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The SHAPE of Impact

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04 September 2023

Leverhulme Centre for Demographic Science

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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) 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 by the same Panel.

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Preface

The British Academy and the Academy of Social Sciences commissioned LCDS researchers to examine and uncover “*the stories, successes and cumulative effects 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 access 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 (REF) 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 REF 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 that combines in-depth narrative interviews ($N=48$) to reveal the stories and successes of the impact of research as well as a questionnaire to SHAPE panel members ($N=263$) with the most advanced machine learning models for Natural Language Processing (NLP) to identify key topical clusters of SHAPE impact. We focus on ICS 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. 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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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.
GCRF	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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Executive Summary

The **overarching question** commissioned for this report asked:

'What are 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?'

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.

SHAPe impact comprises 10 Grand Impact themes that emerged from 83 distinct topic clusters uncovered by generative artificial intelligence across the SHAPE disciplines within REF2021 Impact Case Studies:

1. The Arts and Design
2. Archaeology and Exhibits
3. Education and Teaching
4. Business, Economics and Management
5. Employment
6. Crime and Exclusion
7. Family and Gender
8. Governments and Law
9. Health and Wellbeing
10. Sustainability and Infrastructure

SHAPe impact occurs beyond preconceived boundaries. Impact was not only in cultural, societal and economic domains, but research penetrated virtually all scientific disciplines, with deep technological, industrial, health and environmental impact. Diverse types of impact ranged from developing new technologies and spin-outs, to changing policies, legislation, international regulations, reviving regional and local economies to changing public perceptions, and changing behaviour to build community wellbeing or reduce energy costs.

SHAPe research and impact highly interdisciplinary. A scientometric analysis of the underlying research power impact revealed was highly interdisciplinary in nature, occurring most often in closely related fields.

The largest interdisciplinary pairings in SHAPE disciplines was between 'Health' and 'Biomedical' Fields of Research. This was for:

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

We frequently found underpinning research for SHAPE impact in: Mathematics, Biomedical Science, and Information Technology. For the Social Sciences, the second most commonly observed interdisciplinarity is between 'Biomedical And Clinical Sciences' and the 'Health Sciences' Field of Research.

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), 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 substantially 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. The funders listed for ICS funded research are:

- Social Sciences (Panel D): 40.6% ESRC, 24.5% European Commission, 7.5% EPSRC, 7.3% AHRC, 5.2% BA and 5.1% Leverhulme Trust
- Humanities (Panel C): 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

A caveat is that funders differ substantially in the amount allocated in their overall portfolio spend on research funding, with some comparatively smaller funders emerging as core drivers of SHAPE impact.

Gender representation differs across research and impact area. Examining the authors of the research underpinning impact, the share of female authors differs by panel:

- Panel A (medicine, health and life sciences) (0.49)
- Panel D (arts and humanities) (0.46)
- Panel C (social sciences) (0.41)
- Panel B (Physical sciences, engineering and mathematics) (0.25)

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 (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).

Uneven balance of ICSs: Large Unit of Assessment's (UoA) 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.

Interactive Data Dashboard accompanies this report (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 UoA and geographical impact in the UK and globally.

Limitations and caveats. This report only examines ICS 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 LCDS researchers 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 on which the higher education sector and policymakers can access to articulate the value of research and its impact on society in the UK and around the world. The report aims to serve as a starting point for the SHAPE community to explore the scope and reach of the evidence base.

Using the REF2021 ICS textual corpus as a basis and supplementing it with environmental, research quality, 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 interdisciplinarity, 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, mixed-method approach that is fully reproducible.¹ 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, combined with hierarchical analysis and ‘human in the loop’ categorization (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 Impact Case Studies submitted within

¹ 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.

SHAPE disciplines, in ‘Panel C’ (Social Sciences, N=2,146), 1,528 in ‘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). Given the focus of our research questions and direction that the steering committee advised for the current report, we do not focus in depth on reflections of the meaning of impact or critiques from the qualitative interviews and surveys. These will be explored in future forthcoming publications.

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 outlined 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 percent of a UoA’s total REF score per unique sets of each institution’s Unit of Assessment 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](#)).

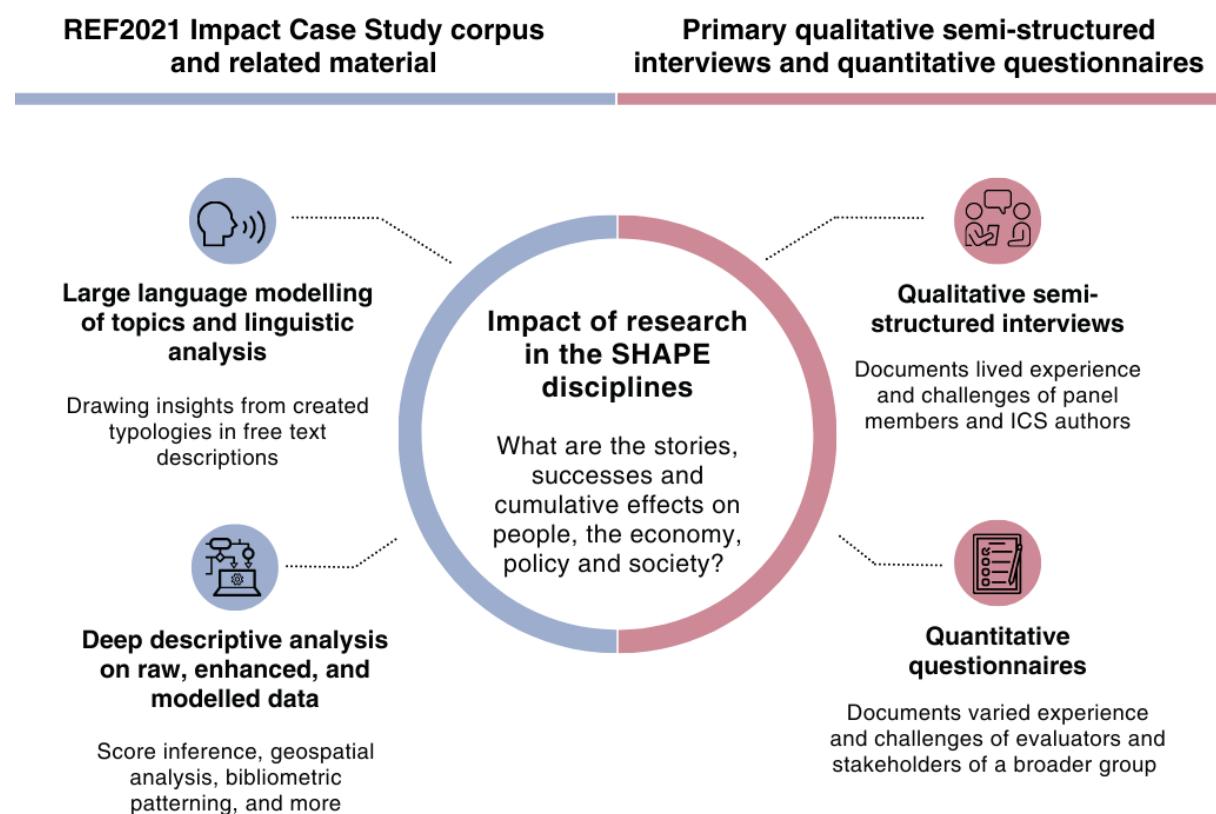
Panels of academic peer reviewers and research users evaluate each case study, giving it a qualitative assessment from unclassified and then between 1* to 4* (Greenhalgh et al., 2016; Reichard et al., 2020). Case studies in 2014 with ongoing and longer term impact only counted as being a ‘continuing’ body of work if it used the same body of work and would be evaluated as free-standing work (REF2021, 2022). Whereas 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 generative AI (artificial intelligence) 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 ICS. For each ICS

study, BERTopic calculated the probability of belonging to each identified topic, and we then assigned the ICS to the topic with the highest probability. We set thresholds such that every ICS belongs to one singular topic. We note that due to interdisciplinarity and innovation of the ICSs, some spanned across multiple topics, but for the purposes of this report, we assign them to the topic with the single highest probability.

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 reasonableness of topics suggested by the algorithm. Our model uses three nearest neighbours, and assigns ICS into topics as long as their singular maximal probability is above 0.01. This results in 179 topics being allocated into a residual, unmappable topic: a reasonable result given that they might either be a singular or one of a small number of ICS working in a substantially more niche area. Once we had verified the integrity of the topics, we used a combination of expert domain knowledge and a computationally determined and hierarchical ordered dendrogram to group the 83 topics into 41 higher level smaller categories. For example, four individual sub-topics – Acoustics, Arts for Health, Shakespeare, and Cultural Capital – group together into the larger Culture/Art hierarchy. These 41 hierarchical groupings were then grouped into ten broad high-level ‘grand impact areas’.

The cumulative weights for all 83 topics and Units of Assessment – along with how these topics fit within the clusters of the ten grand impact themes – is shown in Figure 2. The figure plots all 83 topics (x-axis by UoA (y-axis) according to their average weight. Each small square within the heatmap represents the average weight of the relationship between the 83 topics with a particular UoA. The average weight ranges from 0 – represented by dark blue – to around 0.5 (dark red). These are further sorted by the ten grand themes, which are shown along the braces at the top of the graphic. Table 1 shows descriptive statistics of all Units of Assessments (UoAs) to which ICS submissions can be made, along with the distribution of key properties amongst them. The names of the UoAs pertaining to the y-axis of Figure 2 are shown in Table 1, and the names of the 83 topics, sorted into the ten grand themes, are in Table 2 (see Appendix at end of document). As an example of how to interpret this graphic, consider the first listed topic 3 (bottom left hand corner of graphic): Language, Linguistics and Culture. 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. Looking at the graphic as a whole and focussing on the first large theme of The Arts and Design we see that there is a high overall concentration within the aforementioned UoA 33, but also UoA 27 (English Language and Literature), UoA 31 (Theology and Religious Studies), UoA 32 (Art and Design: History, Practice and Theory) and even – perhaps surprisingly – UoA 25 (Area Studies) and UoA 36 (Social Work and Social Policy). We use these ten clustered grand impact areas described in detail in Section 2, 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 ICS each of the Social Science, Humanities, and then aggregated levels, and Section 4 describes our interactive online dashboard and Section 5 concludes.

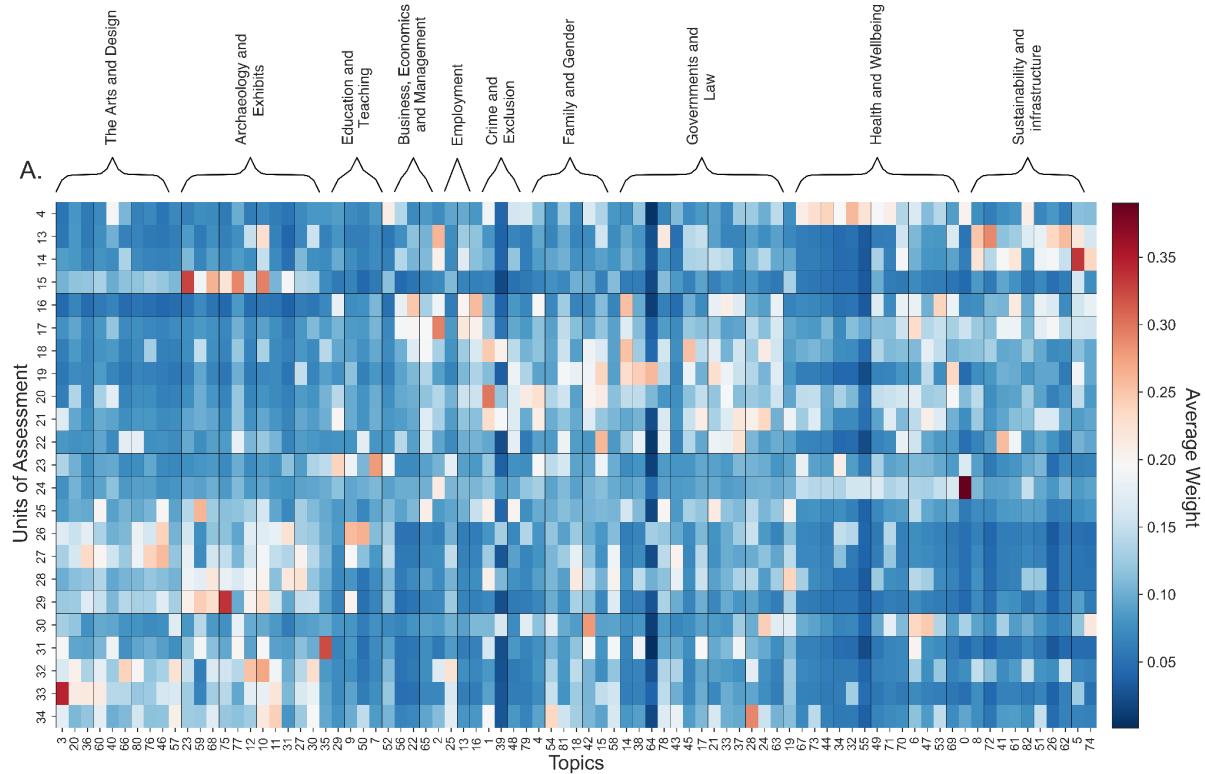


Figure 2. Visualising the Distribution of Topic Weights Across UoAs and Grand Impact Areas

Table 1. Distribution of Key Environmental Statistics Across UoAs

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

D	31	Theology and Religious Studies	68	1.07	505	1723	0.06
D	32	Art and Design: History, Practice and Theory	262	4.12	2566	2937	0.24
D	33	Music, Drama, Dance, Performing Arts, Film and Screen Studies	196	3.08	1375	2200	0.08
D	34	Communication, Cultural and Media Studies, Library and Information Management	145	2.28	1258	1579	0.09

2. 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, and then provide Cluster by Cluster based examples of impact via ‘deep dives’ into selected ICS. 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 3 summarises the key descriptors of each of the ten themes, breaking it 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 4 provides the key facts for the underlying research, emanating from our analysis of the dimensions database, that drives each of the ICSs by the ten themes showing 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. The Altmetric Attention Score provides a composite, weighted measure of how much attention an individual article has achieved. The citation count is a measure of the number of citations discovered within a large bibliometric database (Dimensions). The RCR is a citation-based measure of scientific influence of a publication, comparing an individual output with the median output in that field. We highlight key aspects from these tables within the themes that we describe in this section.

Table 3. Key facts impact by 10 grand themes [WILL THINK OF WAY TO FORMAT THIS BETTER OR GRAPH!]

Theme	N ICSs		Prominent UoAs			Main Concepts	Geographical impact		Main funders	
			Uo A	Name UoA	N		Location	N	Funder	%
1. The Arts & Design	401	33	ADD	13 2	32.9 1	“century”, “history”, “scholars”, “book”, “culture”	Great Britain	250	AHRC	32.1 7
2. Archaeology, Exhibits & Galleries	640	32		12 8	20	“history”, “culture”, “century”, “war”, “identity”	Great Britain	388	AHRC	32.5 0
3. Education, Teaching, Skills	243	23		11 2	46.0 9	“education”, “schools”, “students”, “language”, “teachers”	Great Britain	162	ESRC	23.4 6
4. Business, Economics and Management	159	17		15 9	62.3 5	“development”, “business”, “organization”, “implications”, “innovation”	Great Britain	141	ESRC	26.6 7

		13		13	5.1		International	13		
							European	5		
5. Employment	210	17		79	37.6 2	“people”, “countries”, “development”, “organization”, “workers”	Great Britain	125	ESRC	28.5 7
		16		19	9.05		Ireland	31	AHRC	10
		32		19	9.02		International	8		
							European	5		
6.Crime & Exclusion	282	18		71	25.1 8	“crime”, “law”, “development”, “people”, “England”	Great Britain	170	ESRC	23.0 5
		20		68	24.1 1		Ireland	21	BA	5.67
		4		34	12.0 6		International	10		
							European	3		
7.Family & gender	294	20		41	13.9 5	children”, “women”, “education”, “England”, “development”	Great Britain	166	ESRC	22.7 9
		28		29	9.86		Germany	35	AHRC	14.2 9
		23		27	9.18		International	155		
							European			
8. Governments & law	538	19		84	16.6 1	“government”, “development”, “politics”, “countries”, “law”	Great Britain	306	ESRC	28.6 2
		18		72	13.3 8		Germany	60	AHRC	18.4 0
		28		61	11.3 4		International	36		
							European	9		

9. Health & Wellbeing	562	4		17 3	30.7 8	“outcomes”, “patients”, “people”, “health”, “children”	Great Britain	330	NIHR	15.6 6
		17		68	12.1 0		USA	86	ESRC	11.9 2
		20		29	5.16		International	47		
							European	21		
10. Sustainability & Infrastructure	396	14		11 4	28.7 9	“development”, “area”, “community”, “environment”, “implications”	Great Britain	250	ESRC	20.7 1
		17		72	18.1 8		Netherlands	44	EPRC	15.9 1
		13		71	17.9 3		International	28		
							European	19		

Table 4. Key facts underpinning research by 10 grand themes

Theme	Gender	Publication type		Highest Altmetric Score	Citations	
	% female	Article %	Book chapter %		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.Governments & 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

2.1 The Arts 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 within this theme are summarised in Figure 3c, ranging from impact emanating from the arts, literature, fashion, dance and immersive virtual reality (VR). Within the broader Arts and Culture topic clustering, topics of *music, acoustics and sound innovation* emerged, with music and acoustic-based research sounding out of University corridors to reach large local and international audiences. Music-based projects preserved, rediscovered, and re-interpreted

music traditions, ranging from classical composers, ancient church music, to traditional music (e.g. Mali, Cuba). Technological advances were rife, such as new machine-learning based musical composition software, audio design for commercially successful racing video games and building of soundscapes for museums and heritage sites. Education and broadening engagement formed another backbone of this music topic, 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, ticketing and on-site software applications for festival goers. Although impact flourished, the performing arts experienced significant COVID-19 related impacts, 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 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.

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 3 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 1 million viewers and around 376,000 UK pupils in secondary education.

Bringing Visual and Digital Technology to Modern Dance: Modern visual technologies, allowed dancers to interact with animated 3D counterparts, integrated into acclaimed performances of modern dance and ballet companies with performances and their screenings reaching 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 used to attract over 1 million GBP in investment including contracts with HBO and Microsoft.

The world's largest archive of TV broadcasts: Considerable recent historical heritage is stored in television programs, with a 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 a micro-knitting that produced a much lighter knitted metal mesh reflector for satellite technology. The product has been adapted by aerospace company Oxford Space Systems.

Another striking component within the Arts and Design theme was *theatrical heritage and particularly Shakespeare*. Theatre research exited the stage and entered into classrooms and educational settings, with new techniques designed to make theatre more inclusive and highlight the role of different communities. This 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. *Cultural capital and art for communities* flourished through participatory art performances to raise awareness (e.g., environment, discrimination), as did engagement with the elderly (e.g., Care Home as Cinematic Community), young people (e.g., theatre aimed at young audiences), raising awareness of marginalised groups (e.g., deepening public understanding of migrants and

refugees). *Arts for health and therapy* thrived in diverse forms such (e.g., music, play for therapeutic purposes) to develop novel interventions and assist people with dementia, autism or maternity training and coping.

Literature and poetry was another core sub-topic in this theme, which engaged the public in performances and events, rediscovered voices of past artists or marginalised communities, and provided forums to perform, read and celebrate the diverse language traditions of the British nations. Impact enhanced education to promote reading, influenced library policies and raised awareness about important British writers and literary traditions. *Fashion and design* celebrated the history of fashion, but also developed fashion and materials that were more environmentally friendly and led to cutting edge textile design research that resulted in new technologies.

Finally, VR, *digital content creation and immersive technologies* abounded from the use of immersive technologies for simulating classroom environments, creating health-based therapies and training to the 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 multidisciplinary creative arts, health and education sectors. Impact in the Arts and Design theme revealed a diverse range of research impact that ranged from public engagement and cohesion to therapeutic interventions, preservation, performance, educational tools, and multiple 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

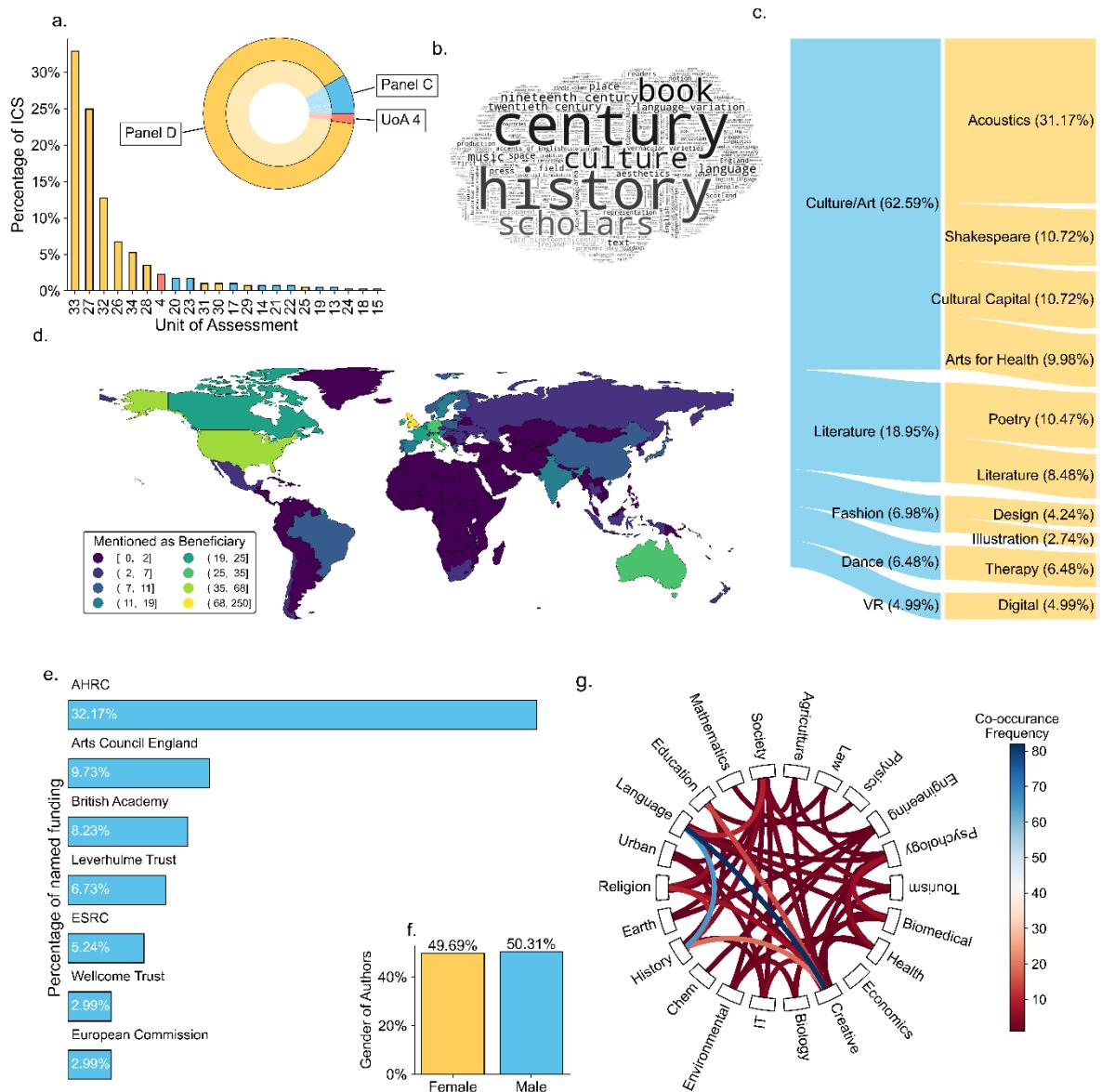


Figure 3. Main Characteristics 'Topic 1: The Arts and Design'

Case Study Examples

Case Study 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 – who is 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. Here she worked with professional performers who interpreted students' experiences of care, first performing in the simulated hospital ward with audiences in the bed.

"It gave them 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 included performances, practical workshops, or remote resources into their training programs. 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." 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 on how to use artistic performance to develop educational resources and experiences for medical students in her new role at King's College.

Using Virtual Reality for the Benefit of Patients and Medical Practitioners

NOTE: There will be a second case study to added top show how work with digital technology also enhances care and therapeutics added in here. It is based on the case study "Using Virtual Reality for the Benefit of Patients and Medical Practitioners" from Sheffield Hallam University <https://results2021.ref.ac.uk/impact/96a05b73-2093-4289-88e5-62ab12296583?page=2>

Distinguishing Facts of The Arts and Design theme:

In addition to the visualisation of this topic, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research. Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- **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 equality achieved in underpinning research:** Across the underpinning research used to drive this impact, 49.69% of the authors of the underpinning research are female, which makes it one of the most gender equal impact themes.
- ❖ **Interdisciplinarity largely within the Humanities:** Interdisciplinarity is classified according to ANZSRC (Australian and New Zealand Standard Research Classification).² The most commonly occurring interdisciplinarity linkage in the underpinning research are between: ‘Language, Communication And Culture’, ‘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 Altmetric scores of 1653.
- ❖ The highest Altmetric score within this cluster was 1653, the highest citation count was 733, and the highest relative citation ratio was 31, which was the second highest after the Health and Wellbeing theme (75).

2.2 Archaeology and Exhibits

“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, heritage sector and the creative industries.

² 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).

Examples of Impact

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

Attributing important historical paintings: The correct attribution of important often newly discovered historical artworks, including Caravaggio, Da Vinci and Parmigianino paintings by art history scholars had considerable economic impact on the art market. Caravaggio's Judith Beheading Holofernes achieved a market sale 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.

Helping protect the world's cultural heritage: Researchers digitized 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, but also led researchers to develop community initiatives among them the first volunteer-run sporting heritage museum in Exeter, giving Exeter City Fans a space to commemorate their clubs' 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 Fitzwilliams 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 fueled by UK university research ignited public curiosity, inspiring them to walk along the Silk Roads of central Asia, explore British tattoo art, reminisce with photos of coastal communities and support the preservation of multiple castles and heritage sites. Impact in this theme has focussed on increasing public understanding, building local identity and engagement as well as commemorating and remembering the past through exhibits and events around historical events, all with the effect of revitalising important heritage sites and fostering public engagement with archeological findings. A humanities panel member remarked that the REF 2021 case studies brought out the: "*potentially vital role for rebooting the heritage sector*". Commemoration and educational work around important military events and education on historical periods (e.g., Holocaust studies) emerged as other topics with substantial impact. Beyond exhibits, public engagement, and preservation, research in this category influenced concrete public policies and resulted in changes in legal regulations and practices to safeguard archives and heritage. Novel ways of heritage management and conservation, of fostering public engagement with novel museum and exhibit curation methods, and of involving local communities to collaborate with researchers in archaeological fieldwork have been pioneered by numerous research-led projects. This not only revitalised the cultural life of local communities, but has also supported local growth and economic prosperity via tourism. Research has also led to the development of protocols and practices ensuring the survival of local endangered communities and important cultural artefacts, with UK researchers emerging as leaders in cultural heritage preservation globally.

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 decolonization of objects to application of the most cutting-edge technologies to produce immersive museum virtual reality experiences. Within this theme, we also see humanities and arts research in the UK emerging as a superpower in heritage preservation, the creative industries, art and festivals. This includes systems being developed to inform festival programming, with Britain's strong film and cinema industry and culture supported by University research strengthening curation, archiving and public engagement. COVID affected this area more deeply, particularly by site closures, which was remarked upon by a REF panel member.

"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

Case Study Examples

The cultural engagement theme uses different creative media, ranging from exhibits, to 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 back 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 added 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. "I just really enjoy trying to understand people from their remains." Appleby comments on her role in identifying the skeletal remains of the king as part of a multidisciplinary team.

"I like to do work that makes a difference which seems odd, because I work in an obscure corner of an obscure field." is how she sums up being part of a research effort which ended up having broad implications for the local cultural and economic life.

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 and Prof. Paul Fletcher of Cambridge Neuroscience contributed with 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

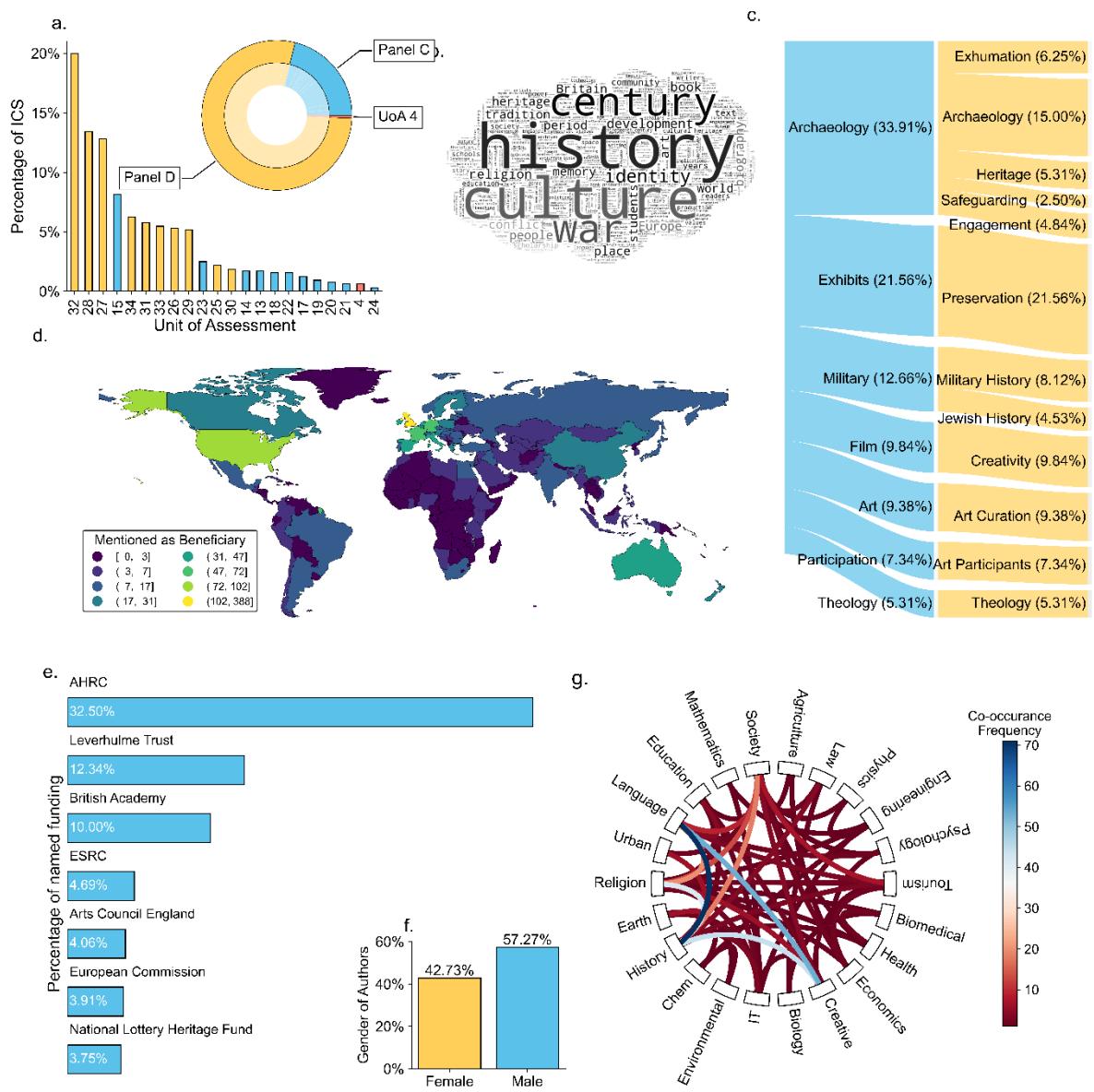


Figure 4. Main Characteristics 'Topic 2: Archaeology and Exhibits'

Distinguishing Facts of the Archaeology and Exhibits theme:

In addition to the visualisation of this topic, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ **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 ICS, followed by the Leverhulme Trust (12.34%)
- ❖ **Underpinning research has a slight over-representation of men:** 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 interdisciplinarity linkage 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 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 and only rivalled pthe Health and Wellbeing theme (4266), with the highest relative citation ratio was 11.

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, equity and disability, literacy, and multiple curricula to the acquisition and preservation of languages. Impact resulted in 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 primary school to higher University education.

A core area of research-driven impact has been in transforming *teaching, training and educational policy*. The ICSs in this area introduces a bountiful range of practices, programmes, policy and curriculum changes, modernising education and 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 (e.g, foreign language acquisition, active learning in primary physical education, maths, science) but also introducing digital innovations and mobile technologies for teaching in rural communities or low-resource

classrooms. There is also a wealth of material to improve teacher training and career development, the evaluation of teaching quality, workload and develop best practices in teacher assessment (e.g., also avoiding gender bias in teaching evaluations).

Examples of Impact

Learning through play in primary schools: A 20-year research program on the synergies between teaching, learning and playing led to educational reform for all 4-6-year-old children in Northern Ireland (NI) 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 changed accreditation procedure, a revised inspection framework, and extensive investment in educational capacity. About 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. Capable of working with 33 languages, Hermes increased Netflix's language coverage from 16 to 32 languages 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 Resources for Grammar 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.

Education was also utilised as an engine for social mobility and equal access. Impact primarily focussed on techniques, tools and policies to widen participation, improve access

and reduce inequalities in admissions amongst groups (e.g., social class, regions). Impacts included evidence-based funding and policy recommendations that led to government and foundation programmes aimed at improving educational access and outcomes of students from disadvantaged backgrounds. Programs broadening access to higher education, changing admissions policies and helping students from disadvantaged backgrounds with the admissions system also feature in this category. One example was the ‘Paired Peers’ project, which focussed on improving access, University experience, and the careers of young working-class people. Another prominent area was improving skills acquisition and linking these to improve graduate outcomes. Other examples include policies which were 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

The literacy and reading cluster produced a plentiful array of programmes, curriculum changes, diagnoses, and new tools to enhance literacy, aid with dyslexia and learning disabilities, 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 introduced with curriculum and programmes to aid with dyslexia, learning disability, comprehension but also increasing financial and digital literacy. Other examples include a web-based tool to diagnose literacy skills.

Language acquisition and preservation and linguistics was another strong area of impact often emanating from Humanities research. This work had multiple impacts including primarily the production of resources for teachers on English language teaching, resources for A level teachers and how to teach English online. A related focus was on instruction for language learning 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. A strong focus on language preservation and policy and language as heritage. ICSs engaged in activities ranging from making available dictionaries, providing classes and online learning tools or influencing government policies and investments that aim to further the historical understanding and encourage the present practice of languages such as Welsh or Irish and Scottish Gaelic.

Case Study Example

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

This will be based on the case study “An Early Start to Foreign Language Learning and Literacy” from University of Southampton

<https://results2021.ref.ac.uk/impact/a65b3302-2441-414a-bb7b-cb2309a96cef?page=1>

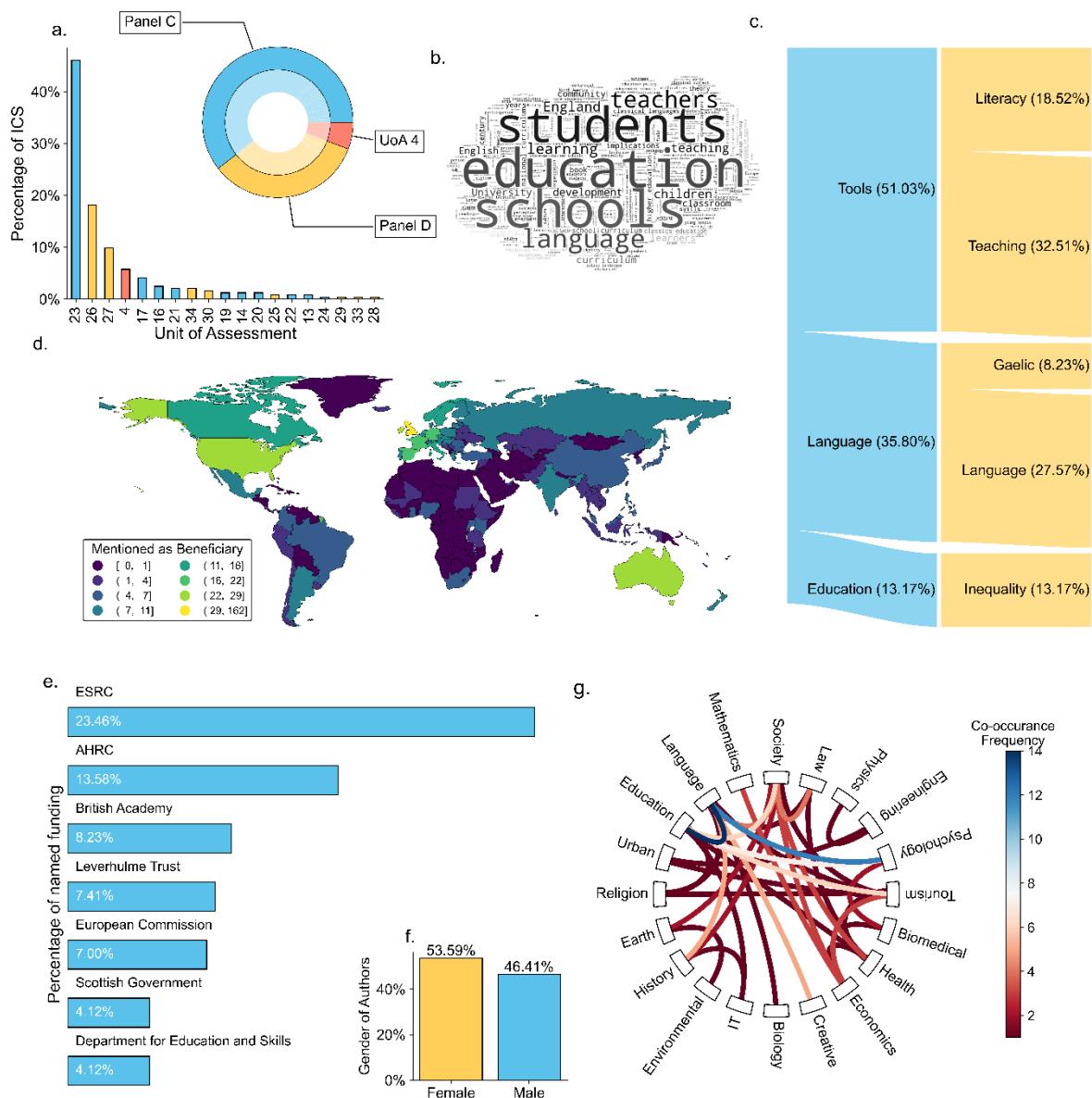


Figure 5. Main Characteristics 'Topic 3: Education and Teaching'

Distinguishing Facts of the Education and Teaching theme:

In addition to the visualisation of this topic in Figure 5, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ 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%), a
 - 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”, with the 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 ICS, 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 of the underpinning research are female.
- ❖ **Wide interdisciplinarity across the social sciences (education), psychology and humanities (language, culture):** The most commonly occurring interdisciplinarity linkage in the underpinning research are between “Education” and “Language, Communication and Culture”, and “Psychology” and “Language, Communication And Culture”.
- ❖ **Publications underpinning research, 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.

2.4 Business, Economics and Management

This theme consists of impact from research driven from the areas of business, entrepreneurship and management and macroeconomics, banking, monetary policy, banking, market regulation, consumer protection and anti-corruption. Research in this theme informs topics denoted as *business, entrepreneurship, management and policies* aimed at improving productivity and firm growth in various forms. Research has identified and implemented effective tools to manage existing firms and successful entrepreneurship. Here, ICSs have led to 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 for companies. The majority of projects aid in small- and medium enterprises (SMEs) growth creating 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 as well as making public sector and publicly procured projects more efficient or enhancing management. This ranges from farming, to supply chains, social enterprises and large infrastructure projects. Focus on firm growth as well as creation of new companies and startups is coupled with hard evidence demonstrating job creation that results 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 shaping of *macroeconomic and monetary policy and relatedly with financial market and banking regulation*. Research on designing macroprudential policies and new tools for monetary policy have operated to make financial

markets more resilient to crises and improve regulations in the banking sector. Many policies and tools for financial 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 as well as of global asset management firms, pension funds, and financial market participants.

Research concerned with the *psychology of consumers and the optimal regulation of markets* has influenced policy and initiatives to protect consumers. Policy impact ranges from influencing financial and lending regulations, housing market policies, consumer protection measures such as transparency requirements in cost and fee declaration. Research insights have helped households make better decisions via programs 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 focussed on reducing corruption and improving public procurements for international aid and projects.



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

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 Construction Contracting: 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 £45bn.

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 £1.5m 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 £230.6m 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

Case Study Example

Many of the ICS 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 for example 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 recognize," 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 programs such as 'Help to Grow'. Several of Van Reenen's graduate students are also involved in implementing programs at the World Bank that seek to improve emerging market economic growth by implementing programs focussed 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. "There's a lot of cynicism about what management and management consultancies do, but there are some things these huge industries do, which make a lot of sense. We have made explicit that tacit knowledge about what works, that is already latently present within good firms. You can think of our work as separating the wheat from the chaff in identifying what really improves management."

Distinguishing Facts of the Business, Economics and Management theme:

In addition to the visualisation of this topic in Figure 6, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

❖ 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, banking:

- The five most highly weighted concepts associated with this underpinning research were: "development", "business", "organization", "implications", and "innovation",

- majority of research in 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 ICS, followed by the European Commision (10.98%) (Fig 2e).
- ❖ **Underpinning research is gender unequal, with 28% female authors, compared to 72% men.**
- ❖ **Interdisciplinarity is across the social sciences but also outside in computing.** The most commonly occurring interdisciplinarity linkage 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.

2.5 Employment

There has been a wealth of impact in the area of labour market and employment, largely in the areas of labour conditions, disability, and inclusion. A central theme was impact in relation to *labour conditions* and within this, policy changes driven by research surrounding worker’s rights, benefits and pay. Research drove 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 also drove changes in maternity protection, reproductive rights at work, and the gender pay gap but also developed tools to help the unemployed find employment and improve skills. There were multiple research-driven policy changes also to improve 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) and evidence-based policy.

Research also drove changes in labour conditions with new policies and interventions related to *improving worker’s wellbeing and performance* (e.g., through guidelines for Police and NHS workers). Performance management and digital transformations for workers was introduced along with multiple interventions and training programmes to reduce and cope with psychosocial risks related to stress and psychological workplace training. Another vibrant area of impact related to changes in labour policies, law, regulations and interventions to reform the public sector complaints process. This included changing ombudsman policy, policies to protect whistleblowers, and ensuring equality of access to justice and inclusion for particular groups (e.g., migrants, blacklisted workers).

Another topic was in the form of impact through policy changes and intervention surrounding *employment, disability and inclusion (EDI)*. Research driven evidence operated to inform and change attitudes towards people with disabilities, such as sharing historical knowledge about disabilities. There was also impact in the area of law and legislation based on rights and liberty-based approaches to protecting people with disabilities and international human rights or disabled people. Largely humanities based research also focussed on 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 £3.1bn annually. Findings led to employment rights policy through the 'Good Work Plan', regulating 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 a million workers by as much as GBP355 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 1.596m workers. Research subsequently showed the NLW reducing 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 decision by the UK Supreme Court – in July 2017 – 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 £18m 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.

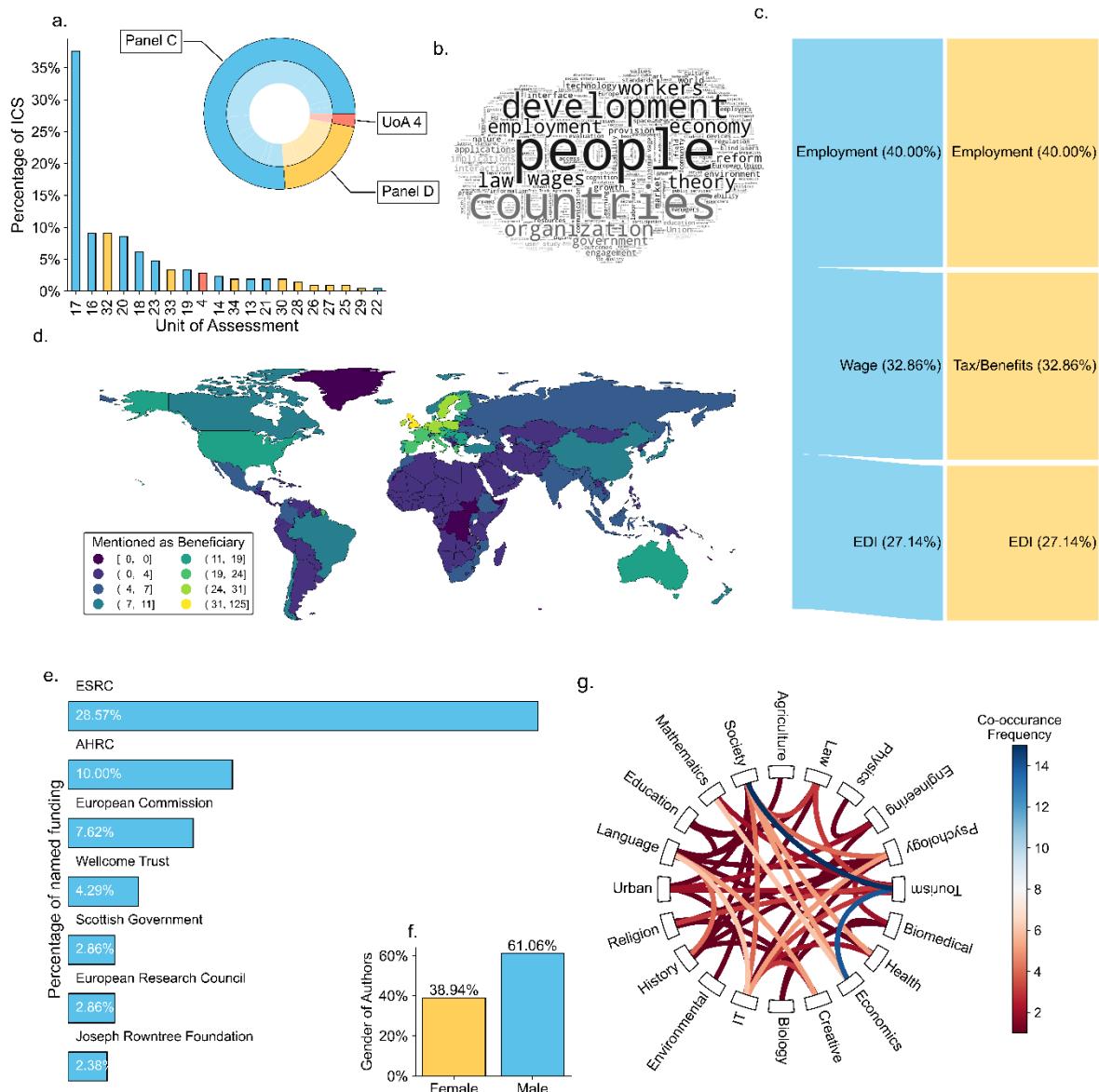


Figure 7. Main Characteristics for 'Topic 5: Employment'

Distinguishing Facts of the Employment theme:

In addition to the visualisation of this topic is in Figure 7, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ **Most prominent UoAs mostly span the social sciences, but also art and design and in 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”, “organization”, and “workers”
- majority of research in the hierarchical groups of Employment, Wages, and EDI
- ❖ **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 ICS, followed by the Arts and Humanities Research Council (10%)
- ❖ **Underpinning research is slightly gender unequal 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 interdisciplinarity linkage 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.

2.6 Crime and Exclusion

Research-based knowledge was used to deeply impact multiple facets of crime enforcement, detention, the justice system, drug, alcohol and substance use problems and counteract hate crime and gambling. Considerable impact has occurred in the area of *crime enforcement, detention, prisons and prisoner reforms*. Innovative tools have been developed to combat serious crimes, with a stronger focus on evidence-based policing and identification of serious crimes and criminals to using policing data more equitably. Novel programmes have been developed and tested to also engage local communities in fighting crime. Research has also had an impact in improving police transparency, holding police accountable, scrutinising individual cases and actions against groups (e.g., strikers), interventions to discourage police informal codes of silence and improve the ethical culture in police.

Policy, interventions and regulation and building changes have been driven by research, including changing the design and architecture in prisons to increase prisoner wellbeing, mental and physical health, education, improving behaviour, co-production of research with the community and supporting the families of the incarcerated. Humanities research has also engaged in theatre in prison, creative works on crime and historical work on prisons and imprisonment. Another strong and transformative strand has developed interventions related to improving post-prison rehabilitation, reducing recidivism and tackling over-imprisonment.

University-based research has *changed gambling policy and reduced harm*, focusing on safer and more responsible gambling and digital gambling. A focus has also been on interventions and policy change for addictive behaviour such as reducing tobacco use and e-cigarettes,

policies related to drugs, alcohol harms and psychoactive substances and supporting children affected by drug abuse.

Other advances include technologies and techniques to improve lie detection during interrogation and cross-examination and the prevention of torture. Numerous ICSs have also worked to develop a better public understanding of *hate speech and crime* in addition to reducing them but also improving legal responses. Finally, new technologies merging multiple disciplines across criminology, forensics, archaeology and the natural sciences have advanced craniofacial identification, transformed aquatic forensics and advanced green criminology.

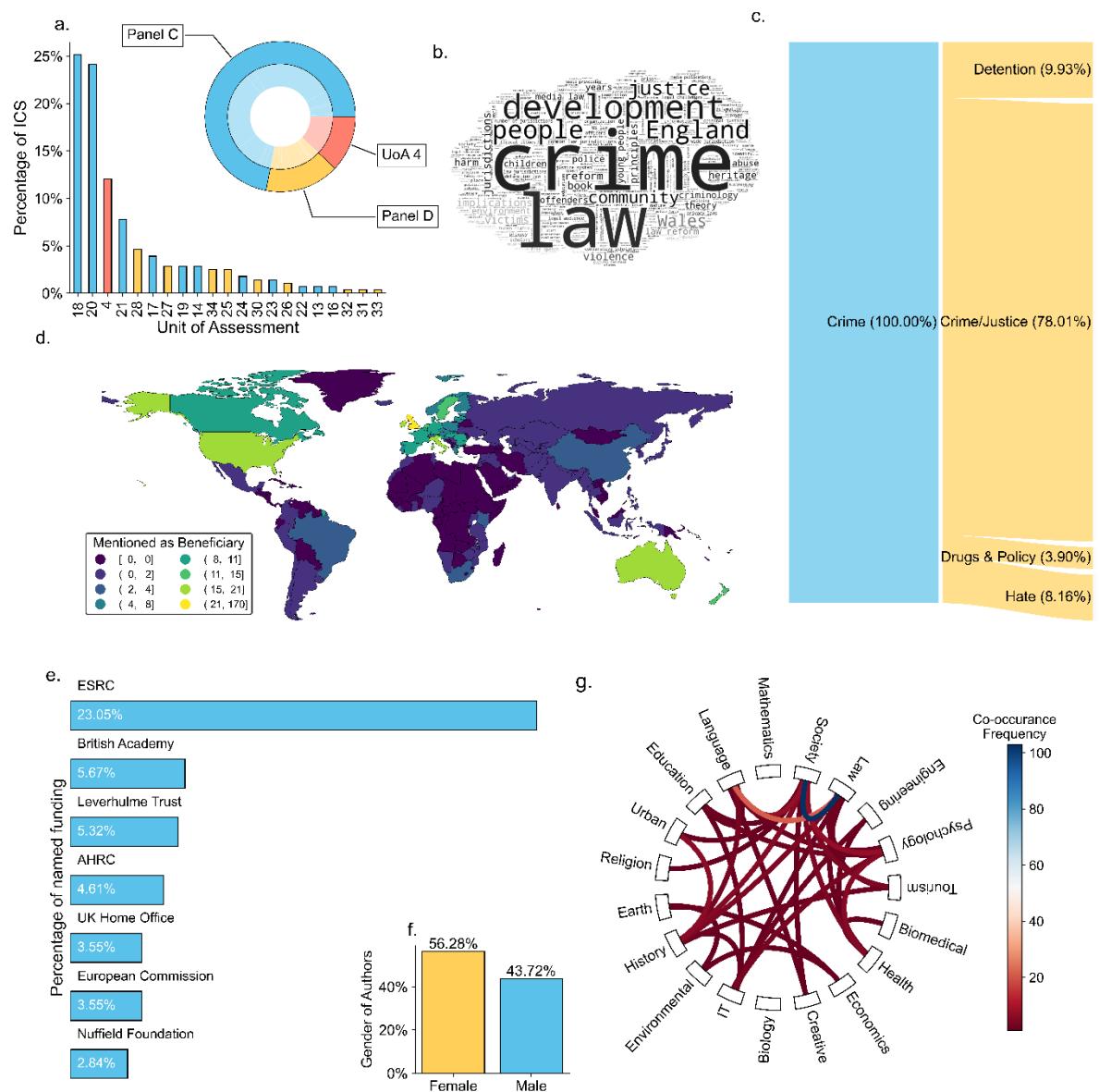


Figure 8. Main Characteristics for 'Topic 6: Crime and Exclusion'

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), EM also added as an option to bail (alternative to custody); and 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-survivors of gender-based violence (GBV) leveraged over £7.2m 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 & 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 UN to take account of TBI and Neurodisability and 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 60,000 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 programme, 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 £7m for the introduction of digital kiosks in UK prisons was announced as a consequence.

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

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 focussed 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: Equipment of UK and international law enforcement to fight online sexual crime was provided via the training of 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 \$180m 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.

Distinguishing Facts of the Crime and Exclusion theme:

In addition to the visualisation of this topic in Figure 8, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ **Highly diverse cross-UoA submissions across the social sciences, humanities and psychology:**
 - 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.
- ❖ **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 of the underpinning research are female, with 43.72% male.
- ❖ **Interdisciplinarity of underpinning research published across the social sciences and humanities.** The most commonly occurring interdisciplinarity linkage 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.

2.7 Family and Gender

Researchers have translated a manifold of research into interventions, programs, 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.

A core area of impact in this theme has been on *safeguarding vulnerable children and families*. Here programmes and interventions have worked to spot 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 to inform regulations. Historians have also been crucial in providing a historical context for violence against children and helping policy-makers effectively reckon with this historical violence. Preventing sexual and intimate abuse of children in multiple settings has been another key focus including from the domain of sport to online forums, with pivotal interventions to prevent and interrupt the grooming of children and understanding the role of grooming. This theme has also examined refugee’s children’s rights and the rights of children of imprisoned mothers. Research also led to changes in child protection legislation and feeding programmes.

Humanities researchers used photography and art to *increase children’s power and early childhood development* such as reading through storytelling and digital technologies. Psychological and behavioural researchers humanised technology and improved technology’s ability to provide socioemotional support. They also increased children’s literacy and numeracy skills in low resource and conflict settings, increasing children’s confidence, personal autonomy and social influence. Other interventions operated to prevent infant deaths and develop tools and techniques to amplify children’s voices in care settings. Countless other interventions operated to improve children’s cognitive and emotional development in different income settings, enhance home learning environments and informing child protection policy.

Research also led to impact in 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 was another key theme with impact that changed practices, policies and provided guidelines in the area of gender representation, such as increasing gender equity or representation of ethnic minority employees in the workplace, reducing employment discrimination and shaping government and business policy to support women in business

and SMEs. Other impacts led to advice and changes in increasing diversity among senior leadership and boards. This topic closely aligned with a grouping of case studies focussed on empowerment of women through education. Gender equity was 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 LMICs.

Research likewise contributed to new policies and practices to improve the experiences of *sexualities* and LGBTQ+ individual's experience in multiple institutions such as the school, workplace and increasing promotion opportunities. Here a focus was also on LGBT+ spaces and inclusion. Humanities research also had considerable impacts towards understanding 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 condition 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 supported 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 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.

Continued... Examples of Impact

Preventing child abuse globally: Researchers used randomized control trials in South Africa, Philippines and Thailand to develop and test the world's first evidence-based, non-commercialised, parenting programmes. Programs were estimated to have reduced 81,000 cases of severe abuse. The programmes are endorsed by the World Health Organisation (WHO), UNICEF, USAID, CDC and Global Partnership to End Violence Against Children. Over 3,000 local staff have been trained as parenting supporters, with programmes translated into 22 languages.

Approval of mitochondrial replacement therapy: In December 2014 the UK Parliament approved regulations allowing the licensing of mitochondrial replacement treatment, a pioneering medical intervention to prevent the transmission from mother to child of extremely serious genetic conditions. The process was guided by input from ethics philosophy on the Human Fertilisation and Embryology Authority (HFEA).

Abortion Law Reform: Research has offered the leading legal analysis relied upon in making the case for the removal of specific criminal prohibitions against abortion and thereby formed the basis for the first three Bills – two in the House of Commons (HC), one in the House of Lords (HL) – to fundamentally challenge the status quo in English law that criminalises abortion rather than seeing it as a matter of health law.

Improving care after pregnancy loss: Each year in the UK, there are approximately 250,000 miscarriages, stillbirths and terminations following a diagnosis of foetal anomaly. To improve on inconsistent levels of care for mothers and families researchers helped develop a newly created National Bereavement Care Pathway (NBCP); informed new UK healthcare guidelines and transformed professional training standards for midwives, registrars and funeral directors.

Preserving the UK's LGBTQ heritage: Two separate research projects on LGBTQ history firmly embedded the preservation of LGBTQ sites and history in Britain's heritage sector. One led to the National Trust's flagship "Pride and Prejudice" project, broadening access to LGBT+ heritage, and setting up a 2017 programme that drew over 350,000 visitors, the other led Historic England to commit to a greater diversity of histories in the properties and achieved 22 new and amended listings of nationally protected sites on the National Heritage List for England.

Expert Women on Air: Journalism research into gender representation in the six flagship UK news programmes revealed that women experts were outnumbered by men by a ratio of 4.4:1 in 2013. The Expert Women survey research and subsequent campaign for better representation inspired broadcaster equity schemes and changed the faces and voices of British broadcasting by the late 2010s. Twice as many women interviewees now appear on radio and TV flagship news broadcasts in the UK compared to 2014.

Distinguishing Facts of the Family and Gender theme:

In addition to the visualisation of this topic in Figure 9, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

❖ 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 focussed 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 ICS, 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 interdisciplinarity linkage 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'

Case Study Examples

ICS Example Box to come: Improving Outcomes for Disadvantaged Children

This will be based on the case studies "Changing policy and practice on the Education of Children Looked After (CLA)" by Judy Sebba

<https://results2021.ref.ac.uk/impact/4d941e42-f382-4f65-9726-7727cc5ba687?page=1>

Changing policy and practice on the Education of Children Looked After (CLA)

2.8 Governments 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.

Humanitarian and peacekeeping research, human rights, war crimes, and terrorism produced considerable impact in the UK and globally. Research led to changes in understanding and policies related to *human rights, privacy, and freedom*. Policies and ways of working were introduced to protect independent journalists and freedom of expression, and to cope with human rights in armed conflict and warzones. An emerging area of research engaged 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. Peace and humanitarian support was a large part of the tools and interventions focussing on conflict analysis, humanitarian projects, facilitating dialogue for sustainable peace, peacemaking and building, peacekeeping at a local and territorial conflict, and supporting local groups and NGOs.

Work on *Ireland and reconciliation and other international conflicts and terrorism studies* engaged in impact to enact social and political change and enhance public participation. Historical work focussed on remembrance, civil wars, rebellion, creative representations of history and challenges to dominant perceptions. Another strand focussed on policies and regulations related to safeguarding human rights. Middle East impact studies also developed *responses to conflict* during and after the reconciliation process, representations of the Arab world and Islam and the role of media and journalism. Work has also taken place to improve policy-makers understanding of *terrorism and violence*, reduce religious- and politically-based (far-right) terrorism and violent extremism prevention, educational interventions to reduce terrorism risk; gender and violent extremism prevention and to enhance interactions between Islam and the criminal legal system.

Impact related to measurement, policies and interventions linked to *migration policy, refugees, asylum seekers, the hostile environment and integration* was immense. A large body of ICS focus on informing and improving government policy toward migration, measuring the number of migrants and reckoning with forced migration. Others developed interventions and programmes to incorporate and enhance the social integration for migrants such as English-language training or other ways to improve lives of the displaced. Historians produced rich narratives of the histories of migration and improved teaching of those histories to enhance understanding.

Digital surveillance, privacy, AI (artificial intelligence) and cybersecurity was another cluster of impact in this area. Here the focus was on impact in the area of AI governance and policy and intelligible AI but also impact on how to devise human centred and digital technologies for cybersecurity to techniques to improve shopper's online experiences. Policy changes were implemented in government and to open up third sector transparency and data sharing infrastructure and technology transfer. Impact also occurred 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.

Case Study Example

ICS Example Box to come: ICS Example Box to come: 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>

Considerable impact also took place in the areas of *political democracy, integrity and representation*. Novel tools of citizens assemblies and engagement reshaped politics and public engagement, understanding and awareness. Techniques and policies were developed to improve the quality 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 politics. Others impacted decision-makers and transformed the public's policy understanding of Brexit and potential changes that may be required for future election and referendum campaigning. Research also drove new policies to bring in more transparency in lobbying, countering electoral fraud, and improving *electoral integrity* and registration. Techniques and policies were also focussed on increasing diversity in representation such as women's and minority participation and representation, 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 and 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 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 obscure or forgotten facets of past violence, improve knowledge, integrate new materials into educational curriculum and document the Holocaust and other atrocities. Justice in Latin America focussed on ways to bring justice for victims of survivors or genocide and truth and reconciliation (e.g., Chile, Mexico, Peru but also Rwanda, Spain). Here practices and regulations emerged on how to recognise indigenous contributions to human rights and accountability for international organisations. Impact has likewise taken place in countering modern slavery within forced labour in supply chains, government policy changes to support survivors of modern slavery, improving interventions to counter it and new technologies to map modern slavery. Actions to cope with legacies of British slavery and participation the slave trade and historical legacies were also implemented.

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 Parliament, 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 provides a sense of legitimacy and belonging in public discourse.

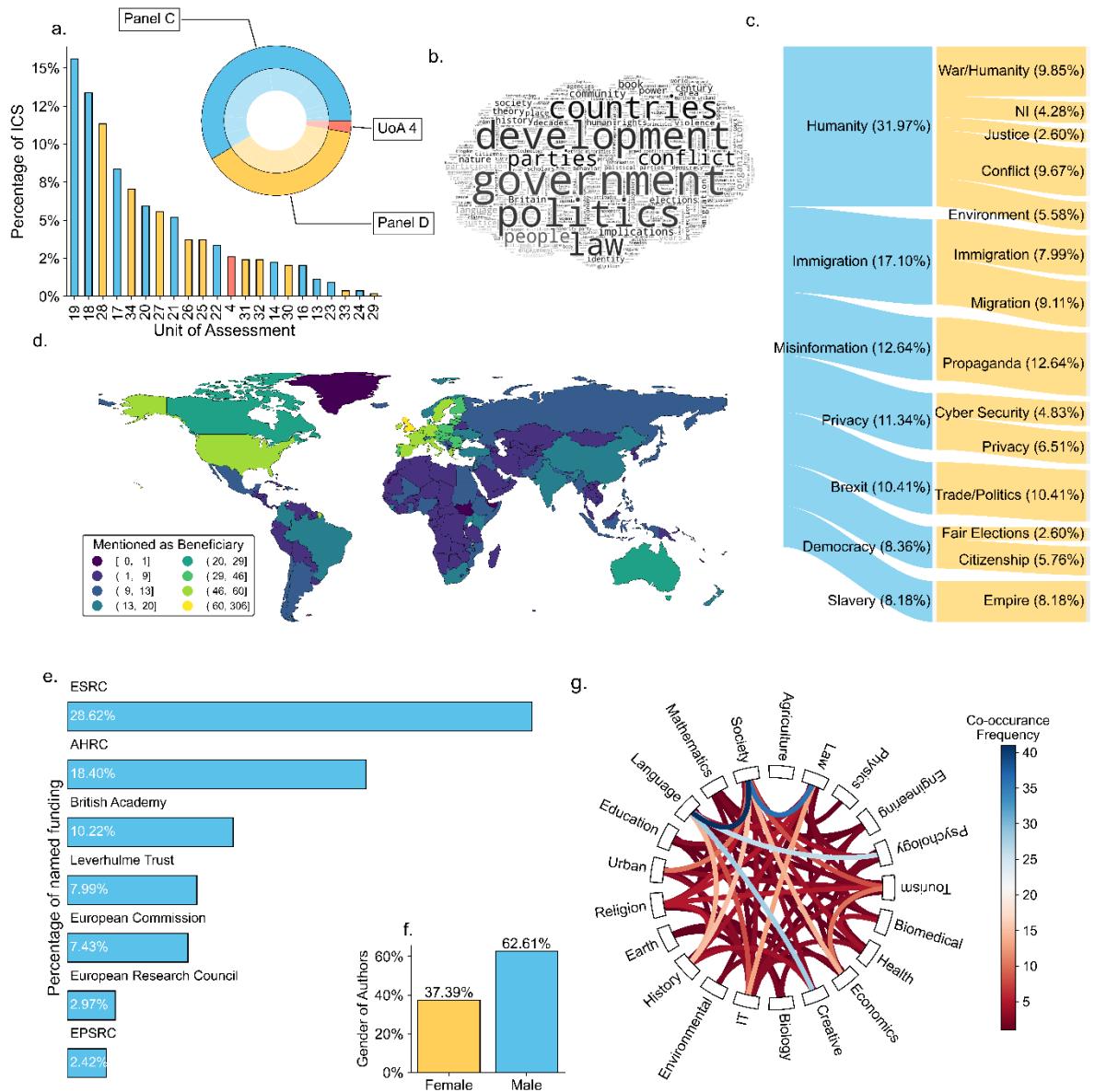


Figure 10. Main Characteristics for 'Topic 8: Governments and Law'

Distinguishing Facts of the Governments and Law theme:

In addition to the visualisation of this topic in Figure 10, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ **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 ICS, followed by the Arts and Humanities Research Council (18.40%)
- ❖ **Underpinning research gender unequal with 62.61% female and 37.39% male authors.**
- ❖ **Interdisciplinarity of underpinning research across the social sciences and humanities.** The most commonly occurring interdisciplinarity linkage 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.

2.9 Health and Wellbeing

The contribution of SHAPE to health and wellbeing research-led impact has been remarkable and contains one of the most ICSs within our ten themes (see Table 3). Impact has been driven by sports and nutrition science research to focus on the efficiency of the NHS and the healthcare system to the diagnosis and behaviour-led interventions of specific diseases. We summarise the fourteen key sub-topics in this area (see Figure 11c), which are broadly divided into the themes of sports, detection, prevention and diet. The accompanying box provides astounding evidence of examples of impact from compelling FIFA to allow a replay for the World Cup, drastic increases in healthcare efficiency in the NHS to saving countless lives through innovative diagnoses, treatments, support and training.

Incredible impact has been made in the realm of *sport*, focussing on *exercise, nutrition, coaching, and the wellbeing of athletes*. Research has led to provisions for creating sporting environments and opportunities which are safe from any abuse or discrimination and promote the potential for sport to support wider social and political change. They also support competitive performance and coaching approaches to facilitate it, as well as underpinning initiatives to improve the health and wellbeing of members of the general public and athletes alike.

Detection, diagnosis and treatment is another core area of impact with 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 issues 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* focuses 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.

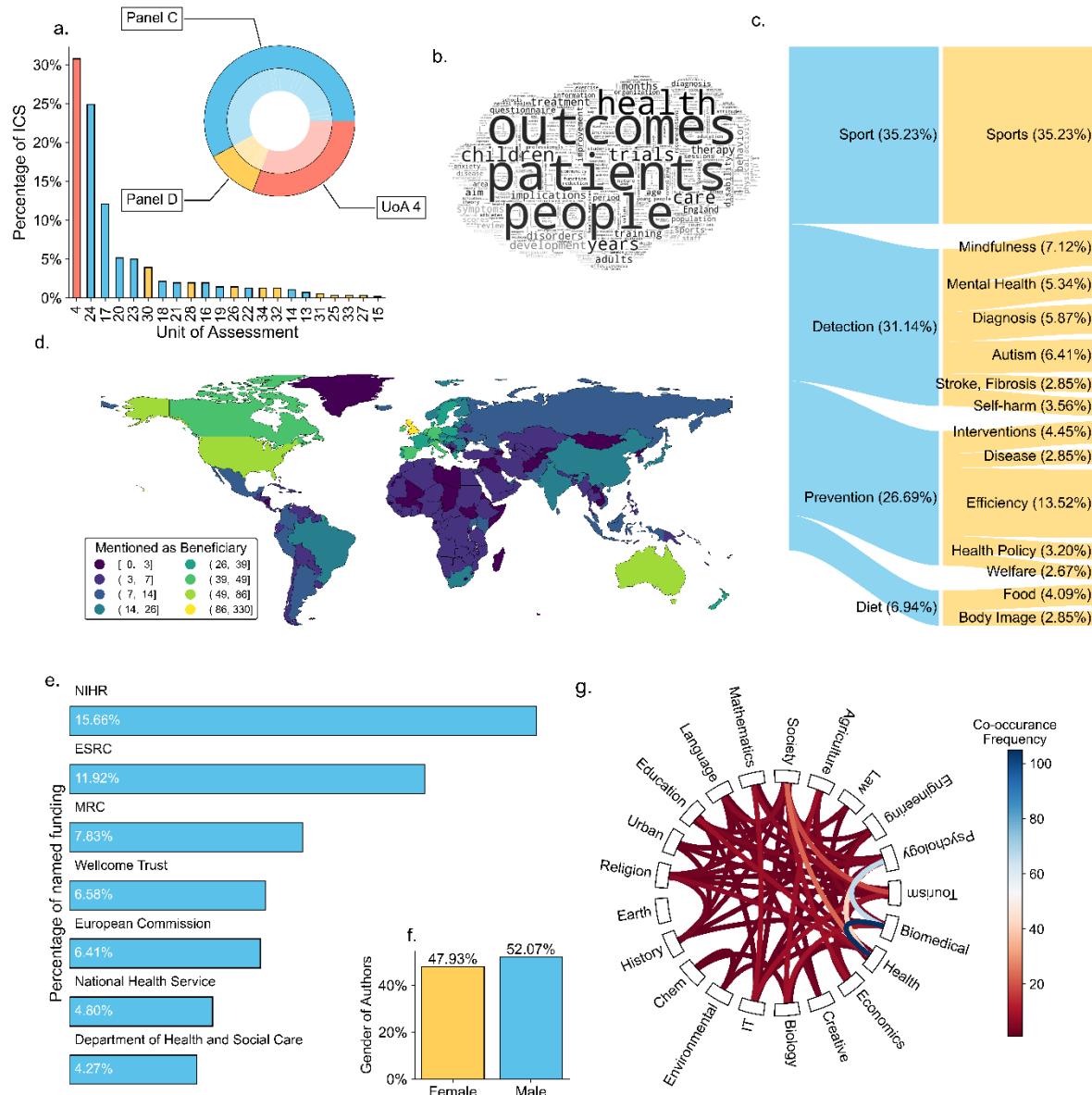


Figure 11. Main Characteristics for 'Topic 9: Health and Wellbeing'

Mental health support and training provides research-driven initiatives that underpin the understanding of mental health and the provision of sustainable, patient-focused support and training. They have been most 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 providing 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)*, *self-harm* has contributed to the diagnosis of severe mental illnesses like PTSD, 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.

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. Others have responded to *infectious disease crises* in both global, national, and localised settings. Here the focus has been on low-resource settings, such as developing countries, to provide treatment, social and cultural understanding, as well as data analysis to equip humanitarian aid and government institutions with the tools to respond to outbreaks.

Within this theme there is another large area of research that has driven impact in health efficiency, prevention and ethics. *Healthcare efficiency and prevention* has driven improvements of healthcare provisions. Here the emphasis has been on early interventions and preventative measures to relieve pressure on healthcare institutions. Subjects ranged from bioethics and the importance of cultural and religious differences when engaging with healthcare, to improving the IT services facilitating healthcare provision. Other research has driven changes to reduce the financial burden on *health and social care providers* and to enable more input from those receiving their care. This is related to *food marketing and food security research* that equips practitioners and individuals to support healthy food habits. *Ethics and data in healthcare interventions* has been another deep contribution focussing on demographic and medical data analysis, and government and institutional policies responding to this information. A related topic focussed on *pharmaceutical research* has had impact in the realm of ethics and cost-effectiveness of the healthcare industry, particularly pharmaceutical research and commercialisation, and healthcare economics.

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.

Continued...Examples of Impact

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 was 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

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 the development of a mental health service for people with CF.

Distinguishing Facts of the Health and Wellbeing theme:

In addition to the visualisation of this topic in Figure 11, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research. Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

- ❖ **One of the largest themes:** 562 ICSs fall within the theme of ‘Health and Wellbeing’.
- ❖ **Distributed across UoAs in psychology different aspects of the social sciences:** 1
 - 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% of 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 interdisciplinarity linkage 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.

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. University-based research has fuelled considerable technological, societal and economic impact in these areas. Impact in this domain contributes to better environmental protection practices and legislation, improved natural and agricultural resource management, as well as technological and legislative changes to mitigate climate change. It also covers 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 as

well as improving house construction practices as well as 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 CO₂ reductions. Considerable transformations also occurred in the realm of water management (water industry, trade, freshwater, marine, coastal, rivers). Policy, legal and regulatory changes transformed fisheries, trade relations, flood management, marine ecosystem management, recreational water, underwater heritage, water treatment, and domestic water sources. Research led 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.

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 CO₂ 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.

Short's work on adapting UK hospitals does not solely focus on reducing emissions but comes with the added benefit of looking for improvements in workplace conditions for NHS staff and medical practitioners, with more natural airflow reducing airborne transmissions in hospitals 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 modeling health costs arising from the effects changing climate has

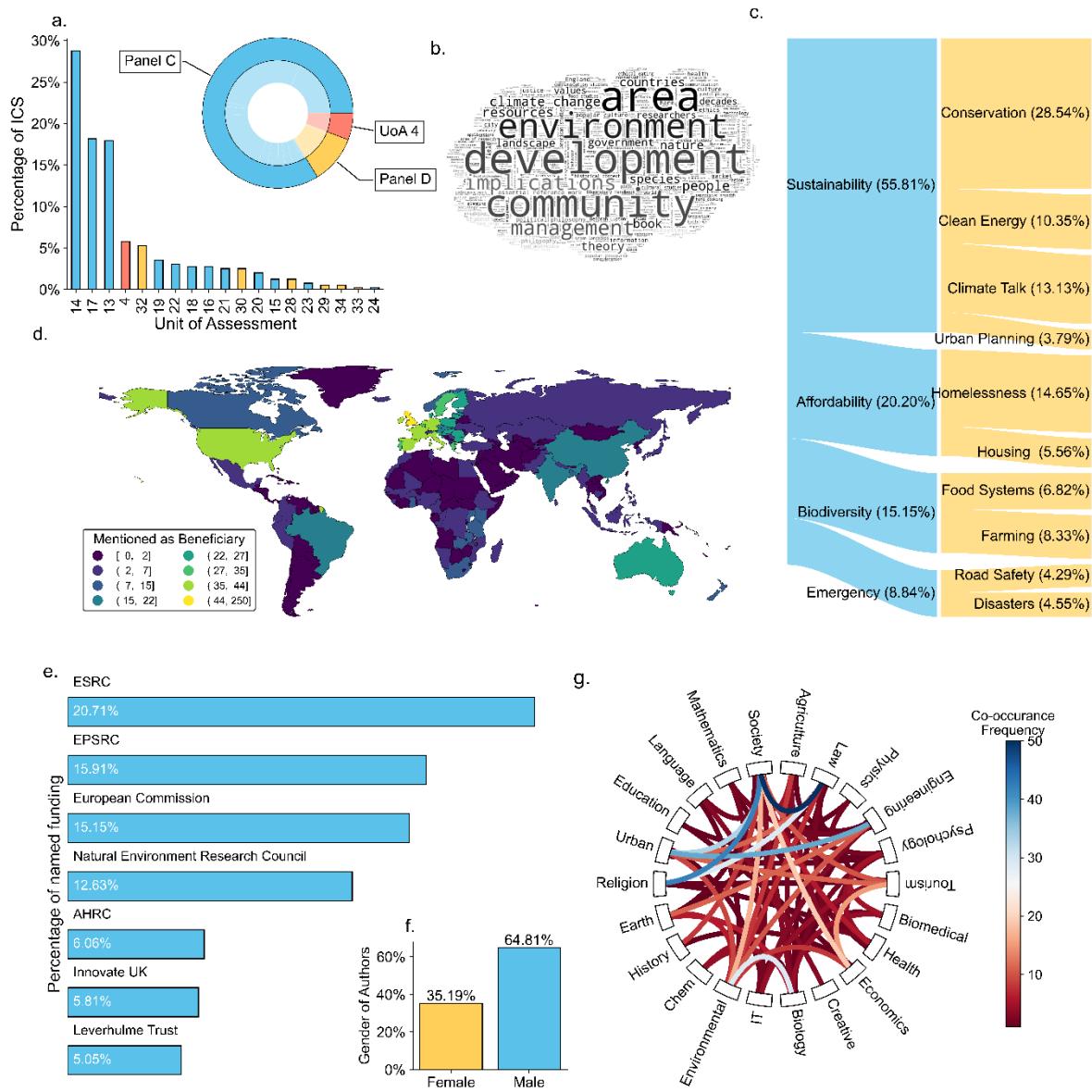


Figure 12. Main Characteristics for 'Topic 10: Sustainability and Infrastructure'

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 CO₂ 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 £4.4B 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 programs that reached over 148,000 households, one million people, in Ethiopia, Zambia, Malawi, Uganda

Biodiversity research drives environmentally and economically sustainable agricultural practices and policies and fosters human and wildlife coexistence, the protection of animal habitats, and community-led agricultural governance. Here, the public or relevant groups are included in environmental management and conservation. Research has also led to changes in environmental protection regulations such as for gas extraction to changes in property management law to protect the marine environment and countless other new approaches to resolve conflict between protected species and infrastructure development in the UK. Research in this domain was also particularly international, with UK researchers often helping foster agricultural and natural resource management for sustainable development.

SHAPE research drives innovative policies, regulations and acceptable technical solutions to *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 centers. 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, modernizing bus payments systems or facilitating bike use in urban communities. Concrete new directives have informed housing associations and policies and practices have changed 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. SHAPE researchers have also shaped legislation on homelessness, which has then impacted and informed international policy debates. *Disaster, safety and emergency preparedness* research has built resilience in the UK and beyond. SHAPE applications range from economic solutions to devise insurance-based finance and industrial strategies after disasters, empowering local communities to research that is instrumental in developing early warning systems.

The Facts:

Distinguishing Facts of the Health and Wellbeing theme:

In addition to the visualisation of this topic in Figure 12, key characteristics of this theme are described in Table 3 (key facts ICSs) and Table 4 (key facts underpinning research). Here we highlight some of the aspects that stand out in this theme in comparison to the other large themes.

❖ 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 ICS, followed by the Engineering and Physical Research Council (15.91%)
- ❖ **Gender of authors of underpinning research is unequal 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 interdisciplinarity linkage 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.

3. Five Defining Features of SHAPE impact

In this section we provide five defining features of SHAPE impact within a comparative perspective. We focus specifically on five aspects of SHAPE Impact, based on its broad, generalised characteristics (Section 3.1), the distribution of geographical beneficiaries (Section 3.2), the funding landscape (Section 3.3), the interdisciplinary nature of this underpinning research (Section 3.4), and finally, the intersectional characteristics of the authors of its underpinning research (Section 3.5).

3.1 General Characteristics

Table 5 summarises the key ICS and environmental data. This simple summary shows that it was Panel C which submitted the largest number of ICS, as might have been expected given that it has the largest number of Full Time Employees. Panel C also contains UoA 17 – Business and Management Studies (UoA 17) – which submitted the largest number of ICS (504) across all units. Panel A has the largest total income (largely due to the Clinical Medicine UoA), and Panel B has the largest number of doctoral degrees conferred (largely due to the Engineering UoA).

Main panel	Number ICS	% Total ICS	FTE	Degrees	Income (£bn)
A	1419	22.31	19763.11	46854.13	22.41
B	1268	19.93	17972.29	51859.17	14.34
C	2146	33.74	23292.24	38122.04	3.61
D	1528	24.02	13946.03	22685.49	1.25

Table 5. 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 while larger departments generally outperformed smaller ones in terms of ICS results, there exist no substantial or systematic difference between SHAPE (mean

GPA: 3.1) and non-SHAPE (3.17), or between UoA 4 (2.98, Psychology), Panel C (3.07, Social Sciences) and Panel D (3.13, Arts and Humanities). 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

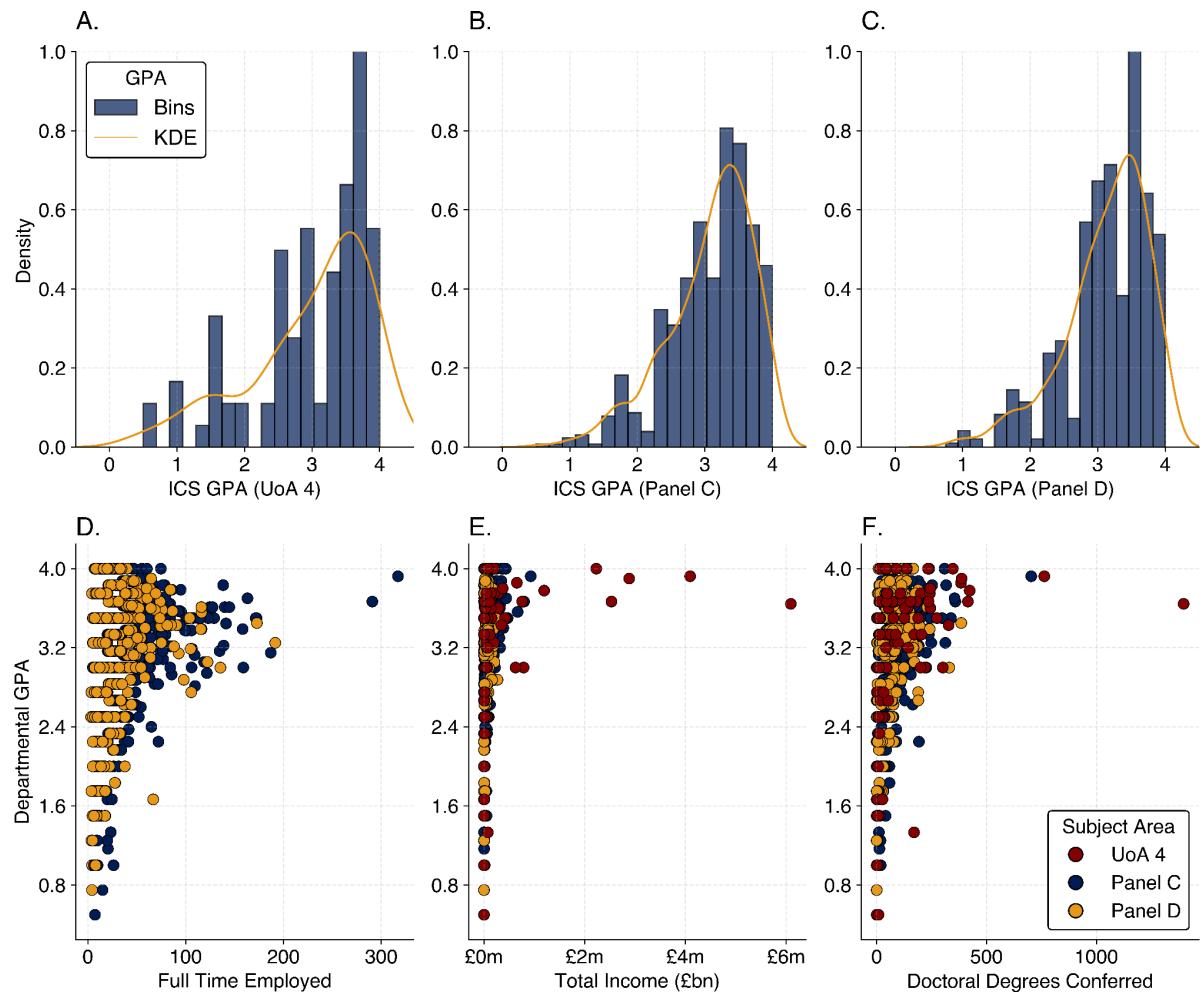


Figure 13. SHAPE environments and ‘Grade Point Average’

This has also been noted by a REF panel advisor, citing the change in the REF2021 rules. This involved moving from being able to submit ten research active staff in order to submit one case study in 2014 to a higher number of 15 active staff per case study in 2021: “this severely disadvantages new and small submissions” (Kerridge 2022). This is due to the fact a very small staff unit of two people (or even those under 15) would have to produce the same number of case studies as one that is considerably larger with 18 or more people. The challenges of assessing larger Units of Assessment was 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 as 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

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 recognize that impact and impact case studies take time and resources, and allocate those to impact goals, generally develop better impact case studies." – Humanities Panel Member

3.2 Geographies of Impact

We enhanced the REF2021 database to facilitate geographic assessments, for example, by including machine-readable ISO-3 country codes and UK institution postcodes. Research and research impact are geographically diverse in terms of where centres of excellence are located within the UK for different research fields. However, our focus here is on the global geography of where institutions generate research impact. We are building on and expanding maps of research and impact similar to what has been done for the REF 2014.^[4] However, 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 esteemed 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 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 – ISO3 code most frequently by far. This is true for each of UoA 4, Panel C, and Panel D. For UoA 4, 40.94% of listed beneficiaries (countries) are for GBR, while this number is 40.35% and 47.58% for Panels C and D respectively. Unit of Assessment 4 lists a total of 87 different country-level beneficiaries, Panel C lists 167, and Panel D lists 170. While 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 two of our three analyses: Unit of Assessment 4 and Panel D, but 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. 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 globally 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. Please see Section 4 for further details.

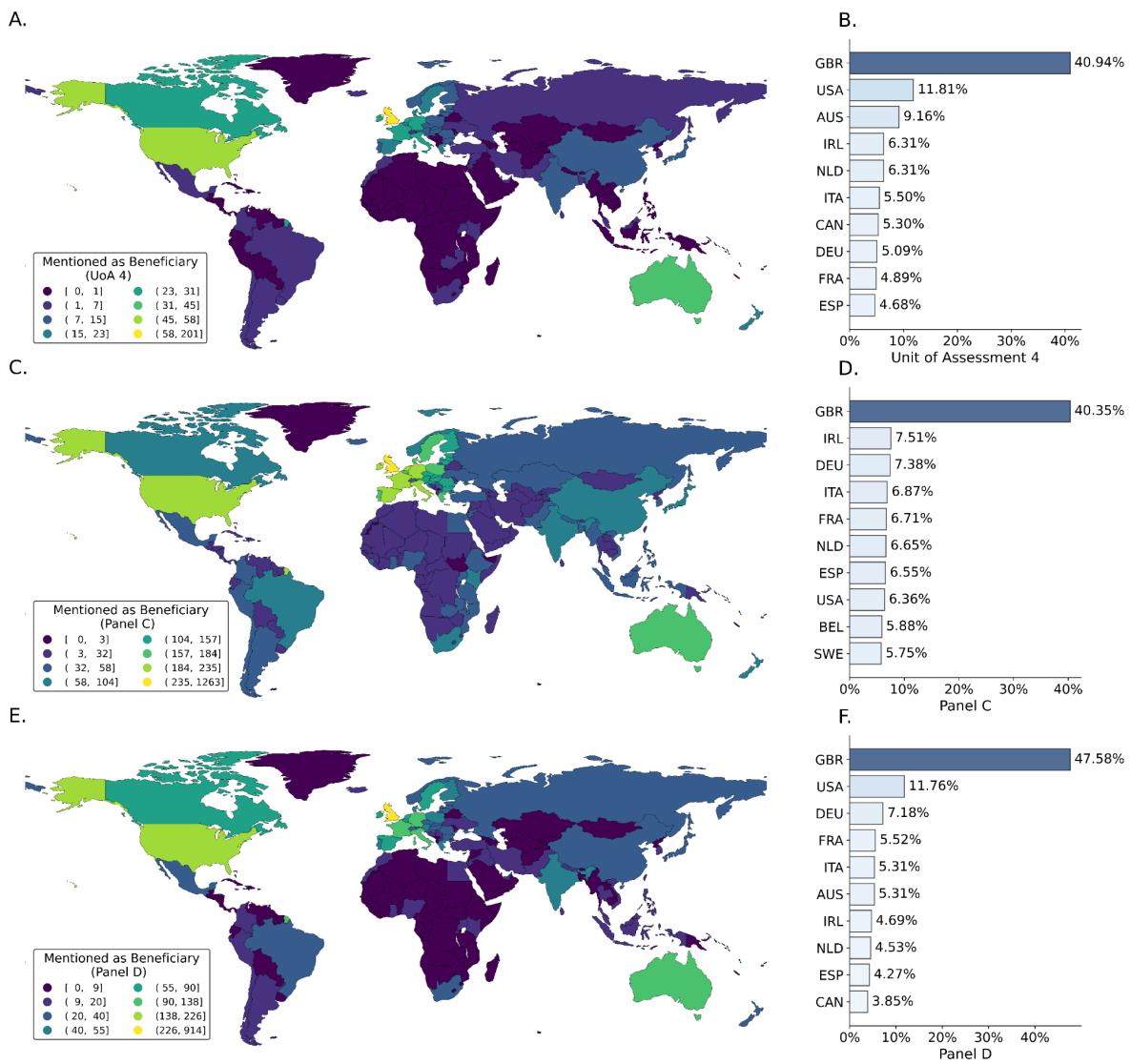


Figure 14. The Geographic Distribution of SHAPE Beneficiaries

3.3 The Role of Funders

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 and embeds 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. Whereas other funders, such as the European Research Council, traditionally did not focus on impact but rather more on scientific excellence and blue-skies risky 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 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 analyse who the main funders of this impact work were. The first row of Figure 15 shows the five most prominent funders of the research which underpins ICS 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 organisations – 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.

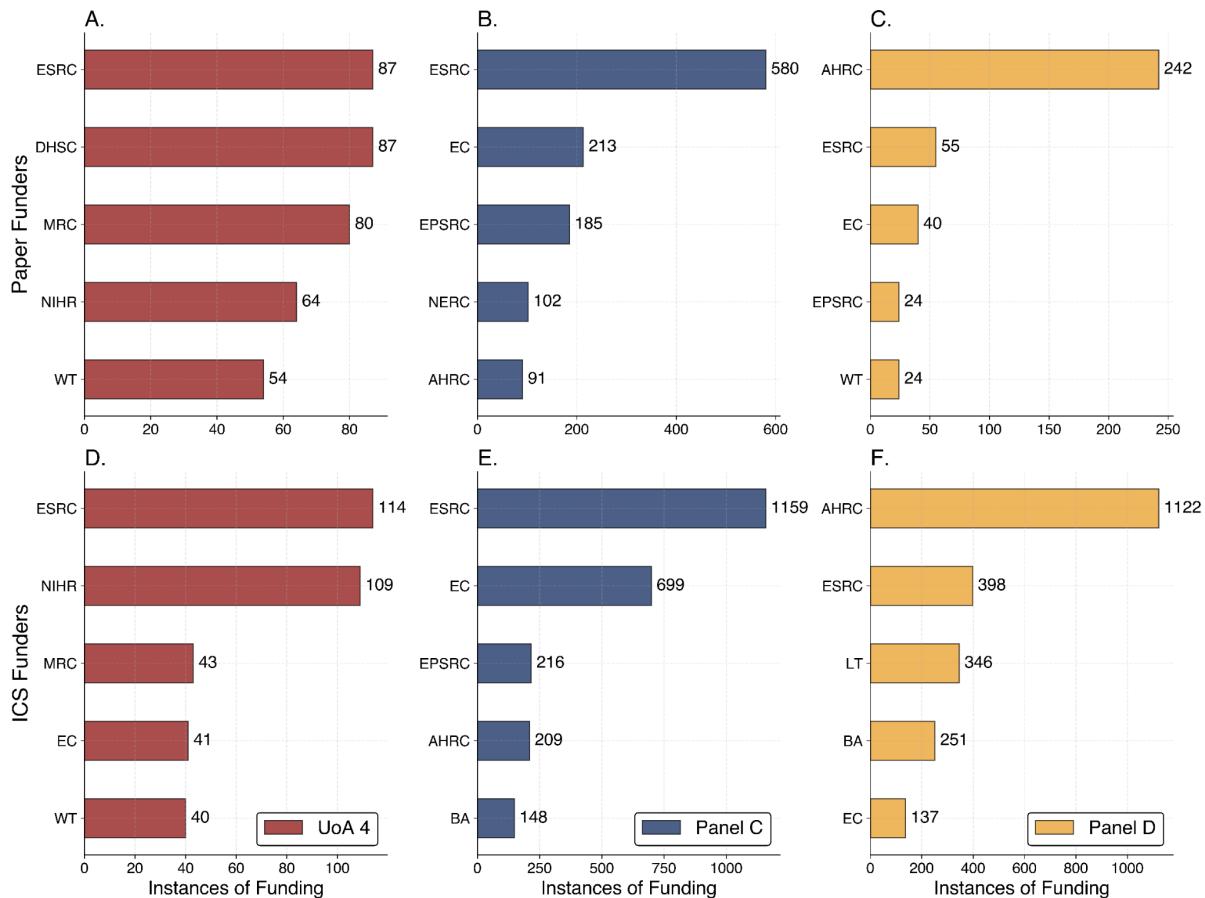


Figure 15. An analysis of funders across both underpinning research (first row), the ICS themselves (second row), and our three delineations of SHAPE disciplines (UoA 4; first column, Panel C; second column, and Panel D; third column).

3.4 Interdisciplinarity in Research

We next analyse aggregate level interdisciplinarity. This was discussed by the majority of our interviewees, too, 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, 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

It was also noted by a REF2021 Panel Advisor that “the ‘interdisciplinary identifier’ used to trigger special treatment for boundary-spanning work was applied very inconsistently” (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 (FoR). This analysis measures every co-occurrence of ‘Level 2’ FoRs, and in this analysis, we combine UoA4 and Panel C. We see a large amount of intuitive patterning, as interdisciplinarity happens most commonly between most closely related fields. This includes, perhaps unsurprisingly, ‘Human Society’ and ‘Law And Legal Studies’, and ‘Economics’ and ‘Commerce, Management, Tourism And Services’ for the Social Sciences. For the Arts and Humanities, this includes ‘Language, Communication And Culture’ and ‘Creative Arts And Writing’, and ‘Language, Communication And Culture’, ‘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.

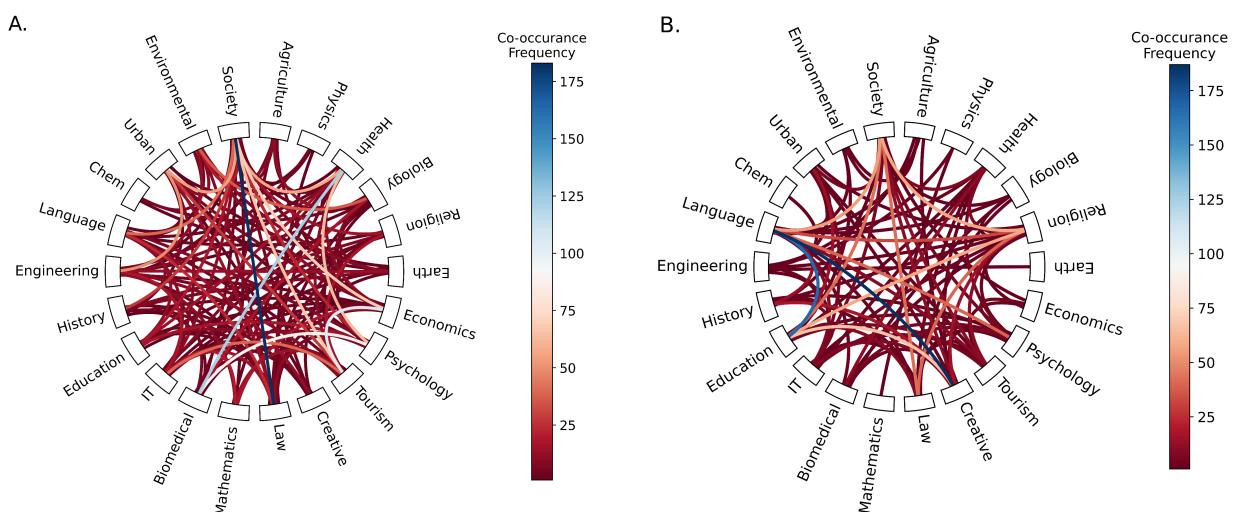


Figure 16. Analysis of interdisciplinarity in underpinning research across SHAPE ICS

We also asked survey participants from the REF panels about what percentage of ICS 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 Units of Assessment. 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 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 to say 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, right, so the planetary process. But climate change is only important to society because if 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 and Intersectional 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), 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 by colours according to whether the Units of Assessment are in STEM or SHAPE subject categories. We see that Panel A (medicine, health and life sciences) (0.49) has the highest share of female authors, followed closely by Panel D (arts and humanities) (0.46) and C (social sciences) (0.41). Panel B (Physical sciences, engineering and mathematics) contains the lowest (0.25). Across some of the UoAs within each Panel, we also see considerable variation. 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).

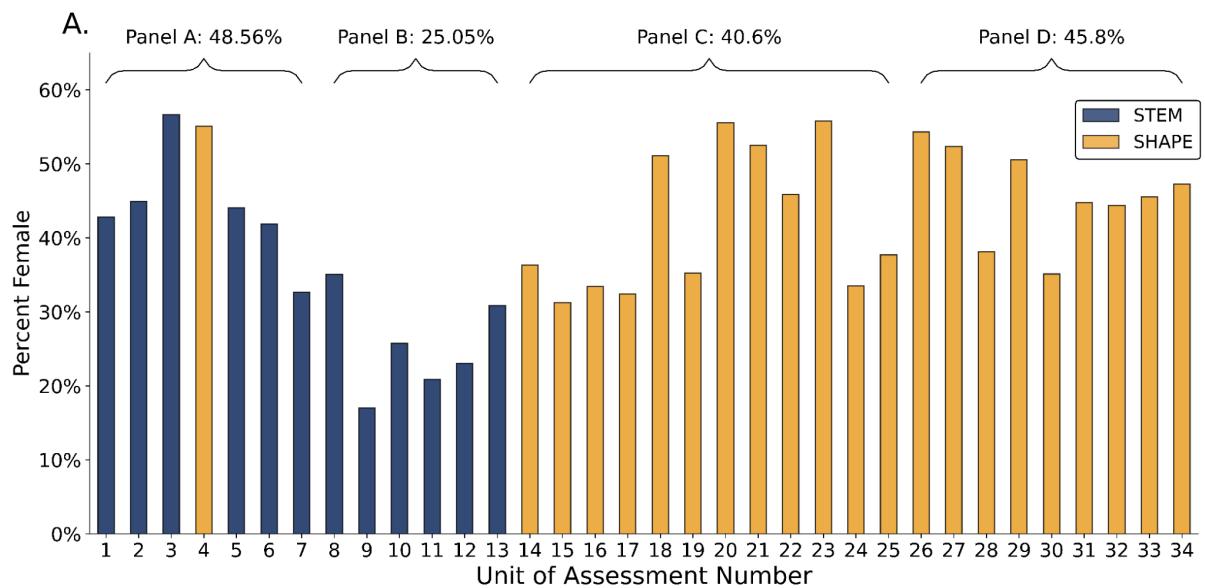


Figure 17. Fraction of female to male authors of Impact of Case Studies by Panel, UoA, differentiated by STEM and SHAPE

The Humanities Panel D has a much more uniform representation of gender equity and female ICS authors across the UoA, 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 impression from 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

We further supplement this bibliometric analysis with responses to our survey. Table 6 provides additional information on the gendered distribution across the two main SHAPE Panels, indicating that the respondents from Panel D – the Humanities – were more predominantly female than male in comparison to Panel C (the Social Sciences).

We can see that the panels are mostly filled with older academics having received their PhDs on average about 26 years prior to the REF2021 assessment. The survey respondents are fairly gender-balanced with humanities being majority female (52%) and social sciences being majority male (54%). The ethnic composition of panel members also lacks diversity but it is also likely a reflection of the lack of diversity at the University level as well, which warrants further research.

	Humanities	Social Sciences	Total
Year receiving PhD	1997.57	1995.29	1994.97
Gender			
Female	51.69%	41.50%	46.04%
Male	46.61%	53.74%	50.57%
Prefer not to say	1.69%	4.76%	3.40%
Ethnicity			
Asian or Asian British	2.54%	6.80%	4.91%
Black, Black British, Caribbean or African	0.00%	0.68%	0.38%
White	92.37%	87.07%	89.43%
Other	5.08%	5.44%	5.28%

Table 6. Characteristics of panel members that answered the questionnaire, broken down by Social Science Panel (Panel C + UOA4) or Humanities Panel (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 including added value generated through our analyses and results.

Our REF2021 dashboard will communicate 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. Target audiences for the dashboard include funders of academic research, policy makers (local to national levels), universities (from administration to academics and students), learned societies, and businesses. The dashboard (Fig. 18-20) brings together qualitative and quantitative elements of this project to provide compelling narratives along with supporting evidence of SHAPE impact. Users can drill down into specific topics that spark their interest to explore where and how impact was generated within that topic.

This snapshot shows results for all SHAPE ICS including the top funders, proportions of ICS by unit of assessment, geographic distribution of UK institutions submitting ICS, and the countries impacted

by the research. These results immediately show the global impact of UK research in SHAPE disciplines. Note: Some text elements of the dashboard are still in development.



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 ICS within that topic. The topics are as per our large language model which identified 83 distinct topics from ICS textual content (see Table 2), assigned each ICS to one or more topics. Results are displayed in five panels for the topic that has been selected (Fig. 18).

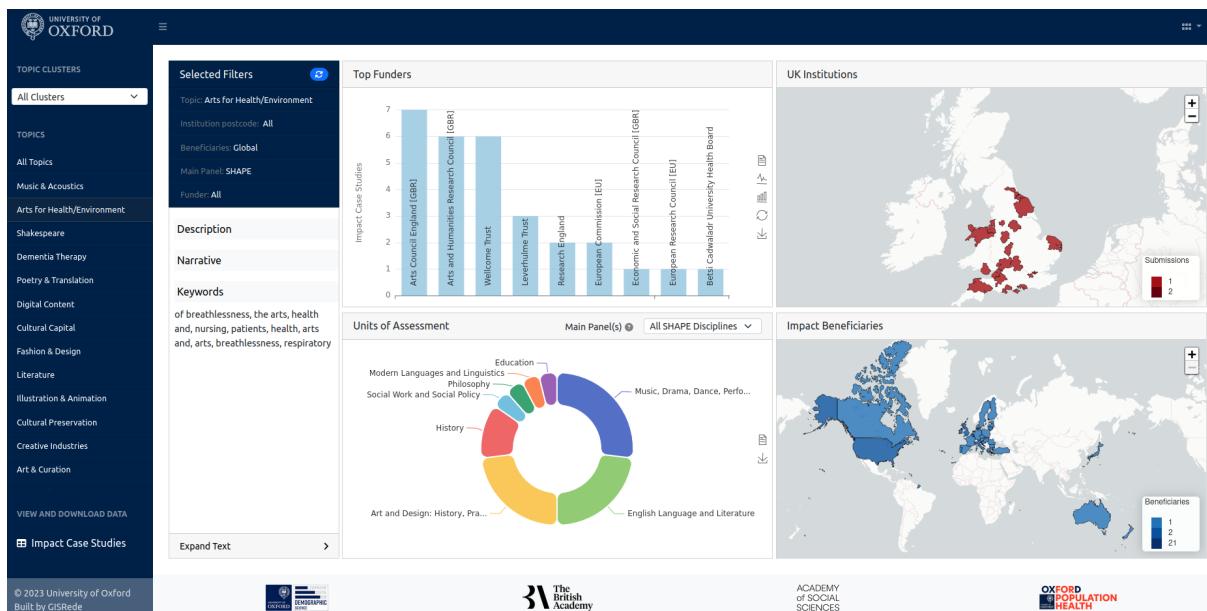


Figure 19. Results for ICS within the ‘Arts for Health and Environment’

This topic shows the top funders, units of assessment evaluating these ICS, and the geographic distributions of submitting institutions and beneficiary countries. This topic includes ICS across

disciplines from History to Literature. We see impact in this topic primarily focused in Europe, North America, and Australia.

The Topic Narrative panel will contain a description of the topic along with a narrative to provide compelling examples of impact case studies in the topic. The topic descriptions provide a concise summary of the types of ICS 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 impact case studies (ICS) in the selected topic and the number of ICS funded by each. This is intended to highlight differences in funding priorities among funders and to emphasise the number of ICS that were unfunded, in which case we may reasonably expect these ICS 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 (Fig. 20).



Figure 20. Results for ICS across all topics that were funded by the British Academy

These results show BA funding spread evenly among UK institutions and SHAPE disciplines, with impacts in almost every country globally. The other funders shown in these results are those who most commonly co-funded underpinning research with the BA.

The UoA panel provides a count of ICS 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 UoA's within a specific main panel (e.g. 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 ICS 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 ICS 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 ICS 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 ICS 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 (Fig. 26). This includes the original columns from the REF database and also the added-value columns that we generated from bibliometric analyses and natural language processing. 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).

Impact Case Studies																		
Show 50 entries <table border="1" style="float: right; margin-top: -10px;"> <tr><td>title</td><td>ics_url</td><td>institution_name</td><td>inst_postcode</td><td>unit_of_assessment_name</td><td>summary_impact_type</td><td>countries_iso3</td><td>main_panel</td><td>unit_c</td></tr> </table>										title	ics_url	institution_name	inst_postcode	unit_of_assessment_name	summary_impact_type	countries_iso3	main_panel	unit_c
title	ics_url	institution_name	inst_postcode	unit_of_assessment_name	summary_impact_type	countries_iso3	main_panel	unit_c										
Arts and Health Eco System of North Wa...	https://results2021.ref.ac.uk/	Wrexham Glyndŵr University / Prifysgol...	LL11 2AW	Art and Design: History, Practice and ...	Societal	['GBR']	D	32										
Arts for Health: increasing wellbeing ...	https://results2021.ref.ac.uk/	Manchester Metropolitan University	M15 6BH	Art and Design: History, Practice and ...	Societal	['GBR', 'USA', 'AUS', 'LTU', 'JPN']	D	32										
Arts, Health and Wellbeing	https://results2021.ref.ac.uk/	Norwich University of the Arts	NR2 4SN	Art and Design: History, Practice and ...	Societal	['GBR']	D	32										
KIMA: Improved wellbeing through parti...	https://results2021.ref.ac.uk/	Bournemouth University	BH12 5BB	Art and Design: History, Practice and ...	Societal	['GBR']	D	32										
Misbehaving Bodies: encouraging collab...	https://results2021.ref.ac.uk/	University of Oxford	OX1 2JD	Art and Design: History, Practice and ...	Societal	['GBR']	D	32										
Sex, Cancer and Art Textile Activism: ...	https://results2021.ref.ac.uk/	Staffordshire University	ST4 2DE	Art and Design: History, Practice and ...	Societal	['GBR']	D	32										
Applied Theatre for Children in Hospital	https://results2021.ref.ac.uk/	Newman University	B32 3NT	Education	Societal	[]	C	23										
Changing approaches to breathing and b...	https://results2021.ref.ac.uk/	University of Durham	DH1 3LE	English Language and Literature	Cultural	['GBR']	D	27										
Ecolingistics and its impact on peopl...	https://results2021.ref.ac.uk/	University of Gloucestershire	GL50 2RH	English Language and Literature	Societal	['GBR', 'TUR', 'SVN', 'ITA']	D	27										
Enriching Ecological Understanding and...	https://results2021.ref.ac.uk/	The University of Liverpool	L69 7ZX	English Language and Literature	Societal	['GBR']	D	27										
Improving cultural understanding of Vi...	https://results2021.ref.ac.uk/	University of Oxford	OX1 2JD	English Language and Literature	Cultural	['GBR', 'NZL', 'IRL']	D	27										
Narrative and voice in health and soci...	https://results2021.ref.ac.uk/	The University of Sheffield	S10 2TN	English Language and Literature	Societal	[]	D	27										
Using geopolitics to enhance community ...	https://results2021.ref.ac.uk/	University of Keele	ST5 5BG	English Language and Literature	Cultural	['GBR', 'CAN']	D	27										
Landscapes and Gardens: Using Historic...	https://results2021.ref.ac.uk/	University of Chester	CH1 4BJ	History	Societal	['GBR']	D	28										
New Histories of Homelessness in Moder...	https://results2021.ref.ac.uk/	The University of Birmingham	B15 2TT	History	Cultural	['GBR']	D	28										
Surgery & Emotion: Using historical re...	https://results2021.ref.ac.uk/	Rochester University	SW15 5PU	History	Societal	['GBR']	D	28										
Re-thinking childhood and well-being in...	https://results2021.ref.ac.uk/	University of Exeter	EX4 4QJ	Modern Languages and Linguistics	Societal	['GBR', 'AUS', 'IRL', 'GBR', 'GBR', 'GBR']	D	28										

Figure 21. The enhanced REF database viewed from the dashboard after selecting the topic “Arts for Health and Environment”

This retrieves a downloadable filtered database of ICS 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 through exploring the dashboard. In this way, we hope to leave a lasting impression on the users and send them away with tangible evidence of their findings from interacting with our results.

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 (ICSs), 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 reinforce our understanding but also found surprising, enlightening, and unexpected pockets of impact.

SHAPE impact is multifaceted and warrants new impact type categorizations

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. The Arts and Design
2. Archaeology and Exhibits
3. Education and Teaching
4. Business, Economics and Management
5. Employment
6. Crime and Exclusion
7. Family and Gender
8. Governments 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 convention (Political, Economic, Societal, Technological, Legal, and Environmental) widely used in UK

Government policy development, with the addition to Health and Cultural impact types (REF2021, 2022b).³

“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 well. 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, who 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, and is ubiquitous across most ICSs. ICSs contributed to profound societal changes from changing public understanding and attitudes about hate speech and misinformation to transforming thinking and operational aspects of entire local, national and international institutions. Societal changes to institutions were innumerable such as changing NHS processes and practices to increase efficiency and lower costs, enhancing productivity across multiple industries, 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 virtually 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 to 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 virtual 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 and 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

³ 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 multi-disciplinary

As noted above, impact went well beyond the original question that was asked how research influenced people, the economy, policy and society. Rather, it had vast cultural, political, health, legal, science, technology and environmental impacts. SHAPE drives preconceived expectations of impact in the arts, design and galleries 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 slavery and their link to modern slavery.

Another striking finding of our analysis is that *SHAPE impact unequivocally reaches far beyond any preconceived boundaries or the social, economic and cultural*. The impact of SHAPE research has transformed health and medical science but also 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 change and technological developments in health, medical science and also towards net zero and more sustainable environments. These ICSs have revealed multiple industrial and business applications, patents, and spin-outs emanating from SHAPE research, which ranged from educational software to Netflix translations and behavioural or performance art driven clinical therapies.

SHAPE research is also highly 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), 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 substantially 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. The funders listed for ICS funded research are:

- Social Sciences (Panel D): 40.6% ESRC, 24.5% European Commission, 7.5% EPSRC, 7.3% AHRC, 5.2% BA and 5.1% Leverhulme Trust
- Humanities (Panel C): 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

A caveat is that funders differ substantially in the amount allocated in their overall portfolio spend on research funding, with some comparatively smaller funders emerging as core drivers of SHAPE impact.

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 (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 and reflection from narrative interviews and experts in the area with lived experience of evaluating or producing impact cases for REF2021. Second, by adopting a generative AI machine learning approach, we were able to more systematically reveal key topics where impact has occurred across SHAPE to highlight and celebrate the depth and diversity. 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 allowed us to produce accompanying information about the research underpinning the REF, such as gender of authors, interdisciplinarity, 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), 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 UoA, and geographical impact in the UK and globally.

But 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 University-based research and impact. The selection is related to the fact that impact must be linked to published research that was deemed sufficient quality to be submitted to the REF, that impact met the pre-defined criteria, namely that the impact needed to have taken place within the

previous 5 years 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 preexisting 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 submitting. Large UoA's 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 categorization of our ICSs into larger themes and subtopics, we recognize that some case studies or groups of them do not easily fall into one of these categories. Readers may find some topics or ICSs that they feel are misclassified, but we note that we took a uniform approach to position them in the category where they matched with the highest probability via outputs that have been extensively manually reviewed. In many situations, ICSs were highly multi-disciplinary and straddled sometimes even more than three or four substantive topics and could have therefore fallen within another grouping. Another caveat is that the REF2021 case studies are taken at face value. For the aim of this report we did not include an analysis of how the REF is perceived (Manville et al., 2021; Murphy & Sage, 2014) or a broader evaluations of the REF, such as the influential RAND report assessing REF2014 (Manville et al., 2014) and REF2021 (forthcoming). We will, however, explore this in future research.

5.3 Final Reflections

The REF has been the subject of considerable analysis and scrutiny. The REF exercises have sometimes been positioned as controversial on the basis of costs, stress for those involved (Arnold et al. 2018; Watermayer & Derrick 2022), and their unclear efficacy. REF2014 cost nearly £250 Million, causing some to question its cost-effectiveness (Bornmann et al., 2019). Although there are critiques of the REF’s effectiveness in achieving its stated mission (e.g., Bornmann et al., 2019; Pinar & Horne, 2022; Pinar & Unlu, 2020; Reichard et al., 2020; Thorpe et al., 2018), for SHAPE researchers it offered the platform to showcase and present the incredible impact of their research.

This report revealed a dizzying array of the impact SHAPE, some surprising and others continuing along a steady path to strengthen the world that we live in. We conclude with the words of an esteemed STEM Panel Member who we interviewed:

*“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 humanities.”*

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Table 2. SHAPE Impact Clusters sorted by main and sub-topic clusters

Main Impact Cluster (human in the loop cluster)	Sub-topic 1 (hierarchical clustering)	Sub-topic 2 (BERT cluster number)
1. The Arts and Design	Cultural capital, art, literature, theatre	3. Music and acoustics 64.Theatre as societal and educational tool 60. Cultural capital, art and theatre 36. Shakespeare, theatre
	Literature, poetry, authors	46. Literature, poetry, performance 76. Individual authors, education, public understanding
	Immersive and virtual reality, digital content creation	57. Digital content creation, animation, immersive technology and cinema, virtual reality
	Textiles, fashion, animation, comics	66.Textile, fashion, design 80. Comics, cartoons, animation, illustration
	Dance, dance/music therapy	40. Dementia therapy (art, music, film, participation)
2.Archaeology and Exhibits	Cultural exhibits, antiquity, conservation	10. Cultural exhibits, Conservation, Influence of antiquity
	Archaeology, heritage, history	23. Archaeology, heritage, history 59. Cultural property protection, safeguarding heritage, endangered cultures 68. Co-production heritage, Oral histories, place-making 75. Public archaeology, increasing public understanding history 77. Forensic exhumation, graveyards, mass violence
	Participatory arts	30. Participatory art, audience engagement, local communities
	Film, cinema, documentaries, creative industries	11. Film, cinema, creative industries
	Art, gallery, museum, curation	12. Art, gallery, museum, curation
3.Education and Training	Military history, commemoration, Holocaust	27. Military, history, commemoration 21. Holocaust, Jewish history, education
	Theology, clergy	35. Theology, clergy, religious education
	Teaching, teachers, educational tools	7. Teaching and teachers, quantitative educational tools 52. Literacy, reading, dyslexia
	Language acquisition, preservation, multilingualism	9. Language learning, linguistics, Welsh language, culture 50. Gaelic acquisition, preservation
	Educational policy, equity, access, social mobility	29. Fair access, equity, social mobility, Higher Education, schools, educational policy

Main Impact Cluster (human in the loop cluster)	Sub-topic 1 (hierarchical clustering)	Sub-topic 2 (BERT cluster number)
4. Business, Economics and Management	Productivity, SMEs, efficiency	2. Productivity, SMEs, entrepreneurs, Industry, efficiency 65. Public procurement and competition, sustainable development
	Banking, finance, debt	22. Banking, finance, Retirement financing 56. Financial control, debt, financial exclusion, risk
5. Employment	Employment conditions	13. Employment conditions
	Wages, benefits, taxes, auditing	16. Minimum wage, regulation, benefits, tax evasion/compliance, auditing
	Employment, disability, inclusion	25. Employment, disability, inclusion, Dementia therapy
6. Crime and Exclusion	Crime, prisons, violence, forensics, gambling, hate speech	1. Crime enforcement, violence, rape, abuse, prisons, prisoners, judicial proceedings, safeguarding, children, vulnerable, forensics, gambling 39. Hate crime, hate speech 48. Torture prevention, lie detection 70. Drug policy, alcohol harms, psychoactive substances
7. Family and Gender	Care, support, family, children	4. Care efficiency and prevention, parental & early childhood care, excluded youth, child empowerment
	Safeguarding children, women, sexual health	15. Protection children, domestic abuse, Sexual health, HIV
	Reproductive rights	42. Abortion, fertility, hormonal pregnancy tests, gamete & embryo donors, egg freezing, ethics
	Feminism, Gender Representation	18. Feminism, activism & women's histories, Gender representation 54. Female imagery/expression, gender stereotyping 81. Gender-based violence, gender equity, female empowerment
	Sexualities	58. Sexualities, LBGTQ+, history, arts, policy, activism
8. Governments and Law	Democracy, representation, electoral integrity, voter experience	38. Democracy, citizen's assemblies, representation 64. Electoral integrity and registration, voter experience, polling
	Brexit, trade, tariffs, constitution, political parties	14. Brexit, hard-border Northern Ireland, Political parties, politics Brexit - Trade, tariffs, legislation, Constitution, Parliament
	Digital, surveillance, privacy, AI, cybersecurity	24. Digital, surveillance, privacy, AI 63. Cybersecurity, safeguarding vulnerable, money laundering
	Misinformation, propaganda, impartiality, journalism	28. Misinformation, propaganda, impartiality, communication, journalism, media literacy
	Immigration, refugees, asylum, hostile environment, integration, migration policy	8. Immigration, refugees, asylum 33. Immigration, refugees, asylum 37. Hostile environment, social integration migrants, migration policy

Main Impact Cluster (human in the loop cluster)	Sub-topic 1 (hierarchical clustering)	Sub-topic 2 (BERT cluster number)
	Humanitarian, peacekeeping, human rights, war crimes, terrorism	21. Peacekeeping, humanitarian, human rights, war crimes, atrocities, genocide 45. Indigenous rights, water politics, environmental justice 17. Conflict, Terrorism, Extremism: Northern Ireland, Islam, Middle East, War histories 43. Northern Irish studies
	Slavery (legacy, modern), colonialism	19. Slavery, legacy, Colonialism, slavery 85. Modern slavery, human trafficking
9. Health and wellbeing	Sports, exercise, obesity, nutrition, performance, coaching, therapy	0. Coaching, Athletics, Sports, Athletes, endurance, Psychiatric therapy. Trials, therapy, Activity, diet, Exercise, food, health
	Healthy diet, obesity, food marketing and security, eating disorders, social media	49. Healthy diet, sugar, obesity, food marketing, food insecurity 71. Eating disorders, social media, body confidence
	Detection, diagnosis, treatment	32. Detection, diagnosis, treatment 34. Autism, diagnosis, treatment 44. Mindfulness, meditation, psychological health, wellbeing 67. Mental health support, training 55. Stroke, cystic fibrosis, care, treatment 73. Suicide, self-harm risk, prevention 86. Death, bereavement
	Healthcare efficiency and prevention	6. Healthcare efficiency and prevention 47. Healthcare interventions, data and evidence based 53. Trials, guidelines, NHS policy, cost-effectiveness 69. Social and health care funding, social prescribing 70. Malaria, infectious disease, low resource settings, global risks 10. Arts, culture and health

Main Impact Cluster (human in the loop cluster)	Sub-topic 1 (hierarchical clustering)	Sub-topic 2 (BERT cluster number)
10.Sustainability and infrastructure	Sustainability, ecosystem conservation, renewable energy, climate change	5. Ecosystem conservation, Sustainability 26. Renewable, clean, low carbon energy, climate change, decarbonisation 74. Climate change policy, public discourse
	Biodiversity, agriculture, food production and systems	41. Biodiversity, agriculture, farmers, sustainability 61. Food production, systems, sustainability
	Housing, affordability, market, innovation, energy homelessness	8. Local urban, housing, housing policy, housing market, homelessness 72. Housing innovations, energy efficiency, ventilation, indoor air quality
	Emergency, disaster preparedness, road safety	51. Emergency, disaster preparedness, management 82. Road safety, driver safety 62. Urban infrastructure, mobility, cycling