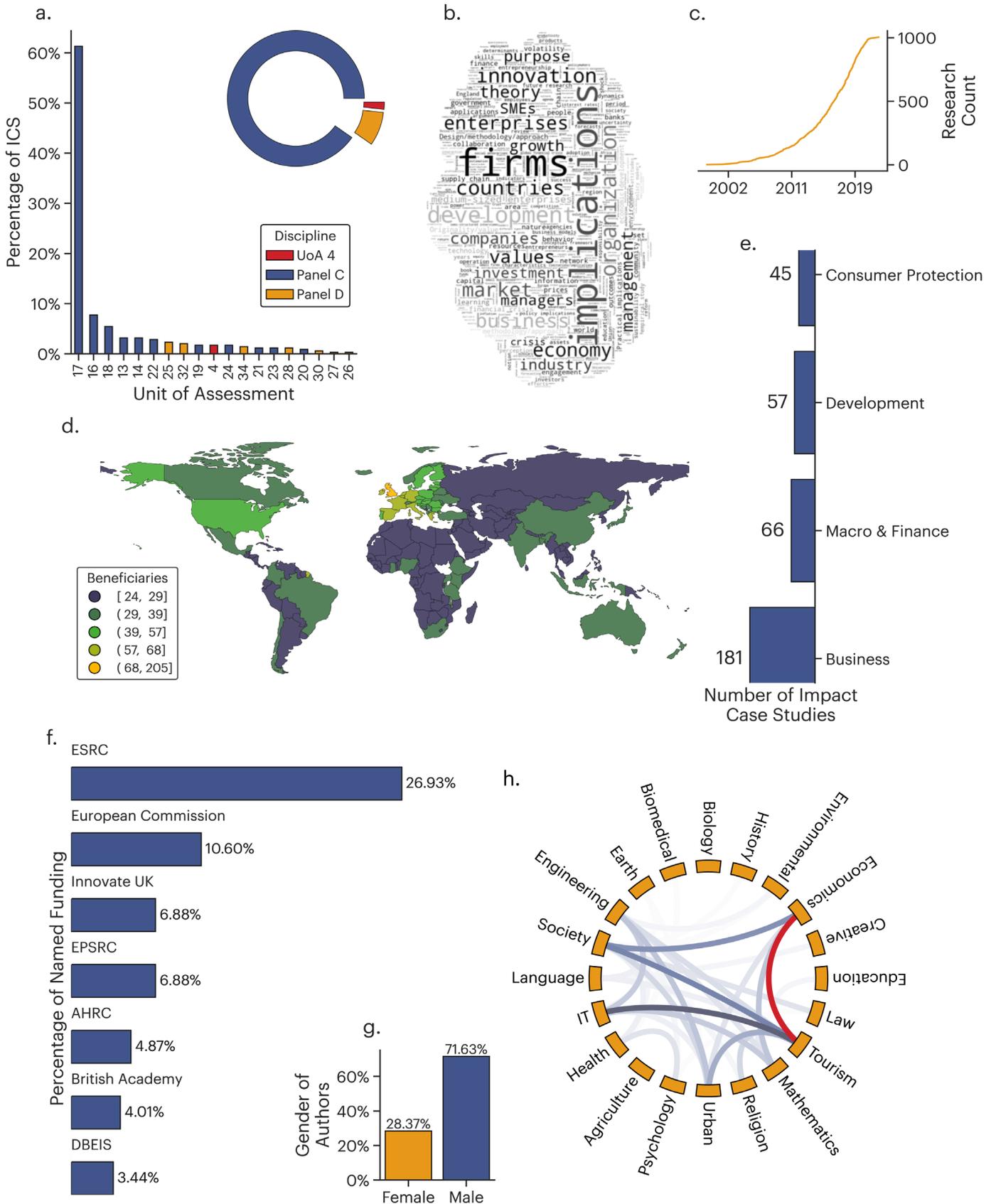
A project by Van Reenen’s former student, Nick Bloom, built on these insights to provide randomised management training in firms based in India, and documented the significant and lasting improvement in productivity that improving management created. Van Reenen’s insights led to a renewed focus of policymakers on improving management practices to increase productivity and growth and influenced the creation of agencies such as BeTheBusiness and large governmental investments in management training programmes such as ‘Help to Grow’. Several of Van Reenen’s graduate students are also involved in implementing programmes at the World Bank that seek to improve emerging market economic growth by improving managerial practices. Van Reenen made a conscious decision to focus on research and not become involved in any management consulting, despite his research being picked up by consultancies. He sees

his purpose as using the dispassionate outsider position of a researcher to understand what works in management: “there’s a lot of cynicism about what management and management consultancies do, but there are some things these huge industries do, which make a lot of sense. We have made explicit that tacit knowledge about what works, that is already latently present within good firms. You can think of our work as separating the wheat from the chaff in identifying what really improves management”.

#### **Distinguishing facts of the Business, Economics and Management theme:**

- **Most prominently situated in Social Science UoAs:**
  - UoA 17: Business and Management Studies (61.32%)
  - UoA 16: Politics and International Studies (7.74%)
  - UoA 13: Law (5.44%)
- The five most seen concepts are: ‘implications’, ‘development’, ‘organization’, ‘countries’, and ‘innovation’.
- **Geographical impact mainly in UK and Germany:** The primary beneficiary of the Impact was the UK (205 instances), followed by Germany (68), and Italy (63).
- **Funding primarily from the ESRC and European Commission:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 26.93% of all funder acknowledgements, followed by the European Commission (10.60%).
- **Gender in authorship of underpinning research:** 28.37% female authors, compared to 71.63% men.
- **Multi-disciplinarity is seen across the social sciences but also in computing:** The most commonly occurring interdisciplinary linkages in the underpinning research are between ‘Commerce, Management, Tourism And Services’ and ‘Economics’, and ‘Commerce, Management, Tourism And Services’ and ‘Information And Computing Sciences’.
- **Publication type underpinning research overwhelmingly articles, but with comparatively lower citations:** The majority of the underpinning research was published in the form of articles (88.37%) and book chapters (2.88%). The highest Altmetric score within this cluster was 305, the highest citation count was 1,701.

**Figure 7. Main Characteristics for 'Grand Impact Theme 4: Business, Economics and Management'.**  
 See footnote 7 for full explainer of graphics



## 2.5 Employment

There has been a wealth of impact in the Grand Impact Theme on employment, largely in the areas of labour conditions, disability, and inclusion. The central theme of labour conditions comprised research-driven policy changes for worker's rights, benefits, and pay. Within this theme research worked with labour unions and shaped policies on projects related to minimum income standards, the living wage and public sector pay, and protection of low wage or precarious workers (e.g., digital gig economy). The labour market situation of women was of concern to several case studies and featured initiatives helping women advance, particularly in male-dominated sectors such as STEM. Research also impacted policy changes related to maternity protection and the gender pay gap. Work aimed at reducing unemployment led to the introduction of tools for assisting employment searches and improving skills. The theme featured multiple research-driven, evidence-based policy changes that improved working conditions, national and international labour standards, and general employment practice for groups of workers (e.g., migrant workers, social care workers, ageing workers).

Among the many research projects focusing on labour conditions, we find the implementation of both policies and interventions seeking to improve workers' wellbeing jointly with performance improvement (e.g., through guidelines protecting rights of police and NHS workers). Workplace management improvements focusing on employees featured digital transformations of the workplace and wellbeing management, including multiple interventions and training programmes to reduce psychosocial risks related to stress. Changes in the public sector complaints process were also driven by research, including changing ombudsman policy, protections for whistleblowers, and ensuring inclusion and access to justice for groups (e.g., migrants, blacklisted workers).

Employment, disability, and inclusion emerged as core topic, as initiatives to support workplace integration of disabled and excluded groups grew out of research into the labour market impediments faced by individuals. Certain projects sought to change attitudes towards people with disabilities by sharing historical knowledge about debilitating conditions to improve public understanding. Researchers also drove changes in legislation, including to international human rights, which intended to protect people with disabilities. Humanities-based research also led projects for inclusive and innovative arts education, authentic casting in film production, and self-presentation and representation of disabled people.

### **Case Study Example: Equate Scotland – Encouraging Women in Scottish STEM Sectors**

Many of the ICSs in this theme helped to combat different inequalities in employment. In Scotland, only 30% of women who graduate with a qualification in STEM go on to work in the sector long term, resulting in only 25% of employees in Scottish STEM sectors being women. The research team at Equate Scotland (formerly the Scottish Resource Centre for Women in Science, Engineering and Technology), a department at Edinburgh Napier University, investigated what factors caused this discrepancy. Equate sought Scottish Government funding to support women and employers in STEM free of charge, bringing a research-led approach to understanding and solving the issues hindering female progression in STEM. Their research directly influenced the Scottish Government's 2014 "Developing the Workforce" policy, which acknowledged the issues of gender discrepancy in STEM sectors.

Between 2013-2020, Equate was funded by the Scottish Government for the Careerwise project. Launched directly after the Developing the Workforce policy was published, Careerwise encouraged STEM employers to provide paid 8-12 week placements for female STEM students at Scottish universities. A three-year evaluation of the project found that Careerwise placements increased productivity for employers, raised their profile among students and recent graduates, and made them more likely to recruit female employees. Student participants reported greater confidence and intent in pursuing a career in STEM. Of student participants in the scheme, 59% remained in STEM compared to the 30% sector average. Careerwise continues to run with the support of Skills Development Scotland, a company which works with the Scottish Government to support national employment objectives. In 2018, Equate delivered a new programme to highlight issues with retention by supporting women returning to a career in STEM.

In 2016, Equate carried out a sector-wide stakeholder analysis on the future of women in STEM in Scotland, producing the Rising to the Challenge report, a novel qualitative dataset on what was needed to address the gender imbalance. The report provided strategies for improvement, such as STEM ambassadors in schools, unconscious bias training, and more student placements. From 2017-2019, Equate has continued to use this approach to help specific STEM industries understand the problems of female under-recruitment and poor retention. They have worked closely with Scottish Engineering, Scotland's largest industry organisation, and have provided best practice guides to companies in the technology and construction sectors.

Equate also worked with education providers to encourage student entry into STEM sectors. They supported The Open University in reviewing the equality of its recruitment approaches, resulting in an increased performance for STEM campaigns by more than 45%, with over 1,000 new enquiries.

### Examples of Impact

**Detecting and improving the recovery of unpaid wages:** Research showed the scale of non-payment of wages, amounting to £3.1 billion annually. Findings led to employment rights policy through the 'Good Work Plan' which regulates enforcement of entitlement to holiday pay, improvements to payslip entitlement, and greater efforts to pursue directors evading employment obligations. Improved enforcement directly benefited over two million of the UK's lowest paid workers.

**Shaping minimum wage policy:** Research exploring effects of the UK National Minimum Wage (NMW) on low-paid workers informed the Low Pay Commission's recommendations to the UK Government to increase the NMW in 2014, 2015, and 2016, which were accepted in full. This raised the pay of around one million workers by as much as £355 per annum.

**Reducing the Gender Pay Gap through the National Living Wage:** Research on the gender pay gap informed the Low Pay Commission to introduce the National Living Wage (NLW) from 2016, which was awarded to 1.59 million workers. Research subsequently showed that the NLW reduces the incidence of low pay amongst women and the aggregate gender wage gap in the UK.

**Abolishing employment tribunal fees:** Economic and legal research was instrumental in providing the legal arguments for the July 2017 UK Supreme Court decision to declare employment tribunal fees introduced by the UK government in 2013 to be unlawful and unconstitutional. Tribunal fees were abolished with immediate effect, affecting many thousands of potential claimants who had been deterred from bringing their cases before the courts. By September 2019, the Ministry of Justice had refunded more than £18 million in illegally levied fees.

**Encouraging global regulatory reform:** Building capacity for better regulation is an important aspect of global development. To encourage bottom-up innovation in regulation, UK researchers started the Regulatory Impact Assessment Awards together with the World Bank. The Awards represent an international learning platform, assisting policymakers in 45 developing and transition economies to share and diffuse models of best practice.

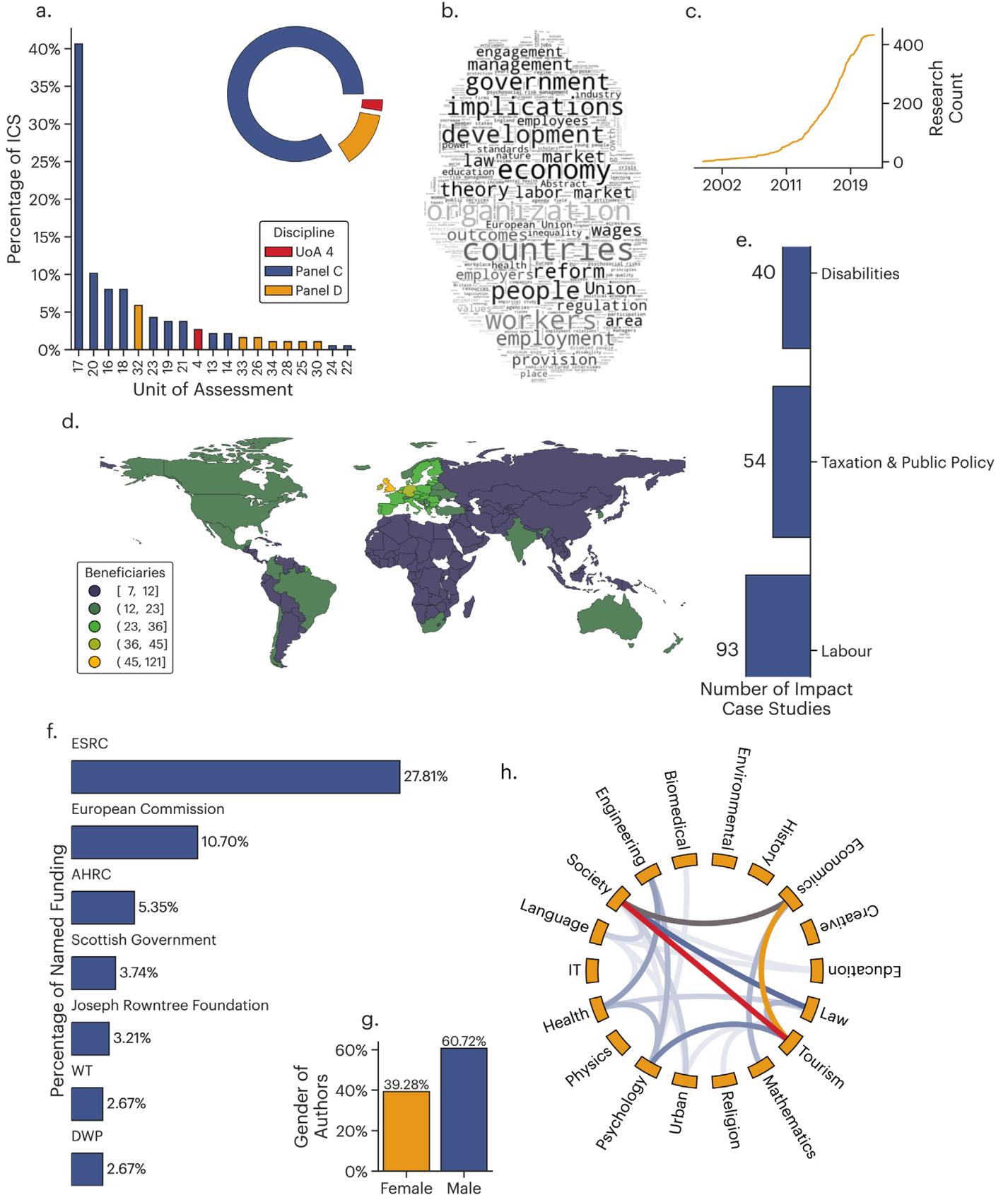
**Developing new capital markets for pension insurance:** The Life Market (LM) is a major new global capital market for transferring longevity risk from corporate pension schemes to reinsurers and capital-market investors. Mortality forecasting models designed by UK researchers, together with longevity bonds and swaps, have been integral to the operating of the LM. To date, one \$50 million longevity bond, 61 UK longevity swaps (worth £105 billion), and seven Dutch longevity swaps have been executed. This contributed to a reduction in the prices reinsurers charge clients by 1% and created industry savings of £1 billion. The reduction in risk benefits pension scheme members, who now have greater confidence that their pensions will be paid in full.

#### Distinguishing facts of the Employment theme:

- **Most prominent UoAs are across the social sciences:**
  - UoA 17: Business and Management Studies (40.64%)
  - UoA 20: Social Work and Social Policy (10.16%)
  - UoA 16: Economics and Econometrics (8.02%)
- The five most seen concepts are: ‘countries’, ‘organization’, ‘economy’, ‘workers’, and ‘people’.
- **Geographical impact mostly UK, followed by Ireland:** The primary beneficiary of the Impact was the UK (121 instances), followed by the Republic of Ireland (45).
- **Funding mostly from the ESRC, followed by AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 23.10% of all funder acknowledgements, followed by the Arts and Humanities Research Council (15.17%).
- **Gender:** This Grand Impact Theme has 39.28% female authorship in the underpinning research compared to 60.72% male authors.
- **Interdisciplinarity of underpinning research is largely published within the social sciences:** The most commonly occurring interdisciplinary linkages in the underpinning research are between ‘Commerce, Management, Tourism and Services’ and ‘Human Society’, and ‘Economics’ and ‘Commerce, Management, Tourism And Services’.
- **Publication type underpinning research is mostly articles, with research achieving relatively high Almetric scores:** Most of the underpinning research was published in the form of articles (90.3%) and book chapters (3.93%). The highest Almetric score within this cluster was 773, and the highest citation count was 1,033.

**Figure 8. Main Characteristics for 'Grand Impact Theme 5: Employment'.**

See footnote 7 for full explainer of graphics



## 2.6 Crime and Exclusion

The Grand Impact Theme of Crime and Exclusion demonstrated vital impact, with research-based knowledge affecting multiple facets of law enforcement and the broader criminal justice system. This included projects aimed at crime reduction; policing and neighbourhood interventions; detention; improving the justice system; reducing drug, alcohol and substance abuse; counteracting hate crime and diminishing the harmful effects of gambling, as illustrated in Figure 9. Considerable impact occurred across the areas of crime enforcement, detention, and prison reform. Innovative tools were developed to combat serious crimes, with a strong focus on evidence-based policing, identification of serious crimes and criminals, and using policing data more equitably. Novel programmes were developed and tested to foster mutually beneficial relationships between the police and local communities towards reducing crime, increasing the police's understanding of local needs and building neighbourhoods that are less conducive to criminal activity. Research also improved police transparency, leading to increased accountability, scrutinising individual cases and actions against groups, and supporting interventions to improve the ethics and culture as well as working conditions in policing.

Research drove tangible changes in prison policy, interventions, and regulation. Many changes and interventions aimed at lowering rates of recidivism, ensuring that released prisoners can be reintegrated into society. Changes included improving design and architecture in prisons to increase prisoner wellbeing, mental and physical health, and education; facilitating behavioural improvement among prisoners; supporting families of the incarcerated; and co-producing research with the community. Humanities research engaged with theatre in prison, which included creative engagement with crime as well as historical work on prisons and imprisonment. Another strong and transformative strand developed interventions related to improving post-prison rehabilitation and tackling over-imprisonment.

University-based research changed gambling policy and reduced harm by demonstrating safer and more responsible ways of regulating gambling, leading to improved rules in the growing realm of digital gambling. Research-based interventions and policy change tackled the problems of addiction and substance abuse in a myriad of ways, generating new policies related to drugs, including alcohol, and psychoactive substances, distributing better and novel treatment methods for substance abuse victims and supporting children affected by family drug abuse.

In addition to the many social and policy-based interventions we also find many advances stemming from direct improvements in technologies and their implementation. This can for example be witnessed in the field of solving crimes (forensic genetics), in the effective monitoring of offenders (electronic monitoring), in the improvement of lie detection during interrogation and cross-examination, or in the design of less crime-prone buildings. Similarly, numerous ICSs leveraged data to develop a better public understanding of crime and its prevention, of hate speech and hate crime, often occurring online. These insights have shown pathways towards incidence reduction and improved legal responses. Finally, new technologies merging multiple disciplines across criminology, forensics, archaeology, and the natural sciences have advanced craniofacial identification, transformed aquatic forensics, and advanced green criminology.

### **Case Study Example: Preventing the rising tide of hate crime and speech**

Police-recorded hate crimes in England and Wales are at their highest levels since records began. The migration of hate crime to the internet created novel operational and policy needs not currently met by existing sources of information. Cardiff University's HateLab, directed by Professor Matthew Williams, has become a global hub for data and insight into hate crime and hate speech. Research draws on a range of methods, from conventional surveys to machine learning, and an array of criminological concepts to generate evidence on hate offline and online within Wales, the UK, and beyond.

The HateLab's All Wales Hate Crime Project (AWHCP) was the largest, most comprehensive study of hate crime in the UK, surveying ~2,000 members of the public, interviewing ~60 victims, and engaging with ~5,000 citizens. Among its many results, it showed that transgender and people with disabilities were communities particularly vulnerable to hate crimes, and that hate crimes have considerable physical and psychological impacts on victims. For example, 18% of respondents attempted to conceal their identity, 18% had considered moving out of Wales, and one in seven experienced suicidal ideations. This evidence formed the primary source of information for the Welsh Government's Framework for Action on Tackling Hate Crime (2014).

The HateLab subsequently worked on multiple projects that addressed the challenges of identifying, monitoring, and stemming online hate speech, using machine learning approaches to cope with the unprecedented scale and speed of social media data.

A key development was the production of a dashboard that provided the opportunity to monitor online incidents of hate-crime in real time rather than having to wait for victims to file a report. This technology was embedded within the UK-wide National Cyber Hate Crime Hub (2019), run by the National Police Chiefs' Council. The Hub, the point of contact for all victims of online hate crime, uses the dashboard to produce intelligence reports for police, senior civil servants, and MPs. Paul Giannasi, Director of the Hub, confirmed that the new data and insights provided by the HateLab "transformed the way my team of police officers and civilian staff at the National Cyber Hate Crime Hub monitor and tackle online hate crime".

### **Examples of Impact**

**Improving support for victims of gender-based violence:** Research into how criminal justice practitioners and service providers in the UK can support victims and survivors of gender-based violence (GBV) leveraged over £7.2 million in funding to expand a GBV-prevention programme in the UK. The GBV-prevention programme has been shown to reduce abuse by high-risk perpetrators by up to 88% and has underpinned new UK family court guidance to protect children from domestic abuse.

**Housing design to counter crime:** Improving planning policy to build safer communities: Crime Prevention through Environmental Design (CPTED) creates housing developments that are less vulnerable to crime, with housing built to Secured by Design (SBD) standards experiencing 55% less burglary. This changed government planning guidance and building regulations in the UK and the United Arab Emirates, increasing the number of secure homes (44% of new homes built between 2013 and 2017 were SBD) which reduced crime and increased feelings of safety.

**Neuroscience of trauma and crime:** Research uncovered that 42,000 of the current UK prison population has some form of Traumatic Brain Injury (TBI) which is associated with impulsivity and problems in social reasoning. This changed judicial and health policies in the UK, which subsequently took into account the impacts of TBI and neurodisability. As a consequence, there were changes in practice across the prison system, including mandatory neurodisability screening alongside enhanced support and staff training, impacting 83,000 existing prisoners and 6,000 new entrants each year.

**Improving prisoner behaviour and reducing recidivism:** Evidence-based interventions in the prison service have shown that behaviour monitoring can predict risk of reoffending after release, and that digital technology terminals (for prisoners to request visits, health care, order food, etc.) bring significant benefits to behaviour within prisons and enhance rehabilitation. Enhanced Behaviour Monitoring was made mandatory in all pre-release prisons. Funding of £7 million was subsequently announced for the introduction of digital kiosks in UK prisons.

**Software for accurate identification of serious criminal offenders:** A new system of software and procedures helps police identify suspects of serious crimes, such as rape and assault, with identification rates around 60-70%, compared to 5% for traditional systems. During the REF period, it has been used by 26 police forces in 11 countries for over 2,500 investigations, assisting in the identification and arrest of an estimated 1,500 serious offenders.

**Improving police ethics training:** Research on effective ethics training has influenced policies, practices, and training affecting at least 13,000 police officers and staff, and – by extension – the communities they serve. A more central role is now given to the virtues of policing and the ethical risks of cognitive biases in police ethics training.

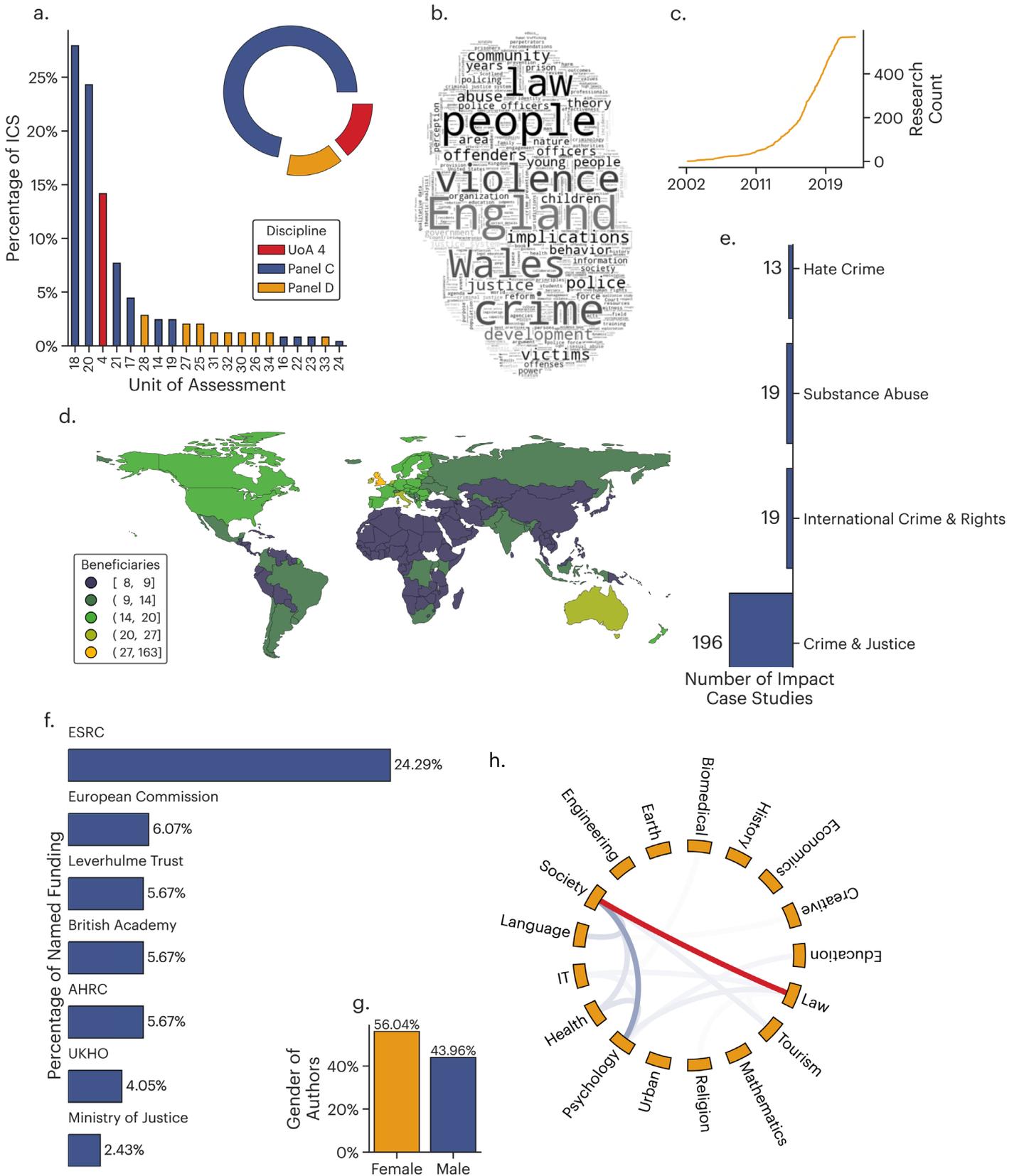
**Equipping law enforcement to fight online sexual crime:** UK and international law enforcement were equipped to fight online sexual crime by training UK and international online undercover police and dark web investigators in linguistic methods and provision of linguistic software. Efforts contributed to the identification and arrest of high-profile Child Sexual Exploitation and Abuse (CSEA) offenders.

**Advancing electronic monitoring of criminal offenders:** Research into effective use of electronic monitoring (EM) underpinned the Management of Offenders (Scotland) Act 2019, resulting in the introduction of new EM technologies (e.g., GPS tags). EM was subsequently added as an option in Community Payback Orders (alternative to prison), and an option to bail (alternative to custody) and was included in updated practice guidance.

**Distinguishing facts of the Crime and Exclusion theme:**

- **Highly diverse submissions across multiple different Units of Assessment.**
  - UoA 18: Law (27.94%)
  - UoA 20: Social Work and Social Policy (24.29%)
  - UoA 4: Psychology, Psychiatry and Neuroscience (14.17%)
- **Main concepts:** The five most highly weighted concepts associated with this underpinning research were: 'England', 'crime', 'people', 'violence', and 'law'.
- **Majority of research within the key topic of 'Crime, Justice and Incarceration'.**
- **Geographical impact mostly in UK, followed by Ireland:** The primary beneficiary of the Impact was the UK (163 instances), followed by the Republic of Ireland (27), and Italy (25).
- **The most prominent funder is the ESRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 24.29% of all funder acknowledgements, followed by the European Commission (6.07%).
- **Underpinning research:** 56.04% of the authors are female, with 43.96% male.
- **Interdisciplinarity of underpinning research published across the social sciences and humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research were between 'Human Society' and 'Law And Legal Studies', and 'Human Society' and 'Psychology'.
- **Publication type underpinning research mostly articles:** Most of the underpinning research was published in the form of articles (86.04%) and monographs (5.19%).
- The highest Altmetric score within this cluster was 1,022, and the highest citation count was 501.

**Figure 9. Main Characteristics for 'Grand Impact Theme 6: Crime and Exclusion'.**  
 See footnote 7 for full explainer of graphics



## 2.7 Family and Gender

A wide array of research translated into interventions, programmes, policy, and regulatory changes to safeguard vulnerable children, enhance family and child welfare, increase children's and parental power, improve mental health, and advance reproductive rights, as shown in Figure 10.

A core area of impact in this theme has been in the domain of family and care. Improving social care and mental health services for families through evidence-based recommendations has been a focus of research. This included improving institutional support for children, in terms of education, care and interventions, as well as legal safeguards for protecting vulnerable children and families. Programmes sought to identify and counter violence in the home, including violence against children and violence by adolescents against parents. The focus in educational institutions and social services was often on concrete improvements to professional practice and education to protect children. Another key strand was the prevention of physical and mental abuse of children in multiple settings outside of the home, from the domain of sport to online forums. Pivotal work has taken place to better understand grooming behaviours. This influenced interventions to prevent and interrupt the grooming of children online. Refugee children's rights and the rights of children of imprisoned mothers were also considered, leading to changes in child protection legislation, children's rights, and tackling childhood food poverty.

Humanities researchers used interventions involving children with photography and art to increase their agency and early childhood development, fostering skills such as reading through storytelling and the skills for social interaction alongside learner engagement with novel digital technologies. Psychological and behavioural researchers sought to increase children's literacy and numeracy skills in low resource and conflict settings, increasing their confidence, personal autonomy and social influence. Interventions provided tools and techniques to amplify children's voices in education and care settings. Countless projects served to improve children's cognitive and emotional development in different income settings, enhance home learning environments, and inform child protection policy.

Research also impacted the area of reproductive rights, shaping attitudes and legislation towards abortion, surrogacy, fertility, hormonal pregnancy tests, gamete and embryo donors, egg freezing, as well as the ethics and regulation of genetic and reproductive advances.

Gender is another key theme with changes in practices, policies, and guidelines in the area of gender representation. Impact included increasing gender equity and representation in the workplace, reducing employment discrimination, and shaping government and business policy to support women. There was a strong overlap with certain projects in the employment theme in this regard, as exemplified by the example case study on increased female representation in STEM occupations in Section 2.5 Policies and interventions also increased diversity among senior leadership and boards. Gender equity was enhanced through specific early education programmes, training in the media to increase women's representation in programming, writing and radio. Gender equity was also supported by gender-empowering policies in the fields of education, health, and employment aimed at Low- or Middle-Income Countries (LMICs). This topic closely aligned with a grouping of case studies focused on the empowerment of women through education.

Research likewise contributed to new policies and practices relating to sexualities to improve the experiences of LGBTQ+ individuals' experience in multiple institutions. This focused on LGBTQ+ spaces, societal and occupational representation, and inclusion. Humanities research has considerable impact on understandings of sexuality through historical figures and 'queering history', queer arts, museums, and sharing stories and experiences through cultural institutions and activism.

### Examples of Impact

**Improving adult social care through better employment:** Research showing the relationship between the employment conditions of adult social care (ASC) workers and quality of domiciliary care was used by the Welsh Government to change employment regulations and introduce legislation that curbs zero-hour contracts and ensures that travel and care times are clearly identified. This has affected the employment conditions of 19,500 workers and the care provided to 23,000 people.

**Transforming early education policy and practice in the UK:** Two major longitudinal studies demonstrated the long-term benefits of early education and identified effective pedagogy. This underpinned UK government initiatives such as the provision of free early childhood education to millions of 2–4 year-olds, encouraging and supporting home learning, and professional development interventions based on quality scales developed by the researchers.

**Early Childhood Development interventions:** Research on Early Childhood Development interventions in low- and middle-income countries provided a scalable programme which has been implemented by governments in Latin America (Colombia, Peru, Ecuador) and by the largest Education NGO in India to improve development and cognition for an estimated 100,000 children between 2014 and 2021. The Inter-American Development Bank and World Health Organisation have endorsed the model in published guidance.

**Preventing and mitigating child poverty:** Research on child poverty led to changes in legislation and local authority policies in Scotland. As a direct result, approximately 120,000 children per year who are living in poverty across Scotland now have access to a £100 school clothing grant. In several local authorities, they also have access to free meals in breakfast clubs and during school holidays.

**Mental health services for traumatised children:** Research underpinned mental health support for more than 44,000 children around the world traumatised by war, displacement, and abuse. Researchers trained 1,200 front-line professionals in 14 countries to recognise trauma in children, implement psychosocial interventions, reduce stigma, and improve mental health and education. The research informed global policies and practices, including UNESCO trauma-reduction policies (2018, 2019) and the World Health Organization's 2018 care guidance for one million asylum-seeking children registered in the EU.

**Improving HIV outcomes for adolescents in Africa:** Research demonstrating that combinations of social welfare, cash transfers, and caregiving support reduced HIV infection risk behaviours, such as transactional sex, by 50-70 per cent; reduced HIV infection rates; and improved health for two million adolescents across Southern and Eastern Africa. Findings have been directly translated into policy and service delivery

for adolescents by the USAID-President's Emergency Plan for AIDS Relief (PEPFAR), UNICEF, UNAIDS, and national governments including South Africa, Kenya, Malawi, Mozambique, Zambia, and Zimbabwe.

**Novel HIV prevention policies in Scotland:** Researchers contributed essential data and understanding needed by Scottish policymakers to plan and fund pre-exposure prophylaxis (PrEP) for HIV prevention. In July 2017, Scotland became the first UK nation to fund PrEP on the NHS. In the first three years, 4,100 people received PrEP, reducing HIV incidence five-fold for men who have sex with men.

**Changing domestic abuse judicial practice:** Research shaped the Domestic Abuse Bill 2020, banning cross-examination of victims by their abusers in family court proceedings, and underpinned the UK Government Plan to improve family court protection for victims of domestic abuse and children.

#### **Case Study Example: Improving education and care of Children Looked After in England**

Many case studies in this topic underpinned policy change and institutional interventions to safeguard and provide for vulnerable groups in educational settings. Judy Sebba, Professor of Education at the University of Oxford (in collaboration with Professor David Berridge at the University of Bristol) led the 'Educational Progress of Looked After Children in England: Linking Care and Educational Data' study, carried out at the Rees Centre. The research identified factors contributing to poor educational outcomes for those supported by children's services in the UK. It thereby shed light on the impact of care on childhood education outcomes, particularly of Children Looked After (CLA).

The study's innovative mixed-methods approach sought to statistically understand the effects of education and care on child outcomes while complementing this with insights from directly interviewing secondary-aged CLA, their foster carers, teachers, and social workers. Results demonstrated that children in longer-term care do better than those with a social worker but not in care and those in shorter-term care. It was also found that some children in care with lower prior attainment made very good progress academically. As such progress, rather than attainment, provides a more realistic depiction of the achievements of CLA. Sebba sees "changing the narrative around children in care – from care itself causing trauma to what happened before care that caused trauma" as a key insight emanating from these results.

The resulting report on improving CLA outcomes was widely disseminated with over 3,000 copies reaching policy makers, local authorities, and children's services practitioners, both in the UK and internationally (particularly in Japan and Australia). The importance of providing stable long-term care was a key element of the report's recommendations. The report was also disseminated as part of in-person briefings at the Department of Education (DfE) and the Association of Directors of Children's Services (ADCS), through workshops which were held with 100 of the 120 Virtual School Heads in England (Virtual Schools support the education of CLA) and to many Ofsted inspectors.

The dissemination of research recommendations generated impacts in numerous ways: they had administrative effects, with the DfE changing their Annual Statistical Release on outcomes for CLA in March 2016. They also led to a greater focus on integrating

education and care, with Ofsted altering their framework for school and social care inspections to extend their focus on CLA. This involved introducing education inspectors on social care inspections, and vice versa. Further, some local authorities (Barking, Dagenham, Salford, Staffordshire, and Suffolk) changed their policies on CLA moving schools and increased resources to Pupil Referral Units. Finally, the reach of this impact went beyond the UK, with Australia's largest fostering organisation changing its policies and practice in 2017 to incorporate recommendations prioritising stability for CLA.

#### **Distinguishing facts of the Family and Gender theme:**

- **Most prominent UoAs spanned the social sciences and humanities:**
  - UoA 20: Social Work and Social Policy (17.28%)
  - UoA 4: Psychology, Psychiatry and Neuroscience (9.56%)
  - UoA 23: Education (9.56%)
- **Main concepts:** The five most highly weighted concepts associated with this underpinning research were: 'children', 'women', 'people', 'violence', and 'development'.
- **Geographical impact mostly focused on United Kingdom, Germany, and Italy:** The primary beneficiary of the impact was the United Kingdom (167 instances), followed by Italy (43) and Germany (42).
- **Funding mostly from the ESRC, followed by the AHRC:** The Economic and Social Research Council was the most prevalent funder, representing 23.53% of all funder acknowledgements, followed by the Arts and Humanities Research Council (12.13%).
- **Underpinning research:** 66.34% female authors compared to 33.66% male authors.
- **Research is highly interdisciplinary, spanning the humanities and social and health sciences:** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Biomedical and Clinical Sciences' and 'Health Sciences', and 'Law and Legal Studies' and 'Human Society'.
- **Publication type underpinning research is largely articles:** Most of the underpinning research was published in the form of articles (86.01%), with book chapters being the second most observed format of underpinning research (5.19%). The highest Altmetric score within this cluster was 1085, and the highest citation count was 1048.



## 2.8 Governance and Law

*“One of the things that’s really vital is that you, no matter whether it’s work on policy, or whether it’s community or culture, it’s that you actually integrate the voices of the people that have been impacted.”*

– Humanities Panel Member

This Grand Theme was one of the more diverse topic clusters, with a focus that united it on the core topics of politics and governments, law, cybersecurity, consumer and privacy protection, human rights, and democracy, while also aligning with conflict and peace studies, Brexit, immigration, and misinformation, as shown in Figure 11.

Research in this domain provided vital insights for policymakers and regulators to create regulatory environments and legislation that protects citizens and consumers. This was particularly seen in newly evolving domains, such as the effects of social media and other novel forms of information media on politics and civil society, or novel forms of cybercrime. The research provides vital insights and understandings for regulators to address the challenges emanating from novel online tools and environments. Research was also conducted to provide updated advice on more traditional domains of policy making and administrative capacity building, such as strengthening the administrative system around migration as well as trade and taxation, often against the backdrop of changing administrative realities due to Brexit.

Internationally oriented work on humanitarian missions and peacekeeping, human rights, war crimes, and the prevention of terrorism produced considerable impact in the UK and around the world. Research led to changes in understanding and policies related to human rights, privacy, and freedom. Policies and ways of working were introduced to protect independent journalists and freedom of expression, and to safeguard human rights in armed conflict and warzones. Much research engaged in evidence-driven policy, providing carefully collected evidence on the many foreseen and unforeseen consequences that changes to policy can entail. Research engaged with shaping the legal and institutional environments related to novel topics such as internet privacy, GDPR, autonomous weapons, as well as the role of privacy and human rights in relation to public camera surveillance, digital surveillance, and artificial intelligence. Both social science and humanities researchers had global impact with work focused on peacekeeping and humanitarian support, developing tools and interventions that provide conflict analysis, generating support for humanitarian projects, facilitating dialogue for sustainable peace, enabling peace-making and peacekeeping in local and territorial conflict, and supporting local groups and NGOs in related efforts.

Work on reconciliation after conflicts, both internationally as well as in Northern Ireland, sought to enact social and political change and enhance public participation in programmes fostering understanding, community and interaction between formerly opposed groups. In addition to the active strand of research focussed on helping and reducing present conflicts, work on past conflicts sought to deepen our understanding with work focused on remembrance, civil wars, rebellion, creative representations of history, and challenges to dominant perceptions. A closely related strand of work engages with policies and regulations safeguarding human rights. Impact studies focusing on the Middle East developed responses to conflict during and after a reconciliation process, addressing the representations of the Arab world and Islam and the role of media and journalism. Research helped both to improve policymakers’ understanding of terrorism and violence, not only theoretically but by providing concrete tools to combat it. This included, for example, novel way of detecting and monitoring extremist and terrorist activities online. Overall, research has focused on reducing

religious- and politically religious and political extremism and sought ways to implement prevention, educational interventions, and replace with programmes fostering understanding to build more peaceful societies.

An immense pool of evidence-based policies and interventions generated impact related to measurements, policies, and interventions linked to migration policy, refugees, asylum seekers, and integration. ICSs often focused on informing and improving government policy toward migration, measuring migrant populations, and reckoning with forced migration. Researcher-led interventions and programmes enhanced the social integration of migrants, such as via English-language training, and other ways to improve lives of the displaced and enhance their capacity to integrate fully into British society. Historians produced rich narratives of the histories of migration and improved the teaching of those histories, giving a voice to individuals' complex histories and simultaneously enhancing societal understanding.

The importance of social science and humanities research in developing tools for society to engage with and integrate technological progress became abundantly evident in the work done on digital surveillance, privacy, AI, and cybersecurity. Work focused on AI governance and policies resulted in advice for novel regulations in domains such as cloud computing, but also supporting the development of public-serving digital technologies from improved digital governance and public service provision to cybersecurity to techniques for improving consumers' online experiences. Research has driven policy changes, which have been implemented in government to increase third sector transparency, data sharing infrastructure and technology transfer. Researchers' commitment to a societal discourse based on evidence and well-founded information showed in projects seeking to understand the threats arising from fake news, viral disinformation and propaganda. Evidence-informed tools were developed to increase efficacy and capacity of online governance and to gauge the public's political astuteness.

Considerable impact also took place in the areas of political democracy, integrity, and representation. Novel tools of engagement, like citizens' assemblies, reshaped politics and public engagement, understanding, and awareness. Work focussed on improving the standard of democracy sought to optimise the voter experience, increase public confidence in polling, and counter far-right or radical challenges. Given the timing of REF2021, Brexit was a core theme of research and subsequent ICSs. Many studies display a highly technical focus on grappling with the detailed implications of the novel arrangement on trade, tariffs, the constitution, Parliament, the hard-border and Northern Ireland. We also find work engaging with how Brexit interplayed and continues to interplay with the role of political parties and political processes. Overall researchers helped provide invaluable guidance to decision-makers on how to deal with the myriad, often unforeseen legal and regulatory consequences and provided sombre analysis to deepen the public's understanding of the societal and political root causes and consequences of the Brexit decision. Research in this theme also brought new policies to achieve more transparency in lobbying, countering electoral fraud, and improving electoral integrity and registration. Other work focused on bringing about increased diversity in political participation and representation, with a particular focus on women and minorities, and the diversity of voices in Parliament and witnesses to Parliament.

Work on colonialism and the legacy of slavery developed practices to memorialise and learn from the histories of those who were enslaved, to amplify voices from the past and of descendants in commemoration, include their stories and plight in the educational curriculum, and diversify teaching on history and legacies of oppression. Researchers work on past injustices was joined by other projects seeking to reduce current wrongs, with work focussed on countering modern slavery and forced labour and its integration into supply chains,

implementing government policy changes to support victims of modern slavery, improving interventions to counter it, and developing new technologies to map it. Actions to address legacies of British slavery and participation in the slave trade, along with similar historical legacies, were also implemented.

Globally oriented research also focused on ways to bring justice to victims or survivors of genocide and support processes of truth and reconciliation (e.g., Chile, Rwanda, Mexico, Peru, Myanmar, Spain). Here practices and regulations emerged on how to recognise indigenous contributions to human rights and force accountability for international organisations. Case studies in this topic represent tremendous depth, including practical measures to improve the functioning of government and regulations, to protect society from threats such as terrorism, to implement changes aimed at increasing trustworthy governance and news sources and to provide a voice to marginalised groups in need of better political representation and societal integration.

#### **Case Study Example: Humanities research informing policy and debate about AI**

“How does the fact that a knight in medieval stories of King Arthur had artificially intelligent guards at the entrance to his tent that only allowed you to pass if you were of noble birth or a virgin depending on your gender... you know, how does that then influence what we’re thinking about AI now? And of course, it does, because it maps onto the way in which AI is used”. This reflection by Sarah Dillon, Professor of Literature and the Public Humanities at Cambridge shows how humanities scholars were already grappling with the implications of Artificial Intelligence for our societies during the REF 2014-2020 period.

Two case studies highlight the different approaches humanities scholars could bring to this topic. Professor Nick Bostrom, a philosopher at Oxford University, explores how superintelligence might arise from AI and what its motivations, consequences and risks for society might be. His 2014 book on the topic, *Superintelligence: Paths, Dangers, Strategies*, sold over 250,000 copies. Bostrom worked jointly with researchers at the Future of Humanity Institute to profoundly change the public understanding of the risks, including existential risks, posed by AI. His work has become central to current policy debates about regulations to mitigate risks related to AI and he has informed UK governance bodies, from the UK House of Commons Science and Technology Committee to the House of Lords Select Committee on Artificial Intelligence. His work is also regularly referred to by leading AI researchers as well as CEOs of the worlds’ largest AI companies. Bostrom’s work on AI alignment (a field of AI safety research that aims to ensure artificial intelligence systems achieve desired outcomes and work in ways that do not harm humans) influenced growing internal efforts in AI companies to monitor alignment and influenced regulators.

While Bostrom is laser-focused on identifying potential AI risks, Professor Sarah Dillon and her colleagues Dr Kanta Dihal and Dr Stephen Cave from the Leverhulme Centre for the Future of Intelligence, along with Dr Claire Craig at the Royal Society, sought to understand how our society perceives and reacts to the advent of AI by studying how intelligent machines are represented and thought about in fictional and non-fictional narratives. Their work, which compiled narratives from different cultures and interviewed AI researchers on their reading habits, makes the case that AI narratives are a social, ethical, and political issue which shapes the technical field and the acceptance and regulation of the resulting technology.

This idea resonated with Boeing Aerospace company, who subsequently worked together with Dillon and postdoctoral fellow Dr Olivia Belton to understand how the public would react to the idea of autonomous flight. The project compiled narratives about autonomous flights, producing a critical taxonomy of its representation in fictional media and deployed a collaborative storytelling game with public focus groups to determine non-expert anticipatory assumptions regarding autonomous flight. Boeing noted that “Dillon’s research effort on Social Perceptions of Autonomy will help us in future research and development efforts around autonomous systems and strengthen our focus on the human aspects”.

Both Bostrom, who remains focused on managing and reducing risks associated with artificial intelligence, and Dillon, who believes that “good policy making should be based on synthesis of evidence” continue to bring their insights to a variety of policy stakeholders and institutions as questions on AI regulation move to the forefront. Their work illustrates how the knowledge produced by humanities scholars, ranging from a philosopher’s study of existential risk to an English professor’s expertise in narrative analysis, can play an important role alongside other types of evidence in analysing and informing society’s reaction to ground-breaking developments such as the advent of AI.

### Examples of Impact

**Combating organised crime and its finances:** Research into quantifying and mapping illicit markets has supported policymakers like the OECD, Bulgarian and European Parliaments, and law enforcement officials like EUROPOL to better address organised crime. Early detection and warning systems for the smuggling of illegal cigarettes and drugs, as well as for VAT fraud, were developed. It directly influenced policymaking to better monitor taxable smuggling, create a register of bank accounts, and set up a reversed VAT charging system.

**Enhancing banknote security:** Research developed new standards for user testing bank notes and led to innovation and commercial impact in banknote production. Intaglio printing and 3D visual cues were shown to be most identified by consumers, influencing design decisions by central banks in England, Europe, Australia, Canada, and the USA.

**Safeguarding vulnerable adults from financial scams:** Learning resources to raise scam awareness have been distributed by national agencies, charities, local authorities, the NHS, financial institutions, and the government to protect vulnerable groups. These tools have saved consumers from scams which would have cost them a total of £22.7 million.

**Transforming mobility in Belfast to reduce divisions:** Mapping out everyday movements of citizens in Belfast has given policymakers (including the Northern Ireland Housing Executive, the Good Relations Unit, the Department of Justice, and the Northern Ireland Executive Office) a better understanding of the psychology of sectarian divisions in the city. This has shaped the approaches of the Neighbourhood Services and City Regeneration and Development teams of Belfast City Council. It also informed the council’s encouragement of residents to live in the city centre and the creation of a new campus site for Ulster University to support this.

**Understanding experiences of refugees:** A three-volume collection of first-hand accounts of refugee experience has been instrumental in changing public perception of the experience of refugees. The Oak National Academy, funded by the Department of Education and the main provider of home-school education during lockdown, dedicated a series of online lessons for KS3 students to the Refugee Tales books, with a reach of 4.7 million visitors to the online site.

**Improving crisis responses via humanitarian journalism:** Research contributed to raising awareness of ‘forgotten crises’ and directing the attention of humanitarian agencies through strengthening humanitarian journalism. For example, reporting on the March 2018 Yazidi healthcare crisis in Iraq resulted in immediate action from the UN migration agency and Doctors Without Borders, among others, and led to the main hospital serving the Yazidi minority being moved to a safer and better-equipped facility.

**Legal and governance structures for Cloud Computing:** Research led to the launch of the first legal research focused entirely on the Cloud, which was co-funded by Microsoft, Hewlett Packard, and the European Commission. This has enabled the development and implementation of legal and governance structures for Cloud Computing services to solve legal uncertainties, resulting in terms from Cloud service providers that better reflect the needs of organisations, including 1000 UK tertiary education and research institutions.

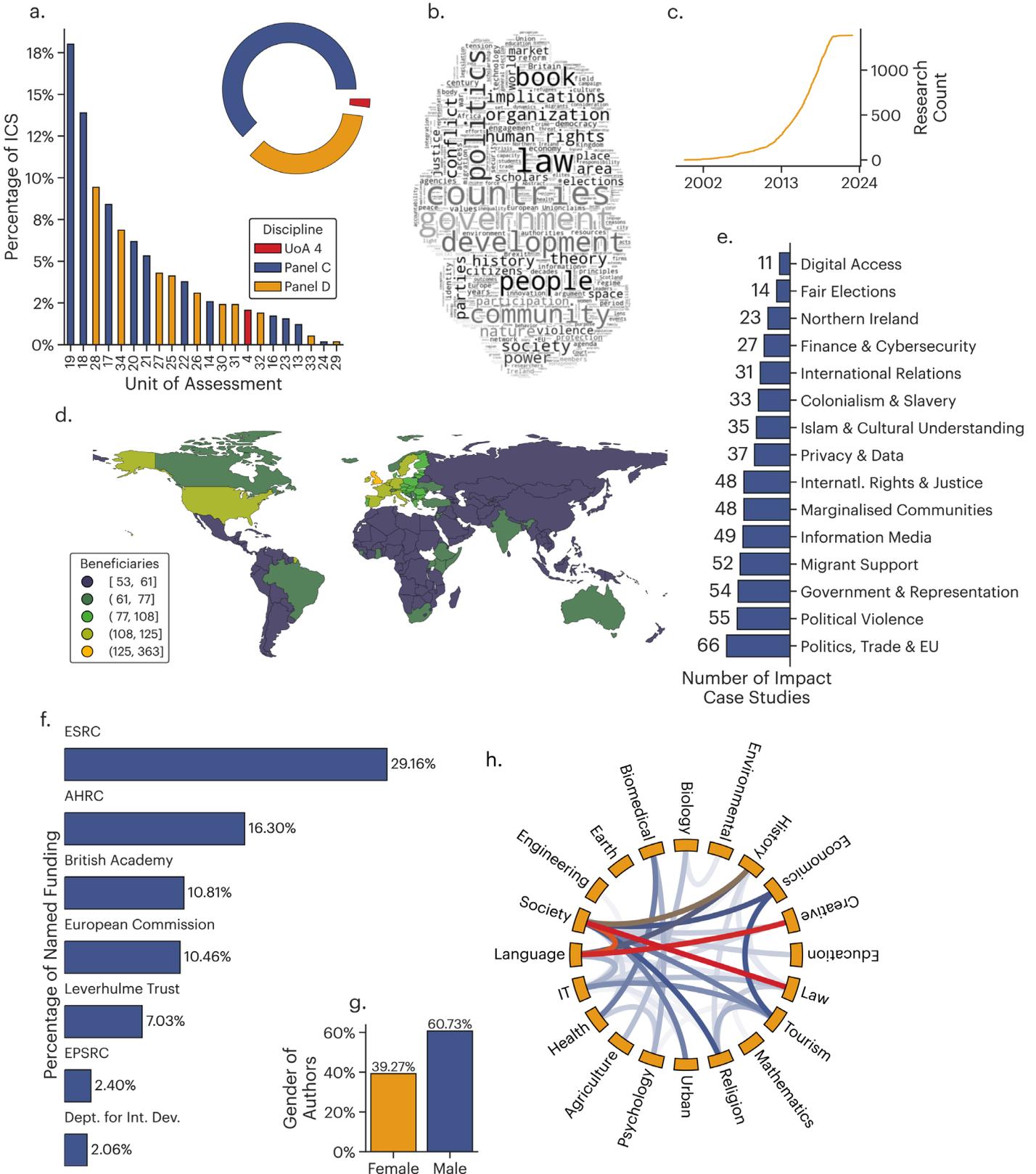
**Shifting the global discourse on the genocide of the Rohingya:** Research in the fields of Law, Political Science and Criminology played a key role in the persecution of the Rohingya being recognised as ‘genocide’ on the international stage. The researchers briefed and worked closely with the UN Fact Finding Missions (FFM) on Myanmar in 2018. Research influenced the International Court of Justice, civil society and advocacy campaigns and the UK government, as well as media discourse on the subject.

#### **Distinguishing facts of the Governments and Law theme:**

- **One of ten Grand Impact Themes with the most ICSs allocated to it:** 583 individual ICSs fall within this theme.
- **Most prominent UoAs across both the social sciences and humanities:**
  - UoA 19: Politics and International Studies (18.01%)
  - UoA 18: Law (13.89%)
  - UoA 28: History (9.43%)
- **Main concepts:** The five most highly weighted concepts associated with this underpinning research were: ‘countries’, ‘government’, ‘law’, ‘development’, and ‘politics’.
- **Majority of research in the key topic of** Brexit, EU, Trade, Tariffs, Politics, and Ethics Legislation.
- **Geographical impact largely in the United Kingdom, Germany, and France:** The primary beneficiary of the impact was the UK (363 instances), followed by Germany (125), and then Ireland (118).

- **Funding largely from the ESRC, followed by the AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 29.16% of all funder acknowledgements, followed by the Arts and Humanities Research Council (16.30%).
- **Underpinning research:** 39.27% female and 60.73% male authors.
- **Interdisciplinarity of underpinning research across the social sciences and humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Law and Legal Studies' and 'Human Society', and 'Language, Communication and Culture' and 'Creative Arts and Writing'.
- **Publication type underpinning research mostly articles but also book chapters:** Most of the underpinning research was published in the form of articles (79.73%) and monographs (7.84%). The highest Altmetric score within this cluster was 1,917, and the highest citation count was 936.

**Figure 11. Main Characteristics for 'Grand Impact Theme 8: Governance and Law'.**  
 See footnote 7 for full explainer of graphics



## 2.9 Health and Wellbeing

*“...impact could be measured by the adoption of research findings as new criteria to assess health or to implement programmes to enhance wellbeing, in medicine or education, those sorts of things.”*

– Social Sciences Panel Member

Multiple social and societal processes are key to shaping population health and wellbeing. This ranges from the institutionalisation of sports in education and clubs, to the organisation of food systems and their regulation, the organisation and humane delivery of health and care services and the interaction of people with drugs and pharmaceuticals. Therefore, it should come as no surprise that the contribution of SHAPE to health and wellbeing research-led impact has been remarkable and contains the largest group of impact case studies within our ten themes (see Table 2). Impact is driven by sports and nutrition science research such as focusing on the efficiency of the NHS and the healthcare system, and research on diagnosis and behaviour-led interventions of specific diseases. We summarise key sub-topics in this area, which are broadly divided into the themes of sports, detection, prevention, and nutrition. The examples of impact in the accompanying box provide astounding evidence of a range of impacts, including increases in healthcare efficiency in the NHS and saving countless lives through innovative diagnoses, treatments, support, and training.

Research-driven impact occurred in the realm of sport, focusing on exercise, nutrition, coaching, and improving the performance of professional athletes. This entailed advances in coaching techniques, training opportunities, performance measurement and technological advances in training and sporting equipment. The focus on athletes was accompanied by an array of projects aimed at bringing exercise to the broader public, including programmes for the elderly, reforms of sporting curricula for schoolchildren, or using physical exercise in therapeutic applications. Beyond a focus on exercise and performance, work also created organisational and legal safeguards to ensure sporting environments and opportunities that were safe from any abuse or discrimination. Initiatives were also aimed at helping current and retired athletes for health, social and economic integration. Research also enabled the efficient and inclusive organisation of sporting events and para-sporting events and found numerous ways to engage with the potential for sport to enable wider social and political change.

Detection, diagnosis, and treatment featured wide-ranging innovations in diagnostic practices, tools and training as well as the development of novel drug- and care-based interventions for patient health and wellbeing. Interventions focus on a very broad range of medical conditions, such as evidence-based quality improvement for the NHS in maternity and neonatal care. Others focused on prevention of cerebral palsy in pre-term birth or provided improved functional recovery training following severe spinal cord injuries to help people regain the capacity to walk. Researcher impact also transformed thoracic trauma surgery. Projects also helped develop and increase accessibility of novel pharmaceutical treatments and assessment tools, related to for instance, reducing hair loss during chemotherapy or improving outcome assessment in acquired brain injury. Much work also focussed on novel forms and equitable access to medical screening, such as promoting bowel cancer screening or uptake of free eye tests by poorer populations.

Further programmes helped individuals and their families manage the circumstances of their conditions with work on pain management guidelines or support for those living with secondary breast cancer. There were also therapies and support initiatives related to mental health, autism, stroke, and self-harm, as well as to very specific and rare diseases and neural conditions. Projects also offered unique data, new tools, and training and intervention programmes to identify individuals and groups in need and provide focussed and efficient

treatment and therapeutics support. Work also impacted neurodiversity diagnosis and support focused on novel diagnostic tools and on supporting neurodivergent individuals within their social and family environments. It likewise aided in seeking interventions to empower those facing exclusion in professional and education settings on the basis of learning and/or communication disabilities. Healthcare approaches inspired by humanities, design and the arts were integral to many projects and can also be found in Section 2.1, particularly in the highlighted impact case studies.

Mental health support and training provided research-driven initiatives that underpin understandings of mental health and the provision of sustainable, patient-focused support and training, like programmes helping psychological therapists to support clients taking or withdrawing from prescribed psychiatric drugs. Several projects sought to identify groups whose mental health has been overlooked or misunderstood and provide support systems in low-resource contexts. For example, this included improved access to evidence-based treatments for children with anxiety disorders or work focussing on providing services for perinatal depression. Interventions in mental health focused on diagnosis and treatment as well as on direct wellbeing support across a vast range of ages, providing support for those affected and their families and interventions easing conditions and continued integration into society. They addressed psychological concerns in diverse settings, such as reducing mathematical and learning anxiety, improving mental wellbeing in the workplace and helping isolated and elderly individuals. Others focused on improving patient quality of life and rehabilitation, and on providing the data and support necessary to facilitate the education of health practitioners.

Research on mental health, social media, eating disorders, and body image in young people and women provided tools to safeguard against the harmful online environments, teenage stress and increased social media use. Other research examining PTSD (Post Traumatic Stress Disorder) and self-harm has helped affected groups cope with severe mental stress, creating supportive environments as well as professional assistance, reducing self-harm and suicide. This research also provided support for families of affected individuals and support to vulnerable individuals through direct intervention, training clinicians and communities, changing institutional policies, and informing public awareness.

Much research focused on specific conditions and diseases in diverse areas, with cardiovascular disease, brain injury, ADHD and cystic fibrosis standing out as particular focal points of research-based interventions. Here research has driven policy change, revision of healthcare guidelines, technological investments, and novel treatments as well as increased education for carers and additional resources for the institutions that offer treatment and support. Impact has also occurred in the realm of infectious disease crises in both global, national, and localised settings. Here the focus was often on low-resource settings, such as developing countries, to provide treatment alongside social and cultural understanding. Research also focused on data analysis to equip humanitarian aid and government institutions with the tools to respond to outbreaks.

A considerable body of research drives impact in health efficiency, prevention, and ethics. Healthcare efficiency and prevention has generated improvements of healthcare provisions, with an emphasis on early interventions and preventative measures to relieve pressure on healthcare institutions. We also find numerous initiatives that train healthcare staff to provide efficient interventions informed by the most recent scientific evidence and improving management practices within the healthcare workforce. Work on bioethics and the importance of cultural and religious differences when engaging with healthcare is another area in which humanities and social science researchers profoundly impacted medical practice. Research impact likewise improves service delivery by putting in place novel monitoring and IT services facilitating healthcare provision. This included, for example, a newly developed app for

accident and emergency department availability, which helped reduce peak-time demand and allowed for easier service access. It becomes abundantly clear that research consistently seeks to reduce financial burdens on health and social care providers, and to enable higher quality treatments and system improvement.

Other research domains contributing to the health and wellbeing theme are concerned with food access, production, analysis and security. Here you can find projects promoting safer and better regulated food production and delivery systems and promoting healthy food habits, but also work ensuring that disadvantaged children are provided with regular meals in educational contexts. Related work on ethics and data in healthcare interventions focused on demographic and medical data analysis and prompted government and institutional policies in response to this information. Finally, considerable social science research interacts with pharmaceutical research, guiding ethical research practices, promoting prescription guidelines and increasing access to pharmaceuticals for those in need.

#### **Case Study Example: Allowing motor-impaired individuals to make music with brain signals**

Many case studies in this topic develop new diagnostic and therapeutic approaches improving the lives of individuals suffering from health conditions. These can be based on novel technology or on using traditional therapeutic tools, such as music. The Brain-Computer Music Interface (BCMI) technology developed by Eduardo Miranda, Professor in Computer Music at the University of Plymouth, does both. The interface allows individuals suffering from severe motor impairment to create and perform music. Professor Miranda's BCMI overcame the fundamental issue of lack of voluntary control that prior Brain-Computer Interface (BCI) systems had been unable to solve. The trial group of four individuals with Locked-In Syndrome, a rare neurological disorder (affecting 1% of people who have a stroke) characterised by complete paralysis of voluntary muscles except those controlling eye movement, were able to create and perform music using their brain signals. The Royal Hospital of Neuro-disability (RHN), where these patients received care, reported a marked improvement in their quality of life and confidence.

The project has also raised awareness of Locked-in Syndrome and individuals suffering from severe motor impairment and changed public perception of these disabilities. In July 2015, the BCMI was used for a public performance in which four musicians and four patients performed Miranda's composition, *Activating Memory*, at RHN. Preparation for this performance was captured in a documentary, *Paramusical Ensemble*, which won Best Documentary at the BioFiction Science Art Film Festival 2019 and was screened around the world.

The publicity around the performance and documentary led to further opportunities and wider audiences. One of the BCMI patient participants was a former violinist of the Welsh National Orchestra (WNO), Rosemary Johnson. As a result of the media attention to Miranda's research, in March 2017 Volvo and Grey advertising agency collaborated to produce a Sky Atlantic TV documentary about Johnson as part of the series *Defiant Pioneers*. Miranda worked with Johnson to facilitate a performance with an orchestra featuring Johnson as a soloist through use of BCMI. The documentary was first aired during the advert break of the season finale of *Game of Thrones*, attracting 12.1 million viewers. This has led to greater awareness and understanding of the issues facing

individuals with Locked-in Syndrome, and to the adoption of BCMI technology by RNH therapists, nurses, and carers. Johnson's performance using BCMI contributed to her receiving an MBE for her services to music in December 2017.

### Examples of Impact

**Supporting people with advanced dementia:** Research into the therapeutic value of playful objects led to the development of a product that improves the quality of life of people affected by advanced dementia, which is now prescribed on the NHS. A six-month trial funded by £185,000 from Welsh Government found the product improved wellbeing for 87% of participants. National and international demand from Health Boards, care homes and the public followed. As a result, a spin-out company was launched in 2020, backed by over £105,000 investment capital from sources including a Crowd Funding campaign and the UK Alzheimer's Society.

**App for health emergency services:** the development of the NHSquicker app enabled patients to choose a treatment facility for their condition, by giving real-time data on A&E/MIU wait times. The app has been made available to 1.7 million patients since 2017, with 40,000 patients using it. It was shown to reduce peak time demand in A&E units.

**Evidence-based treatment of ADHD:** Research producing the most rigorous evidence synthesis available on the treatment of ADHD informed international clinical guidelines, including the American Academy of Paediatrics (67,000 members), European guidance for ADHD management during the pandemic, the World Federation of ADHD (2,000 members), and patients (e.g., from ADHD Europe, including 28 organisations from 23 countries).

**Bringing breakfast to schools:** Research demonstrating the positive impact of breakfast consumption on cognitive function, and classroom behaviour of children helped expand the national school breakfast programme to an additional 650 schools, and underpinned the process that brought the School Breakfast Bill into Parliament.

**New self-administered health technology for slowing down the onset of blindness:** Diabetic retinopathy is the leading cause of blindness among working age adults. Design Researchers working with a private company have developed a novel treatment slowing down the onset of blindness, the Noctura 400 sleep mask. The project has attracted £18m in external funding.

**Mental health care for people with cystic fibrosis:** Life expectancy of people with cystic fibrosis (CF) is 35-40 years. Research highlighting the mental health consequences of this condition led to international policy change by developing and publishing CF Mental Health Guidelines for health professionals and led the US CF Foundation to allocate approximately \$20 million to fund 138 Mental Health Coordinators.

**NHS investment in social prescribing:** Social prescribing (SP) is a community-based approach to health and care which aims to tackle health inequalities by addressing social determinants and broader wellbeing in disadvantaged communities. Based on research evidence demonstrating the effectiveness of SP, NHS England £35 million in local SP services, including £3 million per year in Rotherham alone. 900,000 people per year will be referred to SP schemes, reducing the cost-burden of long-term health conditions on the NHS.

**Distinguishing facts of the Health and Wellbeing theme:**

- **One of the largest themes:** 668 ICSs fall within the theme of ‘Health and Wellbeing’.
- **Distributed across UoAs within the social sciences:**
  - UoA 4: Psychology, Psychiatry and Neuroscience (25.9%)
  - UoA 24: Sport and Exercise Sciences, Leisure and Tourism (21.86%)
  - UoA 17: Business and Management Studies (8.83%)
- **Main concepts:** The five most highly weighted concepts associated with this underpinning research were: ‘outcomes’, ‘patients’, ‘people’, ‘health’, and ‘years’
- **Majority of research in the key topics** of ‘Sport, Exercise, Athlete Performance and Wellbeing’.
- **Geographical impact largely in the United Kingdom, the USA, and Germany:** The primary beneficiary of the impact was the United Kingdom (425 instances), followed by the USA (142), and Germany (122).
- **Funding mostly from NIHR and ESRC:** The National Institute for Health and Care Research was the most prevalent funder, representing 13.77% of all funder acknowledgements, followed by the Economic and Social Research Council (12.13%).
- **Gender:** The authorship of the underpinning research written by 45.53% female authors, 54.47% male authors.
- **Underpinning research is interdisciplinary and largely published outside of the social sciences and humanities in health, biomedical, and psychology outlets:** The most commonly occurring interdisciplinary linkages in the underpinning research are between ‘Health Sciences’ and ‘Biomedical And Clinical Sciences’, and ‘Biomedical And Clinical Sciences’ and ‘Psychology’.
- **Publication type underpinning research is overwhelmingly articles, with some book chapters:** Most of the underpinning research was published in the form of articles (93.59%) and book chapters (2.60%). The highest Altmetric score within this Grand Impact Theme was 2,277, and the highest citation count was 5,548.



## 2.10 Sustainability and Infrastructure

*“For people like us, doing applied research, impact is good news because we have been undervalued in the past. And now they see the value of what we’re doing.”*

– Humanities Panel Member

Research and impact in climate change, renewable energy, ecosystems, and infrastructure is an interdisciplinary enterprise, with social science, behavioural, and legal research often playing a transformative role, as shown in Figure 13. University-based research fuelled considerable technological, societal, and economic impact in this area. This has contributed to better environmental protection practices and legislation, improved natural and agricultural resource management, and led to the implementation of technological and legislative changes to mitigate climate change. It also resulted in improvements in infrastructure and housing, which include conceiving more environmentally friendly buildings, providing broader infrastructure access across the UK, making urban spaces greener and less polluted, and improving residential construction practices and housing legislation and regulations.

SHAPE researchers have changed UK, EU, and global regulations and practices around multiple energy, ecosystem, and infrastructure matters, often resulting in substantial gains in energy efficiency and CO<sub>2</sub> reductions. Considerable transformations occurred in the realm of water management, involving water industry and regulators and affecting resource management, preservation, biodiversity and flood management across freshwater, marine and coastal areas and rivers. Examples range from reducing historic coastal landfill and legacy waste to establishing new marine reserves for example in the Pitcairn Islands. Policy, legal, and regulatory changes transformed practices of fisheries, regulations on trade, and revolutionised warning systems for flooding risk. Research also resulted in improved marine ecosystem management, peatland preservation and protection of biodiversity, as well better domestic water sources.

Research on energy systems has led to vital governance reforms such as accelerating decarbonisation in the British energy system and generated regulatory changes setting new efficiency standards and advancing green energy. We also find applied research directly affecting energy company management and improving efficiency in energy provision. Ethical, legal, regulatory, and community-supported SHAPE research drove both the implementation of technical fixes as well as behavioural change to accelerate clean heating and the move towards net zero, while also ensuring equal access to affordable, reliable, and sustainable energy. A considerable number of researchers in this domain also started for-profit start-ups, providing services on topics ranging from algorithm driven, energy-saving electrical grid management to computer models for flood simulations serving insurers.

SHAPE-fuelled biodiversity research drove environmentally and economically sustainable agriculture and fosters the coexistence of humans and wildlife, the protection of animal habitats, and community-led agricultural governance. Here, the public and other relevant groups were included in environmental management and conservation. Research also led to changes in environmental protection regulations such as regulations for gas extraction, as well as changes in property management law to protect the marine environment and countless other new approaches to resolve conflict between protected species and infrastructure development in the UK. Research in this domain is particularly international, with UK researchers often helping foster agricultural and natural resource management for sustainable development around the world.

SHAPE research also drives innovative policies, regulations, and proactive technical solutions related to the challenges of housing and infrastructure. A considerable body of evidence-based research focused on legal, policy, and ethical changes for local cities and industries. In this

context, researcher-led projects also helped local communities and disadvantaged groups to reshape their communities and regenerate town centres. Other projects were more directly concerned with the provision of new infrastructure. Examples include the development and evaluation of popular tramways in economically disadvantaged regions, modernising bus payment systems, and facilitating bicycle use in urban communities. New directives have informed housing associations, policies and practices, and changed government homebuilding to focus on sustainable and affordable housing. New solutions changed policy and practice in the financial assessment of property developments to improve community benefits. Research has shaped legislation on homelessness, which has subsequently impacted and informed international policy debates. Disaster, safety, and emergency preparedness research has built resilience in the UK and beyond. Finally, much of the housing and urban development innovations brought about by research-led initiatives tie into the broader focus of this Grand Impact Theme by developing pathways towards sustainable, less polluted and greener housing and living environments for the citizens of the United Kingdom.

#### Examples of Impact

**Improved maritime fishery regulation:** Research on using terrestrial property law to better manage maritime resources influenced UK government post-Brexit maritime regulation and resulted in a ban on electric pulse trawling throughout Europe and the establishment of new Marine Protected Areas around Ascension Island and in Scotland.

**Improving energy use of UK Homes:** Research into energy efficient construction led to changes in UK Building Regulations, estimated to reduce 120,000 tonnes of carbon dioxide emissions and saving British households £66 million in energy consumption due to higher energy efficiency.

**Improving the energy efficiency of non-residential buildings across Europe:** Showing that new methods of continuous monitoring are more effective at improving building energy performance than physical inspections informed the 2018 revision of the EU Energy Performance of Buildings Directive, defining legal standards across all 28 EU member states. Insights were also incorporated into the £4.4 billion building programme for new schools by the UK Department for Education.

**Sustainable wetland farming:** Insights from research on best practices for sustainable agricultural wetland use, codified as the Functional Landscape Approach (FLA), were incorporated by governments and NGOs in programmes that reached over 148,000 households, around 1 million people, in Ethiopia, Zambia, Malawi, Uganda, and Tanzania.

**Making homes and businesses more flood resilient:** Research on making households adopt Property-level Flood Resilience (PFR) measures led to a scheme drawing on local knowledge that helped 60,000 property-owners improve their resilience to flooding. It also helped convince a major UK insurer to fund PFR for its customers

**Computer models for global flood management:** Creating the first high-resolution simulations of continental and global flood dynamics and risks via a researcher-led startup has resulted in more than 1,600 non-governmental organisations, multinational companies, governments, (re)insurers, specialist risk modelling firms, and non-commercial users adopting their flood inundation model for better global risk management.

**Delivering smart ticketing in the UK:** A commercial spin-out company from a university team implemented the rollout of contactless payment across UK bus networks. In 2020 over 100 million transactions across 27 local authorities were processed.

**Low emission road repairs:** Producing new emulsions and techniques for sustainable, low emission, and low-cost repairs, surfacing, and maintenance of existing asphalt, resulted in laying over 850,000m<sup>2</sup> of roads in 2018 and 2019.

### Case Study Examples

Many case studies in this grand theme are concerned with translating research insights on sustainability into practical measures for transitioning towards net zero. The two case studies here highlight different avenues for achieving this change: the first is concerned with architectural and infrastructure improvements, the second focuses on policy change.

#### Adapting NHS hospitals for climate change

“What I wanted was to build real buildings,” Professor of Architecture Alan Short says, reflecting on his career. Despite being an academic, Short does exactly that, with his research focusing on adapting buildings to make them more resilient to a changing climate and intense summer heat while reducing their carbon emissions. This research impact suggests that it is possible.

“Architecture is incredibly interdisciplinary” says Short, who works with applied mathematicians to model natural air flows to enable better heat regulation in buildings. This interdisciplinarity was a key component of his project, Design and Delivery of Robust Hospitals in a Changing Climate (DeDeRHECC). This project proposed solutions for better climate adaptation that were prescribed for over 248 NHS England Acute Hospitals. The expertise gained from this project led to the Department of Health commissioning Short to develop the NHS Energy Efficiency Fund (EEF), improving energy efficiency across the retained NHS Estate. The £50 Million EEF funded an additional 117 energy efficiency projects in 48 NHS organisations and is estimated to save 100.6Mkg CO<sub>2</sub> pa, 2.4% of the entire NHS building energy related carbon footprint. Short’s research has also been picked up internationally and influenced the retrofitting of hospitals by a major healthcare facility manager in Canada as well as Chinese governmental guidance for reducing emissions in the construction sector. The resulting government recommendations for adapting and retrofitting existing buildings rather than replacing them within the Hot Summer-Cold Winter Zone, largely across the Yangtze River basin are estimated to mitigate a potential 320.11- 415.8 billion kWh of energy consumption per annum.

Short’s work on adapting UK hospitals does not solely focus on reducing emissions but comes with the added benefit of looking for improvements in workplace conditions for NHS staff and medical practitioners, with more natural airflow reducing airborne transmissions in hospitals. Ongoing research is focused on redesigning surgical theatres for better and safer medical practice.

#### Informing the Paris Climate Agreement

Professor Anil Markandya describes his research as having two objectives: “putting environmental problems on the map by understanding their economic dimension” and addressing these problems to “improve living standards in developing countries particularly in vulnerable communities”. His research examines the harmful effects of

climate change in various contexts and identifies often market-based policy mechanisms to alleviate this damage. This included modelling the health costs arising from the effects of a changing climate on diseases such as malaria and diarrhoea in developing countries. Markandya's work then went on to demonstrate that the health cost savings alone of many climate change mitigation policies tend to outstrip their cost. Markandya used his expertise on this topic as a lead author for chapters of the third and fourth IPCC Assessment Reports on Climate Change, which were awarded a share of the Nobel Peace Prize in 2007.

The report was approved by over 100 national governments, among them the UK, and influenced their climate targets. It was also a key scientific input into the Paris Climate Agreement, which was signed in 2016 and aims to limit the rise in global average temperature to 1.5°C above pre-industrial levels. Markandya's trajectory exemplifies how rigorous research can influence global policy agreements for mitigating climate change. He now actively continues to work on how the commitments of the Paris agreement can become reality, with his current research focusing on "ways in which countries can now develop national commitments to try and meet the 2050 goal and ways in which they can take action to meet that goal".

#### **Distinguishing Facts of the Sustainability and Infrastructure Theme**

- **Most prominent UoAs are across the social sciences:**
  - UoA 14: Geography (31.23%)
  - UoA 13: Architecture, Built Environment and Planning (17.26%)
  - UoA 17: Business and Management Studies (15.89%)
- **Main concepts:** The five most highly weighted concepts associated with this underpinning research were: 'area', 'community', 'development', 'management', and 'climate change'.
- **Majority of research** in the topic of Conservation Ecology and Natural Resource Management.
- **Geographical impact is mostly in UK and the Netherlands:** The primary beneficiary of the Impact was the UK (242 instances), followed by the Netherlands (69).
- **Funding almost equally from the ESRC, EPSRC, NERC, and the European Commission:** The Economic and Social Research Council, UKRI was the most prevalent funder, representing 19.45% of all funder acknowledgements, followed by the EPSRC (15.34%).
- **Gender:** 35% female and 65% male.
- **Publication of research is interdisciplinary across the social and natural sciences and humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Environmental Sciences' and 'Biological Sciences, and 'Human Society' and 'Built Environment and Design'.
- **Publication type underpinning research was largely articles:** Most of the underpinning research was published in the form of articles (93.36%) and monographs (2.18%). The highest Altmetric score within this cluster was 2,160, and the highest citation count was 3,638.



## 3.0 Defining Features of SHAPE Research Impact

### Key points

- Larger departments have – on average – higher departmental ‘Grade Point Averages’, with challenges and successes apparent for both smaller and newly-created units.
- The geographic distribution of impact beneficiaries was typically centred within the UK, but had substantial international coverage, with little difference between the social sciences and humanities.
- UKRI funding represented 25.64% of funder acknowledgement across all Panels and was key to the success of many ICSs. The two principal SHAPE Research Councils received 2.36% (ESRC) and 1.26% (AHRC) of the total UKRI budget in 2021.
- Interdisciplinarity occurs most commonly between the most closely related fields. For the social sciences, interdisciplinarity occurred more frequently between ‘Health Sciences’ and ‘Biomedical and Clinical Sciences’, and between ‘Law and Legal Studies’ and ‘Human Society’. Within the humanities, interdisciplinarity most often occurred between ‘Language, Communication, and Culture’ and ‘Creative Arts and Writing’, and between ‘Language, Communication, and Culture’ and ‘History, Heritage, and Archaeology’.
- Multidisciplinarity is observed for the social sciences, with the most common links between ‘Psychology’ and ‘Medical and Health Sciences’, and between ‘Human Society’ and ‘Economics’. For the humanities, it occurred most between ‘Language, Communication and Culture’ and ‘Creative Arts and Writing’, and between ‘Language, Communication and Culture’ and ‘History and Archaeology’.
- Multidisciplinarity was also found across less “traditional” combinations when observed at an aggregated level of disciplinary groups. For social sciences, there is strong evidence of multidisciplinarity with the physical sciences. For the humanities, notable levels of multidisciplinarity were observed with medical sciences.
- Balance in the gender of authorship of underpinning research was far closer to parity within SHAPE disciplines than STEM, and highest in UoA 4 and Panel D.

We next provide a deeper, quantitative and scientometric analysis of all ICSs within UoA 4 (Psychology), Panel C (Social Sciences), and Panel D (Arts and Humanities) groupings. This is undertaken across five dimensions of ‘The Environment of Impact’ (Section 3.1), ‘The Geography of Impact’ (Section 3.2), ‘The Funding of Impact’ (Section 3.3), ‘The Inter- and Multidisciplinary Nature of SHAPE Impact’ (Section 3.4), and ‘The Gendered Nature of Underpinning Research’ (Section 3.5).

### 3.1 The Environment of Impact

Table 4 summarises the key ICS and environmental data. This simple summary illustrates that it was Panel C which submitted the largest number of ICSs, as might have been expected given that it has the largest number of Full Time Employees (FTEs). Panel C also contains UoA 17 (Business and Management Studies), which submitted the largest number of ICSs (N=504) across all units. Panel A has the largest total income (largely due to the Clinical Medicine UoA), and Panel B has the largest number of doctoral degrees conferred (largely due to the Engineering UoA).

**Table 4. Summary of key Impact Case Study and environmental data**

Main panel	Number ICS	% Total ICS	FTE	Degrees	Income (£bn)
<b>A</b>	1,419	22.31	19,763.11	46,854.13	22.41
<b>B</b>	1,268	19.93	17,972.29	51,859.17	14.34
<b>C</b>	2,146	33.74	23,292.24	38,122.04	3.61
<b>D</b>	1,528	24.02	13,946.03	22,685.49	1.25

In Figure 14 we consider both environmental variables and an engineered ‘Departmental Grade Point Average’, concluding that while larger departments generally scored higher on average than smaller ones in terms of ICS results, there exist no substantial or systematic differences between SHAPE (mean GPA: 3.1) and non-SHAPE (3.17) disciplines, or between UoA 4 (Psychology, 2.98), Panel C (Social Sciences, 3.07), and Panel D (Arts and Humanities, 3.13). That smaller submitting institutions found generating highly relevant impact challenging is reinforced by a quote from one of our interviewees who stated:

*“Small units face a high burden in producing impact case studies, which needs to be addressed in future exercises. Creating impact case studies is onerous, and provisions need to be made to aid smaller units.”*

– Humanities Panel Member

This has also been noted by a REF panel advisor, citing the change in the REF2021 rules. This was a change from needing ten active research staff to submit one case study in 2014 to the requirement of needing a higher number of 15 active staff per case study in 2021, which some have argued severely disadvantages new and smaller institutions (Kerridge 2022). This is since a very small staff unit of two people would have to produce the same number of case studies as a unit that is considerably larger. However, despite these challenges, the successes of smaller units were vast and significant, as recognised by our own internal review of all ICSs, and by a member of Panel D, who noted:

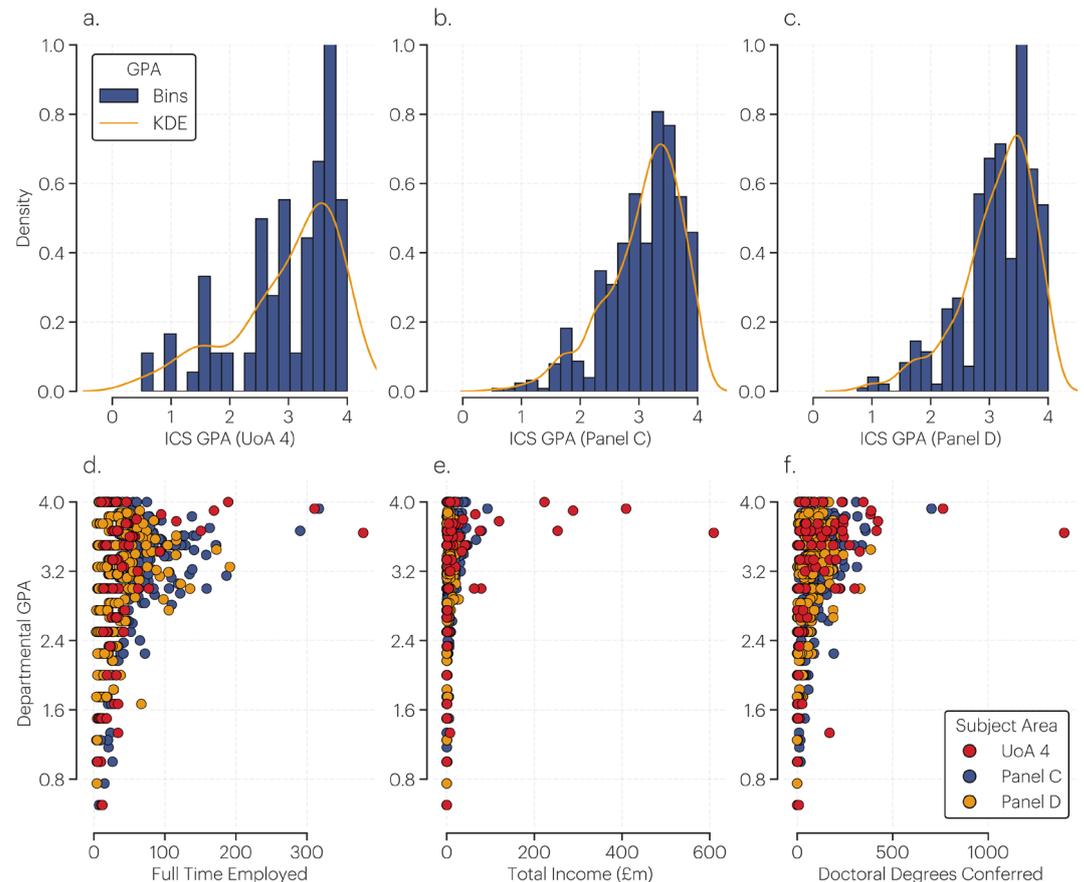
*“Smaller institutions that were more embedded in communities and the provision of intersection between research, practice and public were generally better at hitting the impact markers, but often there was a lot more work, effort, and fundraising needed to get to the point of being able to submit something.”*

– Humanities Panel Member

The environment within which impact gets generated has enormous consequences for the shape of impact that ensues. It also influences the impact that gets submitted to and evaluated by REF panels. We can quantify the role of the environment in terms of size and resources (and by proxy, institutional support) across all SHAPE disciplines. The ten largest departments by ‘total income’ had an average submission Grade Point Average of 3.717. This is compared with just 1.692 for those with the ten lowest Total Incomes. As shown in Figure 14, the same is apparent for the number of Full Time Employed (FTE) staff (3.607 versus 2.000) and the Number of Doctoral Degrees Conferred (3.751 versus 1.617). This gap was largest in UoA 4 (in comparison to the entireties of Panel C and D), where the difference in GPA was 2.220 between the highest and lowest FTE, 1.845 between the highest and lowest income departments, and 2.078 for those with the most and least doctoral degrees conferred.

**Figure 14. SHAPE Environments and ‘Grade Point Average’:**

The first row shows the distribution of Departmental GPA across UoA 4, Panel C, and Panel D, while the second row shows the cross-tabulation of GPA against three key environmental features



Environment and size also represented challenges in terms of evaluation. The challenges of assessing larger UoAs were not under-estimated by our qualitative interviewees:

*“I think for the larger subject panels particularly it was difficult. You know, they just have so many to read and to get through that they ended up needing to break up into subgroups to discuss batches within specific areas of the discipline.”*

– Social Sciences Panel Member

This issue was felt in the largest SHAPE UoA (Business and Management), and emphasised in a recent review (Blackburn et al. 2023) and by another Social Science Panel Member:

*“There’s something around the size of panels as panels become very big, and we’ve certainly had this issue in Business and Management: you can’t assess things in plenary. Partly because you know you can’t have a plenary of 53 people, but the other thing is that if you’ve got 53, you know, if you got 41 academics from different institutions, well, you’ve got so many conflicts of interest.”*

– Social Sciences Panel Member

There were also reflections on newly created units, and the challenges which they faced:

*“If you’re a new unit how are you going to get going on impact? For new units, it’s quite challenging to find the case studies needed. And you’re new and small, you don’t need many case studies. But they’re going to loom large in the proportion of your assessment. So, I think there’s some challenges about the size of institutions and newly created units, I think it can be quite challenging criteria.”*

– Social Sciences Panel Member

The importance of institutional support were also recognised by our interviewees:

*“Institutional support for impact and the creation of impact case studies aids in the creation of better impact case studies. Institutions that recognise that impact and impact case studies take time and resources, and allocate those to impact goals, generally develop better impact case studies.”*

– Humanities Panel Member

### 3.2 The Geography of Impact

Research and research impact are geographically diverse in terms of where centres of excellence for different research fields are located within the UK. However, our focus here is on the global geography of where institutions generate research impact. Geographies and the geographical location of beneficiaries should not be conflated with ‘reach’, and comparisons on a national and international scale remain significantly challenging, as indicated by one Social Science Panel Member:

*“How do you compare something that’s like SMEs in the West Midlands, to something that’s very international? So that was something that we spent a lot of time talking through and talking about the context of impact in each of the cases.”*

– Social Science Panel Member

To analyse the distribution of geographic beneficiaries, we curated (with an independent review by a second researcher) and harmonised free-text country names in the raw REF2021 ICS database, converting them to machine-readable ISO-3 country codes where appropriate and possible to do so. These database enhancements are available from our interactive online portal and supplementary online materials. The primary results of our analysis can be seen in Figure 15, again delineated across UoA 4 (first row, subfigures a. and b.), Panel C (second row, subfigures c. and d.), and Panel D (third row, subfigures e. and f.). Perhaps unsurprisingly, we map to the GBR – the United Kingdom – ISO3 code most frequently by a considerable volume. This is true for each of UoA 4, Panel C, and Panel D:

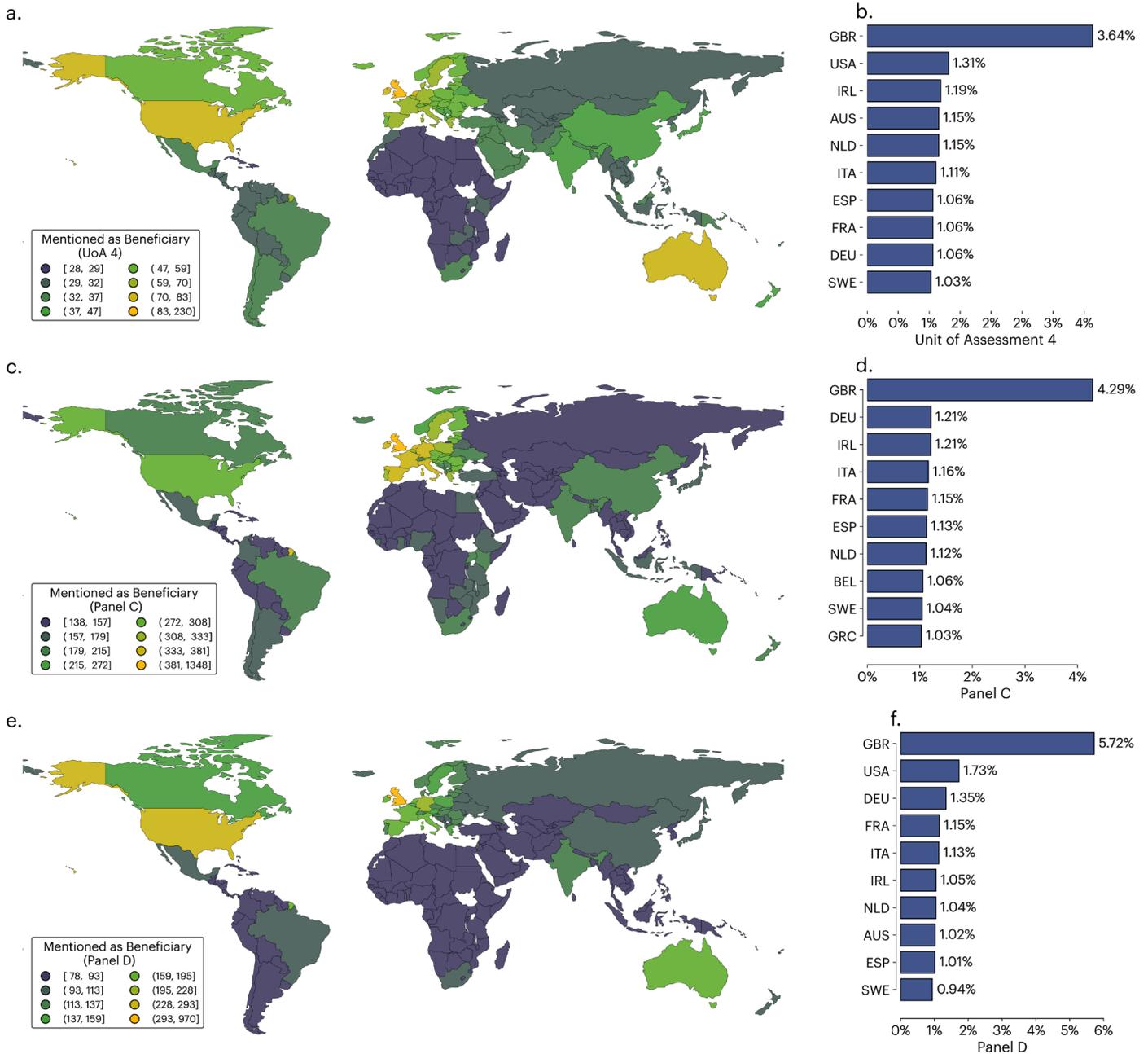
- UoA 4: 3.64% of listed beneficiaries (countries) are within the United Kingdom.
- Panel C: 4.29% of listed beneficiaries are within the United Kingdom.
- Panel D: 5.72% of listed beneficiaries are within the United Kingdom.

Whilst many countries are commonly listed – including as part of many ‘global’ identifiers –, definitive geo-political patterns regarding the beneficiaries of the research are immediately apparent. The United States of America is the second most listed country of benefit in both UoA 4 and Panel D. For Panel C, the second most frequent beneficiary is Germany. Other commonly occurring beneficiaries include the Republic of Ireland, Canada, Australia, France, and the Netherlands. Except for New Zealand, the five core countries of the ‘Anglosphere’ are generally well represented in our analysis. In terms of least benefitting regions, Africa, the Middle East, Asia and – to a lesser extent – South America are mentioned as beneficiaries least frequently for each of UoA 4, Panel C, and Panel D.

Our interactive dashboard and ‘Enhanced REF2021 Database’ acts as an supplementary tool for exploring the geographic trends in research impact. They allow users to inspect data and examine visualisations of the locations of UK institutions that submitted ICSs within a selected topic, and the countries that were impacted by the relevant accompanying research. Users can dynamically filter results by funder, UoA, and institution postcodes to explore how these factors affect the global geographies of impact within each research topic and how these patterns differ among topics (see Section 4 for further details). In terms of mentions of ‘global’ geographic impact, there were 28 instances in UoA 4 (8.59%), 115 in Panel C (5.36%), and 72 in Panel D (4.71%).

**Figure 15. The Geographic Distribution of SHAPE Beneficiaries.**

The first row relates explicitly to UoA 4, the second to Panel C, and the third to Panel D. The first column shows the geographical distribution of named beneficiaries, and the second column shows the percentage values attributed to the ten most commonly seen countries.



The analysis above – and in particular Subfigures 15b, 15d, and 15f – consider country mentions as a percent of all countries mentioned within and across all relevant ICSs. These numbers as presented above are lower than alternative approaches for two reasons. First, we manually and extensively cleaned and disambiguated the country names, and attribute individual ISO codes to individual countries within individual catchment areas (e.g. disambiguating and expanding ISOs within ‘Global’, ‘Eurozone’, etc). Secondly, and as a function of this expanded list, this means that countries appear as relatively lower frequency counts than an approach which simply considered whether a specific ISO country code was mentioned as a beneficiary within an ICS (which can then be disaggregated to the UoA or Panel level). Table 5 presents exactly this; the frequency of times each of the ten most commonly appearing disambiguated ISO-3 codes are mentioned as a fraction of all ICSs within which they could be mentioned.

**Table 5. Geographical Beneficiaries by Percent Mentioned within ICS by ISO (International Organization for Standardization) Code.**

<b>ISO 3 Code</b>	<b>Panel A</b>	<b>UoA 4</b>	<b>Panel B</b>	<b>Panel C</b>	<b>Panel D</b>
<b>GBR</b>	69.27	66.87	66.87	61.93	62.5
<b>USA</b>	30.02	25.46	25.46	13.75	19.24
<b>DEU</b>	27.34	20.55	20.55	17.33	14.86
<b>FRA</b>	25.86	20.55	20.55	16.5	12.57
<b>ITA</b>	26	21.47	29.42	16.87	12.43
<b>IRL</b>	27.06	22.7	28.23	17.52	11.65
<b>NLD</b>	26.71	22.09	29.57	16.36	11.45
<b>ESP</b>	26.22	20.55	29.26	16.45	11.26
<b>BEL</b>	24.59	19.33	28.39	15.33	10.34
<b>SWE</b>	25.02	19.63	27.76	15.19	10.41

### 3.3 The Funding of Impact

Funders are key drivers of impact generation and played an important role in enabling many of the impact successes presented in this report. There is, however, great variation in the approaches which different funders take towards the generation of impact, with a heterogeneous championing of impact's importance in their application processes as well as differing requirements for the demonstration (and reporting) of research. Various interviewees commented on the role of funders:

*“Funders include impact-related elements in their funding, and we see a high correlation of success in projects that were able to exploit that sort of funding base to conduct the impact work in a more professional way.”*

– Social Sciences Case Study Author

*“So, there's a lot more going on within universities, which is the response to REF, but also a response to research councils that also look for pathways to impact, and other funders.”*

– Social Sciences Panel Member

We use two complementary data sources to isolate and analyse funders of research underpinning the REF case studies: 1) We obtained supplementary bibliometric data (Dimensions) at the individual article, book, chapter, monograph, or proceeding level that can be linked to the supporting, underpinning research listed in each ICS (typically up to six pieces); and, 2) Used information on funders which were listed in the raw REF2021 ICS database itself. These were 'self-reports' of funding obtained and were completed by ICS authors and submitting research facilitators at HEIs. We extensively cleaned both sets of data, which were ascribed unique identifiers as part of our internal double review process which utilised two independent curators.

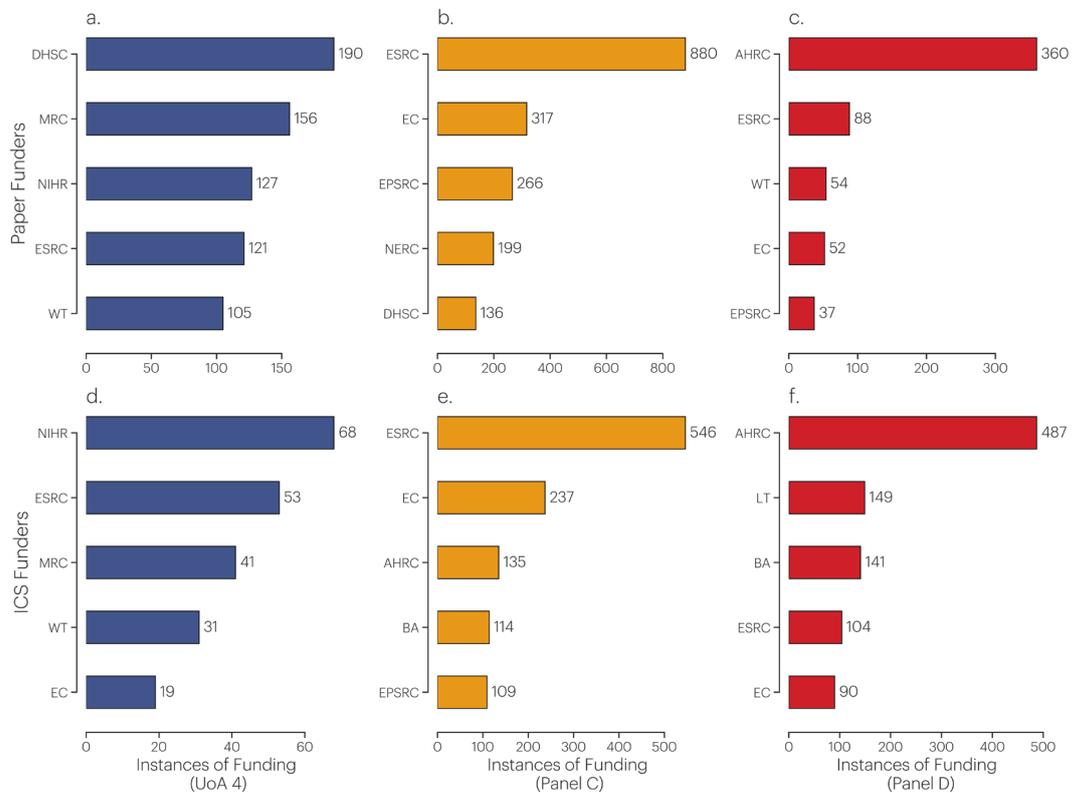
The first row of Figure 16 shows the five most prominent funders of the research that underpin ICSs across UoA 4 (first column), Panel C (second column), and Panel D (third column) based on the first approach of using data from our bibliometric data provider at the individual publication level. The second row of Figure 16 is based on the second approach, using the raw REF2021 ICS database itself (self-reporting of funders at the ICS level). Perhaps unsurprisingly, it is a combination of UKRI councils which are cited most frequently as funders according to both metrics (i.e., both rows of the figure). Other key funders listed in this figure include the Wellcome Trust (WT), the British Academy (BA), the National Institute for Health and Social Care Research (NIHR), the Department of Health and Social Care (DHSC), and the European Commission (EC). Sections 2.1-2.10 provide additional insights by breaking down the funding landscape across the Grand Impact Themes, with a specific focus on the funders of the individual ICSs. The ESRC is the most prevalent funder for Panel C, as is the AHRC for Panel D, but both are well cross represented in other Panels as well.

Table 6 shows the disaggregated counts of funder acknowledgements within each Panel (and UoA4) that received funding from the twelve most prevalent (unique) funders. Biases in the comparability of these numbers might arise from different norms for reporting funders across disciplines and panels. Results are best interpreted as a 'volume of acknowledgements', rather than a statement of fact regarding the precise percentage of research financed by a specific funder. What does however clearly stand out from these figures is the remarkable contribution that the ESRC and AHRC make to supporting – or at the very least being acknowledged as supporting – 'impact' not just within their representative Panels (C and D), but also within the STEM-related Panels A and B. This is even more remarkable given that the ESRC received just

<sup>8</sup> Information on the three most prevalent third sector funders is available in our online supplementary material.

2.36%, and the AHRC just 1.26%, of total ‘Core R&I Budgets’ from UK Research and Innovation (UKRI, 2022). Research support that has come from National Academies (such as the British Academy), as well as philanthropic organisations such as the Leverhulme Trust and the Wellcome Trust, also stands out as being immensely significant, elucidating their crucial role in funding a wide array of societally impactful SHAPE-related research. Going beyond traditional funders, we were also able to isolate the most commonly acknowledged private sector funders.<sup>8</sup> For UoA 4, this included GSK as the primary private sector provider, and for Panels C and D, this included Google (top private sector funder for Panel C and D) and South West Water (second, Panel C), and the BBC (second, Panel D).

**Figure 16. An analysis of funders across both underpinning research (first row), the ICS themselves (second row), and our three delineations of SHAPE disciplines (UoA 4; first column, Panel C; second column, and Panel D; third column).**



**Table 6. Percent ICS Funded Across Categories by Selected Organisations**

	All	Panel A	Panel B	UoA4	Panel C	Panel D
<b>Economic and Social Research Council</b>	6.35	2.44	1.27	8.14	14.42	4.86
<b>Engineering and Physical Research Council</b>	5.54	1.55	17.68	2.00	2.88	1.49
<b>European Commission</b>	5.46	3.44	7.96	2.92	6.26	4.20
<b>Arts and Humanities Research Council</b>	5.29	0.26	0.33	0.61	3.57	22.75
<b>National Institutes of Health and Social Care Research</b>	3.49	9.69	1.19	10.45	1.22	0.28
<b>Innovate UK</b>	2.70	1.49	7.52	0.77	1.40	0.93
<b>Leverhulme Trust</b>	2.53	0.63	1.49	2.00	2.51	6.96
<b>Medical Research Council</b>	2.30	6.14	1.27	6.30	0.58	0.37
<b>British Academy</b>	2.29	0.54	0.11	2.15	3.01	6.59
<b>Wellcome Trust</b>	2.16	4.19	1.41	4.76	0.61	2.52
<b>National Environment Research Council</b>	1.91	1.52	4.17	0.46	1.58	0.28
<b>Biotechnology and Biological Sciences Research Council</b>	1.55	3.64	1.86	1.08	0.24	0.05

### 3.4 The Inter- and Multidisciplinary Nature of SHAPE Impact

Research generating real world impact often grows out of – or fosters – inter- and multidisciplinary cooperation. Multidisciplinarity draws on knowledge from different disciplines but stays within one disciplinary boundary. Interdisciplinarity involves synthesising and harmonising links between disciplines into a coordinated and coherent whole. The particular importance of cross-discipline research for impact-oriented research becomes evident from numerous ICSs highlighted in Section 2 and was frequently acknowledged by interviewed panel members:

*“A lot of effort has been put into thinking about what counts as impact and to make room for interdisciplinary work.”*

– Social Science Panel Member

While there was the opportunity to flag ‘interdisciplinary’ when submitting an ICS, interviewees noted that the use of this signalling mechanism was inconsistent:

*“There was a flag which institutions could tick to flag that their impact case study was interdisciplinary. However, institutions used this tick inconsistently. This does not show that some institutions are less interdisciplinary than others. It instead shows that the data set created through this flag is not reliable.”*

– Humanities Panel Member

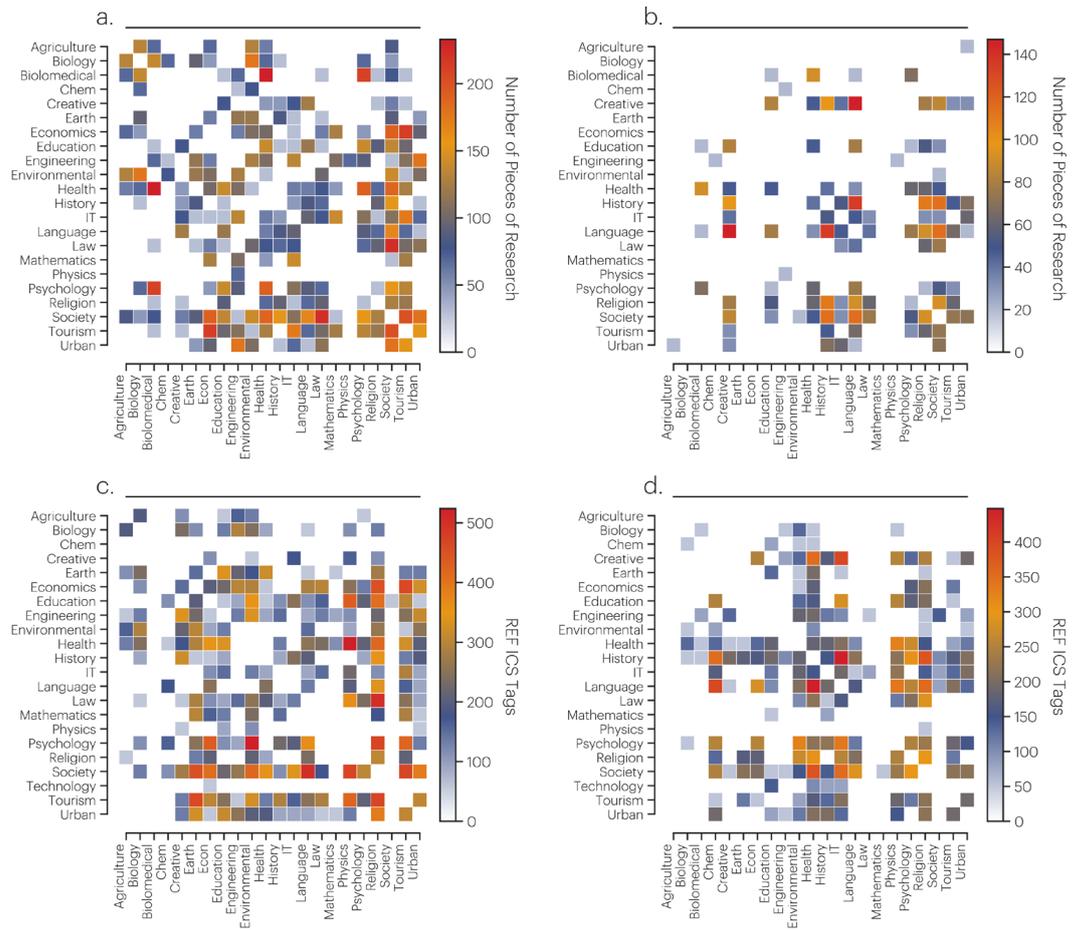
A similar observation was made by a REF2021 Panel Advisor (Kerridge 2022). To develop a reliable quantitative distinction to measure multi- and interdisciplinarity, we therefore developed a bespoke approach of classifying research collaborations across disciplines. This approach relies on individually classifying the research disciplines associated with the research that was submitted to underpin each ICS and using ‘tags’ in the raw REF2021 dataset. We classified the disciplines by grouping the DOIs (digital object identifiers)<sup>9</sup> of underpinning research for a given ICS, consolidated to the three highest weighted Fields of Research (FoR) based on the Australian and New Zealand Standard Research Classification (ANZSRC, 2021) codes within an ICS. If an underlying piece of research work was attributed to more than one Level 2 FoR, meaning that researchers from several disciplines collaborated on one publication of underlying research, we classify it as interdisciplinary. Multidisciplinarity was alternatively defined as an ICS which has more than one Level 2 FoR ascribed to it by the tag or labelling within the REF2021 ICS database. This means that the various research papers underlying the ICS came from different disciplines, even if each individual paper within the ICS’s underpinning research clearly belongs to one discipline. Our approach therefore allows for a cleaner identification of cross-disciplinary collaboration but also allows us to address the distinction between inter- and multidisciplinary approaches.

The first row of Figure 17 showcases the interdisciplinarity of research underpinning the Shape ICSs. The plot displays the number of co-occurrences across different FoR (as identified by Dimensions data, specifically the ANZSRC 2021 schema) within publications which underlie ICSs according to our interdisciplinarity definition. In this analysis, we combine UoA 4 and Panel C into the social sciences (first column), with the arts and humanities in the second column. We see a large amount of intuitive patterning, as interdisciplinarity happens most commonly between the most closely related fields.

<sup>9</sup> Digital Object Identifier, is a string of numbers, letters and symbols used to uniquely identify an article or document, and to provide it with a permanent web address (URL).

**Figure 17. Analysis of interdisciplinarity in underpinning research across SHAPE ICSs at the Level 2 Field of Research Level.**

**First row: Fields of Research of the underpinning pieces of research returned from the Dimensions bibliometric database. Second row: REF 2021 ICS Tags. First column: Social Sciences. Second column: Arts and Humanities.**



Primary occurrences of interdisciplinarity were:

- **Social sciences:** ‘Health Sciences’ with ‘Biomedical and Clinical Sciences’, and ‘Law and Legal Studies’ with ‘Human Society’.
- **Humanities:** ‘Language, Communication, and Culture’ with ‘Creative Arts and Writing’, and ‘Language, Communication, and Culture’ with ‘History, Heritage, and Archaeology’.

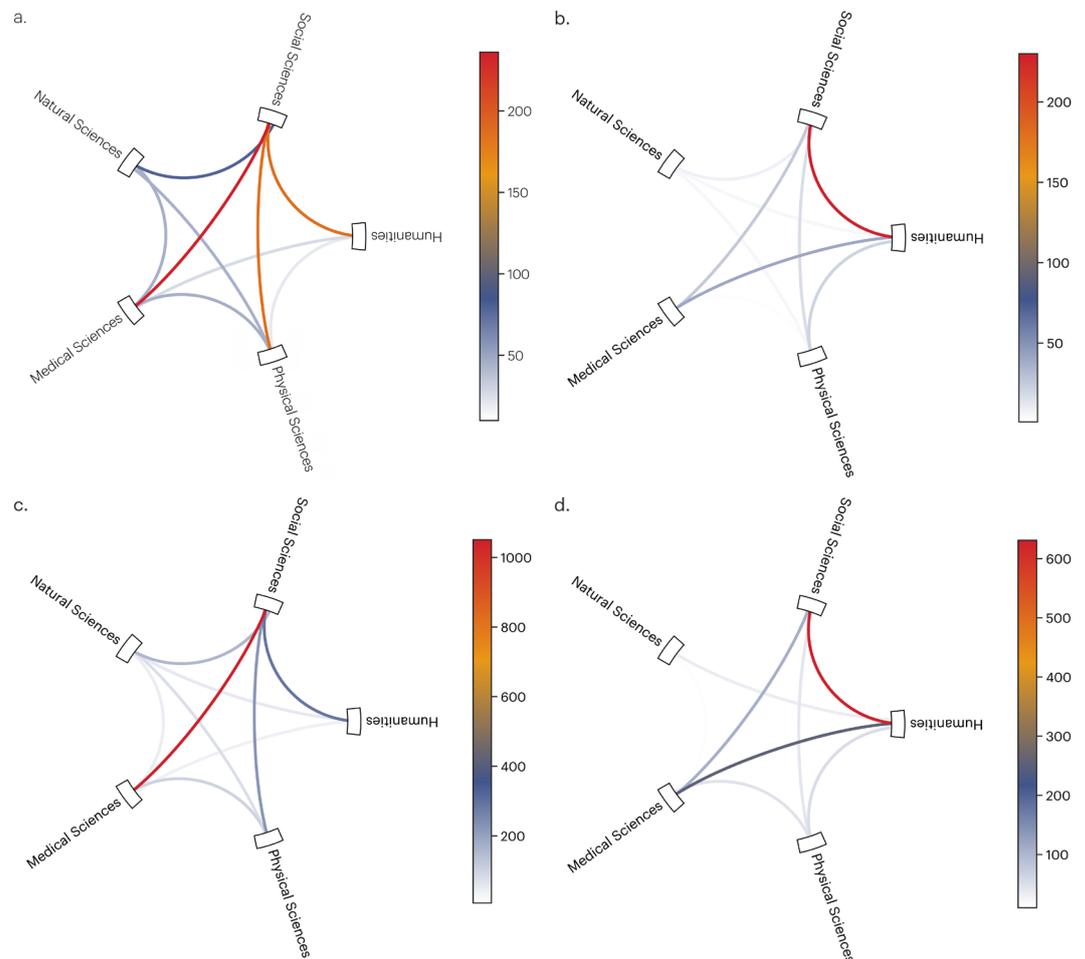
We also frequently see the co-occurrence of multiple FoRs that one might not traditionally expect SHAPE researchers to be publishing in or collaborating across by looking at reference based ‘tags’ in the raw REF2021 database. By looking at these ‘tags’ associated with the underpinning research as provided by the REF2021 database (Figure 17, second row), we were able to observe multidisciplinary and close links for:

- **Social sciences:** ‘Psychology’ with ‘Medical and Health Sciences’, and ‘Human Society’ with ‘Economics’
- **Humanities:** ‘Language, Communication and Culture’ with ‘Creative Arts and Writing’, and ‘Language, Communication and Culture’ with ‘History and Archaeology’.

We were also able to examine this at a ‘higher’ level of aggregation by mapping Level 2 FoR into a ‘Level 1’ FoR mapping: Level 2 FoRs are grouped into one of five representative Level 1 categories of ‘natural sciences’, ‘social sciences’, ‘humanities’, ‘physical sciences’, and ‘medical sciences’. The results can be seen in Figure 18, which shows that while there is commonality in research which links the humanities and the social sciences for research underpinning all four sets of measurement, there are two additional surprising links which become apparent through this analysis. Those are – when measured at the individual paper FoR classification metric (first row, L1 FoR) – a link between the social sciences and the physical sciences (Figure 18a), and between the humanities and medical sciences when measuring the ‘tags’ ascribed by the REF 2021 database (Figure 18d).

**Figure 18. Analysis of interdisciplinarity in underpinning research across SHAPE ICSs at the Level 1 Field of Research Level.**

**First row: Fields of Research of the underpinning pieces of research returned from the Dimensions bibliometric database. Second row: REF 2021 ICS Tags.**



We also asked survey participants from the REF panels about what percentage of ICSs they perceived to be of an ‘interdisciplinary’ nature, which provided a complimentary measure of interdisciplinarity in addition to our bibliometric-based approach. The results of this survey question were striking in the amount of variance observed across SHAPE-related UoAs. It was above 62.08% in one UoA (34: Communication, Cultural and Media Studies, Library and Information Management), and as low as 12.68% in another (UoA 16: Economics and

Econometrics). The split between the humanities and the social sciences was relatively even, at 40.8% and 38.6% respectively. That such a large amount of work was of an interdisciplinary nature might not be surprising, as some of our interviewed panel members noted:

*“Almost all of the case studies that we looked at were interdisciplinary. The people working on the panel are also interdisciplinary, in their professional and academic careers. Whether or not institutions flagged that their case studies were interdisciplinary, most of what my panel looked at was interdisciplinary in nature.”*

– Humanities Panel Member

*“Across the arts and humanities, interdisciplinarity is the norm, rather than the exception, in how people conduct research and undertake academic careers.”*

– Humanities Panel Member

A prominent STEM panel member had this reflection about the role of the social sciences and the humanities, interdisciplinarity, and coping with climate change:

*“As a geophysicist, I’ve studied the earth if you like and go look at it, you know, with or without human beings...so the planetary process. But climate change is only important to society because it affects humans, right? So, the challenges that the world faces are societal challenges. So, social sciences and humanities are the key to that.... Climate change is driven by human behaviour. Understanding human behaviour is a humanities and social science thing.”*

– STEM Panel Member

### 3.5 The Gendered Nature of Underpinning Research

Fostering environments conducive to Equality, Diversity, and Inclusion (EDI) is a vital objective of modern research institutions. EDI indicators – despite providing reductive and incomplete representations – can nevertheless be gauged to gain an understanding of different dimensions of representativeness. Such measures pertain to equality of access, opportunities, treatment, resources, outcomes, and impact and can be patterned by individual characteristics such as disability, gender, sexuality, ethnicity, class, or region of origin. Both REF2014 and REF2021 have employed Equality and Diversity Advisory Panels (EDAP) with the explicit intention of supporting and promoting EDI across panels, for example by monitoring and improving the representativeness of appointed panel members. Looking at all dimensions of inclusiveness would unfortunately go beyond the scope of this report and the measurement possibilities of the data we are using. It is, however, possible to measure one indicator well with our linked bibliometric approach: gender. Our approach to identifying the gender of researchers contributing to ICS research allows us to move beyond existent research related to the REF, or in existing scientometric research.

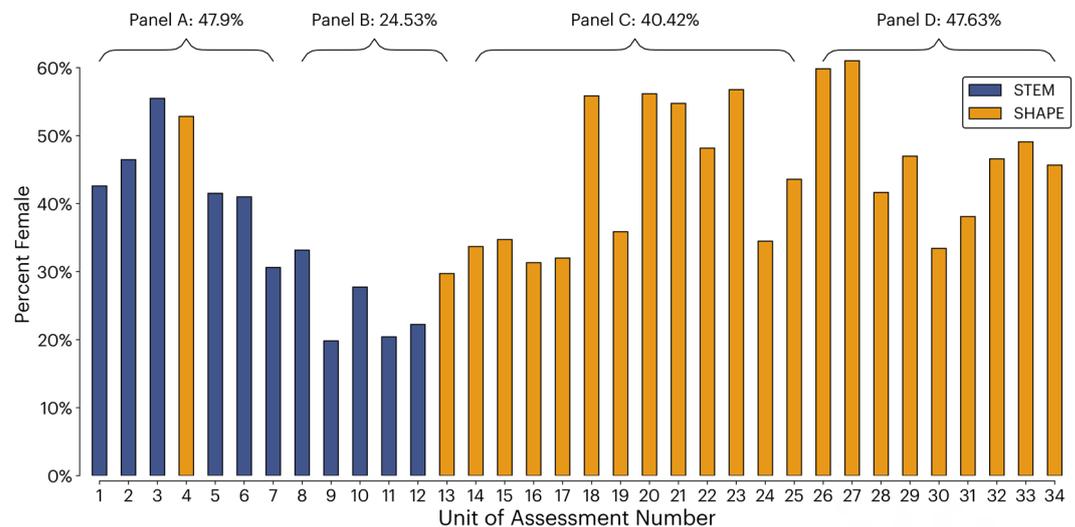
Identification of gender is made possible due to our cleaning of the data pertaining to the underlying research of an ICS which isolates DOIs (Digital Object Identifiers), ISBNs (International Standard Book Number), and titles of that research, which provides metadata-based information on the authors themselves (as used in other sections).

Similar approaches to inferring author information from DOIs were used in the field of genomics (Mills and Rahal 2019, 2020) and population studies (Mills and Rahal 2021) which – while not being without ethical considerations – inferred the gender of authors with a high level of accuracy. This approach allows one to examine the distribution of gender across publications of underpinning research and across Grand Impact Themes as done in Sections 2.1-2.10. An important caveat is that an inferred gender does not necessarily reflect an author’s self-identified gender and can be prone to ethnic bias given that results are predicated on a

probabilistic approach arising from large caches of administrative data (Lockhart et al., 2023). It is also important to note that we analyse the gender of the authors of research underpinning an ICS, rather than the gender of ICS authors themselves.

Figure 19 shows the fraction of female case study authors of the ICS, colour-coded according to whether the UoAs are in STEM or SHAPE subject categories.<sup>10</sup> We see that Panel A (Medicine, Health, and Life Sciences) has the highest share of female authors (47.9%), followed closely by Panel D (Arts and Humanities) (47.63%) and Panel C (Social Sciences) (40.42%). Panel B (Physical Sciences, Engineering, and Mathematics) contains the lowest percentage (24.53%). We also see considerable variation within Panels and across some of the UoAs within them. In Panel C, we only observe a higher fraction of female authors (above 50%) in Law (UoA 18: 55.86%), Social Work and Social Policy (UoA 20: 56.17%), Sociology (UoA 21: 54.74%), and Education (UoA 23: 56.77%).

**Figure 19. Fraction of female to male authors of Impact of Case Studies by Panel, UoA, differentiated by STEM and SHAPE.**



Panel D has a much more uniform representation of gender balance across the UoAs, with only Philosophy (UoA 30) falling under 35% female authorship (33.41%). Women were more frequently authors in Modern Languages and Linguistics (UoA 26: 59.84%) and English Language and Literature (UoA 27: 61.01%). This is further reinforced through an analysis of the frequency of the first names of authors. In Panel C, none of the top ten most observed forenames are traditionally female names. Yet, ‘Sarah’ is the most observed forename across all authors of work in Panel D (although it is the only common female name in the ten most frequent). This mirrors the interpretation made by a Panel D member:

*“REF impact assessments are changing some aspects of research culture for women in a positive way. Particularly in panels A and B a lot of the successful case studies were run by women who were working in more vocational or ‘softer’ areas/fields which have been traditionally overlooked and underfunded in academic arenas. Because of the prestige and financial potential that the REF brings to the kinds of ‘outreach’ projects being championed by them, these women are now being promoted and are in more senior positions than might have been possible in any other way.”*

– Humanities Panel Member

<sup>10</sup> Uo4 has been counted as part of “SHAPE” for the purposes of the exercise and therefore for this specific part of the analysis it is grouped with social sciences not STEM, although we acknowledge that this Unit of Assessment could also be classed within the STEM grouping.

It is important to note that some papers had large numbers of authors, and many were outside of the evaluator sphere of academia within the United Kingdom. While we were able to link 13,820 Digital Object Identifiers, 140 ISBNs, and 9,260 titles; the total number of unique objects which we were able to link was 18,470. Whilst extremely impressive coverage, there are reasons to believe that this may be biased against grey literature. Estimates of gender distribution across the Units of Assessment and Grand Impact Themes must be seen as part of a triangulation and hence be interpreted in conjunction with either UoA-level estimates of gender distribution or with ICS author genders. For example, Davies et al. (2019) estimates that only 25% of leaders of REF2021 ICSs in UoA 17 were female. It must also be interpreted in conjunction with academia-wide estimates of gender distribution across disciplines (West et al, 2013), changes to these distributions over time (Huang et al., 2020), and, of course, the REF2021 EDAP report itself.

## 4.0 Interactive REF2021 SHAPE of Research Impact Online Dashboard and Enhanced REF2021 Dataset

Main takeaways from the forthcoming Impact Dashboard and Enhanced REF2021 Dataset:

- Engages a broader audience through interactive narratives and data, highlighting research in topics selected by the user.
- Brings together qualitative and quantitative elements of the project including natural language processing, qualitative interpretations of narratives, and geographies of impact.
- Provides access to our enhanced REF database and allows users to download it, including added value generated and new data (e.g., rich bibliometric information at underpinning paper level) through our analyses and results.

Our forthcoming REF2021 dashboard, which will be found at [shape-impact.co.uk](https://shape-impact.co.uk), communicates to a broad audience, allowing users to explore results interactively, bringing to life the many successes and captivating stories of how SHAPE research has impacted society. The dashboard (of which Figure 20 shows a screenshot) brings together qualitative and quantitative elements of this project to provide compelling narratives along with supporting evidence of SHAPE impact. Users can delve into specific topics that spark their interest and explore where and how impact was generated within that topic. It shows results for all SHAPE ICSs including the top funders, proportions of ICSs by Unit of Assessment, geographic distribution of UK institutions submitting ICSs, and the countries impacted by the research. These results immediately show the global impact of UK research in SHAPE disciplines.

There is an option to ‘View and Download Data: Impact Case Studies’ that will produce a pop-up window containing a searchable spreadsheet with a row for every ICS associated with the currently selected results, and an option to download a bulk data file that contains all of our uniquely engineered data (which includes over 70 new fields of information, and over 15 new fields of scientometric information)<sup>11</sup>. A codebook which details the content of our Enhanced REF2021 Dataset can be found in our accompanying online supplementary materials, and on our online interactive dashboard. This includes the original columns from the various types of REF database (see Section 1) and the ‘value-added’ columns that we generated from bibliometric analyses, natural language processing, topic modelling, and manual curation. As the user navigates the dashboard, they can make selections to further filter this table by geographies of institutions and beneficiaries. There is always an option to export the currently selected data (e.g., in .csv format). This retrieves a downloadable filtered database of ICSs within the topic along with a link to the full ICS description and other information.

<sup>11</sup> This data includes both publicly available information as found on OpenAlex, as well as licensed proprietary fields from the Dimensions database.

Figure 20. Landing Page of the REF2021 SHAPE of Impact Dashboard.



## 5.0 Conclusion and Discussion

### 5.1 Main Findings

*“I think we all came away from the exercise thinking, wow, what an amazingly varied set of impact.”*

– Social Sciences Panel Member

The aim of this report was to examine and uncover “the stories, successes and cumulative effects on people, the economy, policy and society of the impact of research in the SHAPE (Social Sciences, Humanities and the Arts for People and the Economy) disciplines”. To answer this question, we leveraged and enhanced the REF2021 corpus of data, with a focus on the Impact Case Studies that allowed us to highlight the tremendously rich and varied tapestry of impact the SHAPE disciplines produced.

Using the lens of this guiding question and the structure laid out by our machine learning model, we then provided deeper narratives that uncover and celebrate the stories of the impact of SHAPE research, while simultaneously providing data-driven empirical descriptions of the nature and types of impact. By virtue of this mixed-method approach, we were able to provide both depth and systematic structure to categorise SHAPE impact. We came to several key conclusions that both reinforced our understanding but also uncovered surprising, enlightening, and unexpected pockets of impact.

**SHAPE impact is multifaceted and warrants new impact type categorisations.**

SHAPE research – as characterised by the REF2021 ICSs – can be classified into **84 distinct yet interrelated topics**, which together comprise **ten Grand Impact Themes**. Our analyses suggest that the breadth of SHAPE impact may not be well served by the current REF2021 Summary Impact Types, which follow six categories from the PESTLE (Political, Economic, Societal, Technological, Legal, and Environmental) convention, widely used in UK government policy development, with the addition of Health and Cultural impact types (REF2021, 2022b).<sup>11</sup>

*“The taxonomy regarding impact needs to be broad, to include all types of impact which can occur in the humanities.”*

– Humanities Panel Member

Although there is some overlap between the REF2021 impact types (e.g., Health, Politics, and Economics), the existing categorisations follow a disciplinary logic that might be more closely suited for traditional research assessments rather than capturing the varied ways in which researchers impact society. For example, having one ‘**Cultural**’ category misses the depth and breadth of the humanities, which made up not only two central substantive themes, but can be seen exerting deep impact throughout many other areas. Examples range from using music and drama therapy in health interventions to fostering community cohesion through language and the celebration of communal histories and heritage sites.

<sup>11</sup> This REF model was built using a text classification model using the REF2014 ICS database, with a text model trained using a random sample of 2014 case studies and tested against the remaining third (REF2021, 2022b).

**‘Societal’** impact is another amorphous term that is not synonymous with the social sciences but is instead ubiquitous across most ICSs. ICSs contributed to profound societal changes, through hundreds of interventions enhancing public understanding and education via research outreach and curricula improvements. It also enabled society to better deal with the myriad challenges of novel technology by changing online regulations and providing interventions aimed at reducing hate speech and misinformation. Most substantively, researchers continually transform the thinking and operational aspects of entire local, national, and international institutions. Societal changes to institutions were innumerable, including changing NHS processes and practices, reforming applications and interpretations of both international and national law, bringing in new safeguarding protocols for vulnerable children, transforming policing and the prison system, providing better tools and practices for central banks and providing regulatory agencies for consumer, health and environmental protection with the evidence base to protect the population from financial scams, harms to health and with insights and technologies to manage a green transition. Private sector institutions were equally affected via the provision of tools for better management, productivity, the changing of workplaces to enhance employee wellbeing, and the creation of novel enterprises contributing to the creative industries, healthcare tools, and solutions to climate change.

**‘Economic’** impact was indeed pervasive in almost every study, for example the discovery of a heritage site injected tourism into the local economy, regional levelling-up tools create industrial and entrepreneurial hubs, macroeconomic models transform banking and financial systems, arts experts enable multi-million-pound auctions through identifying historical works and new behaviourally driven technologies reduce energy consumption and costs.

It also becomes clear that **‘Technology’** which is often seen as progress attributable to the STEM disciplines is pervasive throughout SHAPE impact. Researchers not only engaged in technological innovation and product development, but it became abundantly clear that the social sciences and humanities are often key to leveraging how societies, businesses and governments efficiently adopt and integrate novel technologies and regulate them to generate maximal social good. Technology-driven business spinouts can be found across all themes, from digital programmes used in school classrooms to immersive museum VR experiences, to novel sports science designs serving companies, the armed forces and professional athletes.

**‘Legal’** impact pervaded many ICSs across all themes, with research leading to concrete and traceable changes in legislation, regulations, and policies, from local government councils through to the constitutions, procedures, and regulations of supra-national organisations and international banks.

*“Those assessing the case studies had an incredibly wide range of different sorts of impacts to assess.”*

– Social Sciences Panel Member

**SHAPE impact occurs beyond the boundaries of the economy, policy, and technology, and is highly multidisciplinary.**

The in-depth illustration of impact in the ten Grand Impact Themes as well as the section on interdisciplinarity shows how deeply interwoven areas of impact can be. Both beyond the focus on the economy, policy and technology, but also interacting with those types of impact we find vast cultural, health-related, legal, and environmental impacts. SHAPE challenges preconceived expectations of impact. We find innovation in arts and design impacting the cultural landscape and simultaneously propelling creative industries forward. We see curation and exhibition spaces preserving culture but also engaging in the education of schoolchildren. We also uncovered transformations in education and skills which simultaneously propel regional

development and social inclusion forward. There were also transformations to the economy and businesses that fall into the realm of tackling environmental concerns and labour market changes that take employees health and mental wellbeing into account. Improvements in policing and crime reduction can operate in tandem with the design of better neighbourhoods. The fostering of better communities and regional development also operates to preserve regional heritage. Another striking finding is that SHAPE impact reaches far beyond any preconceived boundaries, including far beyond the social, economic, and cultural. Research has driven pivotal interventions, policy changes, and technological developments in health and medical science, and in efforts towards net zero and more sustainable environments. This rich corpus of ICSs revealed multiple industrial and business applications emanating from SHAPE research, ranging from educational software and the next generation of Netflix translations to behavioural or performance art-driven clinical therapies.

Our quantitative analysis shows that the multidisciplinary nature of SHAPE research most often occurs between related fields, with the social sciences in particular interacting with health and biomedical fields of research. The underpinning research driving SHAPE impact was also frequently published in journals concerning the advancement of mathematics, biomedical science, and information technology.

**Beneficiaries of research were concentrated in the UK, but also spanned a global geographical context.** The constituent countries of the UK were the most prominent beneficiaries in the humanities, social sciences, and Psychology. Other frequently mentioned SHAPE beneficiaries include the United States, Western Europe and Australia. The geographical distribution of impact varies considerably by substantive research area.

**Core funders fuel SHAPE research and impact.** Different funders are mentioned across both the raw Impact Case Study data, and in the bibliometric data which is linked to the underpinning research; funders vary substantially by grand theme. The funders listed for ICS funded research are:

- Social sciences (Panel C): 14.42% of funder acknowledgements named Economic and Social Research Council as a funder.
- Arts and humanities (Panel D): 22.75% of funder acknowledgements named the Arts and Humanities Research Council as a funder.
- Psychology (UoA 4): 10.45% of funder acknowledgements named the National Institute of Health and Social Care Research as a funder.

The distribution of authorship gender in underpinning research differs substantially across Panels, Units of Assessment, and Grand Impact Theme. Examining the distribution of gender of the authors of the research underpinning impact, we see:

- Unit of Assessment 4 (Psychology, Psychiatry and Neuroscience): 52.83% female.
- Panel C (Social Sciences): 40.42% female.
- Panel D (Arts and humanities): 47.63% female.

This, however, masks considerable differences within panels.

## 5.2 Strengths and Limitations

Our mixed-method approach afforded us systematic results that were accompanied by depth, reflection, and scrutiny in the narrative interviews of experts in the area with lived experience of evaluating or producing impact cases for REF2021. By adopting a generative AI-based

approach, we were able to more systematically reveal key topics where impact has occurred across SHAPE to highlight and celebrate the depth and diversity represented therein. We processed and re-engineered the REF2021 dataset, augmenting it where appropriate with additional information. An enhanced version is available for further analysis and/or replication of our work on our online, interactive dashboard ([shape-impact.co.uk](https://shape-impact.co.uk)). This has allowed us to produce accompanying information about the research underpinning the REF, such as on the distribution of authorship gender, multidisciplinary, scientometric evaluation, and more. The dashboard also brings together the quantitative and qualitative elements of this analysis, including a searchable topic option, with additional examples (one per topic), divisions of ICSs by Grand Impact Themes, and information on the top funders of each topic as well as their geographical impact and origin.

There are limitations to our approach which need to be considered when interpreting the results. First, given that we only examine research and impact emanating from the REF2021 exercise, we are limited to a specific selection and sample of both research and impact chosen for submission. The selection is related to the fact that impact must be linked to published research that was deemed to be of sufficient quality to be submitted to the REF, and that impact met the pre-defined criteria, namely that the impact needed to have taken place within a specific period and be accompanied by underpinning research.

Second, although we manually reviewed all ICSs to assess their categorisation into larger topics and larger Grand Impact Themes, we recognise that some case studies or case study groupings do not naturally fall into one of these categories. Readers or explorers of our database may find some topics or ICSs that they feel are misclassified, but we note that we took a systematic and transparent approach to position them within the topic to which they were ascribed the highest probability, with extensive manual review by multiple researchers. In many cases, ICSs were highly multi-disciplinary and sometimes straddled more than three or four substantive topics and could have therefore fallen within another grouping. Finally, numerous authors have studied and scrutinised the procedural aspects of the REF exercise, which falls outside of the scope of this review (e.g., Arnold et al., 2018; Bornmann et al., 2019; Pinar and Horne, 2022; Pinar and Unlu, 2020; Reichard et al., 2020; Thorpe et al., 2018, Watermayer and Derrick 2022). Despite that discussion and scrutiny, the REF has offered SHAPE researchers an incredible platform to submit and present an astonishingly broad set of highly impactful contributions across almost every area imaginable.

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**Author Contribution Statement:** MCM conceived and oversaw the project and wrote the initial tender and report draft, with input from all authors. SW led and conducted the qualitative aspects of the project and manual reclassification of topics, with input from AS and MCM. CR led on all quantitative analysis and writing related to relevant sections. CR, BZ and LL conducted the Natural Language Processing, and CR devised and produced all static data visualisations. YL analysed the questionnaire data, together with SW. YL undertook various data wrangling tasks. DL developed and oversaw the dashboard construction and geographical aspects of the project, together with CR. MV led on aspects related to open science and data engineering. CR led on all ethical and legal procedures. SW, CR, AS and MCM drafted the report, with input from all authors.

**Data and Code Availability Statement:** Raw REF2021 ICS data is available via the REF2021 project website. Code to construct our enhanced dataset, and all code for analysis (and to recreate our interactive dashboard), is available via our online supplementary material, hosted on GitHub ([https://github.com/OxfordDemSci/ICS\\_Analysis](https://github.com/OxfordDemSci/ICS_Analysis)) and via Zenodo.

**Safeguarding Confidentiality and oath REF Panel Members.** This work has been approved by the Departmental Research Committee (DREC), Sociology Department, University of Oxford (CUREC approval number: R2\_001\_C1A\_23\_03). This work also had a Data Protection Impact Assessment approved by the same panel.

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# List of Acronyms

<b>AcSS</b>	Academy of Social Sciences
<b>AHRC</b>	Arts and Humanities Research Council
<b>API</b>	Application Programming Interface
<b>BA</b>	British Academy
<b>BERT</b>	Bidirectional Encoder Representations from Transformers
<b>DHSC</b>	Department of Health and Social Care
<b>DOI</b>	Digital Object Identifier
<b>EC</b>	European Commission
<b>EDI</b>	Equality, Diversity and Inclusion
<b>EPSRC</b>	Engineering & Physical Sciences Research Council
<b>ESRC</b>	Economic and Social Research Council
<b>FTE</b>	Full-Time Equivalent. Used as an alternative to headcount (volume of research).
<b>GCRF</b>	Global Challenges Research Fund
<b>HEI</b>	Higher Education Institution
<b>HESA</b>	Higher Education Statistics Agency
<b>ICS</b>	Impact Case Study
<b>ISO3</b>	International Organisation for Standardisation country codes
<b>IT</b>	Information Technology
<b>LT</b>	Leverhulme Trust
<b>ML</b>	Machine Learning
<b>MRC</b>	Medical Research Council
<b>NERC</b>	Natural Environment Research Council

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<b>NIHR</b>	National Institute for Health and Care Research
<b>NLP</b>	Natural Language Processing
<b>NGO</b>	Nongovernmental organisation
<b>NUTS3</b>	Nomenclature of Territorial Units (3 small regions)
<b>ORCID</b>	Open Researcher and Contributor Identifier
<b>PRES</b>	Performance-based research funding system
<b>REF</b>	Research Excellence Framework
<b>REF2021</b>	Research Excellence Framework evaluation in 2021
<b>RES</b>	Research Selectivity Exercise
<b>SHAPE</b>	Social Sciences, Humanities and the Arts for People and the Economy/Environment
<b>STEM</b>	Science, Technology, Engineering and Mathematics
<b>UKPRN</b>	UK Provider Reference Numbers
<b>UKRI</b>	UK Research and Innovation
<b>UOA</b>	Unit of Assessment (in REF2021)
<b>WT</b>	Wellcome Trust

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