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# The SHAPE of 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 REF2021 Panel Member

## Preface

The British Academy and the Academy of Social Sciences commissioned LCDS researchers 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/Environment) disciplines*” within the United Kingdom’s Research Excellence Framework of 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 – and accompanying online dashboard – aims to serve as a starting point for the SHAPE community to explore the scope and reach of the 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 UK higher education providers, with results used to inform the distribution of approximately £2 billion per year of public funding for universities’ research. The publication of impact case studies presents an opportunity for the research community to demonstrate the broader footprint of their published research and to recognise the achievements and successes of research across the UK.

We develop a novel mixed-method approach. The bulk of our work applied the most advanced machine learning models for Natural Language Processing (NLP) to identify key topical clusters of SHAPE impact. We focus on impact case studies (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=528), sometimes in comparison to other non-SHAPE disciplines (total ICS N=6,361). We supplement the REF2021 ICS database with newly engineered fields, our topic models, the scientometric Dimensions database, REF environment, and REF quality databases. These results are then interrogated and enhanced with in-depth narrative interviews (N=48) to reveal the stories and successes of the impact of research as well as some information from a questionnaire to SHAPE panel members (N=263). The project was overseen by a steering group consisting of representatives from business, academia, major funders, and Fellows of the British Academy and the Academy of Social Sciences.

Oxford, September 2023

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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/Environment) disciplines on people, the economy, policy and society?'* Through the lens of this guiding question, we uncover deeper 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 10 Grand Impact Areas** that emerged from 83 distinct topic clusters uncovered by applying generative artificial intelligence to the SHAPE disciplines REF2021 Impact Case Studies:

1. Arts, Performance and Design
2. History and Cultural Heritage
3. Education and Teaching
4. Business, Economics and Management
5. Employment
6. Crime and Exclusion
7. Family and Gender
8. Governance and Law
9. Health and Wellbeing
10. Sustainability and Infrastructure

**SHAPE impact occurs beyond boundaries of the economy, policy and society.** Impact was penetrated virtually all scientific disciplines and realms including technological, industrial, health and environmental impact. Impact ranged from developing new technologies and spin-outs to changing policies, legislation, and international regulations; from reviving regional and local economies to preserving and expanding a rich cultural and artistic heritage. Public knowledge was increased and perceptions and behaviours were changed, ranging from teachers learning to employ better pedagogical tools, consumer protection markets being improved, communities being encouraged to celebrate their historical heritage, or energy costs being reduced through better grid management and environmentally sound buildings and behaviour.

**SHAPE research and impact is highly interdisciplinary.** Scientometric analysis of the research underlying impact case studies in SHAPE panels revealed that it is highly interdisciplinary work, with multidisciplinary cooperation occurring most often in closely related fields but with many research co-operations also including less naturally related scientific fields and STEM research. We frequently found underpinning research for SHAPE impact in Mathematics, Biomedical Science, and Information Technology. The largest interdisciplinary pairings in the SHAPE disciplines were between 'Health' and 'Biomedical' Fields of Research.

**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 47.58% of listed beneficiaries), Social Sciences (Panel C 40.97%) and Psychology (UoA 4, 40.94%). The majority of 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, India, Russia and in South America (Brazil, Colombia), with the least impact found in the African continent and the Middle East (those most commonly reported being South Africa, Kenya, and Turkey). Geographical distribution of impact varies substantially by substantive research area.

**UK Research and Innovation based Research Councils (including Research England and Innovate UK) represented only 27.01% of funder acknowledgements, but the ESRC and AHRC were exceptionally well represented in comparison to other, better funded Research Councils.** UKRI-related institutions were only mentioned as a funder in 27.01% of ICS submission-based funder acknowledgements, but within this, the ESRC was mentioned as a funder a relative amount of 23.92% of those times, and the AHRC was mentioned a relative amount of 19.84% times. This is in relation to the fact those two Research Councils only received a fraction of the final UKRI Core R&I budget in 2021 (ESRC: 2.36%, AHRC 1.26%).

**Gender composition differs across research and impact areas.** Examining the authors of the research underpinning impact, the share of female authors differs by panel:

- Panel A (Medicine, Health and Life Sciences): 49%
- Panel D (Arts and Humanities): 46%
- Panel C (Social Sciences): 41%
- Panel B (Physical Sciences, Engineering and Mathematics): 25%

This, however, masks considerable differences within panels. A lower fraction of female authors (below 40%) was seen in Panel C in Geography and Environmental Studies (UoA 14), Archaeology (UoA 15), Economics and Econometrics (UoA 16, the lowest fraction of females of any SHAPE discipline), Business and Management Studies (UoA 17), Politics and International Studies (UoA 19) and Sport, Exercise Science, Leisure and Tourism (UoA 24). Men were under-represented (<50%) in Social Work and Social Policy (UoA 20), Education (UoA 23), Sociology (UoA 21) and Law (UoA 18).

**There is an uneven balance of ICSs across Units of Assessment (UoAs).** 2,146 (53.7%) case studies from Panel C, 1,528 (38.2%) from Panel D and 326 (8.2%) from UoA 4 were analysed. Large UoAs submitted more ICSs, with Business and Management Studies (UoA 17), submitting the largest number of ICSs of any UoA (N=504), making up 12.6% of all SHAPE ICSs analysed in this report and 23.5% of Panel C (Social Sciences). English Language and Literature was the largest UOA in Panel D with 273 case studies, making up 17.9% of Panel D. This balance in turn impacts the topics and themes that emerged from this analysis.

**An Interactive Data Dashboard accompanies this report ([shape-impact.co.uk](http://shape-impact.co.uk)).** It brings together 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 UoA and geographical impact in the UK and globally.

**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 represents a fraction of impactful research conducted by SHAPE researchers at Higher Educational Institutions in the UK.

## 1. Background, aim and methodology

### 1.1 Background and aim of study

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 (Social Sciences, Humanities and the Arts for People and the Economy/Environment) disciplines*” within the United Kingdom’s Research Excellence Framework of 2021 (REF2021). REF2021 was the UK’s system for assessing the quality of research in UK higher education providers, and the results are used to inform the distribution of approximately £2 billion per annum of public funding for universities’ research (see Pinar & Horne, 2022 for a comprehensive overview; Torrance, 2020; UKRI Research England et al., 2021b, 2021a).

During the REF2021 process, Higher Education Institutions (HEIs) were evaluated across three areas: research output, impact, and environment. The publication of impact case studies (ICS) 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, bibliometrics, large language modelling and qualitative interviews, we investigated the following research questions:

- ⇒ What are the main **topic areas** and overarching **grand 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-disciplinarity, gender representation and the geographies of impact?
- ⇒ 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 be excited by SHAPE impact?

### 1.2 Data, Methodology and Analytical Approach

The research adopts an open science approach that allows the textual and quantitative analysis of ICS cases to be fully reproducible.<sup>1</sup> As illustrated in Figure 1, with more detailed information available upon request, we developed a novel mixed-methods approach that combines the frontier of large language models with hierarchical analysis and ‘human in the loop’

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<sup>1</sup> The code to reproduce this project will be made available in its entirety via Github ([github.com/OxfordDemSci/ICS\\_Analysis](https://github.com/OxfordDemSci/ICS_Analysis)) and via an equivalent and frozen Zenodo repository.

categorisation (Filippova et al. 2019) to identify the key hierarchical clusters of how SHAPE impacts our world. Data for our quantitative work focuses on analysing the REF2021 ICSs 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=528), a subset of all ICS submitted to REF2021 (N=6,361). We supplement the REF2021 ICS database with a large bibliometric database (see: <https://www.dimensions.ai/>), REF environmental and REF quality databases, topic modelling, and other customised fields and metrics. This is then interrogated and enhanced by qualitative interviews of REF panel members (N=36), case study authors (N=12), and quantitative surveys of SHAPE REF panel members (N=268).

#### 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 through their impact on culture, the economy, and public policy (Reichard et al., 2020). In REF2021, ICSs contributed 25% of a UoA's total REF score per unique sets of each institution's 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; Torrance, 2020).

Each case study is between four to five-pages long. They are formatted according to a prescribed template (Bornmann et al., 2019; [template available here](#)) with maximum and indicative lengths. Case study components include an impact summary (100 words), supporting research (500 words), research references (up to 6 references), impact details (750 words), and impact references (up to 10 references). Case studies describe research impact achieved during the twenty-year period prior to that specific REF (Greenhalgh et al., 2016). After each REF, submitted case studies are made available via a public, searchable database ([REF 2014 case studies](#), [REF 2021 case studies](#)).

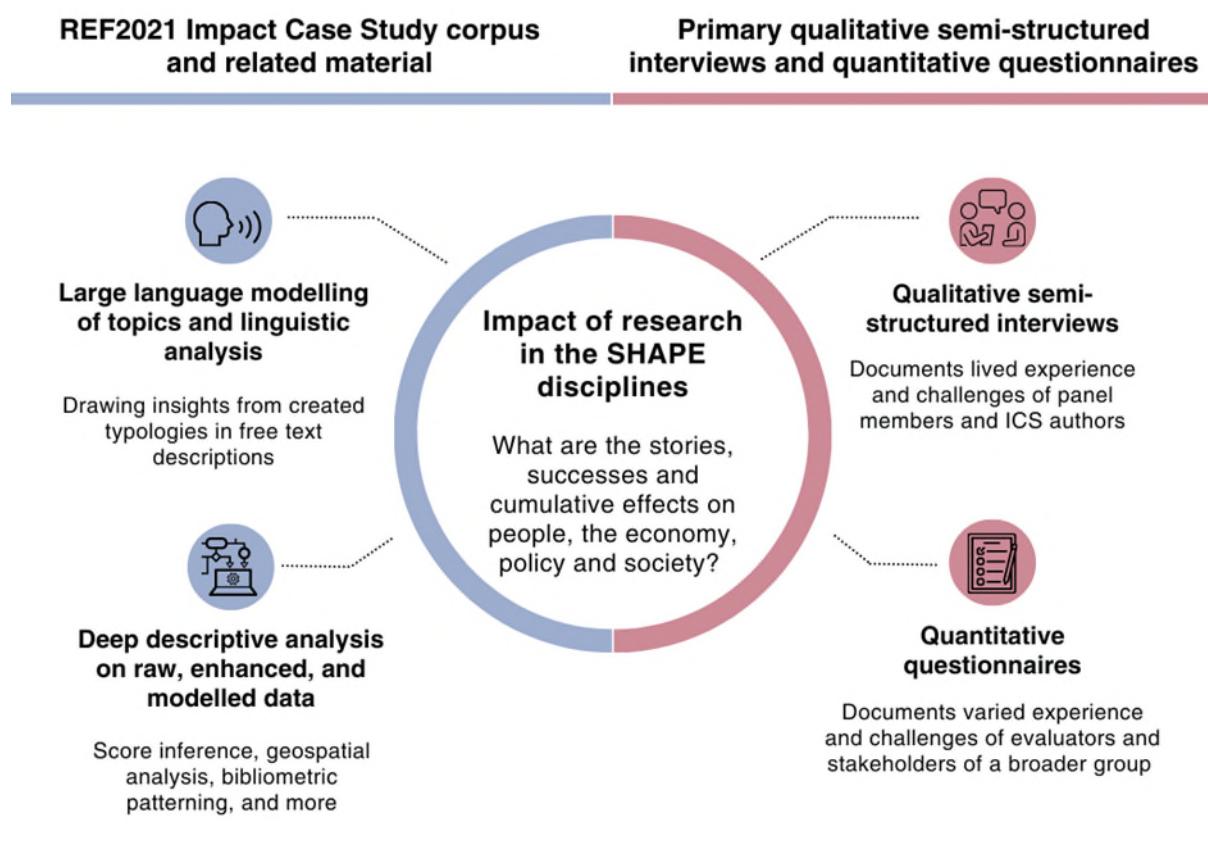
Panels of academic peer reviewers and research users evaluate each case study, giving it a qualitative assessment from unclassified to between 1\* to 4\* (Greenhalgh et al., 2016; Reichard et al., 2020). Case studies in 2014 with ongoing and longer-term impact only counted as being a 'continuing' body of work if they used the same body of work, and would be evaluated as free-standing work (REF2021, 2022). In 2021, adding additional pieces of evidence did not need to trigger a new case study, but 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). 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: i) dimensional reduction of word representations, ii) clustering corpuses; and,

iii) 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’. BERTopic identified an initial 83 distinct topics across the nearly 4,000 SHAPE-related REF2021 ICSs. For each ICS, BERTopic calculated the probability of belonging to each identified topic. We then assigned the ICS to the topic with the highest probability. We set thresholds such that every ICS belongs to one singular topic, as long as the highest probability for an individual topic is greater than 0.01. While the model subjectively performs extremely well, a small number of ICS remain unclassified ( $N=179$ , as they do not cluster with any others), and some span multiple topics (resulting in a low congruence with any single individual topic).

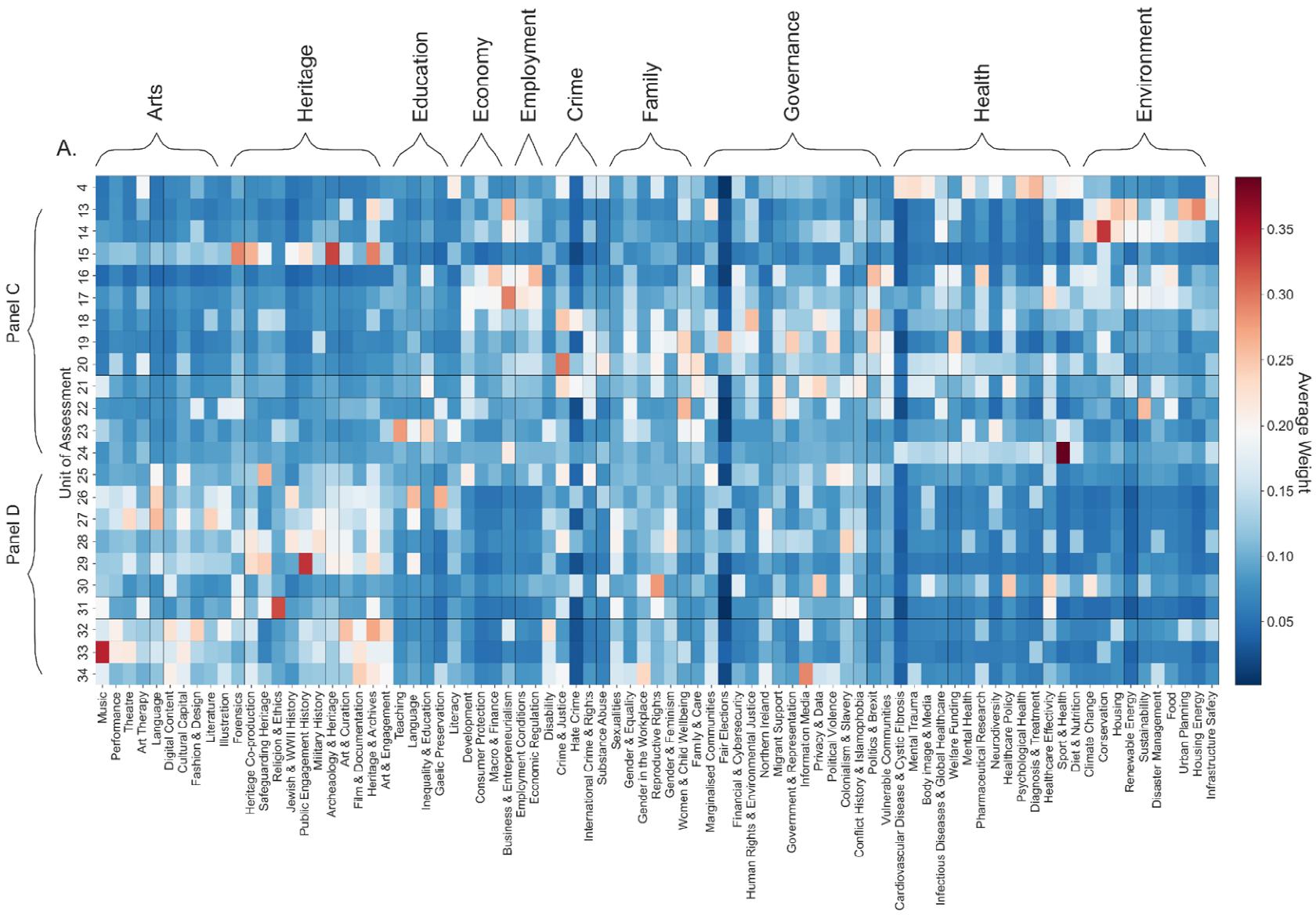
**Figure 1.** Overview of data, analytical methods, and contribution of each approach



We both programmatically and ‘humanly’ cross-validated the results with multiple coders to ensure the suitability of topics suggested by the algorithm. Our model uses the three nearest neighbours, and assigns an ICS into a topic as long as their singular maximal probability is above 0.01. This results in 179 topics being allocated into a residual, unmappable topic, which is considered a reasonable result given that they might either be a singular or unique topic of a small number of ICSs working in a considerably more niche area. Once we humanly verified the integrity of the topics with multiple coders, we used a combination of expert domain

knowledge and dendograms to group the 83 topics into ten broad high-level ‘Grand Impact Areas’. The cumulative weights for all 83 topics (*x*-axis) across all SHAPE based UoAs (*y*-axis) – along with how they fit within the clusters of the ten Grand Impact Areas – are shown in Figure 2. Table 1 displays the names (*y*-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.

As an example of how to interpret this graphic, consider the first listed Topic 3, called ‘Music’ (bottom left corner of graphic), which represents a group of ICS titled “Music and Acoustics (short name, Music)”. 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 dark red colour. Focusing on the first large theme of Arts (shown in upper left hand of graph), we see that there is a high overall concentration within the aforementioned UoA 33, and also UoA 27 (English Language and Literature), UoA 31 (Theology and Religious Studies), UoA 32 (Art and Design: History, Practice and Theory). The ten clustered Grand Impact Areas are individually described in detail in the next section, providing a breakdown of impact generated and submitted to SHAPE-related Units of Assessment in REF2021. Each subsection contains examples of impact, specific case studies, quantitative facts, and various visualisations. Section 3 analyses the ICSs across the Social Sciences and Humanities as broad subject bodies, as well as at the aggregate SHAPE level. Section 4 describes our interactive online dashboard, and Section 5 provides concluding remarks and reflection.



**Figure 2.** Visualising the Distribution of Topic Weights Across UoAs and Grand Impact Areas

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

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

## 2. The SHAPE of Impact: Ten Grand Impact Areas

Our large generative model clusters SHAPE impact into ten ‘Grand Impact Areas’. In this section, we describe each of these core themes in more detail, beginning with an overview of key facts. We then provide examples of impact via ‘deep dives’ into selected ICSs from each cluster. Those desiring a deeper understanding of each of these impact areas are encouraged to visit our online interactive dashboard, described later in this report.

Table S1 (see Appendix) summarises the key descriptors of each of the ten themes, breaking them down to provide the key facts, such as the number of ICS in the theme, key UoAs (N, %), the five most frequently seen concepts, the location of the main geographical beneficiaries, and the main funders. Table 2 provides the key facts for the underlying research that drives each of the ICSs, drawn from our analysis of the Dimensions bibliometric database.

**Table 2.** Key facts underpinning research by 10 grand themes

Theme	Gender	Publication type		Highest Altmetric Score	Citations	
		% female	Article %		Highest citation Count	Relative Citation Ratios
1.Arts & Design	49.69	32.51	56.09	1653	773	31
2.Archaeology, Exhibits & Galleries	42.73	43.95	73.74	1335	3885	11
3.Education, Teaching, Skills	53.59	61.35	32.57	2161	1419	14
4. Business, Economics and Management	27.95	86.81	4.99	423	984	13
5. Employment	38.94	50.52	25.12	2231	1580	13
6. Crime & Exclusion	56.28	64.09	28.37	1018	1376	9
7. Family & gender	63.67	60.33	33.09	1150	1150	10
8.Governance & law	62.61	55.04	36.02	986	793	10
9. Health & Wellbeing	47.93	86.69	6.96	2127	4266	75
10. Sustainability & Infrastructure	35.19	79.48	16.34	2928	1471	17

It shows gender of authors (%), publication type (% article or book chapter), the highest and mean Altmetric Attention Score, highest citation score, and the highest individual Relative Citation Ratio (RCR) for ICSs in each of the ten themes. 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 dissemination of a piece of research's reach beyond typical academic channels such as through social and news media. The citation count is a measure of the number of citations discovered within a large bibliometric database (Dimensions). The RCR (relative citation ratio) is a citation-based measure of 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 scientific fields and is not easily interpretable as equivalent to scientific influence in many domains.

## 2.1 Arts, Performance 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 impact theme is driven by the arts and humanities, operating to preserve and reinterpret traditional material (music, literature, poetry, dance) while also fostering social inclusion, cohesion and a deeper sense of identity. The core topics in this theme represent a broad range of impact emanating from the arts and culture, literature, fashion, dance and immersive virtual reality (VR), with key facts summarised in Figure 3.

Within the broader Arts, Performance and Design core topic, 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 the traditional music that plays a central part in preserving and celebrating cultural identities (e.g. Mali, Cuba). Technological advances were widespread, such as new machine-learning software for musical composition, audio design for commercially successful racing video games, and building 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 increasing access to music education for disadvantaged groups. Researchers also supported the UK music and festival industry through development of curatorial and audience engagement techniques, and ticketing and on-site software applications for festival goers. Although impact flourished, the performing arts experienced significant COVID-19 related challenges, as noted by one REF panel member.

*“Almost a quarter of the impact case studies which were reviewed on my panel included COVID 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

## **Impact in the Arts, Performance and Design**

**Classical music for youth:** Development of an App to introduce younger audiences to classical music, now used by 9 of the UK's leading symphony Orchestras and resulting in 11,000 ticket sales for over 200 concerts annually.

**Sound in museums:** 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.

**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 with 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 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 screening 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 were used to attract 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 2,500,000 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

Another striking topic was in the area of art and performance for heritage and the community. Theatre research exited the stage and entered into classrooms and educational settings, with new techniques designed to make theatre more inclusive and participatory, highlighting the role of different communities. There was particularly strong engagement with the elderly and young people, such as conceptualising care homes as cinematic communities and theatre aimed at young people. 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 10-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 emerged, full of multiple modes of art and performance from music to play as therapeutic tools to assist groups (e.g., maternity, dementia, autism). Performance widely used the theatre for education and awareness ranging from the bedside of sick children to integrating individuals into performance to raise awareness in areas such as the environment or discrimination.

## 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 1 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.

Literature, poetry and translation was another core topic engaging the public in performances and events, rediscovering voices of past artists and marginalised communities, and providing forums to perform, read and celebrate the diverse language traditions of the nations of the United Kingdom. Work on particular authors and libraries enhanced education to promote reading, influenced library policies, gave voice to marginalised artists through poetic expression and raised awareness about important British writers and literary traditions.

Textile, fashion and design ICSs celebrated the history of fashion, while also looking to the future, developing fashion and materials that are more environmentally friendly and leading to cutting edge textile design research that resulted in new technologies. Another cluster of comics, cartoons, animation and illustration ranged from the use of comics in history and political satire to jump off the page into children's picture books.

A final topic around digital content, animation, immersive technologies and Virtual Reality abounded, 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 game and film production. Impact included multiple start-up companies driven by research in the multi-disciplinary creative arts, health and education sectors.

Impact in the Arts, Performance and Design theme revealed a diverse range of research impact, spanning from public engagement and cohesion to therapeutic interventions, preservation, performance, educational tools, and many new technologies and business spin-outs. 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.”*

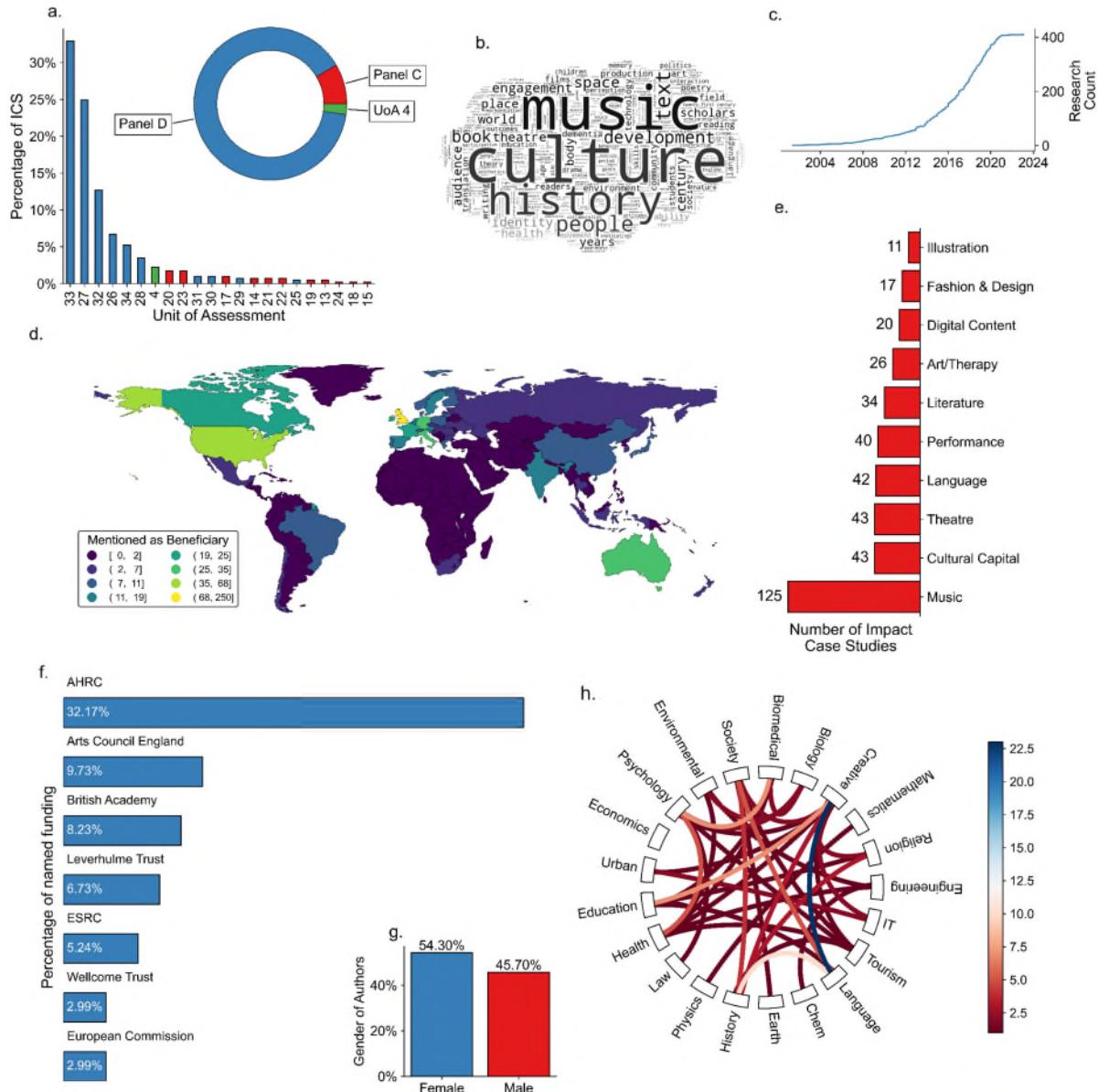
– Humanities panel member

### **Distinguishing Facts of ‘Arts, Performance and Design theme’:**

- **Impact most prominently located in Humanities UoAs:**
  - UoA 33: Music, Drama, Dance, Performing Arts, Film and Screen Studies (32.92%)
  - UoA 27: English Language and Literature (24.94%)
  - UoA 32: Art and Design: History, Practice and Theory (12.72%)
- **Geographical impact largely in Great Britain and USA:** Primary beneficiary is Great Britain (250 instances), followed by the USA (68), followed by broad ‘International’ and ‘European’ classes of beneficiaries mentioned 15 and 9 times respectively.
- **Funding mostly from AHRC and Arts Council England:** The Arts and Humanities Research Council, UKRI was the most prevalent funder, mentioned in 32.17% of all submitted ICS, followed by Arts Council England (9.73%).
- **Gender-balance achieved in underpinning research:** Across the underpinning research used to drive this impact, 49.69% of the authors are female, making it one of the most gender balanced Grand Impact Areas.
- **Interdisciplinarity largely within the Humanities:** Interdisciplinarity is classified according to ANZSRC (Australian and New Zealand Standard Research Classification).<sup>2</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’.
- **Book chapters as the most prominent publication type underpinning research, with a comparatively high Altmetric score and one of the highest relative citation ratio of all themes:** The majority of the underpinning research was published in the form of book chapters (56.09%) and articles (32.51%). Underpinning research in this theme also had one of the highest Almetric scores of 1653.
- The highest Altmetric score (a measurement of the amount of attention received by a publication) within this theme was 1653 and the highest citation count was 733. The highest relative citation ratio was 31, which was the second highest after the Health and Wellbeing theme (75).

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<sup>2</sup> Each Cluster of Impact Case Studies contains an associated infographic of equivalent style and structure, split into seven subfigures. Subfigure a. displays the distribution of ICS across Units of Assessment. Subfigure b. shows a wordcloud of the most frequently mentioned concepts of the underlying pieces of research as made available by Digital Science. Subfigure c. shows a Sankey plot mapping this ‘Cluster’ to lower level Hierarchies and individual Topics. Subfigure d. shows the geographic distribution of beneficiaries of ICS within this Cluster. Subfigure e. shows the distribution of funders as mentioned within the raw REF 2021 data. Subfigure f. shows the distribution of gender within the pieces of underlying research. Subfigure g. 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).



**Figure 3.** Main Characteristics 'Topic 1: The Arts, Performance and Design'

Notes: Each Cluster of Impact Case Studies contains an associated infographic of equivalent style and structure, split into seven subfigures. Subfigure a. displays the distribution of ICS across Units of Assessment. Subfigure b. shows a wordcloud of the most frequently mentioned concepts of the underlying pieces of research as made available by the bibliometric database Digital Science. Subfigure c. shows a frequency of the publication date of the underpinning research mentioned in the ICS. Subfigure d. shows the geographic distribution of beneficiaries of ICS within this Cluster. Subfigure e. shows the distribution of funders as mentioned within the raw REF 2021 data. Subfigure f. shows the distribution of gender within the pieces of underlying research. Subfigure g. 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 Arts and Humanities have captivated and engaged the public in multiple ways, while simultaneously safeguarding and celebrating cultural heritage. A wealth of impact and public engagement has occurred in the realm of archaeology, cultural exhibits, galleries, museums, the heritage sector and the creative industries, with key facts summarised in Figure 4.

### 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, Da Vinci 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 subsequently purchased by the Getty Museum.

**Virtual Reality app for touring Florence:** An award-winning app developed with UK art history scholars allows visitors to experience what the places they are visiting would have been like in Renaissance Florence as they tour the city.

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

**Helping protect the world's cultural heritage:** Researchers digitised and documented over 80,000 unique modernist architectural drawings, maps, and buildings in Asmara, the capital of Eritrea. This work 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, and also led researchers to develop community initiatives. Among these initiatives 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 themselves during their visit, and 3,800 primary school pupils being made to engage with how monks used to illuminate paintings in COLOUR-inspired school drawing lessons.

Cultural exhibits fuelled by UK university research ignited public curiosity, inspiring them to walk the intercontinental Silk Road, explore British tattoo art, reminisce with photos of coastal communities, and support the preservation of multiple castles and 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

archeological 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 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 actively 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 protocols and practices ensuring 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 programs in schools and so on."*

- Humanities panel member

This line of historical and archaeological research also takes on the most compelling contemporary topics of our times. This ranges from engaging in debates and cultural policy-making around the decolonisation of objects to the application of the most cutting-edge technologies like virtual reality to create immersive museum experiences. Within this theme, we also see humanities and arts research in the UK emerging as a superpower in heritage preservation, the creative industries, arts and festivals. This includes systems being developed to inform festival programming, with university research strengthening curation, archiving and public engagement to support Britain's already strong film industry and culture. COVID affected this area more deeply, particularly by site closures, which was remarked upon by a REF panel member.

## Case Study Examples

The cultural engagement theme uses different creative media, ranging from exhibits and virtual reality visits of historical sites, to video games and the creation of 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 a commercially successful video game developed on the basis of research by a Scandinavian History and a Psychology researcher.

### 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 tourism in Leicester. 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. Archaeologists from the team such as Appleby would often split their time between societal outreach activities and public talks to cater to the public interest in the discovery and continued scientific work on the discovery. Appleby comments on her role in identifying the skeletal remains of the monarch as part of a multidisciplinary team, "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."

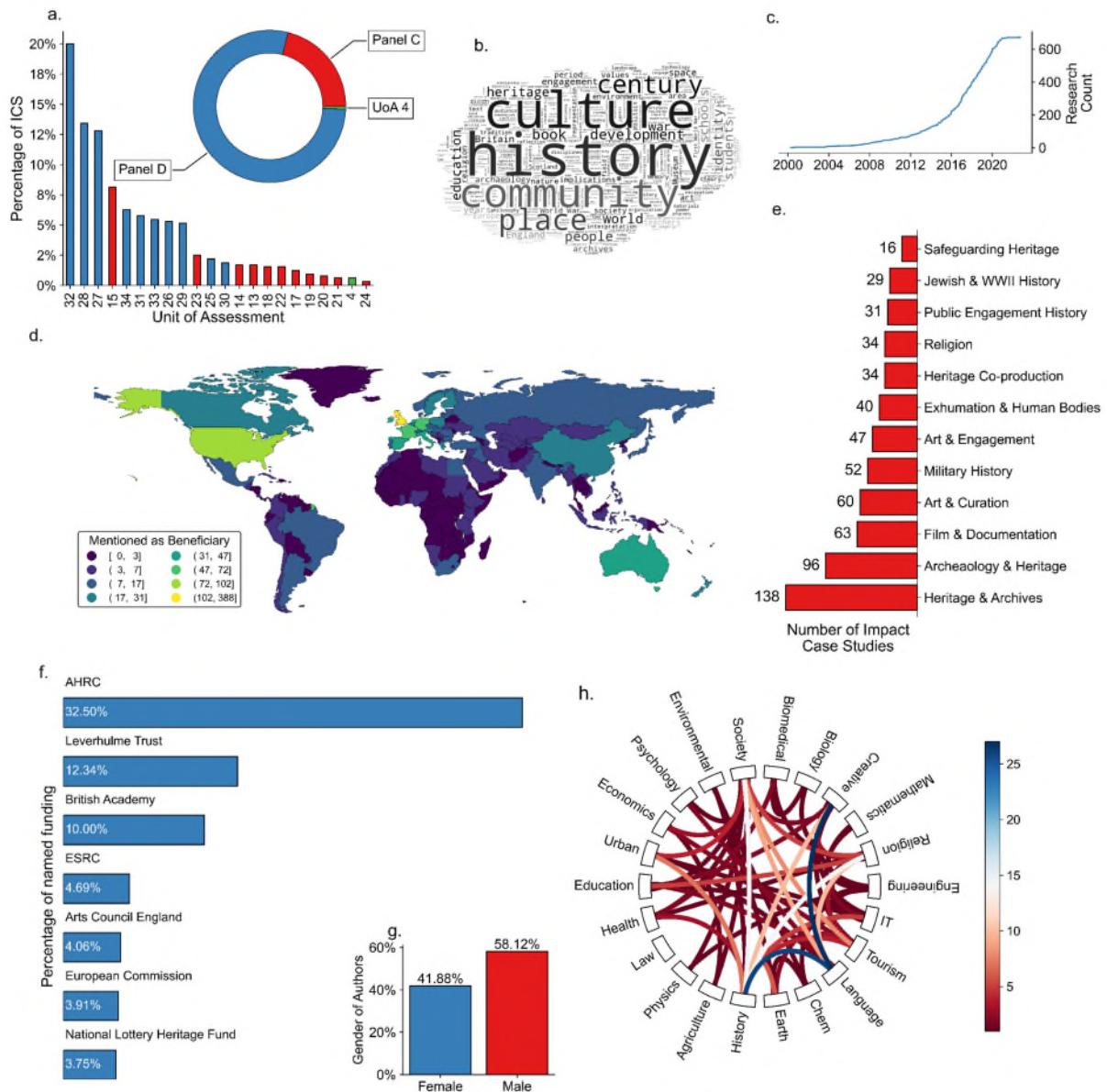
### Hellblade Video Game

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 History, 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 University of Cambridge".

### **Distinguishing Facts of ‘History and Cultural Heritage’:**

- **One of ten themes with the most ICSs allocated to it:** 640 individual ICSs fall within this Grand Impact Area.
- **Impacted most prominently located in Humanities UoAs:**
  - UoA 32: Art and Design: History, Practice and Theory (20%)
  - UoA 28: History (13.44%)
  - UoA 27: English Language and Literature (12.81%)
- **Geographical impact largely benefited those in Great Britain but also strongly in USA:** The primary beneficiary of the Impact was Great Britain (388 instances), followed by the USA (102), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 28 and 7 times respectively.
- **Funding mostly from AHRC and Leverhulme Trust:** The Arts and Humanities Research Council, UKRI was the most prevalent funder, mentioned in 32.50% of all submitted ICSs, followed by the Leverhulme Trust (12.34%).
- **Men are slightly over-represented in the underpinning research:** Across the underpinning research used to drive this impact, 42.73% of the authors of the underpinning research are female and 57.27% 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 ‘History, Heritage And Archaeology’; and ‘Language, Communication And Culture’ and ‘Creative Arts And Writing’.
- **Publication type of underpinning research split between articles and book chapters, with higher than average citations:** The majority of the underpinning research was published in the form of articles (43.95%) and book chapters (43.74%). The highest citation count was 3885, which was the second highest, rivalled only by the Health and Wellbeing theme (4266), with the highest relative citation ratio of 11.



**Figure 4.** Main Characteristics 'Topic 2: Archaeology and Exhibits'

Notes: See Notes Fig 3.

## 2.3 Education and Teaching

*“Amongst the 232 impact case studies that we looked at there are quite a lot of policy focused ones where government policies have changed because of 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 there between some research and some of the things that whole education systems offer. And then, of course, there's a whole list of other kinds of impact....Some of them professional in other professions, some of them to do with children. Something to do with adults and everything in between.”*

– Social Sciences Panel Member

The Grand Impact Area of education and teaching demonstrated deep impacts in teaching, training and educational policy, access, social mobility, equity, literacy, pedagogy and the acquisition and preservation of languages, illustrated in Figure 5. Impact resulted in a myriad of types ranging from institutional educational reforms, reforms of curricula, rethinking government skills policy, redesign of student loan policies around the world and teacher training at all levels of schooling, from preschool and primary school to university and vocational training and apprenticeships.

A core area of research-driven impact has been in transforming teaching, training, and educational policy. The ICSs in this area display an extensive range of influence on practice, programmes, policy, and curriculum, modernising education tools and programmes to improve and support teacher training, career progression and assessment. Enhancing teaching within particular subjects was another key area, with attention to innovations in teaching in specific subject areas and levels such as language learning, physical education, maths and science. Research also introduced digital innovations and mobile technologies for teaching in rural communities and low-resource classrooms. There is also a wealth of material to improve teacher training and career development, as well as the evaluation of teaching quality, workload and development of best practice in teacher assessment (e.g., avoiding gender bias in teaching evaluations).

Education was also utilised 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 such students with admissions systems also feature in this category. One example was the ‘Paired Peers’ project, which focused on improving access, university experience, and career opportunities for young working-class people. Another prominent area was improving skills acquisition and using these to improve graduate outcomes. Others included policies introduced to transform the student loan system and a technique to measure international student migration. One Social Sciences panel member also discussed the diversity of research in this realm:

*“the first thing I'd say about education is that it's inherently interdisciplinary. There are a whole range of approaches to studying the world of education which draw on and connect with other kinds of discipline, such as psychology, sociology, history, philosophy, and so on.”*

– Social Sciences Panel member

#### Examples of Impact

**Learning through play in primary schools:** A 20-year research programme on the synergies between teaching, learning, and playing led to educational reform for all 4-6-year-old children in Northern Ireland, affecting 720,000 children since 2015.

**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.

**Increasing Netflix's subtitled content coverage:** Development of the first ever online subtitling test and indexing system, Hermes. This software is capable of working with 33 languages, doubling Netflix's language coverage in a year. A novel accreditation system measuring translation performance – the 'Hermes number' became the de facto standard of accreditation in the industry and led to an increase in demand and in subtitlers' financial remuneration.

**Making the Welsh language Accessible:** The Geiriadur Prifysgol Cymru (GPC) is a historical dictionary similar to the Oxford English Dictionary. A research team maintains and updates entries and makes GPC available online and as a mobile app. The number of entries consulted has risen from 216,418 in 2014 to 3,236,543 in 2020.

**Online grammar resources for school teachers:** 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 for England standard. 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 on improving outcomes for learners, particularly those from disadvantaged backgrounds. It guides the work of the Education Endowment Foundation (EEF) and its funding strategy for the £200 million being spent over 15 years to reduce inequalities in school 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 3,400,000 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 Scottish Gaelic between 2013 and 2020.

**Enhancing children's reading comprehension:** Research that 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 has improved reading instruction for 4 million children in the UK by underpinning policy changes that require reading comprehension to be taught; since 2014 and beyond that 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 NICE guidelines and therapeutic practice.

### **ICS Example Box to come: Bringing Foreign Languages to UK pupils**

Many case studies in the area of education are concerned with informing education policy and shaping curricula, some focus on improving teacher performance and job conditions, while others create novel pedagogical resources, both inside the classroom and in the form of online tools. The work of Assoc. Prof. Alison Porter and Prof. Rosamud Mitchell from the University of Southampton has done all of the above in the field of early foreign language (FL) learning in schools.

Mitchell's research showed 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. Mitchell's insights contributed to the inclusion of foreign languages in the Primary National Curriculum in 2014.

Porter, who worked for 10 years as a foreign language teacher in primary school before becoming a researcher, built on Mitchell's insights and went about compiling scientific evidence on what really works in foreign language teaching to young children. She then used that scientific evidence to provide teachers with better classroom tools for supporting young children to learn French, Spanish or whichever second language a school may offer.

Porter describes her work 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/practice partnership (SUPL). This enabled Porter to take their research insights and to work directly with school leadership and teachers in developing face-to-face and online training to improve classroom practice and school-level 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 and to then measure which techniques improve childrens' learning. The research showed that "a lot of the pedagogical 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 [to speak?] French. And whilst you're learning French, you're going to also learn how to read and write in French at the same time", and results supported the idea that literacy should be integrated into curricula at earlier stages. She also introduced the use of multimodality (gesture) to support spoken language for children aged 4-7.

Disseminated at events such as the Research in Primary Languages (RiPL) policy summit at the British Academy, these insights helped shape curricula and inform pedagogical practices via teachers' workshops and events. To further share her insights and the pedagogical resources, Porter helped develop a 3-week massive online open course (MOOC), 'Teaching Languages in Primary Schools: Putting Research into Practice (TLiPS)', that offered training and resources for teachers on a global scale. Over 6,000 participants from 90 countries registered to join. The MOOC has changed pedagogical practices, with 83% of survey takers responding that it will change their classroom practice after week 3. In the words of one participating teacher: "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".

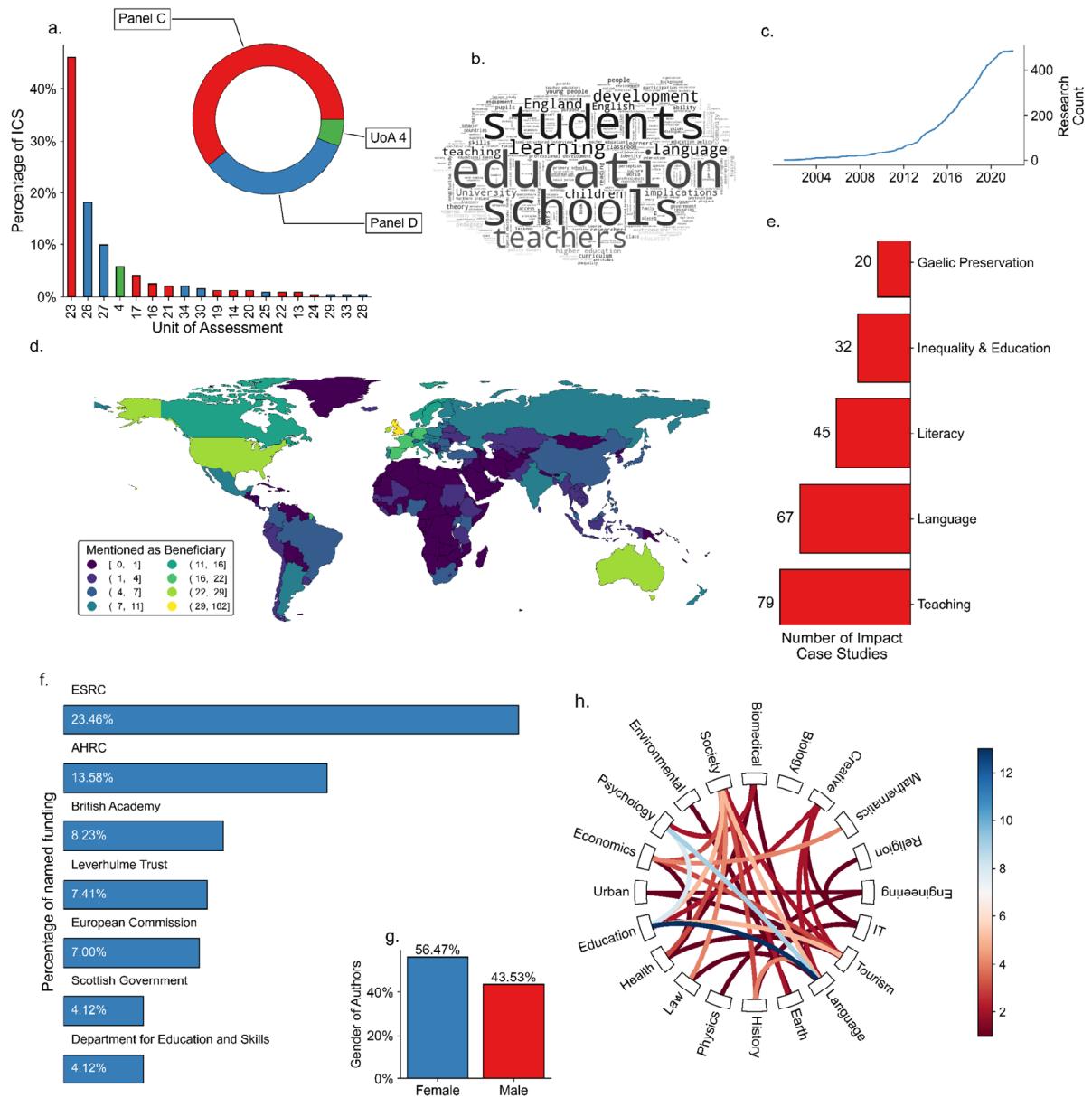
The literacy, reading and dyslexia cluster produced a plentiful array of programmes, curriculum changes, diagnoses, and new tools to enhance literacy, aid with dyslexia and learning disabilities, support multilingualism, and increase enjoyment of reading across multiple domains. Programmes were introduced to increase literacy in families, communities, and prisons, engaging youth in new ways (e.g., play or reading for pleasure in schools). Teacher training and classroom practice changes were also developed with curricula and programmes

designed to aid with dyslexia, learning disability, and comprehension skills, as well as increasing financial and digital literacy. Other examples include a web-based tool to diagnose literacy skills.

Language acquisition, language preservation and linguistics was another strong area of impact arising from Humanities research. This work had multiple impacts, primarily 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 ranging from 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.

### **Distinguishing Facts of ‘Education and Teaching’ theme:**

- **Considerable variation across UoAs, situated across both the social sciences and humanities:**
  - UoA 23: Education (46.09%)
  - UoA 26: Modern Languages and Linguistics (18.11%)
  - UoA 24: Sport and Exercise Sciences, Leisure and Tourism (9.88%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘education’, ‘schools’, ‘students’, ‘language’, and ‘teachers’, w
  - Majority of research in the hierarchical groups of Educational Tools and Language.
- **Geographical impact was largely in Great Britain and to a lesser extent the USA:** The primary beneficiary of the Impact was Great Britain (162 instances), followed by the USA (29), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 8 and 10 times respectively.
- **Funding mostly from the ESRC, followed by AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 23.46% of all submitted ICSs, followed by the Arts and Humanities Research Council (13.58%).
- **Gender equality, with a slight over-representation of women:** Across the underpinning research used to drive this impact, 53.59% of the authors are 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:** The majority of the underpinning research was published in the form of articles (61.35%) and book chapters (32.57%). The highest Altmetric score within this cluster was 2161, the highest citation count was 1419, and the highest relative citation ratio was 14.



**Figure 5.** Main Characteristics 'Topic 3: Education and Teaching'

Notes: See Notes Fig 3.

## 2.4 Business, Economics and Management

Impacts in this theme arise from research in the areas of business, entrepreneurship and management, macroeconomics, banking, monetary policy, market regulation, consumer protection and anti-corruption, illustrated in Figure 6. A core topic cluster was business, entrepreneurship, management and policies, which aims to improve productivity and firm growth in various forms. Researchers regularly work with firms to implement effective research-based management or to use research insights to foster, encourage and fund entrepreneurship. ICSs also evidence multiple business spinoffs emerging from research or 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 that help them thrive, particularly in economically challenging regions of the UK. Research on management informs both private sector firms and their training of higher and midlevel managers as well as public sector and publicly procured projects, providing insights to make them more efficient. Sectoral impacts range 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 is coupled with hard evidence documenting job creation resulting from the interplay of business and research. Several projects are also concerned with sustainable practices in business and entrepreneurialism for a greener economy.

Another core area in this theme is 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 increased 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 influences policy and generates initiatives to protect consumers. Policy impact ranges from influencing financial and lending regulations to housing market policies, or consumer protection measures such as transparency requirements in cost and fee declaration. Research insights helped households make better decisions via programmes improving financial literacy and providing debt advice.

Work in this domain also focuses on fostering international development in low-income countries and anti-corruption. Sustainability and sustainable development are a focus of many projects as are increasing efficiency in aid-giving. Work also concentrates on reducing

corruption and improving public procurements 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, and shifts in travel behaviours underpinned €22.3m in strategic investments in public transport across North West Europe. Among the newly supported projects is 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 €10m 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 £1.5 million of funding, as well as providing advice and training support for company finance and growth.

**Making startups and scale-ups grow:** Research on effective business models and the entrepreneurial life-cycle provides the foundation for programmes supporting 253 startup 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.

**Supporting housing policy reform around the world:** Policy reforms aimed at improving land and housing market efficiency and affordability sparked debate in many countries, including the UK, and led to the Mortgage Interest Deduction in the USA (2017), the Mortgage Interest and Capital Deduction in Flanders (2015) and Brussels (2017), and the Ontario Housing Supply Action Plan (2019), affecting housing policies for 137 million households.

**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.

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

- **Most prominently situated in Social Science UoAs:**
  - UoA 17: Business and Management Studies (62.35%)
  - UoA 16: Politics and International Studies (7.45%)
  - UoA 13: Architecture, Built Environment and Planning (5.1%)
- **Main concepts surrounding business, productivity and banking:**

The five most highly weighted concepts associated with this underpinning research were: ‘development’, ‘business’, ‘organisation’, ‘implications’, and ‘innovation’. Majority of research was the hierarchical groups of Productivity and Banking.
- **Geographical impact mainly in Great Britain and Germany:** The primary beneficiary of the Impact was Great Britain (141 instances), followed by Germany (33), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 13 and 5 times respectively.
- **Funding primarily from the ESRC and European Commission:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 26.67% of all submitted ICSs, followed by the European Commission (10.98%) (Fig 2e).
- **Underpinning research is gender imbalanced, with 28% female authors, compared to 72% men.**
- **Interdisciplinarity 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 (86.81%) and book chapters (4.99%). The highest Altmetric score within this cluster was 423, the highest citation count was 984, and the highest relative citation ratio was 1.

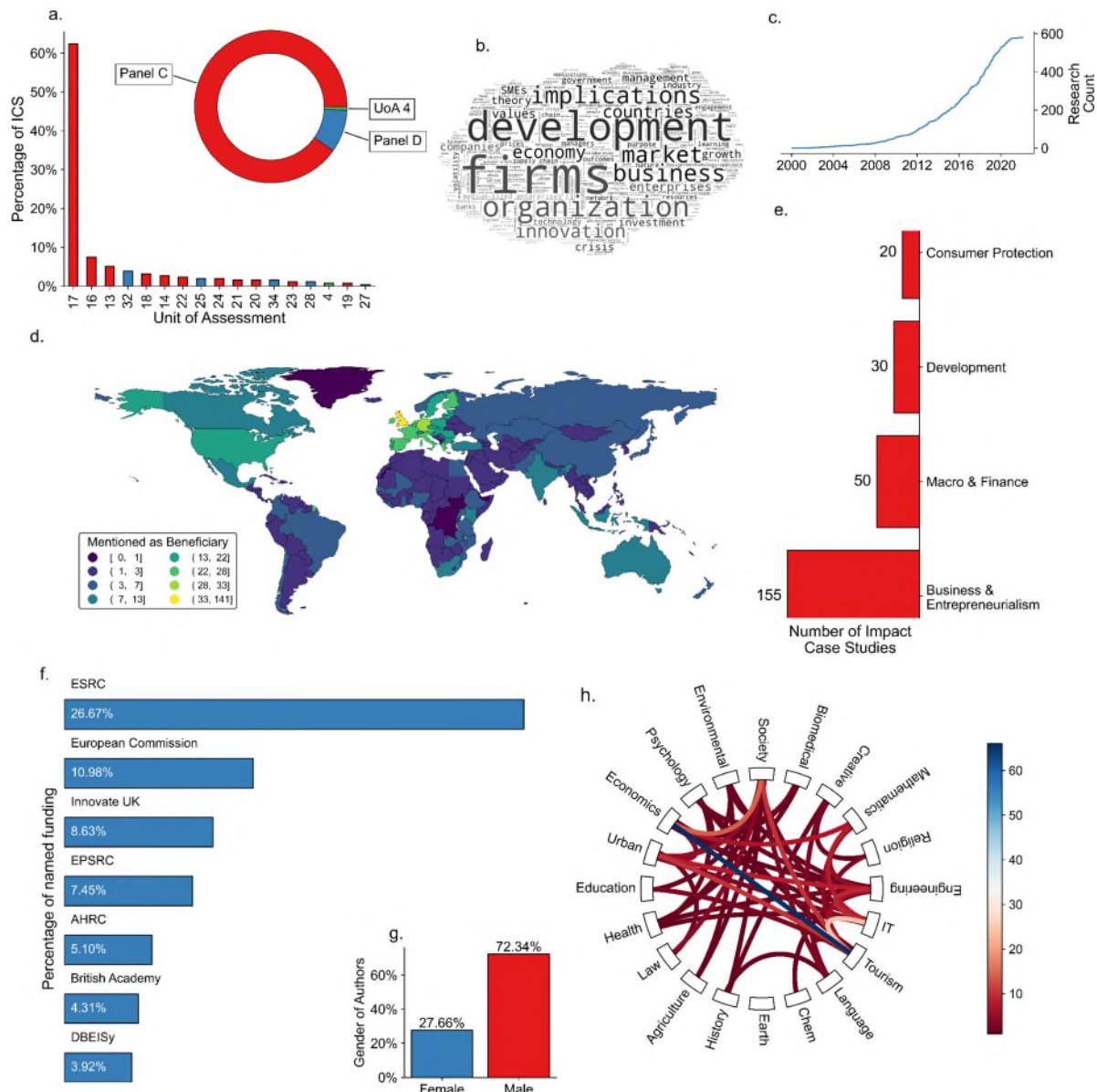
### Case Study Example

Many of the ICSs in this cluster are projects improving management practices at companies or 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?’” says Van Reenen as he describes the motivation for 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 that, whether or not 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 implementing programmes focused on 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 explains his reasoning: “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”.



**Figure 6.** Main Characteristics for 'Topic 4: Business, Economics and Management'

Notes: See Notes Fig 3.

## 2.5 Employment

There has been a wealth of impact in the area of labour markets and employment, largely in the areas of labour conditions, disability, and inclusion. A central theme is labour conditions and within this, policy changes driven by research surrounding worker's rights, benefits and pay. Research has driven policy changes 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). University research has driven core policy changes in maternity protection, reproductive rights at work, and the gender pay gap and developed tools to help the unemployed find employment and improve skills. There are multiple research-driven, evidence-based policy changes that improved working conditions, national and international labour standards, and general employment practice for particular groups of workers (e.g., migrant workers, social care workers, ageing workers).

Research particularly drives changes in labour conditions with new policies and interventions that have improved worker's wellbeing and performance (e.g., through guidelines for police and NHS workers). Performance management and digital transformations for workers were introduced along with multiple interventions and training programmes to reduce psychosocial risks related to stress and psychological workplace training and to cope with their effects. 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 particular groups (e.g., migrants, blacklisted workers).

Employment, disability and inclusion emerged as another core topic, as research evidence informs and changes attitudes towards people with disabilities, such as sharing historical knowledge about disabilities to improve understanding. Law and legislation based on the use of international human rights and liberty-based approaches, also operates to protect people with disabilities. Largely humanities-based research also develops methods for inclusive and innovative arts education, authentic casting in film production, self-presentation and representation of disabled people.

### **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 Britain’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 (LPC) to introduce the National Living Wage (NLW) from 2016, which was awarded to 1.596 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.

**Encouraging women in the Scottish STEM sector:** Research on barriers that prevent women progressing in STEM education and careers has recommended holistic approaches to increasing female engagement, employment, and retention that directly influenced Scottish Government policies on education and employment. It has also informed educational establishments such as The Open University and City of Glasgow College, where the proportion of women studying engineering rose from 4% to 28%.

**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 (RIA) 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 mostly span the social sciences, but also art and design and the humanities:**
  - UoA 17: Business and Management Studies (37.62%)
  - UoA 16: Economics and Econometrics (9.05%)
  - UoA 32: Art and Design: History, Practice and Theory (9.02%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘people’, ‘countries’, ‘development’, ‘organisation’, and ‘workers’.
  - Majority of research in the hierarchical groups of Employment, Wages, and Employment, Disability and Inclusion.
  -
- **Geographical impact mostly Great Britain, followed by Ireland:** The primary beneficiary of the Impact was Great Britain (125 instances), followed by Ireland (31), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 8 and 5 times respectively.
- **Funding mostly from the ESRC, followed by AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 28.57% of all submitted ICSs, followed by the Arts and Humanities Research Council (10%).
- **Underpinning research is slightly gender imbalanced with 38.94% female authors of underpinning research compared to 61.05% 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:** The majority of the underpinning research was published in the form of articles (50.52%) and book chapters (25.12%). The highest Altmetric score within this cluster was 2231, one of the highest across the ten themes, the highest citation count was 1580, and the highest relative citation ratio was 13.



**Figure 7.** Main Characteristics for 'Topic 5: Employment'

Notes: See Notes Fig 3.

## 2.6 Crime and Exclusion

Research-based knowledge is used for multiple facets of crime enforcement, interventions, detention, the justice system, drug, alcohol and substance use problems, and to counteract hate crime and the harmful effects of gambling, illustrated in Figure 8. Considerable impact occurs in the area of crime enforcement, detention, prisons and prisoner reforms. Innovative tools are 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 are developed and tested to also engage local communities in fighting crime. Research also improves police transparency, holding police accountable, scrutinising individual cases and actions against groups (e.g., strikers), and supporting interventions to discourage informal codes of silence and improve the ethics and culture in policing.

Research drives tangible change in prison policy, interventions and regulation and prison buildings. This includes changing the design and architecture in prisons to increase prisoner wellbeing, mental and physical health, education, facilitating behavioural improvement among prisoners, supporting families of the incarcerated, and co-production of research with the community. Humanities research engages with theatre in prison, creative works on crime, and historical work on prisons and imprisonment. Another strong and transformative strand develops interventions related to improving post-prison rehabilitation, reducing recidivism, and tackling over-imprisonment.

University-based research changes gambling policy and reduces harm, by demonstrating safer and more responsible ways of gambling and regulation of digital gambling. Research-based interventions and policy change in the realm of addictive behaviour has generated new policies related to drugs, alcohol harms and psychoactive substances, and supporting children affected by drug abuse.

Other advances are technologies and techniques to improve lie detection during interrogation and cross-examination and the prevention of torture. Numerous ICSs develop a better public understanding of hate speech and hate crime, not only through reduction, but also improving legal responses. Finally, new technologies merging multiple disciplines across criminology, forensics, archaeology, and the natural sciences advance craniofacial identification, transform aquatic forensics, and advance green criminology.

### Distinguishing Facts of the Crime and Exclusion theme:

- **Highly diverse submissions across multiple different Units of Assessment.**
  - UoA 18:Law (25.18%)
  - UoA 20: Social Work and Social Policy (24.11%)
  - UoA 4: Psychology, Psychiatry and Neuroscience (12.06%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘crime’, ‘law’, ‘development’, ‘people’, and ‘England’.
  - Majority of research in the key topics of Drugs, Justice, Detention and Hate.

## Examples of Impact

**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 as an option to bail (alternative to custody), and to updated practice guidance.

**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 that has been shown to reduce abuse by high-risk perpetrators by up to 88%, underpinning new UK family court guidance to protect children from domestic abuse.

**Designing out 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 and in the UN, which subsequently take account of TBI and Neurodisability. This led to changes in practice across the prison system, including mandatory neurodisability screening and enhanced support, and staff training, impacting 83,000 existing prisoners and 60,00 new entrants each year.

**Evidence-based strategies for citizens in policing:** The largest-scale research programme undertaken in the field of citizens in policing helped develop evidence-based strategy and practice for police volunteering programmes, thereby shaping the national strategy across more than 38,000 volunteers in Special Constabularies, Police Support Volunteers, Volunteer Police Cadets, and the Mini Police.

**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.

**Changing domestic violence perpetrator practices:** Research changed how Domestic Violence Perpetrator Programmes (DVPPs) are understood, designed, and implemented across the world, particularly in the UK, USA, and Australia. In the UK this contributed to the perpetrator sections of the UK Government 'Ending Violence Against Women and Girls Strategy', and to an increased focus on perpetrators in the Domestic Abuse Bill effecting changes to DVPP programme delivery.

#### Continued, Examples of Impact

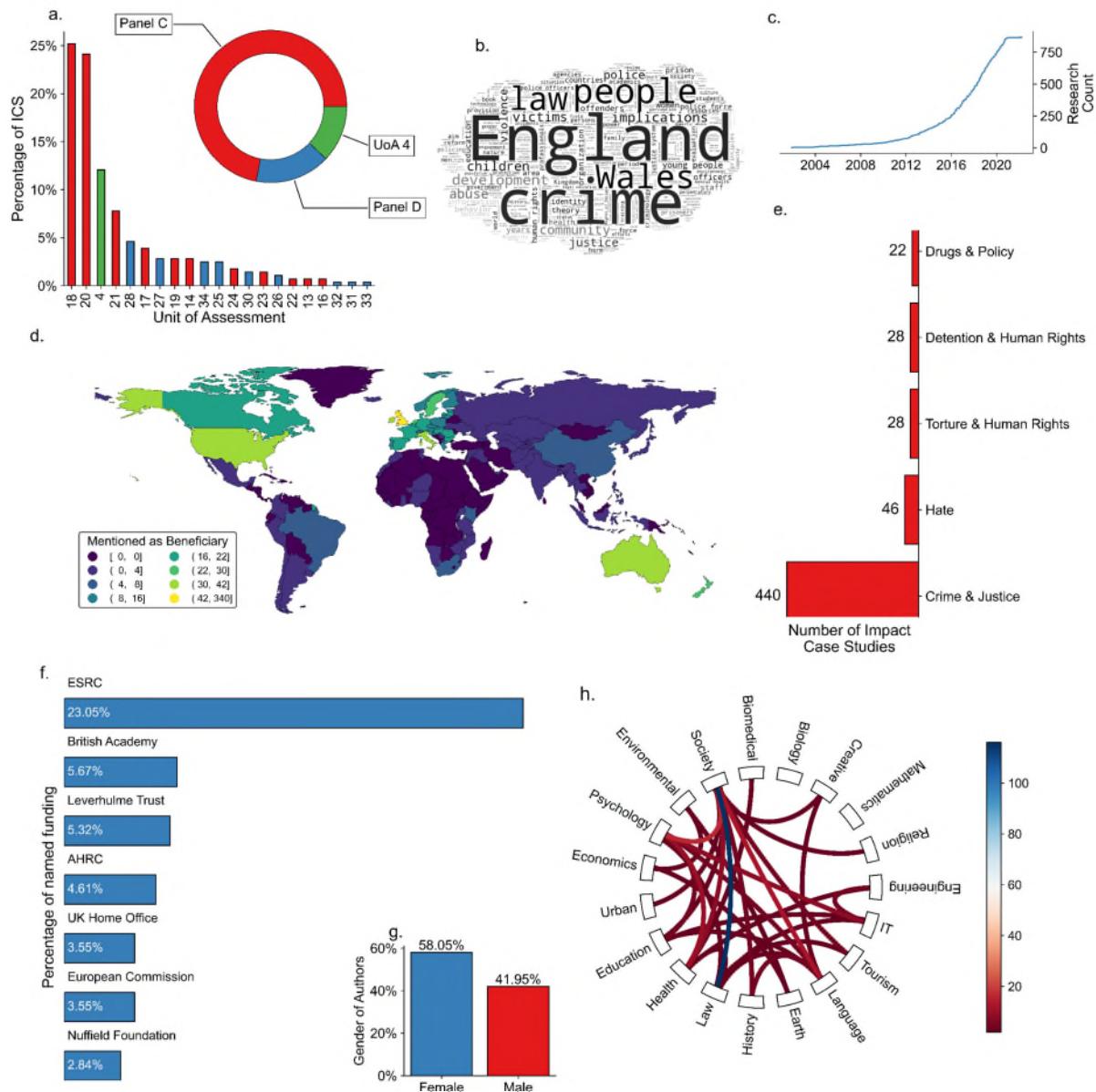
**Addressing hate crimes:** Research outlining prevalence, impact and prevention of hate crime formed the primary source of information for the Welsh Government's Framework for Action on Tackling Hate Crime (2014). Researcher developed technologies were also embedded within the National Cyber Hate Crime Hub (run by the UK's National Police Chiefs' Council), allowing policymakers and police to address the problem.

**Effective torture prevention:** Research showing that the best protection against torture is provided by safeguards when people are first arrested enhanced previous policy which focused on monitoring detention places, and prosecuting torturers. The research led UN anti-torture bodies and two prominent international NGOs to change their approach to torture prevention, and shaped policy and practice in the Republic of Georgia, Uruguay, Ethiopia, and the United Kingdom, leading to greater protection for thousands of people previously at risk of torture.

**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.

**Preventing community deaths from opioid overdoses via nasal spray:** Naloxone saves lives by reversing the effects of opioid overdose. Researchers pioneered the concept of pre-providing naloxone to laypeople, known as Take-Home Naloxone (THN), which led to the development of a medically approved naloxone nasal spray as a safer, easier mode of administration than injection. The United Nations (UN) and World Health Organisation (WHO) subsequently endorsed THN and recommended its wider provision globally. Over 23 countries have now implemented THN programmes, with the US alone having committed an extra \$180 million in funding. Increased distribution of this intervention across the world ensures that opioid users, carers, and families have THN ready for when they need it to save lives.

- **Geographical impact mostly in Great Britain, followed by Ireland:** The primary beneficiary of the Impact was Great Britain (170 instances), followed by Ireland (21), with broad 'International' and 'European' classes of beneficiaries mentioned 10 and 3 times respectively.
- **Prominent Funders are the ESRC, followed by the British Academy:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 23.05% of all submitted ICS, followed by the British Academy (5.67%).
- **Underpinning research is roughly gender equal, with a slight over-representation of women:** Across the underpinning research used to drive this impact, 56.28% of the authors are female, with 43.72% male.
- **Interdisciplinarity of underpinning research published across the social sciences and humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research are between 'Human Society' and 'Law And Legal Studies', and 'Language, Communication And Culture' and 'Law And Legal Studies'.
- **Publication type underpinning research mostly articles:** The majority of the underpinning research was published in the form of articles (64.09%) and book chapters (28.37%). The highest Altmetric score within this cluster was 1018, the highest citation count was 1376, and the highest relative citation ratio was 9.



**Figure 8. Main Characteristics for 'Topic 6: Crime and Exclusion'**

Notes: See Notes Fig 3.

## 2.7 Family and Gender

A wide array of research translates 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, shown in Figure 9.

A core area of impact in this theme has been on safeguarding vulnerable children and families. Programmes and interventions work to identify and counter violence in the home, including violence against children and violence by adolescents against parents. The focus is often on concrete improvements to professional practice and education to protect children and inform regulations. Historians are crucial in providing a historical context for violence against children and helping policy-makers to effectively reckon with this historical violence. Another key strand is the prevention of physical and mental abuse of children in multiple settings, from the domain of sport to online forums. Pivotal interventions prevent and interrupt the grooming of children and gain a deeper understanding of the role of grooming. Refugee's children's rights and the rights of children of imprisoned mothers are also considered, leading to changes in child protection legislation, children's rights and tackling childhood food poverty.

Humanities researchers use photography and art to increase children's agency and early childhood development such as reading through storytelling and digital technologies. Psychological and behavioural researchers humanise technology and improve technology's ability to provide socioemotional support. They also increase children's literacy and numeracy skills in low resource and conflict settings, increasing children's confidence, personal autonomy and social influence. Other interventions operate to prevent infant deaths and provide tools and techniques to amplify children's voices in care settings. Countless others operate to improve children's cognitive and emotional development in different income settings, enhance home learning environments and inform child protection policy.

Research impacts the area of reproductive rights, shaping attitudes and legislation towards abortion, surrogacy, fertility, hormonal pregnancy tests, gamete and embryo donors, egg freezing, and 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. Impacts included increasing gender equity and representation of ethnic minority employees in the workplace, reducing employment discrimination and shaping government and business policy to support women in business and SMEs. Policies and interventions increased diversity among senior leadership and boards. Gender equity is enhanced through specific early education programmes, training in the media to increase women's power in programming, writing and radio and locally and gender-informed policy in Low- or Middle-Income Countries (LMICs). This topic closely aligned with a grouping of case studies focused on empowerment of women through education.

Research likewise contributed to new policies and practices relating to sexualities to improve the experiences of LGBTQ+ individual's experience in multiple institutions. Here a focus is also on LGBT+ spaces 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 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 the largest Education NGO in India, to improve development and cognition for an estimated 100,000+ children between 2014-2021. 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 annually 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 >44,000 children traumatised by war, displacement, and abuse, globally. 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 gave 50-70% reductions in HIV infection risk behaviours, such as transactional sex, reduced HIV infection risks, and improved health for 2,000,000 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 in men who have sex with men (MSM) with high risk behaviour.

**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.

## **Improving education and care of Children Looked After**

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, led the ‘Educational Progress of Looked After Children in England: Linking Care and Educational Data’ study, carried out at the Rees Centre in the Department of Education at Oxford. In 2015 the Rees Centre research identified factors contributing to poor educational outcomes for those supported by children’s services in the UK. This research shed important light on the impact of care on childhood education outcomes, particularly of Children Looked After (CLA). It has informed a number of policy changes and public debates to address this issue.

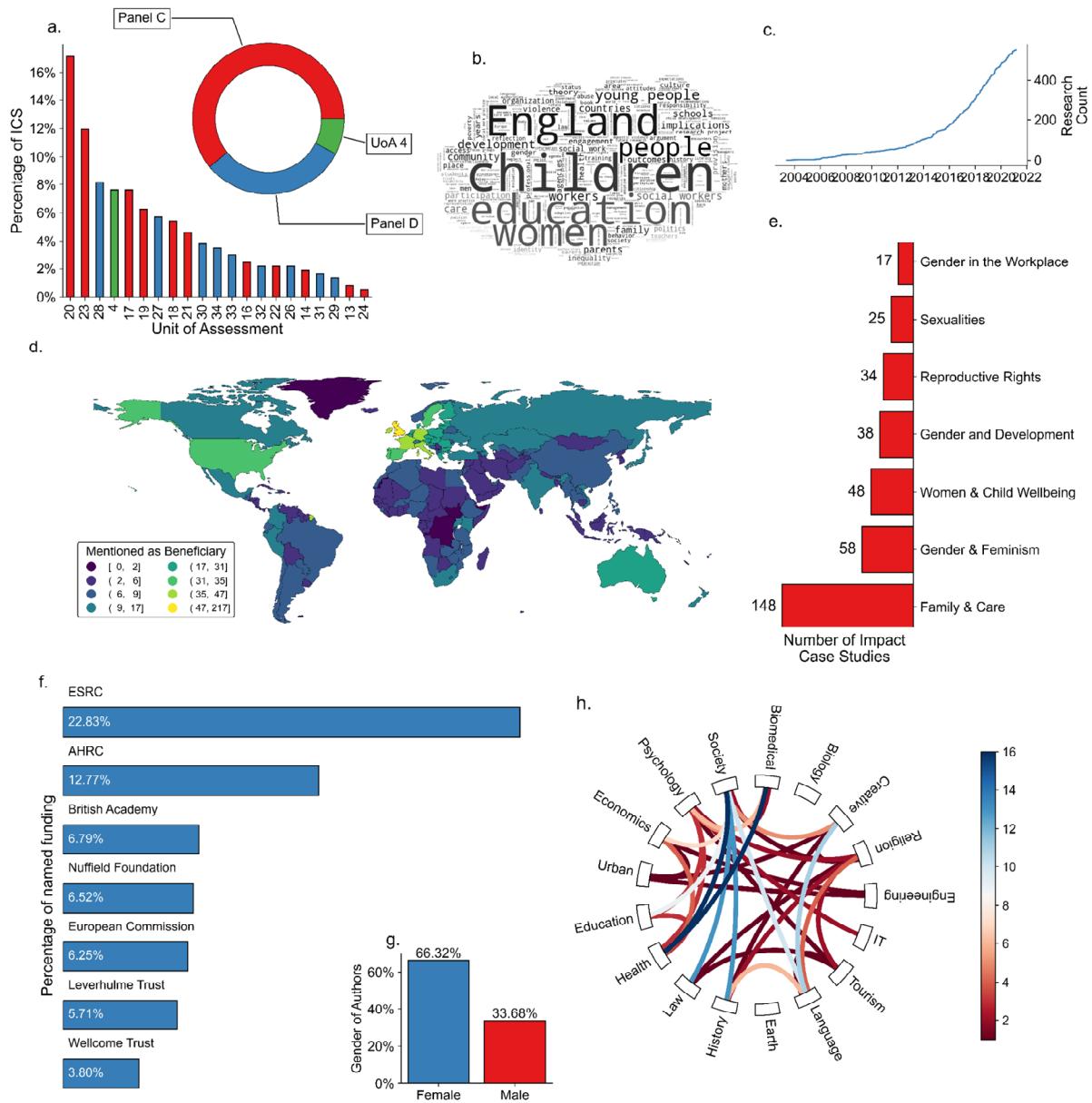
This study was the first to combine education and care factors statistics with complimentary interviews with secondary-aged CLA. The research showed that children in longer-term care do better than those children with a social worker but not in care (children ‘in need’), or those in shorter-term care. It was found that children in need are a more suitable comparison group than the general population when producing official statistics and informing debate on children in care. It was also found that some children in care with lower prior attainment made very good progress academically, thus progress rather than attainment makes a more realistic depiction of the achievements of CLA. As Sebba herself testifies, their most significant finding was “changing the narrative around children in care – from care is what hurts, to no, it is what happens before”.

The research produced a series of recommendations with special attention to the importance of stability for CLA outcomes in education. These outcomes and recommendations were widely disseminated through distribution of over 3,000 copies of the report to policy makers, local authorities, children’s services practitioners, both in the UK and internationally (particularly in Japan and Australia). In-person briefings were also given to Department of Education (DfE) officials and the Association of Directors of Children’s Services (ADCS), and workshops were held with 100 of the 120 Virtual School Heads in England (Virtual Schools support the education of CLA).

In response to the Rees Centre’s CLA research recommendations, the DfE changed their Annual Statistical Release on outcomes for CLA in March 2016. In 2017, Ofsted altered their framework for schools and social care inspections to extend their focus on CLA. This involved introducing education inspectors on social care inspections, and vice versa. Some local authorities (Barking, Dagenham, Salford, Staffordshire, and Suffolk) changed their policies on CLA moving schools and increased resources to Pupil Referral Units in response to recommendations that local authorities should ensure that school staff provide appropriate support and limit placement and school changes in KS4. Based on the report, greater emphasis has been placed on the role of Virtual Schools, including the 2020 proposal by the DfE that Virtual Schools take responsibility for the education of children in need. 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 from the Rees Centre research in 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 (13.95%)
  - UoA 28: History (9.86%)
  - UoA 23: Education (9.18%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘children’, ‘women’, ‘education’, ‘England’, and ‘development’.
  - Majority of research in the key hierarchies of Gender, Care, and Safeguarding.
- **Geographical impact mostly focused on Great Britain and Germany:** The primary beneficiary of the Impact was Great Britain (166 instances), followed by Germany (35), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 15 and 5 times respectively.
- **Funding mostly from the ESRC, followed by the AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 22.79% of all submitted ICSs, followed by the Arts and Humanities Research Council (14.29%).
- **Underpinning research is gender unequal, with 63.67% female authors compared to 36.33% male authors.**
- **Research is highly interdisciplinary, spanning the humanities, social and health sciences:** The most commonly occurring interdisciplinary linkages in the underpinning research are between ‘Law And Legal Studies’ and ‘Human Society’, and ‘Health Sciences’ and ‘Human Society’.
- **Publication type underpinning research is largely articles:** The majority of the underpinning research was published in the form of articles (60.33%) and book chapters (33.09%). The highest Altmetric score within this cluster was 1018, the highest citation count was 1150, and the highest relative citation ratio was 10.



**Figure 9.** Main Characteristics for 'Topic 7: Family and Gender'

Notes: See Notes Fig 3.

## 2.8 Governance and Law

This theme was one of the more diverse clusters, with a focus that united it on the core topics of governments, law, human rights and democracy, while also being aligned with conflict and peace studies, Brexit, immigration, and misinformation, shown in Figure 10.

Humanitarian and peacekeeping research, human rights, war crimes, and terrorism produce considerable impact in the UK and globally. Research leads to changes in understanding and policies related to human rights, privacy, and freedom. Policies and ways of working are

introduced to protect independent journalists and freedom of expression, and to safeguard human rights in armed conflict and warzones. An emerging area of research engages in evidence-driven policy, legal and institutional changes related to internet privacy, GDPR, autonomous weapons, and the role of privacy and human rights in relation to national camera surveillance, digital surveillance, and artificial intelligence. Much of the research focuses on peacekeeping and humanitarian support, develops tools and interventions that provide conflict analysis, support for humanitarian projects, facilitation of dialogue for sustainable peace, enabling peacemaking and peacekeeping in local and territorial conflict, and supporting local groups and NGOs in related efforts.

Work on Ireland and reconciliation, other international conflicts, and terrorism studies enact social and political change and enhance public participation in that change. Impact is driven by research supported by historical work that focuses on remembrance, civil wars, rebellion, creative representations of history, and challenges to dominant perceptions. Another strand focuses on policies and regulations related to safeguarding human rights. Middle East impact studies develop responses to conflict during and after the reconciliation process, in particular addressing the representations of the Arab world and Islam and the role of media and journalism. Impact stemming from research improves policy-makers' understanding of terrorism and violence. This has focused on reducing religious- and politically-based (far-right) terrorism, violent extremism prevention, educational interventions to reduce terrorism risk, preventing gender-based violence and extremism, and enhancing interactions between Islam and the criminal legal system.

An immense pool of evidence-based policies and interventions generate impact related to measurements, policies and interventions linked to migration policy, refugees, asylum seekers, the hostile environment and integration. A large body of ICSs focus on informing and improving government policy toward migration, measuring the number of migrants, and reckoning with forced migration. Others develop interventions and programmes to incorporate and enhance the social integration of migrants such as English-language training and other ways to improve lives of the displaced. Historians produce rich narratives of the histories of migration and improved teaching of those histories to enhance understanding.

Digital surveillance, privacy, AI (artificial intelligence), and cybersecurity is a related cluster of impact in this area. Here the focus is on AI governance and policy and intelligible AI, but also how to devise human-centred and digital technologies from cybersecurity to techniques for improving shoppers' online experiences. Research drives policy changes, which are implemented in government to open up third sector transparency and data sharing infrastructure and technology transfer. Impact also occurs in the area of computational propaganda to counter fake news and viral disinformation and propaganda. Evidence-informed tools were also developed to increase government efficacy and capacity in this area, and to gauge the public's political astuteness skills.

## Examples of Impact

**Combating organised crime and its finances:** Research into quantifying and mapping illicit markets has supported policymakers like the OECD, and 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 policy-making 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 commonly 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 £22,703,586.

**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 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. 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 4.7million visitors to the online site.

**Improving crisis responses via humanitarian journalism:** Research contributed to improve key media news sources raising awareness of 'forgotten crises', directing attention of humanitarian agencies. 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 launching 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 better 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 influenced offices of the UN to recognise the persecution of the Rohingya as 'genocide'. The researchers briefed and worked closely with the UN Fact Finding Missions (FFM) on Myanmar in 2018.

**Historical and cultural recognition of the British mosque:** Research contributed to the recognition of several mosques by Historic England, protecting them for future generations, and integrating the architectural contribution of British Muslims into the narrative of British culture and heritage. The Muslim Council of Britain has credited this research and its outcomes with consolidating a place for British Muslims in the history of the nation, and providing a sense of legitimacy and belonging in public discourse.

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. Techniques and policies were developed to improve the standard of democracy, 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. Here the focus was on trade, tariffs, the constitution, Parliament, the hard-border and Northern Ireland, and the role of political parties and political processes. Others impacted decision-makers and transformed the public's understanding of Brexit and the potential changes that may be required for future election and referendum campaigning. Research also drove new policies to achieve more transparency in lobbying, countering electoral fraud, and improving electoral integrity and registration. Techniques and policies were also focused on increasing diversity in representation, particularly women's and minority participation and representation, and the diversity of voices in Parliament and witnesses to Parliament.

Considerable work on colonialism, the legacy of slavery, and modern slavery developed practices to memorialise those who were enslaved, amplify black voices in commemoration, decolonise the educational curriculum, and diversify teaching on history and legacies of oppression. This related to war history research, such as work on persecution and the Holocaust, which developed ways to hold governments and members of government accountable for past and present wrongs, and found ways of documenting complicity (e.g., Dutch government in WWII). Historical and archaeological work continued to unearth and emphasise previously obscured or forgotten facets of past violence, improve knowledge, integrate new materials into educational curricula, and document the Holocaust and other atrocities. Research in Latin America focused on ways to bring justice for victims or survivors of genocide, and support processes of truth and reconciliation (e.g., Chile, Mexico, Peru, Rwanda, Spain). Here practices and regulations emerged on how to recognise indigenous contributions to human rights and force accountability for international organisations. Impact has likewise taken place in countering modern slavery within forced labour in supply chains, implementing government policy changes to support survivors 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.

#### Case Study Example

#### ICS Example Boxes we suggest to add for geographic / topic diversity

Impact Box: If more examples from diverse university backgrounds are desired we could add a box on the "Hatelab" exploring Hate Speech and Hate Crimes here <https://results2021.ref.ac.uk/impact/1f4350a8-9793-4fcc-8748-f31fe878391f?page=1>

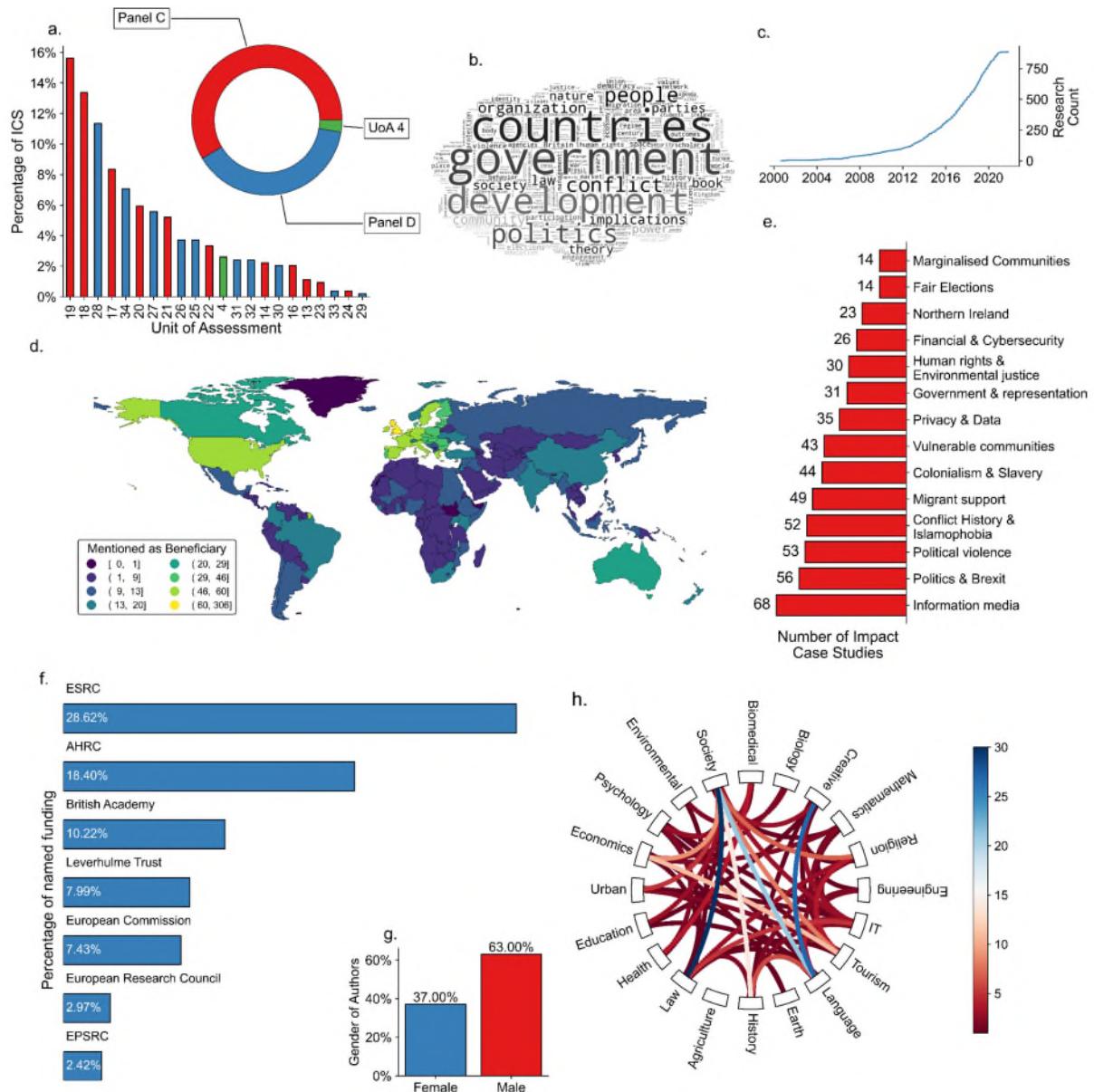
OR

#### Anticipating the debate about AI Regulation

This will be based on the case studies "AI narratives: shaping public debate, policy and cultural responses to the future of Artificial Intelligence" and "AI: Alignment, Policy and Governance" by Sarah Dillon and Nick Bostrom  
<https://results2021.ref.ac.uk/impact/06c86fde-0d35-4385-994b-9787ec9d7839?page=1>  
<https://results2021.ref.ac.uk/impact/911191cd-84dc-48b9-bf43-89ede77fb17b?page=1>

## Distinguishing Facts of the Governments and Law theme:

- **One of ten Grand Impact Areas with the most ICSs allocated to it:** 538 individual ICSs fall within this theme.
- **Most prominent UoAs across both the social sciences and humanities:**
  - UoA 19: Politics and International Studies (15.61%)
  - UoA 18: Law (13.38%)
  - UoA 28: History (11.34%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘government’, ‘development’, ‘politics’, ‘countries’, and ‘law’.
  - Majority of research in the key hierarchies of Humanity, Immigration and Misinformation.
- **Geographical impact largely in Great Britain and Germany:** The primary beneficiary of the Impact was Great Britain (306 instances), followed by Germany (60), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 36 and 9 times respectively.
- **Funding largely from the ESRC, followed by the AHRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 28.62% of all submitted ICSs, followed by the Arts and Humanities Research Council (18.40%).
- **Underpinning research gender imbalance, with 62.61% female and 37.39% male authors.**
- **Interdisciplinarity of underpinning research across the social sciences and humanities:** The most commonly occurring interdisciplinary linkages in the underpinning research are between ‘Human Society’ and ‘Language, Communication And Culture’, and ‘Human Society’ and ‘Law And Legal Studies’.
- **Publication type underpinning research, mostly articles but also book chapters:** The majority of the underpinning research was published in the form of articles (55.04%) and book chapters (36.02%). The highest Altmetric score within this cluster was 986, the highest citation count was 793, and the highest relative citation ratio was 10.



**Figure 10.** Main Characteristics for 'Topic 8: Governance and Law'

Notes: See Notes Fig 3.

## 2.9 Health and Wellbeing

The contribution of SHAPE to health and wellbeing research-led impact has been remarkable and contains one of the largest groups within our ten themes (see Table S1), illustrated in Figure 11. Impact is driven by sports and nutrition science research, research 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 diet. The accompanying box provides astounding evidence of a range of impacts, from compelling FIFA to allow a replay for the World Cup to drastic increases in healthcare efficiency in the NHS and saving countless lives through innovative diagnoses, treatments, support, and training.

Deep research-driven impact occurs in the realm of sport, focusing on exercise, nutrition, coaching, and the wellbeing of athletes. Research leads to creating sporting environments and opportunities safe from any abuse or discrimination. It also promotes the potential for sport to enable wider social and political change, supports competitive performance and coaching, as well as underpinning initiatives to improve the health and wellbeing of members of the general public and athletes alike.

Detection, diagnosis, and treatment produces innovations in diagnosis and prevention related to mental health, autism, stroke and self-harm. Research informs methods and technologies for the detection, diagnosis, and treatment of various health conditions. Interventions in mental health focus on the diagnosis and treatment of mental health and wellbeing across a vast range of ages and contexts. They address a number of psychological concerns, from reducing mathematical anxiety to improving mental wellbeing in the workplace. They often offer unique data, new tools, and training and intervention programmes to provide mental health support. Work on neurodiversity, diagnosis and support focus on improving diagnosis and support for neurodivergent individuals, and those facing exclusion in professional and education settings on the basis of learning and/or communication disabilities.

Mental health support and training provides research-driven initiatives that underpin understandings of mental health and the provision of sustainable, patient-focused support and training. They are successful in identifying groups whose mental health has been overlooked or misunderstood, and in providing support systems in low-resource contexts. Others focus on improving patient quality of life and rehabilitation, and provide the data and support necessary to support the education of health practitioners. Research on mental health, social media, eating disorders and body image in young people and women provides tools to safeguard against the harms of digital addiction and social media ‘echo chambers’. Other research examining PTSD (Post Traumatic Stress Disorder) and self-harm contributes to the diagnosis of severe mental illnesses, and the prevention of self-harm and suicide. This research provides support to vulnerable individuals through direct intervention, training clinicians and communities, changing institutions policies, and informing public awareness.

## Examples of Impact

**Capacity building in para-sport:** Research on organisation, healthcare, and practical advice for organisers, coaches, and athletes in para-sports events led to establishment of new sports at the Paralympics and Commonwealth Games, including Paracanoe at the 2020 Tokyo Paralympics, and Wheelchair Basketball at the 2022 Commonwealth Games.

**Anti-match fixing:** Research convinced the Court of Arbitration for Sport (CAS) to rule that evidence from betting markets was sufficient to identify match fixing. As a consequence, FIFA ordered a replay enabling Senegal to qualify for the 2018 World Cup. Researchers educate coaches and athletes on match-fixing.

**Fostering inclusivity in sports:** Development of new textbooks and of events with athletes and collaborations with Sports and Football Associations to allow for greater inclusivity of LGBT+ Athletes.

**Career transition support for athletes:** Research on helping athletes plan careers after their competitive careers raised awareness of the issue in sports associations and led the Rugby Association to hire 8 Development Managers and 1 Transition Manager to support over 800 current and 400 former players across premiership clubs. It also led to campaigns by the English Institute of Sport and the International Federation of Professional Footballers Associations to help athletes in planning life after sport.

**Football4Peace (F4P):** Values-based coaching methodology used to promote peace-building in divided and post-conflict societies. Early work in Northern Ireland, Israel and South Africa has been extended to The Gambia, Colombia and South Korea. NGOs and UNESCO Clubs have been formed. The model has been applied to several other sports, and benefitted 532 coaches/volunteers, 4,699 young people, and residents and pupils in 87 local communities in 7 major cities.

**Safeguarding children in sport:** Development of an evidence-based flexible framework informed safeguarding guidelines for working with children in 32 countries and 126 organisations across the world. This effort helped to safeguard 35 million children who access sport through local, national, and international organisations.

**App for health emergency services:** 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.

**Helping patients suffering visual field defects after brain injury:** Durham Reading and Exploration (DREX), a computerised training for the rehabilitation of brain injury related visual field defects, has been converted into an app to maximise accessibility and effectiveness. The app has over 2,250 individual users and is now listed in the British and Irish Orthoptic Society list of available rehabilitation options.

**Allowing motor-impaired individuals to make music with brain signals:** Brain-Computer Music Interface (BCMI) technology allows individuals suffering from severe motor impairment to create and perform music. A documentary about Rosemary Johnson, a former violinist of the Welsh National Orchestra, paralysed in a car accident and using the technology was aired during the advert break of the season finale of *Game of Thrones*, attracting 12.1 million viewers.

**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 (2000 members), and patients (e.g., from *ADHD Europe*, including 28 organisations from 23 countries).

**Improving health in people with severe mental illness (SMI):** New prediction tools and health management strategies for people with severe mental illness (SMI) have been adopted across the NHS, ranging from annual cardiovascular screenings to new evidence-based, nurse-led care services. Research also informed medical guidelines worldwide on managing physical health in SMI patients.

**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 £ 18 million of external funding.

### Continued, examples of Impact

**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.

**Cost-effective imaging strategies for improving stroke diagnosis:** Research influenced clinical stroke guidelines to recommend immediate CT scanning after acute stroke. Immediate CT scanning in the UK has caused 42,000 more quality-adjusted life-years and a reduction in the cost of stroke patients for the NHS by £1-2 Billion over the REF2021 period.

**Improving medicine adherence in chronic illness:** The New Medicine Service (NMS) review by researchers informed the NHS decision to adopt the service delivered by community pharmacists. Over 5,348,000 NMS consultations have been delivered to patients starting a new medicine for a chronic condition in England from 2014-2020. The increased medicine adherence created by NMS has provided long-term savings of £558,000,000 for the NHS, and 213,952 quality adjusted life years gained for patients overall.

**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 social prescribing (SP) NHS England invested £35 million local SP services, including £3,000,000 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.

**Preventing railway suicide:** 59% of TfL staff have received researcher-led suicide prevention training at date of ICS authorship. This has resulted in an unprecedented drop in suicide on TCS Rails of a third in two years.

Others focus on specific diseases in areas such as cardiovascular disease or cystic fibrosis. Research has driven policy change, revision of healthcare guidelines, technological investments, and novel treatments for people with cystic fibrosis and patients with cardiovascular disease, their carers, and the institutions that treat and support them. Impact has also occurred in the realm of infectious disease crises in both global, national, and localised settings. Here the focus is often on low-resource settings, such as developing countries, to provide treatment and social and cultural understanding, as well as 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 drives improvements of healthcare provisions, with an emphasis on early interventions and preventative measures to relieve pressure on healthcare institutions. Subjects range from bioethics and the importance of cultural and religious differences when engaging with healthcare, to improving the IT services facilitating healthcare provision. Research results in reducing the financial burden on health and social care providers, and to enable more input from those receiving their care. Food marketing and food security research also equips practitioners and individuals to support healthy food habits. Ethics and data in healthcare interventions focuses on demographic and medical data analysis, and prompts government and institutional policies in response to this information. A related topic focuses on pharmaceutical research, which has had impact in the realm of the ethics and cost-effectiveness of the healthcare industry, particularly pharmaceutical research and commercialisation, and healthcare economics.

### **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.

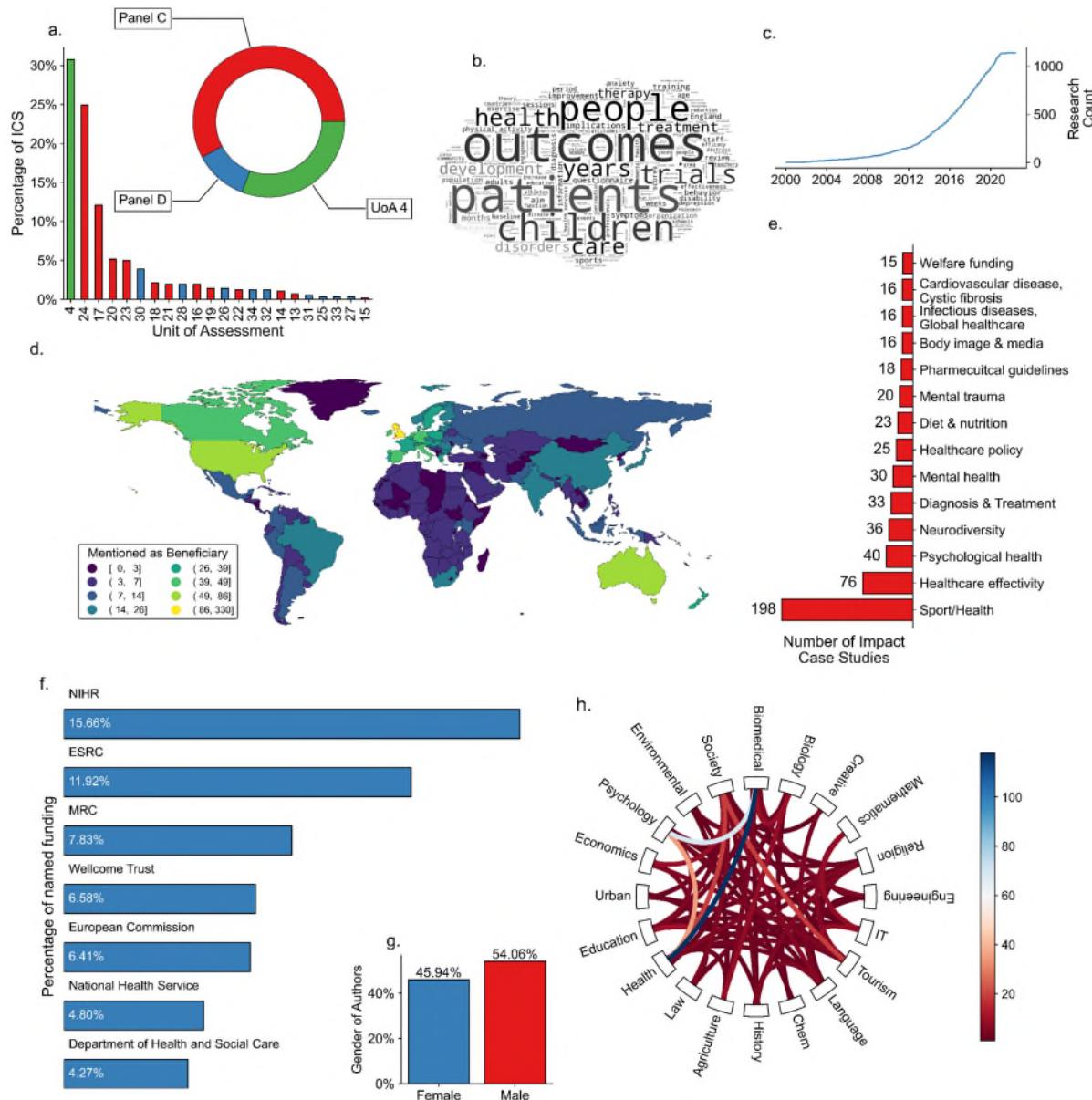
The publicity around the performance and documentary led to further opportunities and wider audiences. One of the BCMI patient participants was a former violinist of the Welsh National Orchestra (WNO), Rosemary Johnson. As a result of the media attention to Miranda's research, in March 2017 Volvo and 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 RHN therapists, nurses, and carers. Johnson's performance using BCMI contributed to her receiving an MBE for her services to music in December 2017.

### **Distinguishing Facts of the Health and Wellbeing theme:**

- **One of the largest themes:** 562 ICSs fall within the theme of 'Health and Wellbeing'.
- **Distributed across UoAs within the social sciences:**
  - UoA 4: Psychology, Psychiatry and Neuroscience (30.78%)
  - UoA 17: Business and Management Studies (12.1%)
  - UoA 20: Social Work and Social Policy (5.16%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: 'outcomes', 'patients', 'people', 'health', and 'children'.
  - Majority of research in the key hierarchies of Sport, Health Detection, and Health Prevention.
- **Geographical impact largely in Great Britain and the USA and internationally:**  
The primary beneficiary of the Impact was Great Britain (330 instances), followed by

the USA (86), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 47 and 21 times respectively.

- **Funding mostly from NIHCR and ESRC:** The National Institute for Health and Care Research was the most prevalent funder, mentioned in 15.66% of all submitted ICS, followed by the Economic and Social Research Council (11.92%).
- **Gender of authors of underpinning research is roughly equal with 47.93% female 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 few book chapters and the highest relative citation ratios of all themes:** The majority of the underpinning research was published in the form of articles (89.69%) and book chapters (6.96%). The highest Altmetric score within this cluster was 2127, the highest citation count was 4266, and the highest relative citation ratio was 75.



**Figure 11.** Main Characteristics for 'Topic 9: Health and Wellbeing'

Notes: See Notes Fig 3.

## 2.10 Sustainability and Infrastructure

Research and impact in the area of climate change, renewable energy, ecosystems and infrastructure is an interdisciplinary enterprise, with social science, behavioural, and legal research often playing a transformative role, shown in Figure 12. University-based research fuelled considerable technological, societal, and economic impact in this area. Impact contributes to better environmental protection practices and legislation, improves natural and agricultural resource management, as well as technological and legislative changes to mitigate climate change. It also results 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 house 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 occur in the realm of water management (water industry, trade, freshwater, marine, coastal, rivers). Policy, legal, and regulatory changes transform fisheries, trade relations, flood management, marine ecosystem management, recreational water, underwater heritage, water treatment, and domestic water sources. Research leads to vital governance reforms such as accelerating decarbonisation in the entire British energy system and regulatory changes in revenues in the British water industry. Ethical, legal, regulatory and community-supported SHAPE research drives changes to accelerate clean heating, a move to 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 drives 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/or relevant groups are included in environmental management and conservation. Research also leads 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 is particularly international, with UK researchers often helping foster agricultural and natural resource management for sustainable development around the world.

SHAPE research drives innovative policies, regulations, and proactive technical solutions to the challenges of housing and infrastructure. A considerable body of evidence-based research focuses on legal, policy, and ethical changes for local cities and industries. In this context, researcher-led projects also help local communities and disadvantaged groups to reshape their communities and regenerate town centres. Other projects are 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 bike use in urban communities. New directives inform housing associations, policies and practices, and change government homebuilding to focus on sustainable and affordable housing. New solutions change policy and practice in the financial assessment of

property developments to improve community benefits. Research also shapes 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. Applications range from economic solutions to devising insurance-based finance and industrial strategies after disasters and empowering local communities to contribute to research that is instrumental in developing early warning systems.

#### 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, a ban on electric pulse trawling throughout Europe, and 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 CO<sub>2</sub> emissions and saving British households £66 million pounds 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 one 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 >1600 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 Great Britain:** 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 850,000 m<sup>2</sup> of roads in 2018 and 2019.

**Changing homelessness policy to focus on prevention:** Research on how to reduce homelessness via a focus on prevention resulted in new legislation: the Housing (Wales) Act 2014 and England's Homelessness Reduction Act (2017).

**Improving legal protections for renters:** Research on the application of housing law to tenants led to the Renting Homes (Wales) Act 2016 and the Human Habitation Law in England, affecting the rights of over 8 million households.

## **Case Study Examples**

Many case studies in this topic area 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,” recalls Alan Short, Professor of Architecture in Cambridge, whose research focuses on adapting buildings to make them more resilient to a changing climate and conditions of high heat and on reducing their carbon emissions.

“Architecture is incredibly interdisciplinary” says Short, who for example works with mathematicians and geologists modelling air flows for better heat regulation in buildings. This interdisciplinarity was a key component of his project on design and delivery of robust hospital environments in a changing climate (DeDeRHECC) which proposed solutions for better climate adaptation that were implemented in over 248 NHS England Acute Hospitals. The expertise from this project led to Short developing the NHS Energy Efficiency Fund (EEF), improving energy efficiency across the retained NHS Estate. The implemented changes in buildings and guidance led to an additional 117 energy efficiency projects in 48 NHS organisations and are 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. Government recommendations for adapting and retrofitting existing buildings rather than replacing them are estimated to mitigate a potential 320.11- 415.8 billion kWh of energy consumption per annum.

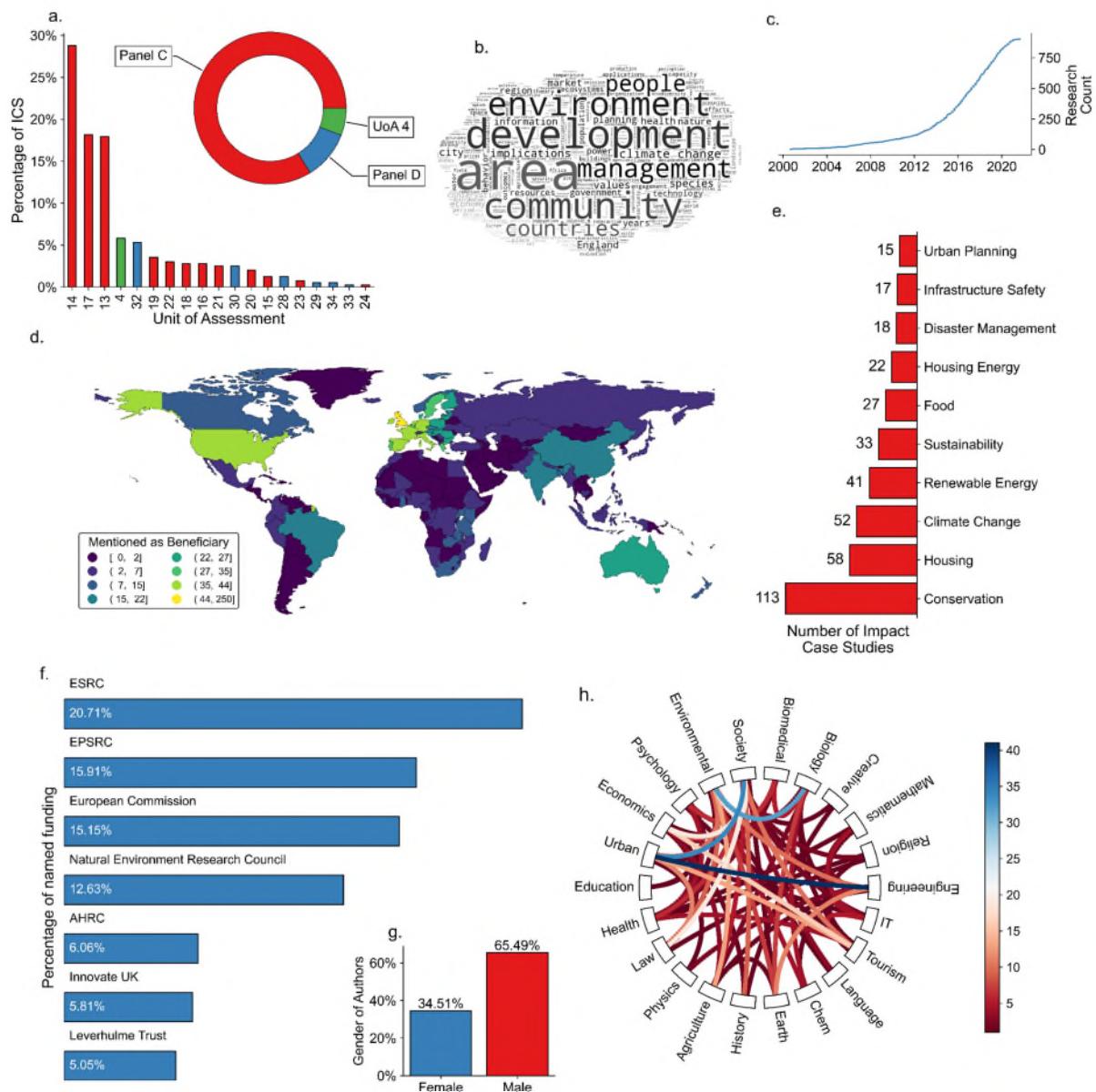
Shorts’ work on adapting UK hospitals does not solely focus on reducing emissions but comes with the added benefit of looking for improvements in workplace conditions for NHS staff and medical practitioners, with more natural airflow reducing airborne transmissions in hospitals and ongoing research on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

### **Informing the Paris Climate Agreement**

Anil Markandya describes his research as having two objectives: “putting environmental problems on the map by understanding their economic dimension” and addressing these problems in order 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 health costs arising from the effects changing climate has on diseases such as malaria and diarrhoea in developing countries as well as demonstrating that the health cost savings of climate change mitigation policies often outstrip their cost. This expertise led to Markandya becoming a lead author for chapters of the 3rd and 4th 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. Markandaya’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 Health and Wellbeing theme:**

- **Most prominent UoAs are across the social sciences:**
  - UoA 14: Social Work and Social Policy (28.79%)
  - UoA 17: Business and Management Studies (18.18%)
  - UoA 13: Architecture, Built Environment and Planning (17.93%)
- **Main concepts:**
  - The five most highly weighted concepts associated with this underpinning research were: ‘development’, ‘area’, ‘community’, ‘environment’, and ‘implications’.
  - Majority of research in the key hierarchies of Sustainability, Affordability, and Biodiversity.
- **Geographical impact is mostly in Great Britain and the Netherlands:** The primary beneficiary of the Impact was Great Britain (250 instances), followed by the Netherlands (44), with broad ‘International’ and ‘European’ classes of beneficiaries mentioned 28 and 19 times respectively.
- **Funding almost equally from the ESRC and EPRC:** The Economic and Social Research Council, UKRI was the most prevalent funder, mentioned in 20.71% of all submitted ICSs, followed by the Engineering and Physical Research Council (15.91%).
- **Gender of authors of underpinning research is imbalanced, with 35.19% female and 64.81% 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 ‘Human Society’ and ‘Law And Legal Studies’, and ‘Human Society’ and ‘Philosophy And Religious Studies’.
- **Publication type underpinning research was largely articles:** The majority of the underpinning research was published in the form of articles (79.48%) and book chapters (16.34%). The highest Altmetric score within this cluster was 2928, the highest citation count was 1471, and the highest relative citation ratio was 17.



**Figure 12.** Main Characteristics for 'Topic 10: Sustainability and Infrastructure'

Notes: See Notes Fig 3.

### 3. Five Defining Features of SHAPE impact

**The main take-aways five defining features of SHAPE impact:**

- Larger departments perform almost ubiquitously better with enormous divergence in quality between large and small departments, with substantial challenges apparent for both small and newly-created units.
- The geographic distribution of impact beneficiaries was typically centred within the UK but had substantial international reach, with little difference between the Social Sciences and Humanities.
- While the ‘Core R&I Budget’ from UK Research and Innovation funded a relatively modest amount of ICSs, with ESRC and AHRC UKRI research councils funding a disproportionately large amount of Impact (23.92% and 19.84% of all UKRI mentions).
- Across the Social Sciences, the main source of multidisciplinarity synergies were between ‘Health’ and ‘Bioscience’ Fields of Research, while in the Humanities, it was between ‘Language, Communication And Culture’ and ‘Creative Arts And Writing’.
- Balance in the gender of authorship was far closer to parity within SHAPE disciplines than STEM, and highest in UoA 4 and Panel D.

We next analyse all ICSs within UoA 4, Panel C, and Panel D groupings. This is undertaken across five dimensions of: general characteristics, geographies, funders, multidisciplinarity, and gender-balance.

#### 3.1 Large Departments Perform Ubiquitously Better

Table 3 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 the largest number of doctoral degrees conferred (largely due to the Engineering UoA).

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

**Table 3.** Summary of key Impact Case Study (ICS) and environmental data REF2021

In Figure 13 we consider both environmental variables and an engineered ‘Departmental GPA’, concluding that whilst larger departments generally outperformed 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), 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 qualitative interviews:

*“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 being able to submit ten active research staff in order to submit one case study in 2014 to a higher number of fifteen active staff per case study in 2021, which some have argued severely disadvantages new and small submissions (Kerridge 2022). This is due to the fact that a very small staff unit of two people (or even those under fifteen) would have to produce the same number of case studies as a unit that is considerably larger with eighteen or more people. The challenges of assessing larger UoAs were not under-estimated by our qualitative interviewee's:

*“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 Science Panel Member

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

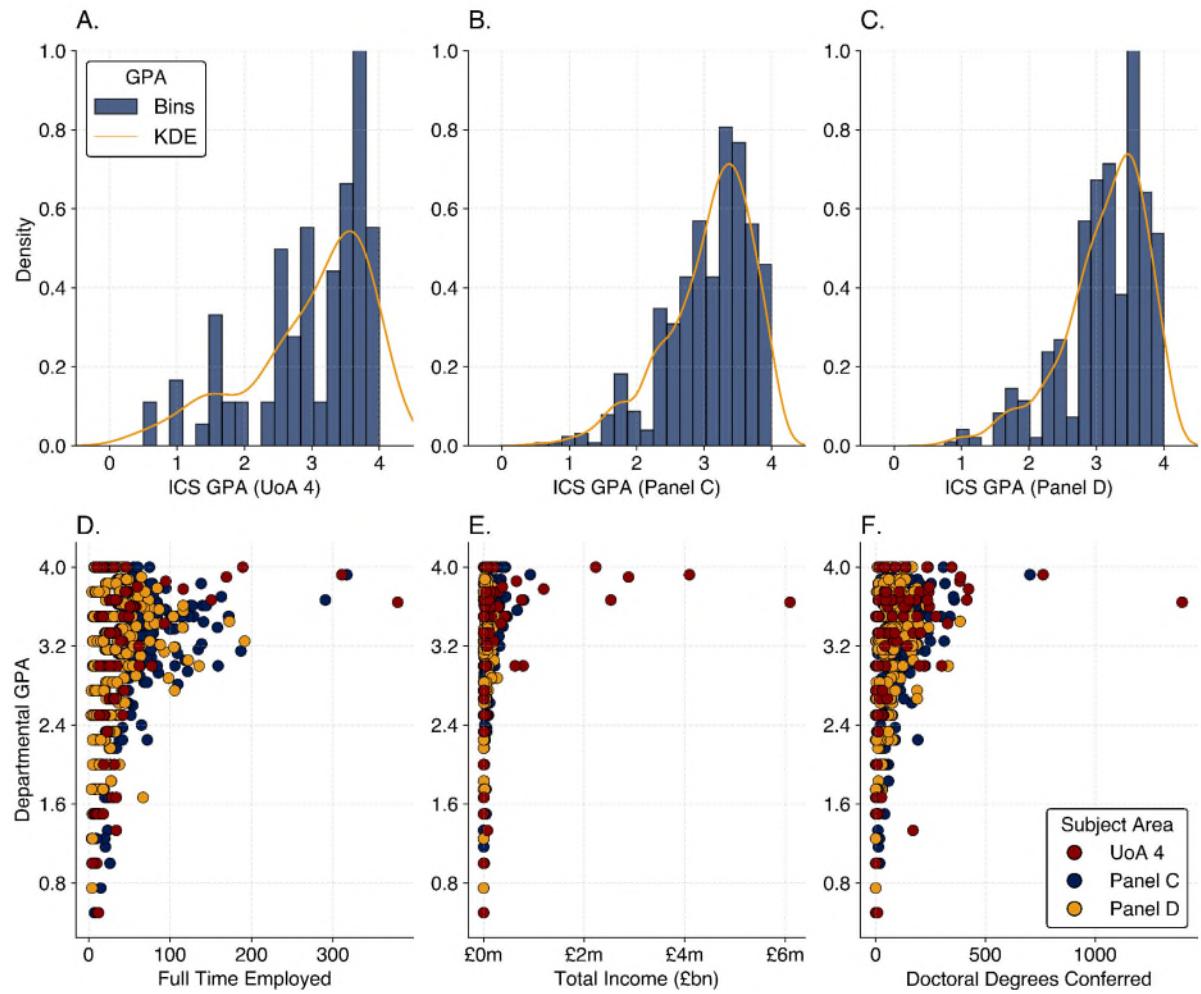
*“There's something around the size of panels as panels become very big, and we've certainly had this issue in Business and Management: you can't assess things in plenary. Partly because you know you can't have a plenary of 53 people, but the other thing is that if you've got 53, you know, if you got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

– Social Science 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 Science Panel Member



**Figure 13.** SHAPE environments and ‘Grade Point Average’

Relatedly, size and institutional support were also well 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

We can quantify this discrepancy across size (and by proxy, institutional support) even further: across all SHAPE disciplines, the ten largest departments by the ‘total income’ environment variable 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. The same is – as apparent in Figure 13 – 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 gap in GPA was 2.2198 between ten highest and lowest FTE, 1.8446 between the highest and lowest income departments, and 2.0781 for those with the most and least Doctoral Degrees Conferred.

### 3.2 UK Centred Impact, with Broad Reach

Research and research impact are geographically diverse in terms of where centres of excellence are located in the UK for different research fields. 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

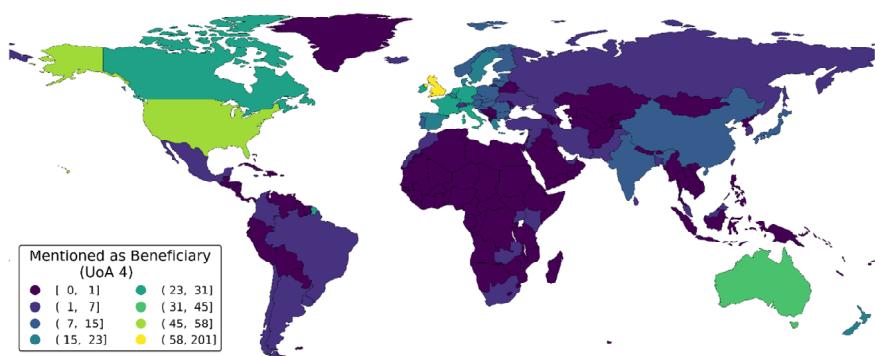
To analyse the distribution of geographic beneficiaries, we curated (double blind) and harmonised the free-text country names, converting them to machine-readable ISO-3 country codes. These database enhancements are available from our interactive online portal. The primary results of our analysis can be seen in Figure 14, 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 – Great Britain and Northern Ireland – ISO3 code as the most frequent by a considerable range. This is true for each of UoA 4, Panel C, and Panel D:

- UoA 4: 40.94% of listed beneficiaries (countries) are within GBR
- Panel C: 40.35% of listed beneficiaries are within GBR
- Panel D: 47.58% of listed beneficiaries are within GBR

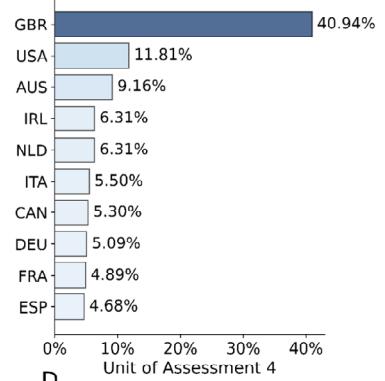
UoA 4 lists a total of 87 different country-level beneficiaries, Panel C lists 167, and Panel D lists 170. Whilst many countries are listed, definitive geo-political patterns regarding the beneficiaries of the research are immediately apparent. The United States of America is the second most listed country of benefit in both UoA 4 and Panel D. For Panel C, the second most frequent beneficiary is the Republic of Ireland. Other commonly occurring beneficiaries include Germany, Canada, Australia, France, and the Netherlands. With the exception of New Zealand, the five core countries of the ‘Anglosphere’ are generally well represented in this analysis. In terms of least benefitting regions, Africa, Middle East Asia, and South America are mentioned as beneficiaries least frequently for each of UoA 4, Panel C, and Panel D. Notable countries where there is perhaps surprisingly little mention of beneficiaries of impact include Greenland, the Falklands, and Puerto Rico.

Our interactive dashboard acts as an additional, supplementary tool for exploring geographic trends in research impact. It also allows users to visualise the locations of UK institutions that submitted ICSs on a selected topic, and the countries that were impacted by that 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).

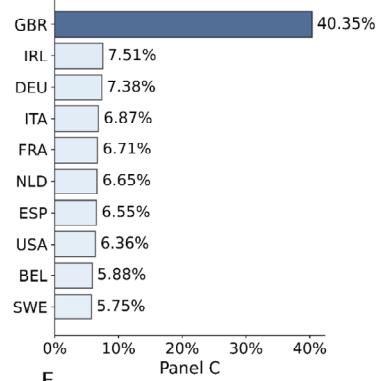
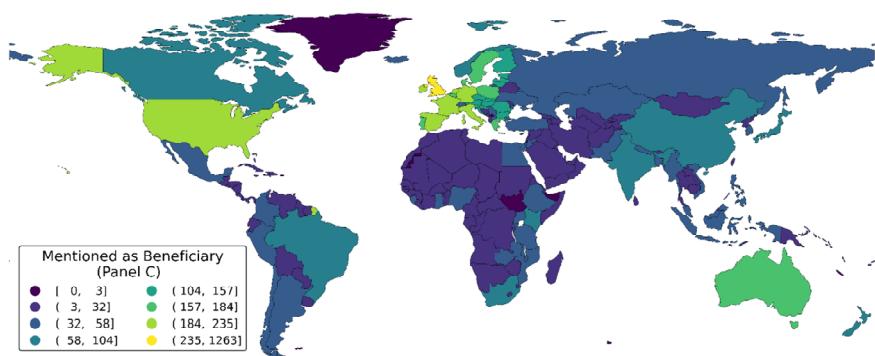
A.



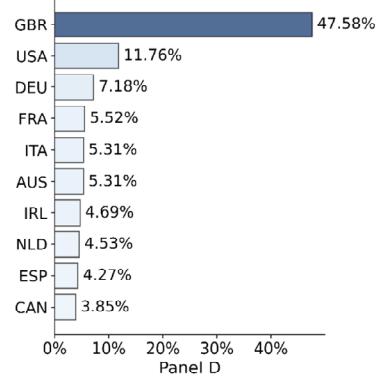
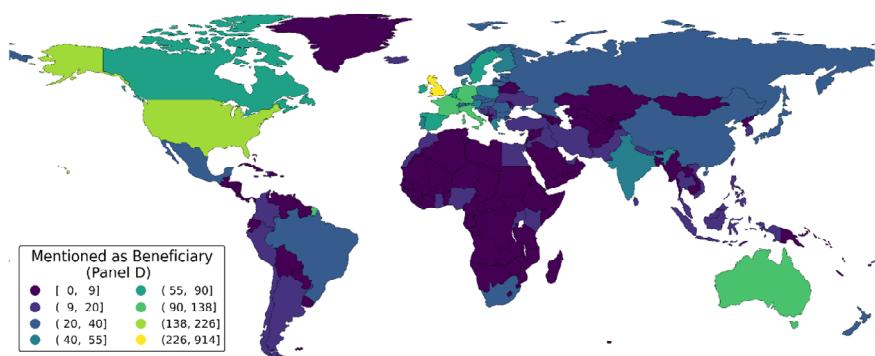
B.



C.



E.



**Figure 14.** The Geographic Distribution of SHAPE Beneficiaries

### 3.3 UKRI Funds Large Majority of Impact

The role of funders in the generation of Impact is both varied and storied, with funders heterogeneously championing the importance of impact in their application processes. UKRI, for example, offers several Impact Acceleration Accounts (IAAs) which provide strategic awards and funding to research organisations to use creatively for a wide range of impact-generating activities. Such IAAs embed pathways to impact as a criteria of funding in this period. The latest round brings together awards from five councils for a total budget of over £117 million over three years. Other funders, such as the European Research Council, traditionally did not focus on impact but rather more on scientific excellence and blue-skies high-risk research. Various interviewees also 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”*

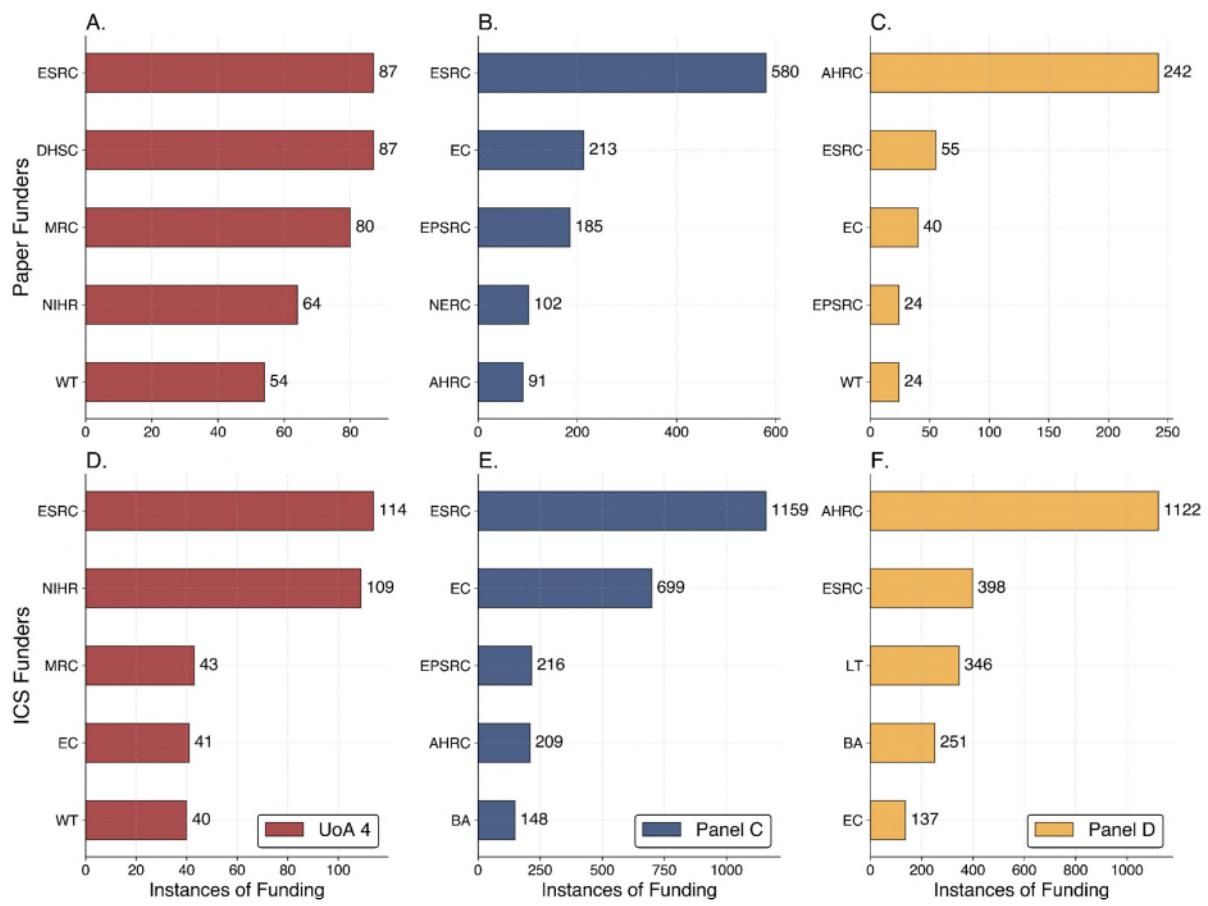
– Social Science Case Study Author

*“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 Science Panel Member

We use two complementary sources of data to isolate and analyse the main funders of this impact work. The first row of Figure 15 shows the five most prominent funders of the research which underpins ICSs across UoA 4 (first column), Panel C (second column), and Panel D (third column). The second row of Figure 15 pertains to funders listed in the raw REF2021 ICS database itself. Perhaps unsurprisingly, it is a combination of UKRI councils – the Economic and Social Research Council (ESRC), the Engineering and Physical Research Council (EPSRC), and the Arts and Humanities Research Council (AHRC) – which are the most prevalent funders of both the underpinning research and the impact generation itself. Other funders listed in Figure 15 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 analyse the funding landscape across the Grand Impact Areas, with a specific focus on the funders of the ICS themselves. Naturally, the ESRC and the AHRC are the most prevalent funders for Panel C and Panel D work respectively, but each are well cross-represented in their corresponding Panels.

Table 4 shows the twelve most prevalent named (unique) funders of ICSs across all ICSs, across UoA4, and across all four separate Panels. This shows the remarkable contribution that the ESRC and AHRC contribute to generating ‘impact’ not just within their representative Panels (C and D respectively), but also in Panels A and B. This is despite the fact that the ESRC received just 2.36%, and the AHRC just 1.26% of total ‘Core R&I Budgets’ from the UK Research and Innovation (UKRI, 2022). Yet, of the nine primary organisations in receipt of Core R&I budget, they produced 23.92% and 19.84% of all UKRI funded Impact Case Studies (for ESRC and AHRC respectively).



**Figure 15.** 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 4.** Percent ICS Funded Across Categories by Selected Organisations

	All	Panel A	Panel B	UoA4	Panel C	Panel D
ESRC	6.46	2.48	1.27	8.43	14.62	4.98
EPSRC	5.62	1.57	17.8	2.07	2.93	1.53
AHRC	5.36	0.26	0.37	0.64	3.6	23.25
EC	4.66	3.21	7.12	2.54	5.23	2.87
NIHR	3.53	9.86	1.2	10.81	1.2	0.29
Innovate UK	2.74	1.52	7.57	0.79	1.41	0.96
LT	2.54	0.64	1.46	2.07	2.48	7.13
BA	2.33	0.55	0.11	2.23	3.09	6.7
MRC	2.32	6.24	1.27	6.52	0.56	0.38
WT	2.16	4.23	1.35	4.93	0.61	2.58
NERC	1.94	1.57	4.2	0.48	1.6	0.29
BBSRC	1.57	3.7	1.87	1.11	0.24	0.05

### 3.4 Interdisciplinarity in Research

We next analyse aggregate-level interdisciplinarity. This was discussed by the majority of our interviewees, with a common acknowledgement of its importance:

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

– Social Science Panel Member

While there was indeed an ‘interdisciplinary’ flag for submitting institutions to tick, some interviewees noted that this did not work as optimally as might have been hoped, as indicated by one Humanities Panel Member:

*“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.”*

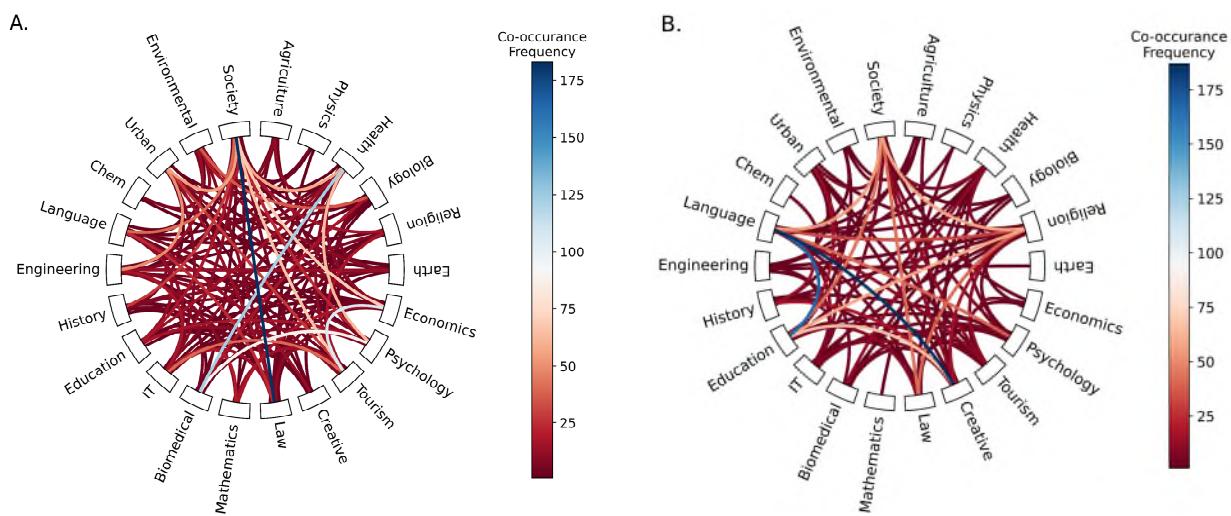
– Humanities Panel Member

This same observation was made by a REF2021 Panel Advisor (Kerridge 2022). The institutional structure of the REF Units of Assessment and most departments within Higher Education Institutions place an emphasis on discipline specificity, as opposed to interdisciplinarity. In order to measure interdisciplinarity and move beyond the widely critiqued ‘interdisciplinarity identifier’, we use a different approach.

Figure 16 showcases interdisciplinarity across the underpinning research using Dimensions data, and specifically the Australian and New Zealand Standard Research Classification (ANZSRC) scheme for understanding Fields of Research (FoRs). This analysis measures every co-occurrence of ‘Level 2’ FoRs. In this analysis, we combine UoA 4 and Panel C. We see a large amount of intuitive patterning, as interdisciplinarity happens most commonly between the most closely related fields. Primary occurrences of interdisciplinarity were:

- Social Sciences: ‘Human Society’ and ‘Law and Legal Studies’, and ‘Economics’ and ‘Commerce, Management, Tourism, and Services’.
- Arts and Humanities: ‘Language, Communication, and Culture’ and ‘Creative Arts and Writing’, and ‘Language, Communication, and Culture’ and ‘History, Heritage, and Archaeology’.

We also frequently see the occurrence of multiple FoRs that we might not *traditionally* expect SHAPE to be publishing in, let alone collaborating across. This includes Mathematics, Biomedical Science, and Information Technology. Indeed, for the Social Sciences, the second most commonly observed interdisciplinarity is between ‘Biomedical and Clinical Sciences’ and the ‘Health Sciences’ Field of Research.



**Figure 16.** Analysis of interdisciplinarity in underpinning research across SHAPE ICS

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 approach above. The results of this survey question were striking in the amount of variance observed across SHAPE-related UoAs. This 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 considered to be 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 social science and humanities, interdisciplinarity and coping with climate change:

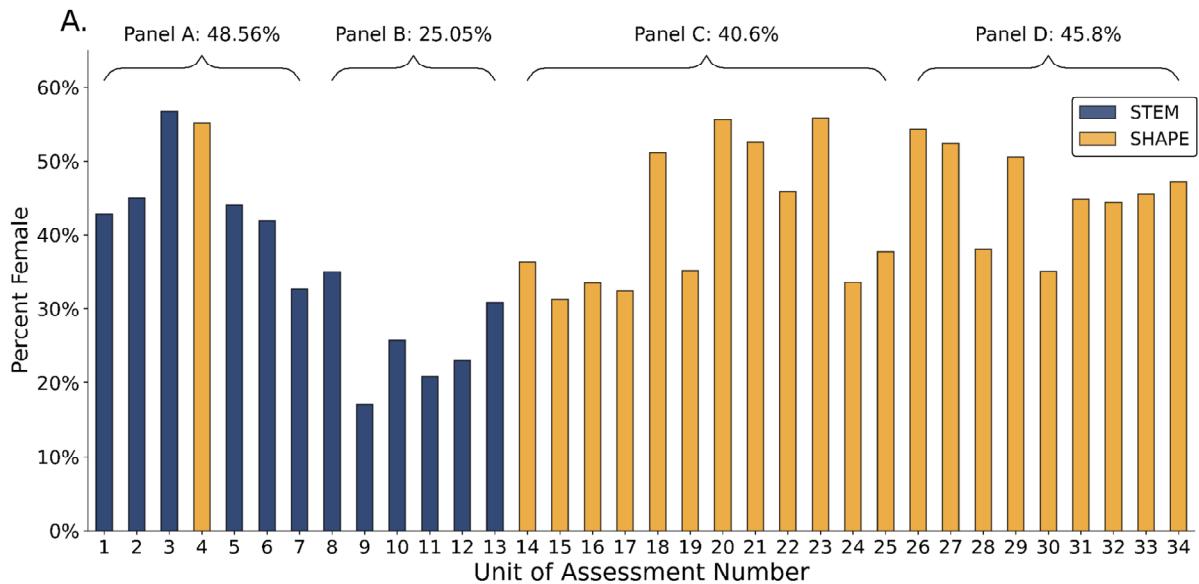
*“As a geophysicist, I've studied the earth if you like and go look at it, you know, with or without human beings...so the planetary process. But climate change is only important to society because it affects humans, right? So, the challenges that the world faces are societal challenges. So, social sciences 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 Gender Representation

Equality, Diversity, and Inclusion (EDI) is a vital aspect of research, with mounting pressure to measure and account for balance in EDI indicators. As mentioned previously, each REFid is associated with multiple types of information, and it is possible to clean the data to isolate DOIs (Digital Object Identifiers), ISBNs (International Standard Book Number), and titles of research which provide metadata-based information on not only the research, but also on the authors themselves. We have conducted previous analyses using author information from DOIs in genomics (Mills and Rahal 2019, 2020), population studies (Mills and Rahal 2021), and ESRC data-funded investments (Mills and Rahal 2018) to identify the estimated gender of authors with a reasonable level of accuracy. This approach allows us to examine gender imbalances in publications, and across Grand Impact Challenges as in Sections 2.1-2.10 above. An important caveat is that this inferred gender does not necessarily reflect an author's self-identified gender and can be prone to ethnic bias, as results are predicated on a probabilistic approach based on large caches of administrative data.

Figure 17 shows the fraction of female case study authors of the ICSs colour-coded according to whether the UoAs are in STEM or SHAPE subject categories. We see that Panel A (Medicine, Health, and Life Sciences) has the highest share of female authors (0.49), followed closely by Panel D (Arts and Humanities) (0.46) and Panel C (Social Sciences) (0.41). Panel B (Physical Sciences, Engineering, and Mathematics) contains the lowest share (0.25). We also see considerable variation across some of the UoAs. In Panel C, we observe a lower fraction of female authors (below 40%) in Geography and Environmental Studies (UoA 14), Archaeology (UoA 15), Economics and Econometrics (UoA 16, the lowest fraction of females of any SHAPE discipline), Business and Management Studies (UoA 17), Politics and International Studies (19) and Sport, Exercise Science, Leisure, and Tourism (UoA 24). Female authors are overrepresented (>50%) in Social Work and Social Policy (UoA 20), Education (UoA 23), Sociology (UoA 21), and Law (UoA 18).



**Figure 17.** Fraction of female to male authors of Impact of Case Studies by Panel, UoA, differentiated by STEM and SHAPE

The Art and Humanities Panel D has a much more uniform representation of gender balance and female ICS authors across the UoAs, with only Philosophy (UoA 30) and History (UoA 28) falling under or around 40% female authorship. Women are overrepresented only in Modern Languages and Linguistics (UoA 26), English Language and Literature (UoA 27), and Classics (UoA 29). 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

This is further reinforced through an analysis of first names of authors. In Panel C, none of the top ten most commonly observed forenames are traditionally female names. Yet, Sarah is the most commonly observed forename across all authors of work in Panel D.

## 4. Interactive REF2021 SHAPE of Impact Online Dashboard

### Main take-aways Impact Dashboard:

- Engages a broader audience through interactive narratives and data highlighting world-leading 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 augmented REF database and allows users to download it, including added value generated cleaned and new data through our analyses and results.

Our REF2021 dashboard 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 (Figure 18) 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. This snapshot (Figure 18) 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.



**Figure 18.** Current prototype of the REF2021 SHAPE of Impact Dashboard

The control panel on the left of the dashboard allows users to select a topic to update the results for only ICSs within that topic. The topics are as per our large language model which identified

83 distinct topics from ICS textual content (Figure 2), with assignment here of each ICS to one or more topics (via a topic probability slider).

The Topic Narrative panel contains a description of the topic along with a narrative providing compelling examples of ICSs in the topic. The topic descriptions provide a concise summary of the types of ICSs that are likely to be associated with the topic along with some of the keywords that the natural language processing algorithm used to identify the topic. This provides context for the quantitative results shown in other panels. The topic-specific narrative weaves a short story to bring the topic to life through particularly impactful examples of research. The Funder panel lists up to ten of the top funders cited by ICSs in the selected topic and the number of ICSs funded by each. This is intended to highlight differences in funding priorities among funders and to emphasise the number of ICSs that were unfunded, in which case we may reasonably expect these ICSs relied upon core funding from QR or other internal sources. The results may be filtered by funder by simply clicking a funder bar in the graphic. The UoA panel provides a count of ICSs in the selected topic that were evaluated under each unit of assessment (UoA). This breakdown by UoA gives insight into which disciplines are most active in and across research topics. The dropdown menu in the top-right of this panel allows you to show only UoAs within a specific Panel (e.g., Panel C or D; see Table 1).

The UK institution panel provides an interactive map of postcode areas within the United Kingdom, indicating the number of ICSs within the topic that were submitted from institutions in each postcode. Hovering over a postcode provides additional information, including a listing of the institutions that submitted ICSs from that postcode. Clicking a postcode will further filter the current results to only those submitted by institutions in the selected postcode. The Global Beneficiaries panel (bottom-right) is an interactive map that indicates the number of ICSs from the currently selected results that had beneficiaries in each country. Hovering over a country will display its name and the number of ICS listing it as a beneficiary. Clicking a country will further filter results to only ICSs with beneficiaries in that country.

In the bottom-left of the dashboard, 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. This includes the original columns from the REF database and also the added-value columns that we generated from bibliometric analyses, natural language processing, 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. Lastly, there is an option to generate a report in .pdf format based on the results currently displayed in the dashboard. This includes content from all of the panels for the currently selected results, and provides a convenient mechanism for users to save interesting results as they discover them while exploring the dashboard.

## 5. 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/Environment) disciplines*”. To answer this question, we leveraged the REF2021 corpus of data, with a focus on the Impact Case Studies, supplemented with other information such as the research environment and characteristics of the underpinning research.

Using the lens of this guiding question, we 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 our mixed-method approach that weaved narrative interviews with large language models, we provided both depth and systematic structure to categorise SHAPE impact. We came to several key conclusions that both reinforced our understanding and 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 **83 distinct but still interrelated topics**, which together comprise **ten Grand Impact Areas**. These are:

1. Arts, Performance and Design
2. History and Cultural Heritage
3. Education and Teaching
4. Business, Economics and Management
5. Employment
6. Crime and Exclusion
7. Family and Gender
8. Governance and Law
9. Health and Wellbeing
10. Sustainability and Infrastructure

Our analyses suggest that 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>3</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/PESTLE impact types (e.g., Health, Politics, and Economics), the existing categorisations do not sufficiently capture research-driven impact from the social sciences and humanities. It is an empirical question of whether this holds for all disciplines and Panels, which we explore elsewhere. For example, having one category of ‘Cultural’ misses the depth and breadth of the Humanities, which made up not only two central substantive themes, but has deep impact throughout many themes, from using music and drama therapy in health interventions to fostering community cohesion through language and artefacts.

‘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, from altering public understanding and attitudes towards hate speech and misinformation to transforming the thinking and operational aspects of entire local, national, and international institutions. Societal changes to institutions were innumerable, including changing NHS processes and practices to increase efficiency and lower costs, enhancing productivity across multiple industries, new net zero and green technology, changing workplaces to enhance employee wellbeing, bringing in new safeguarding protocols for vulnerable children, and transforming policing and the prison system. ‘Economic impact’ was likewise pervasive in almost every study, such as the discovery of a heritage site that injected tourism, regional levelling-up tools to create industrial and entrepreneurial hubs, macroeconomic models that transformed banking and financial systems, and new behavioural driven technologies that reduced energy consumption and costs.

‘Technology’ and technological innovation, product development, and business spin-outs took place across all of the themes, from digital programmes used in school classrooms to immersive museum VR experiences and products used by professional athletes. ‘Legal’ impact pervaded many ICSs across all themes, with research leading to many concrete and traceable changes in legislation, regulations, and policies, from local government councils to 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

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<sup>3</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).

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

As noted above, impact went well beyond the original question that asked how research influenced people, the economy, policy, and society. Rather, it had vast cultural, political, health-related, legal, scientific, technological, and environmental impacts. SHAPE drives preconceived expectations of impact in the arts, design, and curation and exhibition spaces, and transforms education and skills, the economy and business, and the labour market. It has also driven improvements in policing, crime and detention, transformed interventions to help families, children and social care, and impacted the very laws and governance of our societies. It has driven regional development and regeneration in previously deprived areas, and shone a light on legacies of historic slavery and their link to modern slavery.

Another striking finding of our analysis is that *SHAPE impact unequivocally reaches far beyond any preconceived boundaries and beyond the social, economic, and cultural*. The impact of SHAPE research has transformed health and medical science as well as environmental, sustainability, biodiversity, and climate change research, which made up two central and very large themes across the ICSs. Research has driven pivotal interventions, policy changes, and technological developments in health, medical science, and efforts towards net-zero and more sustainable environments. These ICSs have revealed multiple industrial and business applications, and spin-outs emanating from SHAPE research, ranging from educational software to Netflix translations and behavioural or performance art-driven clinical therapies.

SHAPE research is also highly multi- and interdisciplinary, most often occurring between related fields, with the social sciences particularly interacting with health and biomedical fields of research. Underpinning research driving SHAPE impact was also frequently published in mathematics, biomedical science, and information technology.

**Beneficiaries of research were concentrated in the UK, but also spanned a global geographical context.**

Great Britain was the most prominent beneficiary in the Humanities (Panel D, 47.58% of listed beneficiaries), Social Sciences (Panel C, 40.97%) and Psychology (UoA 4, 40.94%). SHAPE ICSs have more impact for beneficiaries in the UK, Western Europe, the United States, and Australia. International impact is also concentrated in certain areas on the Asian Content (China, India, Russia), and in South America (Brazil, Colombia), with the least in the African continent and the Middle East (with those most commonly reported being South Africa, Kenya, and Turkey). Geographical distribution of impact varies considerably by substantive research area.

**Core funders fuel SHAPE research and impact.** Different funders emerge as prominent supporters of the research driving impact, with funders varying by grand theme. Funders differ substantially in the amount allocated to spend on research funding in their overall portfolio, with some comparatively smaller UKRI councils (ESRC, AHRC) emerging as core drivers of SHAPE impact. The funders listed for ICS funded research are:

- Social Sciences (Panel C): 40.6% ESRC, 24.5% European Commission, 7.5% EPSRC, 7.3% AHRC, 5.2% BA, and 5.1% Leverhulme Trust.
- Humanities (Panel D): 48.2% AHRC, 17.1% ESRC, 14.9% Leverhulme Trust, 10.8% British Academy, and 5.9% European Commission.
- Psychology (UoA 4): 26.4% ESRC, 25.2% NIHR, 10% MRC, 9.5% European Commission, 9.3% WT, 7.4% British Academy, and 6.9% Leverhulme Trust.

**Gender representation differs across research and impact area.** Examining the authors of the research underpinning impact, the share of female authors differs quite substantially across (and within) panels:

- Panel A (Medicine, Health and Life Sciences): 49%
- Panel D (Arts and Humanities): 46%
- Panel C (Social Sciences): 41%
- Panel B (Physical Sciences, Engineering and Mathematics): 25%

This, however, masks considerable differences within panels, with a lower fraction of female authors (below 40%) in Panel C in Geography and Environmental Studies (UoA 14), Archaeology (UoA 15), Economics and Econometrics (UoA 16, the lowest fraction of females of any SHAPE discipline), Business and Management Studies (UoA 17), Politics and International Studies (UoA 19), and Sport, Exercise Science, Leisure and Tourism (UoA 24). Men are under-represented (<50%) in Social Work and Social Policy (UoA 20), Education (UoA 23), Sociology (UoA 21), and Law (UoA 18).

## 5.2 Strengths and Limitations of this approach

By virtue of our approach, we made several unique contributions to the existing work in this area. First, our mixed-method approach afforded us systematic results that were also accompanied by the depth, reflection and scrutiny from narrative interviews of experts in the area with lived experience of evaluating or producing impact cases for REF2021. Second, 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. Third, we engaged in the extensive cleaning of the REF2021 dataset and made it available for others for further analysis and/or replication. Fourth, we supplemented and enriched the existing REF2021 data corpus by layering on scientometric data from Dimensions. This has allowed us to produce accompanying information about the research underpinning the REF, such as gender of authors, interdisciplinarity, and Altmetric and citation scores. Finally, we allow users to further experience and explore the data via the interactive dashboard that accompanies this report ([shape-impact.co.uk](http://shape-impact.co.uk)), bringing together quantitative and qualitative elements of this analysis, including a searchable topic option, division of ICSs by topic clusters, top funders of each topic, their UoAs, and geographical impact in the UK and globally.

There are limitations to our approach which need to be taken into account when interpreting the data. First, given that we only examine research and impact emanating from the REF2021

exercise, we analyse a specific selection and sample of both research and impact. 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. This relates to research that argues that the REF forces a narrowing of the scope of academic inquiry or is an exercise that reaffirms pre-existing rankings (Berg et al. 2016; Lee et al. 2013; Watermeyer & Derrick 2022), and may increase funding disparities across UK Universities (Pinar & Unlu, 2020). A second related note is that there was an unevenness in the types of impact submitted. Large UoAs submitted more, with Business and Management Studies (UoA 17) submitting the largest number of ICSs (N=504) of all, making up 7.9% of all SHAPE ICSs analysed in this report and 23.5% of Panel C (Social Sciences). This balance in turn impacts the topics and themes that emerged from this analysis.

Second, although we included the ‘human in the loop’ approach to assess the categorisation of our ICSs into larger themes and subtopics, we recognise that some case studies or case study groupings do not easily 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 uniform and transparent approach to position them to the topic with highest probability match, with extensive manual review. In many cases, ICS 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 REF exercise, which falls out of the scope of this review (e.g., Arnold et al. 2018; Bornmann et al., 2019; Pinar & Horne, 2022; Pinar & Unlu, 2020; Reichard et al., 2020; Thorpe et al., 2018; Watermayer & Derrick 2022). We note that despite discussion and scrutiny, the REF has offered SHAPE researchers a platform to show and present the incredible impact of their research.

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## 7. Appendix

### 7.1 Acknowledgements, contributions, ethics, data and code availability

#### Leverhulme Centre for Demographic Science

LCDS is an interdisciplinary research centre funded by the Leverhulme Trust and directed by Professor Melinda Mills which aims to disrupt and realign how we measure and model populations, by infusing new types of data, methods and unconventional approaches to tackle the most challenging demographic problems of our time. LCDS is embedded within Nuffield College and Oxford Population Health (Nuffield Department of Population Health) at the University of Oxford, which contains world-renowned population health research groups and is an excellent environment for multi-disciplinary teaching and research. LCDS brings together multiple departments and disciplines from demography, population health, statistics, epidemiology, molecular genetics, economics, statistics, biology, zoology, history, sociology, marketing, and business.

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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, with input from 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. 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 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 GitHub ([https://github.com/OxfordDemSci/ICS\\_Analysis](https://github.com/OxfordDemSci/ICS_Analysis)) and latterly via Zenodo.

**Safeguarding Confidentiality and oath REF Panel Members.** This work has been approved by the Departmental Research Committee (DREC) at the 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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## **7.2 List of Acronyms**

AcSS	Academy of Social Sciences
AHRC	Arts and Humanities Research Council
API	Application Programming Interface
BA	British Academy
BERT	Bidirectional Encoder Representations from Transformers
DHSC	Department of Health and Social Care
DOI	Digital Object Identifier
EC	European Commission
EDI	Equality, Diversity and Inclusion
EPSRC	Engineering & Physical Sciences Council
ESRC	Economic and Social Research Council
FTE	Full-time equivalent. Used as an alternative to headcount to indicate the actual volume of activity.
GCRC	Global Challenges Research Fund
HEI	Higher Education Institution
HESA	Higher Education Statistics Agency
ICS	Impact Case Studies
ISO3	International Organisation for Standardisation country codes
IT	Information Technology
LT	Leverhulme Trust
ML	Machine Learning
MRC	Medical Research Council
NERC	Natural Environment Research Council
NIHR	National Institute for Health and Care Research
NLP	Natural Language Processing
NGO	Non-governmental organisation
NUTS3	Nomenclature of Territorial Units (3 small regions)
ORCID	Open Researcher and Contributor Identifier
PRFS	performance-based research funding system
REF	Research Excellence Framework
REF2021	Research Excellence Framework evaluation in 2021
RES	Research Selectivity Exercise
SHAPE	Social Sciences, Humanities and the Arts for People and the Economy/Environment
STEM	Science, Technology, Engineering and Mathematics
UKPRN	UK Provider Reference Numbers
UKRI	UK Research and Innovation
UOA	Unit of Assessment (in REF2021)
WT	Wellcome Trust

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**Table S1.** SHAPE Impact Clusters sorted by main and sub-topic clusters

Main Impact Cluster (human in the loop cluster)	Sub-topic 2 (BERT cluster number)
<b>1. Arts, Performance and Design (Arts)</b>	3. Music and Acoustics (Music) 20. Performance for Health and Society (Performance) 36. Theatre (Theatre) 40. Therapeutic Art for Ageing and Disorders (Art Therapy) 46. Language, Poetry and Translation (Language) 57. Digital Content, Animation, Immersive Technology and Virtual Reality (Digital Content) 60. Art and Performance for Heritage and Community (Cultural Capital) 66. Textile, Fashion and Design (Fashion & Design) 76. Literature, Authors and Libraries (Literature) 80. Comics, Cartoons, Animation and Illustration (Illustration)
<b>2. History and Cultural Heritage (Heritage)</b>	10. Archives, Heritage, Exhibits, Conservation and Cultural Preservation (Heritage & Archives) 11. Film, Cinema and Documentation (Film & Documentation) 12. Art and History in Museums and Curation (Art & Curation) 23. Archaeology, Heritage and Historical Places (Archaeology & Heritage) 27. Military History and Commemoration (Military History) 30. Participatory Art, Audience Engagement and Local Communities (Art & Engagement) 31. Holocaust, Jewish History and WWII (Jewish & WWII History) 35. Religion, Theology and Ethics (Religion & Ethics) 59. Cultural Property Protection, Safeguarding Heritage and Endangered Cultures (Safeguarding Heritage) 68. Co-Production Heritage, Oral Histories and Remembrance (Heritage Co-production) 77. Forensics and Historic Crime (Forensics)
<b>3. Education and Teaching (Education)</b>	7. Teaching, Training and Education Policy (Teaching) 9. Language, Linguistics and Culture (Language) 29. Educational Access, Equity, Social Mobility and Educational Policy (Inequality & Education) 50. Gaelic Acquisition and Preservation (Gaelic Preservation) 52. Literacy, Reading and Dyslexia (Literacy)
<b>4. Business, Economics and Management (Economy)</b>	2. Business, Entrepreneurialism and Management (Business & Entrepreneurialism) 22. Macroeconomics, Monetary Policy, Financial Markets and Banking (Macro & Finance) 56. Consumer Protection and Market Regulation (Consumer Protection) 65. Development, Sustainability and Anticorruption (Development)
<b>5. Employment (Employment)</b>	13. Employment Conditions (Employment Conditions)

	16. Market Regulation, Taxation and Benefit Schemes (Economic Regulation) 25. Integrating and Supporting Disabilities (Disability)
<b>6. Crime and Exclusion (Crime)</b>	1. Violent Crime and Incarceration (Crime & Justice) 39. Hate Crime and Hate Speech (Hate Crime) 48. International Crime, Rights and Torture Prevention (International Crime & Rights) 70. Substance Abuse Interventions and Policy and Alcohol Harms (Substance Abuse)
<b>7. Family and Gender (Family)</b>	4. Care, Support, Family and Children (Family & Care) 15. Safeguarding Children, Women and Sexual Health (Women & Child Wellbeing) 18. Feminism, Women's Histories and Gender Representation (Gender & Feminism) 42. Reproductive Rights and Care (Reproductive Rights) 54. Gender Equality at Work and Stereotyping (Gender in the Workplace) 58. Sexualities and LGBT+ Communities (Gender in the Workplace) 81. Female-Centred Development, Global Equality and Sexual Health (Gender & Equality)
<b>8. Governance and Law (Governance)</b>	14. Brexit, Trade, Tariffs, Constitution, Political Parties and Ethics Legislation (Politics & Brexit) 17. Conflict History, Islamophobia, Islamic Communities, Terrorism and Cultural Understanding (Conflict History & Islamophobia) 19. Colonialism, Slavery, Cultural Memory and Marginalised Identity (Colonialism & Slavery) 21. War, Political Violence, Peacekeeping and Humanity (Political Violence) 24. Surveillance, Privacy, Personal Data, AI and Information Transparency (Privacy & Data) 28. News, Media Literacy, Misinformation, Propaganda, Impartiality and Journalism (Information Media) 33. Immigration, Refugees, Asylum, Sex Work and Vulnerable Communities (Vulnerable Communities) 37. Migrant Rights, Integration, Migrant Policy and Legislation (Migrant Support) 38. Government Process and Representation (Government & Representation) 43. Northern Irish Studies (Northern Ireland) 45. Human Rights, Environmental Justice, Indigenous Rights and International Law (Human Rights & Environmental Justice) 63. Finance, Cybersecurity, Digital Government and Online Safeguarding (Financial & Cybersecurity) 64. Electoral Integrity, Voter Experience, Polling and Representation (Fair Elections) 78. Representing Marginalised Communities (Marginalised Communities)

<b>9. Health and Wellbeing (Health)</b>	0. Sport, Exercise, Nutrition, Coaching, Athlete Performance and Wellbeing (Sport & Health) 6. Healthcare Efficiency and Preventative Care (Healthcare Efficiency) 32. Detection, Diagnosis and Treatment (Diagnosis & Treatment) 34. Neurodiversity, Diagnosis and Support (Neurodiversity) 44. Psychological Health, Wellbeing, Diagnosis and Management (Psychological Health) 47. Healthcare Policy, Interventions, Data and Ethics (Healthcare Policy) 49. Diet, Nutrition, Food Marketing and Food Insecurity (Diet & Nutrition) 53. Pharmaceutical Research, Ethics, Treatment and Cost-Effectiveness (Pharmaceutical Research) 55. Cardiovascular Disease, Cystic Fibrosis, Care and Treatment (Cardiovascular Disease & Cystic Fibrosis) 67. Mental Health Support and Training (Mental Health) 69. Social and Health Care Funding and Social Prescribing (Healthcare Funding) 70. Infectious Diseases, Low-Resource Settings and Global Contexts (Infectious Diseases & Global Health) 71. Mental Health, Social Media, Eating Disorders and Body Image (Body image & Media) 73. PTSD, Suicide, Self-Harm, Diagnosis and Prevention (Mental Trauma)
<b>10. Sustainability and Infrastructure (Environment)</b>	5. Conservation Ecology and Natural Resource Management (Conservation) 8. Housing: Building and Policy (Housing) 26. Energy Transition, Renewables, Decarbonisation and Energy Policy (Renewable Energy) 41. Sustainability in Agriculture, Production and Resource Management (Sustainability) 51. Natural Hazard Management (Disaster Management) 61. Food Production, Distribution and Security (Food) 62. Urban Planning and Mobility (Urban Planning) 72. Housing Innovations, Energy Efficiency, Ventilation and Utilities (Housing Energy) 74. Climate Change Mitigation, Policy and Public Discourse (Climate Change) 82. Road and Workplace Safety (Infrastructure Safety)